**PROFILE of Professor Banks**

**Ferdinand E. Banks (Uppsala University, Sweden), performed his undergraduate studies at Illinois Institute of Technology (electrical engineering) and Roosevelt University (Chicago), graduating with honors in economics. He also attended the University of Maryland and UCLA. He has the MSc from Stockholm University and the PhD from Uppsala University. He has been visiting professor at 5 universities in Australia, 2 universities in France, The Czech University (Prague), Stockholm University (?), Nanyang Technical University in Singapore, and has held energy economics (guest) professorships in France (Grenoble), Hongkong, and the Asian Institute of Technology (Bangkok). The main portion of his military service was in Japan (infantry) and Germany (artillery), and he was employed for one year in the engineering department of the U.S. Navy at the Great Lakes Naval Training Station (Illinois). He has also been a lecturer in mathematical and development economics in Dakar (Senegal) for 15 months, and macroeconomics at the University of Technology in Lisbon (Portugal) for one term. He was an econometrician for UNCTAD (United Nations Commission on Trade and Development) in Geneva (Switzerland) for 3 years, fellow of the Reserve Bank of Australia when visiting professor of mathematical economics at the University of New South Wales (Sydney) for one academic year, and later taught at Sydney University of Technology for 2 months under the auspices of the University of New England. He was a consultant for the Hudson Institute in Paris, and a systems analyst and applied mathematician for a consulting firm in Chicago. He has published internationally 12 books, to include 2 energy economics textbooks and an international finance textbook, and 200+ articles. According to GOOGLE, his book ENERGY AND ECONOMIC THEORY will be published this year (2014).**

**ENERGY ECONOMICS: A MODERN FIRST COURSE©**

**By Professor Ferdinand E. Banks**

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 **0. FINAL COMMENTS OF PROFESSOR BANKS**

**A comment on questions and exercises.**

**With the exception of the brilliant books *Mathematical Economics*, by R.G.D Allen, and the book *Microeconomic Theory* by James M. Henderson and Richard E. Quandt, I do not remember much about the questions and exercises in the many textbooks that I have taught from. There are questions and/or exercises in my other textbooks, and some day I might have questions and exercises in a future version of this book, but not now. Rather than having readers pouring over questions and exercises, I suggest that they read every chapter several times, and if possible discuss the contents with their friends. I have tried to keep this book relatively simple, and for the most part I have succeeded – or so I have been told – but unfortunately there are often bad pedagogical surprises possible when involved with writing projects of this kind, even though in the long run I should be able to produce the kind of book I should have written when I began to write books on energy,**

**0. EXECUTIVE INTRODUCTION**

**Following this introduction, there are 8 comparatively non-technical expositions (= chapters) dealing with energy economics. Think of this book as ENERGY ECONOMICS 101! Portions of most of these chapters have been published, and there is some repetition, but repetition doesn’t bother me. This is because I want to assist in imparting *fluency* about the most important energy economics topics, especially to beginners! There are only a few diagrams, and far less mathematics than in my previous energy economics textbooks (2000. 2007, 2014), because my aim is to examine, simplify and repeat. Too much mathematics gets in the way of understanding, because as both Albert Einstein and Enrico Fermi noted, mathematics is a lovely tool, but not when overindulged in!**

**Some explanation is necessary where the title of this book is concerned. My other 3 textbooks are sometimes advertised as books for the first course in energy economics, but often they are more suitable for intermediate courses. Yes, several times below you will encounter (in appendices) mathematics that would be out of place in first-year presentations, but my intention is for this book to be referred to as Energy Economics 101. Moreover, if you encounter a problem while reading this book, *move on* and come back to the problem later after you have become familiar with the rhythm of the topic.**

**During the last few years, this teacher has found irresistible the concept of students having some simple energy economics reading at hand when on a bus or train, or for that matter sitting in one of Uppsala University’s marvellous student clubs on a Friday or Saturday evening, waiting for the music to begin. Here I can recall one of my colleagues in the *Palais des Nations* in Geneva (Switzerland) who often had an economics textbook nearby, but who hardly ever read it. When I asked why he read it so seldom, he answered that it was too difficult, but having it within arms reach made him feel good, and also impressed his superiors. I want *all* students, *all* readers to be able to answer, partially or otherwise, *most* of the questions they receive about energy economics at any hour of the day or night, and if they cannot answer comprehensively, they at least give the right impression. In the briefing students receive on the first day of my course in energy economics (as was once the case with my courses in financial economics), it is made clear that if they prefer a passing to a failing grade, the expression “I don’t know”, followed by silence, is mostly taboo. Of course, what I am always willing to accept is “I don’t know because your explanation is not clear, Professor Banks. Would you explain again, and please keep explaining until I get the message.”**

**Everyone will not agree with everything in this book, but after you begin to read these 8 chapters, I hope that you will not ask me or anyone else to believe that OPEC is going to collapse, or nuclear reactors are no longer being constructed, or speculators caused the oil price escalation in 2008. Remember, the purpose of this book is to help you to *shine*, by which I mean to convince friends, neighbours and anybody else that your knowledge of these highly relevant topics identifies you as together, today, world class. I want to help all readers to become stars.**

**1. IMPORTANT NUMBERS AND CONCEPTS**

**INTRODUCTION**

**Most of the numbers and concepts that you will become acquainted with in this chapter will also be brought to your attention later in the book. But the point now is to take the same approach as John von Neumann, who by the time he reached voting age had almost every number and concept stored in his brain that he thought he would need later in life. What I hope that you and my students will be able to do by the end of this course is to be capable of providing at a moment’s notice a reasonable fraction of the numbers and concepts in this chapter and book, and to do so at any hour of the day or night. In addition to impressing friends and neighbors, that kind of performance should put them in a position to learn more about the subject of energy economics than almost everybody who might come their way, but who have not read this introductory book.**

**To begin, think about a furnace in the basement of your home, into which you have been shoveling coal, and which will provide you and the other residents of the house with heat. There is a fire in the furnace, and the thermometer on the side tells you how hot (or cold) the interior of the furnace is. Unfortunately, the reading on the thermometer is only in Fahrenheit degrees (F) or Centigrade (Celsius) degrees (C), but not both. This annoyance can be easily dealt with, because the formula for turning one of these into the other is F = (9/5)C + 32. In other words, if C = 0, then F = 32, while if C = 100, then F = 212. Many of you are familiar with these numbers. For example C = 0 and F = 32 have to do with the temperatures at which water freezes. Now, going the other way, C = (5/9)(F – 32), and you can use this opportunity to say something clever about how you obtained this equation, and its significance for the boiling of water.**

**At this point there might be trouble, because while you know about temperatures, you probably don’t know anything about the energy content of fuels. In this book that energy content is measured in *British Thermal Units (Btu),* although when you studied physics or chemistry, *Joules* might have been used. In any event, if you look at a container of oil, natural gas, coal, or for that matter wood chips, you should know that it has a certain energy content, and a valuable unit for that energy content might be Btu. For instance, if the container was a barrel filled with oil, the average energy content is 5,800,000 British Thermal Units (= 5,800,000 Btu). You should not expect that it will be exactly 5,800,000 because oil from different deposits has different characteristics.**

**For *bituminous* coal – which is usually the preferred kind of (thermal) coal for burning in household furnaces or raising steam in electricity generating processes – the average energy content is about 12,600 Btu per pound, while for natural gas the average energy content is 1035 Btu per cubic foot (= 1035 Btu/ft3). To keep things simple, it is often assumed that the energy content of natural gas is 1000 Btu/ft3. (There is also metallurgical coal, which is used in e.g. processes for making steel.)**

**Now it is likely that somebody is in trouble, because in addition to dealing with Btu, they must handle units like pounds (instead of e.g. kilograms), and cubic feet instead of e.g. cubic meters. Put another way, saying that a barrel containing oil has an energy or heating value of 5,800,000 Btu should not cause any anxiety, because it is easy to picture the oil in a barrel having a certain heating value, but how did ‘pounds’ and ‘cubic feet’ get into this discussion. The answer is not difficult, but it requires more numbers, since the basic problem is that feet (and inches), and pounds are used in some countries or parts of the world, while meters and kilograms are used elsewhere.**

**THE LOGICAL NEXT STEP: Numbers, Diagrams and Theories**

**To begin, a pound is 0.453 kilograms, and since a kilogram is 1000 grams, a pound is 453 grams. Happily, grams will not play a meaningful role in this book, and so there is no point in turning grams into pounds, but it can be noted that a kilogram is 2.205 pounds! Continuing, a meter is 39.37 inches, and since 12 inches are a foot, a meter is 3.28 feet. A *square* meter (3.282) is therefore 10.76 square feet (= 10.76 ft2). What is a cubic meter?**

**In my school on the South Side of Chicago, I was taught that a ton was 2000 pounds, but this should have been called a *short ton*. When dealing with coal the ton we are mostly interested in the *metric ton* (= tonne = t), and this is 2,205 pounds. Kilograms can be obtained here by dividing by 0.453. Now examine the following:**

 **Prefix Symbol Power Meaning Example**

 **Kilo k 103 thousand kW (kilowatts)**

 **mega M 106 million MW (megawatts)**

 **giga G 109 billion GW (gigawatts)**

 **tera T 1012 trillion TW (terawatts)**

 **peta P 1015 thousand-trillion PW (petawatts)**

 **exa E 1018 million-trillion EX (exawatts)**

 **The only peculiarity in the above is the G, although occasionally B is used for billion. Now I shall write out ten relationships that you can think about.**

1. **1 barrel of crude oil weighs about 0.136 tonnes (= 0.136t), so 1t = 7.35 barrels**
2. **1000 ft3 of natural gas = 28.3 cubic meters.**
3. **3412 Btu will produce 1 kWh of electricity (in e.g. a laboratory or perfect setting).**
4. **1 tonne of coal has a heat/energy content of approximately 27,763,000 Btu.**
5. **1000 ft3 of natural gas has a heat/energy content of about 1.035 x 106 Btu.**
6. **On average, 1 tonne of coal weighs about as much as 4.8 barrels of crude oil.**
7. **1000 ft3 of natural gas has an average heat/energy content of 0.178 barrels of crude.**
8. **1000 kilowatt hours of electricity can be obtained with 0.588 barrels of crude.**
9. **1 centimeter = 0.032808 feet = 0.3937 inches.**
10. **1 foot = 0.3048 meters; 1 inch = 2.54 centimeters; 1 kilogram = 2.204622 pounds**

**The above numbers permit a simple exercise. One thousand cubic feet (= 1000 cf = 1000 ft3) of natural gas has an energy content of approximately 1,000,000 Btu, while a barrel (b) of oil has an energy content of about 5,800,000 Btu. (These are averages!) Observe what we can do with these numbers. Recently natural gas in the U.S. cost about $4/Mbtu (= 4 dollars per million Btu), and oil was $100/b. Thus, 5,800,000 Btu of natural gas is equivalent to an oil price of (5,800,000/1,000.000) x 4 = $23.2. (EXERCISE: Find out the *present* price of natural gas and oil, and obtain the cost of natural gas as compared to oil. Then say something about a possible U.S. energy renaissance, given estimates of the amount of natural gas in the U.S. due to the so-called shale ‘boom’.**

**Notice in 7 and 8 the term ‘crude’. This means crude oil, or oil that has not been processed into *oil products* (like gasoline, fuel oil, etc), It is also useful to know that 1 barrel of ethanol is equal to 0.57 barrels of oil, and 1 barrel of biodiesel is equal to 0.86 barrels of oil. (EXERCISE: Use GOOGLE to find out what ethanol and biodiesel are.)**

**The assumption (in 3 above) that 3412 Btu (of some fuel) will provide a *kilowatt hour* of electric energy is something that I have never had a problem remembering, but unfortunately that is true only when generation efficiencies are 100% (as might be the case in a perfect laboratory). Otherwise, more than 3412 Btu are necessary to obtain a kilowatt hour of electric energy, and the amount – which may be as high or higher than 10,000 Btu per kilowatt hours – is called the ‘*heat rate’*. (NOTE: per kilowatt hours, and not per kilowatt!) As you will find out later, kilowatt is *power*, and kilowatt hour is *energy*. My book ENERGY AND ECONOMIC THEORY (2014) goes into detail on this.**

**In the book by Professor John Fisher (1974), he considers the matter of the heat rate for hydroelectricity, which often creates a problem in the classroom. The value he chooses is 10,500 Btu, which he assumes is the heat rate in a typical power station, and thus the ‘opportunity energy cost’. What does that mean? It means that *theoretically*, if it requires more than 10,500 Btu to obtain a kilowatt hour in a hydroelectric installation, then it probably – *probably* – makes economic sense to obtain that kilowatt hour in a power station that uses oil, or coal or natural gas or uranium as an input, and forget about hydro. I was stationed next to a Dam in Japan for a few months, and had I been aware of this issue, I might have asked the Dam manager for some information. Might!**

**Next we can consider the *Second Law of Thermodynamics*, first formulated by the French artillery officer Sadi Carnot in 1824 (and later termed *Carnot’s Principle)*. This theory states that the maximum amount of work that can be obtain from a certain amount of heat depends only on the temperature of the heat, or T, and the temperature of the surroundings T0, where the temperatures are turned into *absolute values* by adding 273. The relevant equation here is (T – T0)/T = E\*, where E\* is efficiency. As an**

**example, assume that water in a boiler has been heated by a furnace to 555degrees (Celsius, or centigrade) and the temperature in the ‘sink’ (into which the steam from the boiler flows is 55 degrees celsius. *Carnot Efficiency* can be calculated as [(555+273) – (55+273)]/(555+273) = 0.603 = 60.3%. Not very impressive is it, despite the difference between temperatures, although I don’t mind admitting that in terms of importance, Carnot’s equation reminds me of Einstein’s famous E = mc2.**

**In continuing, we shall examine a diagram that often seems to be a problem**

Load

p

1200

2400

q (TWh)

Base Load

Intermediate

 Load

Peak Load

Hydro

Nuclear

Coal

Gas, Oil, etc

(a)

(b)

D

Figure 1

S (short run

 supply)

**First of all, the figure on the right is useless. Try to remember that the next time you see it in your classroom, or in a magazine such as RUNWAY. As for the (pedagogically useful but not very realistic) diagram on the left, which shows the load on a certain line during 24 hours, the expression *intermediate load* might be superfluous, and some of it could be considered a part of the peak load, while the rest of it is a part of the base load. Here we can turn to GOOGLE for the best definition: baseload power plants are production facilities used to meet some or all of a given region's *continuous* energy demand, with the emphasis on *continuous* that is mostly carried by nuclear and/or coal. In Figure 1(a) the base load is the maximum value of the load that is ALWAYS on the line, and everything else is the non-base load. In Sweden the base load is mostly *carried* by nuclear and hydro, and the peak load by hydro or imported power.**

**Something to always remember is that in many countries, *fast-start* hydro and natural gas equipment deal with the peak load, and *more* important, equipment must always be available to satisfy loads that might be placed on the line. Overloaded electric lines are dangerous, so turn to GOOGLE again and peruse *overloaded electric lines*!**

**The algebraic argument presented below may look impressive, but this is not necessarily so. There is nothing inherently difficult with the issue that we are taking up here, and in the more analytical portion of this chapter, instead of a day (24 hours), I consider a year (= 365 days). The peak load is sometimes called the *maximum* load!**

**As you may know, it gets cold in Sweden in the winter, but Swedish engineering is capable of dealing with this annoyance. Sometimes though the temperature touches or exceeds record lows, and when this happens you do not call in the engineers and tell them to increase the size of the radiators. Instead, you might purchase a small item that in Swedish is called a fläkt, *which is ‘driven’ by electricity and blows out hot air*. ‘Blower’ is one of the translations, but the basic point here is the emitting of hot air.**

**The same logic applies in Figure 1a. If you need extra heat for a party in your ski lodge, do not do not buy a nuclear reactor. Buy a fläkt or two. (What is the word for fläkt in your native language?) What about the situation in a university town such as Uppsala, which contains a number of student clubs where there are often large parties or dances on the weekends? The ‘extra’ (= e.g. *non-base*) electric load that is involved could be dealt with using electric generators in club basements, although an optimal arrangement might be for it to be handled by a generator burning natural gas at the local generating station, which is on ‘standby’ to supply large unexpected loads.**

**Now for some algebra based on the following simple diagrams, with ‘O’ as the ‘origin’ (or intersection) of the horizontal (t) and vertical L) axes.**



 **Figure 2.**

**Figure 2(b) shows two *screening* *curves* that involve two types of equipment, X and Y. (If you want more information about screening curves, examine the elementary book by Professor Fisher (1974).) If the base load is constant at *unity* (= 1), but the peak load *area* is as in Figure 2(c), where the entire load (base+peak) is constant at 2 for time t”, then it can be shown by some simple algebra of the kind presented below that the *peak* is carried by Y. But if it is as in Figure 2(d), where it is also constant at 2, but must be carried for a time t’. then some algebra indicates that the *entire load* (base + peak) is carried by X, which is clearly (capital intensive) equipment that is generally associated with only the base load. In case you encounter the expression *merit order* – which is the issue here *– it is fundamentally about the cost and correct deployment of equipment..***

**As for the *load curve* in Figure 2(a), that figure is *not* related to the other three diagrams, but it has a pedagogical value. While O-LT is a base load (in that it is on the line for the entire period under discussion), and O–L(0) is an unambiguous peak load according to the diagram, it may be necessary to introduce the expression *intermediate* *load* for all or a part of LT-L”, and usually with some ambiguity about what kind of equipment should carry this part of the total load. For instance, In Figure 2(d), while we might identify the smaller rectangle as the *peak load area*, with a constant peak load, the cost situation is apparently such that the *entire* load is serviced by capital intensive equipment. In addition, some readers might feel that rather than identifying a unique peak load – e.g. O–L(O) in Figure 2-(a) – the triangle next to L”–L(0) should be called the peak load. To clarify some aspects of this mystery, some algebra is useful, so that on a cold winter evening in Stockholm or Siberia, you can get your beauty sleep without wondering whether you will have to identify peak or off-peak loads on your next examination, or fret about definitions and exact sizes of generating equipment.**

**As for the algebra, *F* is fixed cost and *v* variable (e.g. fuel) cost. As shown in 2(b), we have a situation where at time t\*, the total costs are equal. Algebraically we write:**

 **Fx + t\*vx = Fy + t\*vy (or) t\* = (Fx – Fy)/(vy – vx) (1)**

**Next, assume that regardless of how things appear in the Figure 2(b), we consider using *only* the X type of equipment to supply the peak load in Figure 2(c). The total cost is then;**

 **TCxx = Fx + Fx + Tvx + t”vx (2)**

**If we had used both X and Y (which is obviously the correct choice):**

 **TCxy = Fx + Fy + Tvx + t”vy (3)**

**The next step is to compare these :**

 **TCxx – TCxy = (Fx + Fy) + t\*(vy – vx) (4)**

**And using (vy - vx) from (1), this can be written as:**

 **TCxx - TCxy = (Fx – Fy)/[(t\* - t”)/t\*] (5)**

**Since Fx > Fy and t\* > t”), the right hand side of (5) is positive, and so TCxx is larger than TCxy. Thus we confirm with some simple algebra that it is *uneconomic* to use only the X type of equipment to service the entire ( base + peak) load, as of course we immediately comprehended if we understood the story being told in Figures 2(b) and 2(c). Furthermore, in this exercise, comparing t” with *any t* enables us to determine, for any load, whether the addition of an extra unit (e.g. kW) of capacity should be X or Y type equipment. To be precise, as long as t\* > t, then Y type equipment should be added, while if t\* < t, then X type equipment should be added. Once again: the issue here is the correct *merit order*, based on cost minimization!**

**Now let me confess that there is something important that I overlooked in the first version of this lecture. The *exact* appearance of the load curve is *relatively* unimportant, and the same is true of the units used for the load: theoretically it doesn’t make any difference if we measure load in kilowatts or megawatts. The thing that is important is where the screening curves intersect. Readers should therefore make sure that they can calculate the values of ‘t’ (=t\*) in the diagrams above where the screening curves intersect. Secondary school algebra is all you need here.**

**I can also present readers with a question on the next examination that I will give in energy economics: Explain why, *without mathematics*, the peak load in Figure 4(d) will be serviced by what is usually thought of as (capital intensive) base load equipment? The answer is – as is always the case in economic theory – that if we used the other equipment, the (variable) cost normally involved in servicing the peak load would be greater than the cost for the additional capital intensive equipment.**

**A few more comments might be useful. With ‘t’ the time that equipment is on the line, then if as above we are thinking about a period of one day, we must have t ≤ 24 (hours), while if we are considering a year then we have t ≤ 8760 (hours). Here we might write in a general sort of way t ≤ T (hours). We might also have the case of a day in which the base load is 1000 kW, which is on the line for 24 hours, but during 8 hours an additional 1000 kW must be generated. The *peak* load is thus 2000 kW, while the *off-peak* load is 1000 kW. (Trivially, the base load plus the maximum value of the non-base load is the peak load, although obviously this can create some algebraic difficulties).**

**Readers who have come this far without feeling frustrated should be very satisfied, but before congratulating yourself go through the above presentation once more. There is often a certain amount of ambiguity in these matters, and I don’t mind saying that you should always have your bunkum detectors available when you are dealing with some of the more complex energy and environmental enigmas. For instance, generally the peak load represents only a small fraction of the demand for electricity, and so it can happen that only a portion of the generating capacity serving a given load is in use. But since the available generating equipment must be able to satisfy the maximum demand that may appear in the system, *capacity* *factors* – the actual number of hours that equipment is operating in relation to hours in a year – for peak load equipment are often quite small. This is unavoidable, and if you need to turn to GOOGLE for more information, the items to examine are *peak loads*, *short* *circuits* and *overloads*!**

**OIL AND MONEY: Futures and Options**

**Earlier versions of this chapter did not include the present section, however some earlier readers – to include the important researcher and my former colleague from the University of New South Wales (Australia), Tom Moder Mozina – believe that this new section is useful for beginning energy economics students, as long as it does not contain any unnecessary math. My favorite futures market story – involving two young financial geniuses named Millicent and Condi – is in the next chapter, but since that story is fiction, I will mostly – but not entirely – keep to the ‘straight and narrow’ here, without surrogates, and with crude oil and money the subject of the exercise. Incidentally OIL AND MONEY is the title of an up-market conference in London (UK) every year, and reading this section will be useful before you give a brilliant talk there.**

**Commodity futures markets (e.g. oil) operate as follows. Against a background of spectators ‘betting’ on the direction and size of commodity price movements by buying and selling futures contracts, an impersonal agency can be created which permits producers, consumers, inventory holders and other dealers in physical products (e.g. physical oil) to reduce (i.e. ‘hedge’) undesired price risk. As simple as this turns out to be in both theory and practice, there are a great many misunderstandings about these markets. For instance, the Fox News commentator Bill O’Reilly once suggested that “little guys in Las Vegas” play a key role in these markets. Bill was not correct.**

**Other observers have also insisted that the oil futures markets (or markets for *paper oil*) were responsible for the devastating price rise of crude oil in the summer of 2008, but as will be noted below, futures trading helps to decrease the volatility and level of oil prices by facilitating the reduction of price risk. Furthermore, *the oil price shock of 2008 was almost entirely due to demand outrunning supply in the markets for physical oil.* This is something that you should never forget, and it is so obvious that you should never waste your time discussing this issue with persons who think otherwise.**

**What futures trading can do is to encourage producers and consumers to carry larger (physical) inventories of oil, because the risk associated with carrying these inventories can be lessened by ‘shorting’ (= selling) futures. As a result, these inventories are available to help dampen upward price spikes or sustained price shocks like the bad news in 2008. There are plenty of claims that futures trading results in less ambiguous (or strange) price movements, which may or may not be true, but it appears accurate to say that there is an upgrading in the efficiency of crude oil markets due to more information being made available to market participants. Information that someday you and smart people like you may be employed to help interpret.**

**The speculative component of futures trading is simple. If a person whom we shall define as a speculator believes that the price of oil is going to rise, he or she opens a position by *buying* futures contracts (or *going long*). These contracts are also forward contracts in that delivery conditions are stipulated on them relating to a specified amount of oil, delivered during a certain month to one or more specified locations. Something that must be noted (*and remembered*) is that when buying (or selling) a futures contract, a security deposit (called *margin*) must be paid your broker in case the price does not move the way you think it will, and your position loses money. (For instance, if you go long and the price declines.) In addition, dealings in futures take place with a broker, and not at the futures exchange, and so a *brokers fee* is involved.**

**Focus on the following. Although delivery of the commodity is usually possible, it would not take place to your home or business, but almost always to some out-of-the-way location. Put another way, futures markets are not about physical delivery, but about opening positions and closing them by reverse transactions. If you open a position in oil by buying (going long), you can avoid taking delivery of the item if, at any time before the contract *matures* (i.e. *expires*), an *offsetting* *sale* is made of a contract for the same amount of oil, referred to the same delivery month. (Offsetting = reversing.)**

**Offsetting is always possible in a viable futures market: for instance, you might phone your broker and open a position by buying a futures contract, while just a few hours (or a few weeks) later you phone her and close your position with the sale of a contract. As noted, if you opened a position by buying a contract (or going long), the offsetting action is selling a contract (or going short).**

**If it happens that the long contract was sold for a higher price than it was purchased, then a profit has been made – assuming that the difference between the sell and buy price is greater than the broker’s fee, which is almost always the case. Similarly, if the speculator thinks that the price of oil will decline, he or she opens a position by *selling* a contract (*going short*), and if the price actually declines, a profit is usually made when you close your position by buying a contract (going long). Think about it: as John Garfield said in a film, buying low and selling high can make you rich.**

 **OBSERVE; you walk into a brokerage, pay the broker a fee and sell a contract (go short) for a certain amount of oil. You need not discuss your reasons for this action. Then you walk out the door, and if the price does fall within the (maturity) period specified on the contract, and the broker’s fee is less than the difference between the sell and buy price, you make a profit when you close your position with a buy! *Once again*: you opened this transaction by selling a futures contract, and closed it by buying one. The actual possession of the physical commodity is irrelevant!**

**The mechanics of this operation will be explained in a kind of soap opera in the next chapter, and without any mathematics, but obviously a partial explanation may be necessary now, because what we have in the discussion just above is selling a commodity (e.g. oil) without owning any, However, as you will find out, the process is as easy (or easier) to understand than buying and selling shares (i.e. stocks). Moreover, buying or selling oil futures – which are sometimes called ‘paper oil’ – does not involve your coming into contact with physical oil, or knowing anything about physical oil other than your belief that you know in which direction the oil price is going to move.**

**Now for an example of *hedging*, or guarding against undesired price rises or falls. Suppose that every room in your house – as well as your garage and garden – contains barrels of oil, stacked as high as you can get them, because a friend who works for Gordon Gekko has assured you that the price of oil is going to rise, and when it rises you can sell this oil and make a lot of money. But after Mr Gekko was indicted for telling false tales about various commodity price movements, you wonder if it might not be best to take out some price insurance on this oil. In other words, to hedge against the price falling instead of rising, which will involve *going short in futures*!**

**Assume that 1000 barrels of oil are being kept on your property. Then you might *sell* a futures contract for 1000 barrels, because if the physical oil you have on your property loses value (i.e. its price falls), *the ‘sell’ contract that you started with* gains value: It gains value because of the profit you can make with an offsetting buy.**

**What is this example all about again? It is about *opening* a position by calling your broker and selling a contract at the then prevailing futures market price (*going short*), and later calling your broker before the expiry date on your sell contract and making a purchase (*going long*) at the then prevailing futures market price. Thus, a possible fall in the price of physical oil could be totally or partially compensated for by a fall in the price of your paper oil, and here you can provide a simple numerical example in which a gain is made by making an *offsetting* buy of a contract at a lower price than that at which you opened your position: a buy which closes your position, and gains you a profit. Understanding this means that you understand what part futures contracts play in obtaining price insurance. Now I suggest that you go through the above discussion more slowly, perhaps with a colleague or two, and discuss the kind of hedging that you would do if you were a buyer of oil, and wanted to guard against a price rise.**

 **Next we can turn to options. It is a fairly common belief that options are more difficult to understand than futures. This is not true, and it behooves everyone with even a slight interest in the subject to learn a few things about the basic mechanics of this particular ‘*derivative’* – where a derivative is an asset (= something of value) whose value is dependent on what happens in the market for another asset. In this case, paper oil (= oil futures or oil options) whose value depends on the value of *physical* oil.**

**Sticking with oil, an option provides the buyer (of an option) the right to buy or sell a given amount of an underlying commodity at a fixed price – called the *exercise* (or strike) price – within a given period that (as with futures) is called the expiry or maturity period. (The asset or commodity in question is often just called the ‘*underlying’*, and the end of the period during which the option can be traded is called the expiry or maturity value of the period.) If the transactor buys an option that involves purchasing the underlying, he or she has bought a *call* option. If the option involves selling the underlying, he or she has bought a *put* option! Remember these words!**

**And please note the following: unlike a futures contract, an option contract does not have to be exercised by buying, selling, or taking delivery. It can simply be discarded if the purchaser so desires – in other words, no reversing transaction is necessary. In fact the seller of the option, generally called the *writer*, wants nothing more than to see the option go unexercised. An important point here is that an American-type option can be exercised whenever the option buyer feels like it, so long as the exercising takes place before the maturity date, while a European-type option can only be exercised at the expiry date, assuming that the buyer prefers exercising to dumping the option. Most options in every part of the world are American options.**

**When the initial transaction takes place, the buyer of a put or call option pays what is called a *premium* to the option writer. *This premium is the option price*, and ideally it would be formed in an auction type market (such as a stock exchange) by the forces of supply and demand. (NOTE: it is the premium and not the exercise price that is the price of the option). It also happens that options are usually sold over-the-counter (OTC) basis by financial institutions.**

**Once a position is opened in a futures market, it stays open until the expiry date of the contract or, in the usual case, is closed by a reverse transaction. (QUESTION: explain what that means?) If no reverse transaction (= offsetting transaction) takes place, then oil will be received or delivered. But with options a right is being purchased for the purchase (and perhaps delivery) of a commodity (e.g. oil) at any time over the maturity period of the option, and conditions of one sort or another may convince the buyer to simply tear up the option, thus forfeiting the premium.**

**Now for an example. Suppose Sven purchased some options contracts from the star trader Millicent on March 15 which gave him the right to purchase 1000 barrels of oil from Millie by April 1st for 100 dollars a barrel (= $100/b). The premium for this transaction is $6/b, and so Sven immediately turns 6000 dollars over to Millicent.**

**Why would he find this arrangement attractive. One reason might be that the present price is $98/b, and remembering what happened in 2008 (when the price of oil moved rapidly to $147/b), paying a premium of $6/b in order to purchase 1000 barrels of oil for 100 dollars a barrel seems like a bargain. As for Millicent’s she looks at the existing oil price several times a day, and talks with various people who know a lot about that subject, and they have convinced her that the price of oil is on its way down.**

**Suppose Millicent and her sources are correct, and the market price of oil declines sharply to $90/b. Then Sven tears up his option and buys his oil on the open market, and Millicent has 6000 dollars. Male sure that you understand the action here.**

**Now, suppose Sven is selling oil, and he wanted to obtain some money via a transaction with Millicent. After dinner one night in Stockholm’s Club Alexandra, he informed Millicent on March 15th, with the oil price at $100/b, that he would sell her 1000 barrels of oil at any time between that date and April 1st for $105/b, but to obtain that arrangement she must immediately pay him a premium of 3 dollars a barrel.**

**She agrees, because on the previous day her friend and colleague Condi Montana informed her that the oil price was going to escalate because there was a likelihood that Monaco was going to attempt to seize the nearest ski resorts in France, and wars or rumors of wars almost always led to increases in the prices of fossil fuels, especially oil.**

**Condi was right. Monoco unexpectedly mobilized and armed all the employees of the casinos, and the oil price shot up to $114/b, because wars anywhere in the world have a tendency to influence the oil price. Millicent exercised her option, receiving 1000 barrels of oil from Sven for which she paid 105 dollars a barrel, plus the 3 dollars a barrel she paid as a premium. Her oil was delivered by Sven the next day, at which time she immediately sold it on the spot market for $114/b, which meant that her profit per barrel was $113/b – $108/b = $5/b. What was her total profit? Now suppose that Sven was buying oil. What kind of option deal would he propose to Millicent?**

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**2. SOME ENERGY MESSAGES FOR THE 21ST CENTURY**

**On every ship there is somebody who doesn’t get the message**

**– U.S. Navy adage**

**A FRIENDLY INTRODUCTION**

**“An Energy Message for the 21st Century’ is the title of the last chapter in my previous energy economics textbook (2007), and some of the present messages are ‘spinoffs’ from the last chapter of my forthcoming energy economics textbook (2014). Even more unusual, I begin this long chapter with some materials from the last chapter of my first textbook (2000), a work that aroused the ire of Richard Gordon (of Pennsylvania State University), but whose hostile review in *The Energy Journal* unfortunately failed to cause me the annoyance that he thought was appropriate. Unfortunately for him that is, because as it turned out, his review was correctly interpreted as pseudo-scientific posturing, and I never hesitate to mention this in my lectures with a smile on my face.**

**Do yourself a big favor and read the chapters in this book carefully. The teaching and studying of energy economics is not just a business for me, but intrinsically personal, and I have taken special care to keep most of this book on the level of Energy Economics 101. With this in mind I can immediately refer to Dennis Gabor, who won a Nobel Prize in physics in l971, and who once spoke of ”forming the New Man who can be at peace with himself and his world”. Assuming that he also meant the New Woman, this made a great deal of sense, and it will make even more sense in the future, although some question remains as to exactly how this forming is to be done. Professor Gabor supplied the first part of the answer when he said that “millions of persons can contribute if they increase their education”, and here I recall a casual remark by a member of my platoon at the Fuji live-firing area in Japan, when he spoke of returning to school after he left the army: “The more I know, the better I feel.”**

**A slight correction might be useful at this point, because the correct word is – or will be – *billions* and not *millions* of persons, and that being the case, what we are dealing with here is more than ‘business’ or ‘personal’, but survival. The survival of our civilization in an acceptable form, as well as a facsimile of our standard of living, whatever that is going to mean in the not too distant future. It is survival because (*ceteris paribus*), the carrying capacity of the global ‘ecological’ and economic systems are likely to come under considerable stress after the middle of present century, given the expected development of the global population. I think it safe to say that almost every intelligent person knows this, just as intelligent persons and otherwise knew in l936 or 1937 that a devastating war was approaching. And now – just as then – they try to avoid discussing or thinking about issues like overpopulation.**

**There are persons who have read a part of this book, and say that much of it belongs in the op-ed section of their local newspaper rather than in a university classroom. I wish that this were true, and also wish that the newspapers I read were filled with the kind of information you will find in these 8 chapters. Then I would not have to confront ladies and gentlemen who wisely proclaim that it is time to get serious about energy and environmental issues, but brazenly offer a sub-optimal strategy based on a full-fledged nuclear retreat that should be commenced as soon as possible,**

**Together with that absurd recommendation they often propose making our planet as green as green can be, which may turn out to have a great deal of economic sense, assuming that all this ‘greening’ will not entail an unnecessary cost in lost welfare (particularly hospitals and schools), in addition to reduced employment opportunities. Let me put this another way: making mistakes in the selection and deployment of energy resources is the fastest way to undermine the existing standard of living.**

**An example is useful here. The U.K. has become one of the most wind-turbine intensive countries in the world. One of the results is that electricity and natural gas prices have roughly tripled in the last decade, and according to David Rose (2013), five million households are now experiencing “fuel poverty”, by which he apparently means that high energy prices are having a deleterious effect on household food budgets. He states that each winter in the U.K., thousands of elderly persons die from the cold.**

**This dilemma has resulted in some well-known conservatives in Britain asking their government why they are taking actions that would prevent the UK economy from fully recovering from a period of semi-stagnation that has lasted five years. A former conservative prime minister, Sir John Major, has informed his colleagues that there are persons in their country facing a choice between eating and heating their homes, and recently several U.K. energy suppliers made it clear to their clients that they can expect energy costs to increase by 8-10% in the near future. Utilities (= sellers of electricity to households) often insist that the problem reflects higher costs for the electricity they purchase from ‘wholesalers’ (i.e. generators), and they have somehow become involved in paying for a part of the subsidies needed to keep renewables in the picture.**

**Rose calls it “sacrificing industry on the altar of environmentalism”, and he offers as a solution to his country’s energy problem a thoroughgoing exploitation of shale natural gas, which he calls “clean” He also explicitly endorses the technique called ‘fracking’, which will be discussed at some length later in this book. I endorse it also *if or when it works*, but according to my interpretation of the evidence, it may be considerably overrated where the long-term production of oil and natural gas are concerned, and in addition may have some ugly environmental consequences.**

***Ceteris paribus*, I am prepared to recognize that shale natural gas and shale oil are valuable resources, and there is no reason to claim otherwise, but there is NO evidence that they are as valuable as certain people want to believe, and for various reasons – mostly having to do with money – want others to believe. Moreover, I have very often heard that the output of shale oil and gas from some of the large deposits is ‘flattening’.**

 **The UK has or will have something to teach us about this situation, because if shale could deliver what its advocates claim, there would already be thousands of shale gas installations existing or planned in that and a number of other countries, especially China, where lies about the employment of renewables seem to be as thick in the air as pollution from the hundreds of coal fired plants that were constructed in the last few decades. Incidentally, according to American sources, shale gas *reserves* in China (and Russia) are the largest in the world, although in both production from shale is minimal.**

**Some EU countries are almost 100 percent dependent on Russian natural gas, and have signed contracts for gas that are linked to high oil prices. I suspect that governments and voters (and journalists and propagandists) would not tolerate this undesirable situation if competent geologists assured them that they are sitting on a domestic largesse of shale natural gas!**

**Environmental economics does not play a major role in my teaching or thinking. I gave a few introductory lectures on this subject once in Brisbane (Australia), but after an outburst of the first gutter language that I ever heard in a university classroom, I concluded that I should find something less provocative to discuss. However recently I decided to peruse some written materials that could provide me with enough environmental knowledge to at least pretend that I was not completely ignorant when the subject was broached, because unavoidably energy economics and environmental economics go together, and this unison can only increase in the future.**

**The item I chose was the book of David Goodstein, who is professor of thermodynamics at the California Institute of Technology (2004). I had already read his book several times, but when I came to sections about environment I tuned out. I don’t plan to do that again, because pedagogically it probably makes sense to focus on his belief that nuclear energy and “sunlight” (or the various dimensions of solar energy) should be the basis of the future energy economy. At least a basis for California, and especially if the means for storing electricity are greatly improved, which now seems possible. (And note, “sunlight/solar energy” governs the movement of wind and hydro.)**

**The gentlemen who provide the most elegant (and simple) reason for accepting the nuclear option – by which I specifically mean nuclear energy paired with renewables and alternatives – are Richard Rhodes and Denis Beller (2000). They say that while renewables are valuable, nuclear should be the core of the energy economy, at least for the United States (U.S.), but they do not give a reason.**

**It is my pleasure to supply the reason: nuclear can (or will be able to) provide a *reliability* that *increases the value of renewables*, and without which an exclusive resort to renewables might be an expensive way to begin a journey toward a lower or much lower standard of living for energy intensive regions such as those in North America and Europe. In addition, I can make a claim that infuriated certain people at a recent Singapore Energy Week: the splendid march of technology is on the side of nuclear, and here I am primarily thinking about the sophistication of the next generation of reactors (Gen 4), which may involve a substantial decrease in the size of some of this equipment, and what that will mean for lowering the cost of constructing nuclear facilities.**

**Nuclear can also provide energy for what Professor Goodstein calls ‘*The Rate of Conversion Problem’*, which involves altering the structure of an economy so that more renewables and alternatives can be employed as sources of energy, with an emphasis on the systematic introduction of the *correct* renewables and alternatives. This is a complex matter that I hope that I can understand and discuss in the near rather than the distant future, but I am qualified to appreciate some information that nuclear sceptics need to know about nuclear energy. According to the nuclear executive Malcolm Rawlingson, the present nuclear story where new construction is concerned is as follows.**

**The Chinese have 30 large (= 1000 Megawatt) nuclear plants under construction, and over 100 planned. In the United Arab Emirates there are 2 nuclear plants under construction and 2 planned. In Russia 10 plants are under construction and 21 more planned, and the “concrete has been poured for 4 reactors in the U.S.” (where more than 100 nuclear plants are already in operation). He adds that there are a total of 67 large reactors under construction around the world, and as we know, there are more than 400 in operation. (By the way, in case you forgot, 1 Megawatt is 1,000,000 watts).**

**GOOD AND BAD ENERGY NEWS**

**Seek truth from facts.**

**–Deng Xiaoping**

**Many years ago I asked the late Nobel Laureate (in economics) Professor John Hicks why he had such faith in neo-classical economic theory. He obviously resented my question, or perhaps it was my good self that he resented for asking it, but he replied by saying that if we were going to make any progress in economics research, we require the systematic approach which neo-classical economic theory and its sophisticated mathematical machinery made available. I’m glad to report that I waited until I was outside the building to laugh, which I did not do at the *Singapore Energy Week*, when a friend of the Uppsala physics professor Kjell Aleklett informed me in a distraught tone of voice that it required ten years to construct a nuclear reactor.**

 **I am sure that, in a limited (and uninteresting) sense, that gentleman was correct, because if he or anyone else wants to find construction sites where reactors that were supposed to be constructed in 5 years take *at least* 3 more, he has only to visit Finland. He would not be pleased to learn however that the Finns have reacted to this disappointment by ordering another reactor, because they understand, just as I do, that brilliant firms (in this case Areva of France) can fall short of expectations when operating a thousand or so miles away from home. Moreover, nuclear is indispensable if Finland wants to protect the prosperity now enjoyed in that country.**

**Rather than incite an argument this early in the present contribution, I will merely state a fact. It does not take ten years to construct a large nuclear reactor (e.g. 1000 MW), regardless of who thinks it does. Conventional economic theory says otherwise, in that ten years in this case suggests a state of industrial degeneration that does not belong in reactor construction dramas starring countries like France and Finland. In my forthcoming textbook (2014) I claim that it takes 5 years or less, and persons with another opinion should be told the significance of their opinion for the price they would have to pay for the electricity they buy if nonsense about energy sources is taken seriously by the decision makers. My students will hear this many times in my lectures, and for proof I will point out what is happening in China: China is showing the way in nuclear, although that country (and others) constantly claim that they are madly in love with the use of wind for generating electricity. (China’s installed wind capacity was reputedly 91.4 ‘gigawatts’ at the end of 2013, which was an increase of 15 GW from the end of 2012. I can also note that 1 gigawatt = 1 GW = 1 billion watts = 106 kilowatts.)**

**What I will not do at the present time – although sorely tempted – is to launch into my usual harangue about the significance in terms of costs and benefits of producing 12 reactors in just under 14 years, which is a near miracle that happened in Sweden many years ago, and which few Swedes know anything about today, and a surprisingly large number do not want to know anything about. I hesitate to bring up this matter because many persons in Sweden do not ascertain what a superb engineering achievement of that nature means for their incomes and welfare, and even if they do, many Swedes regard the most innocent statement about academic or engineering excellence *on the part of Swedes* as arrogance or worse, which is a depressing cultural trait (or deficiency) that I personally am unable to understand. Put another way, they do not know nor are they interested in what it would mean if the 10 remaining Swedish reactors were dismantled, and instead this country’s energy fortunes were exclusively based on the use of wind and solar.**

**A SAD STORY ABOUT ECONOMICS AND CLIMATE**

 **So yes, climate change is an important problem. But presenting**

 **people with a one-sided, ineffective message helps no one.**

 **– Bjorn Lomborg (2014)**

**This is not an especially long book, although it will consider many energy economics topics, and do so without an overdose of mathematics. Fortunately, I have convinced myself that all of it except some advanced materials on electricity can be read in a short time by anyone with a genuine interest in these topics, because the mathematics and diagrams that I usually employ in my classrooms are kept to a minimum.**

**At the same time I must admit that occasionally I have informed my students that (Lord) John Maynard Keynes – easily one of the top ten economists of the 20th century – at least once informed his audiences that economics (presumably without an excess of mathematics) was an *easy* topic, but at the same time *difficult*. What he said was that “The study of economics does not seem to require any specialized gifts of a very high order. Is it not, intellectually regarded, a very easy subject compared with the higher branches of philosophy and pure science? Yet good or even competent economists are the rarest of birds. An easy subject at which few excel.”**

**There are plenty of good or competent economics students in every classroom in every country in the world, and also a large number working in the private or public sectors. Probably the main reason that the latter are good or competent is because they are doing things they are capable of doing, and like to do, and most important they have been taught by teachers who deserve to be rated higher than a modest good or competent, though perhaps not as high as Lord Keynes. Teachers like myself.**

 **That brings us to (Lord) Nicolas Stern (of Brentford), who once appeared in Stockholm in order to clarify for a large audience at the Royal Institute of Technology the conclusions reached in his widely advertised analysis of the issues – mainly cost issues – that may be encountered when attempting to understand or prevent various environmental adversities. I was not invited to attend that event, because it was probably believed by its arrangers that had I been present, there might have been what is sometimes called an ‘incident’ or a ‘scene’. The truth is that had I been summoned, I would have gladly attended, and in addition exercised a maximum of self-restraint in order to avoid informing Lord Stern that many leading economic theorists consider the ‘*Stern Review’* (of the climate) to be scientifically meaningless.**

**“Meaningless” and ‘pedagogically insignificant’. That document – or at least the very small portion that I forced myself to examine – is an insult to economics teachers like myself, as well as the students who require our guidance where their reading materials are concerned. Here I believe it correct to admit that a number of brilliant economists, some of whom are Nobel laureates, and persons I greatly respect, expressed satisfaction with Lord Stern’s work, but as far as I am concerned Lord Stern has wasted his and – what is infinitely more important – *my* valuable time by accepting the burden of telling us how to approach the climate riddle. *That riddle cannot be dealt with by employing the economics and mathematics that Lord Stern specialized in before joining the crusade to help comprehend and possibly liquidate the Climate Menace*.**

**Something else of interest is that the team working on the Stern Report reportedly came to 23 men and women, as well as many consultants. In other words, it was another example of what George Orwell called a “system of indoor welfare”, because according to Professor Richard Tol, if the Stern Review had been presented to him as a ‘Master’s’ thesis, he would have graded it F (for failure). Other academics might have graded it A+ (for superior), and if the two sides had lined up for a shouting or cursing competition, I have no doubt that Professor Tol’s team would have lost. They would have lost for the same reason that President George W. Bush defeated John Kerry in a presidential election, which is because the sophisticated lie that Bush and his team fabricated to commence the war in Iraq was easier for voters to comprehend and accept than the unsophisticated truth of Kerry’s combat experience in Vietnam, which he failed to capitalize on sufficiently after accepting the nomination for president of his country.**

**“Fear mongering” is the expression that Bjorn Lomborg used to describe the research of Lord Stern, but the situation is much simpler than that. Professor Stern was utilizing the opportunity to score a beautiful reward that he could never have obtained by simply writing equations on a black or white board for the edification of bored *or* enthusiastic graduate students.**

**In a situation like this academic soap opera, it is always possible to find ladies and gentlemen who are thrilled to the marrow in their bones by the waffle presented in the Stern Review, or Stern-like reviews. Take for example Joan Ruddock, once a Parliamentary Under-Secretary of State for Energy and Climate Change in the UK. Like many others she neither understood the criticisms of Stern by world-class economists like Professors Richard Tol, Partha Dasgupta and Martin Weitzman (or for that matter praise from people like Amartya Sen, Joseph Stiglitz or my favourite Robert Solow) because – according to her – the critics suffer from “a fundamental misunderstanding of the role of formal, highly aggregated economic modelling in evaluating a policy issue.”**

 **I’m terribly afraid that I must reject that point of view my excellent Ms Ruddock: they do not misunderstand! People like you are guilty of that shortcoming! What you don’t comprehend is that the pompous bunkum you mistakenly call “aggregated economic modelling” is irrelevant. We need governments capable of understanding that potential environmental disasters and perilous climate ‘events’ are best dealt with by a scrupulous expansion and regulation of primary and secondary education, whose purpose is to ensure that every segment – every ‘drop’ – of technical talent in the population is discovered as soon as possible, and given the opportunity for a maximum development. That way, when or if future bad news appears in the form of e.g. a super-storm Sandy, it can be dealt with swiftly and optimally.**

**Let me conclude by insisting that the basic dilemma in this instance is that the highly educated Lord Stern does not have the kind of education necessary to do the very special and complicated job he was appointed to do by the ignorant Gordon Brown, and the same would have been true of Lord Keynes or Paul Samuelson – the leading American economist of the 20th century – if they had accepted this crank commission. Or for that matter Albert Einstein had he read economics instead of physics, or John von Neumann, sometimes labelled the best brain of the 20th century. Put it this way: Stern was not driving on empty – he was going nowhere on a full tank!**

**Before turning to a genuinely important theme, let me say that I am not against climate research, nor Lord Stern, but since I know the difference between truth and misunderstandings (and lies), I definitely reject the pretentious approach of Lord Stern, and approved of by people like the neo-con Paul Wolfowitz, and the former director of the International Energy Agency, Claude Mandil, who once grandly informed me that his organization was interested in oil consumption and not production, when I ridiculed the forecasts of his organization for 2030. Despite the claims of various charlatans, more coal is being burned at the present time than in the last 40 years, and although many scientists and others believe that nuclear power is essential if long-term climate goals are to be realized, at the current rate of reactor constructions, it will not be possible to count on much help from nuclear if the putative climate problem is to be resolved.**

**This is the place to note a valuable suggestion by Richard Vesel in *Energy Pulse*. He wants the term ‘*climate disruption*’ used instead of climate change, and notes that *methane* is about 1/4th of the conjectured emissions problem and CO2 is about 2/3.**

**If I ever encountered issues of this sort in one or more of my day dreams, or nightmares, then I hope that it would not be accompanied by commentaries of the CNN or Fox News type discussing what will or could happen during the various stages of disasters unleased by large-scale climate disruptions. This is because I remember hearing arguments originating at one of the best known American universities that the outcome of even major climate disruptions would be no more portentous than the kind of things that I saw in Japan and Germany fairly soon after the last world war (WW2). Panoramas that featured smashed cities in the early stages of recovery, although recovery from a major climate event – or even worse a *series* of major climate events – of the magnitude of *Hurricane Katrina* (in New Orleans) would be a different proposition, given the political and social ramifications that would have to be dealt with.**

**ANOTHER IMPORTANT TOPIC: JAPAN AND NUCLEAR ENERGY**

**Oil is my favourite topic, because I recognize its exceptional importance, and as a former teacher of development economics and game theory, I admire the style with which OPEC chose their goals and developed their strategy. I would like to see every economics student study the oil market, because studying that important market when equipped with an elementary background in economic theory (and an interest in history) will make them and their teachers feel better about themselves. For example, they might learn that Alan Greenspan – the former governor of the U.S. Central Bank (The Federal Reserve System) – made it clear that almost everyone in his professional and dinner-party sphere believed that the war in Iraq was about oil. Here I want to assure readers that the recent war in Libya was also about oil.**

**Great changes have taken place in the U.S. because of shale oil and shale natural gas, though perhaps not so great as we are often told. There are two principal oil prices, the *West Texas Intermediate Price* (WTI), which mostly serves as a ‘marker’ or benchmark for North America sales, and the *Brent Price*, which does the same for Europe. By ‘benchmark’ I mean that discounts and premiums to these prices often take place: the last time I looked both the WTI and the Brent price were under 100 dollars a barrel ($100/b) and it looked that would continue down. Buyers of oil in the WTI and Brent ‘markets’ receive discounts and/or pay premiums on these (base point) prices. Until recently the *aggregate* oil price (computed from WTI and Brent prices) has averaged about $101/b, which would enable OPEC to collect another trillion dollars for the oil they will sell. Congratulations OPEC, because ten years ago the aggregate oil price averaged about $25/b, and certain people talked about it sliding to $5/b, or less.**

**I also want my students to study Japan and its energy ambitions, because on the basis of what I have recently heard about that country, things have happened and probably will happen again that could serve as examples for every country in the world. To be specific, I mean that in the latter half of this century, almost every country in the world could be in or close to the position of Japan where the scarcity of domestic energy resources are concerned, but as a teacher of energy economics I intend to avoid any reference to the opinion or opinions held and circulated by the former highest energy bureaucrat in Sweden. His wisdom – such as it is – raises a number of questions.**

**Last March, in the paper *Svenska Dagbladet*, the journalist Johan Myrsten informed his readers about the glorious future awaiting Japan, because the new prime minister (Mr Shinzo Abe) has the support of between 60 and 70 percent of the electorate. Although not adequately stressed, much of this support is due to Mr Abe's acceptance of nuclear, because most Japanese voters comprehend their detrimental energy situation with regard to energy resources. That situation reflects badly on their preference for higher incomes and more welfare, as compared to the naïve and insistent misunderstandings about the importance of electricity and nuclear energy serially promulgated by Thomas Kåberger, presently a professor at the Chalmers University of Technology in Gothenberg Sweden, and who for a short time held a research position at Japan's Masayoshi Sons Foundation for Renewable Energy.**

**German voters will also eventually duplicate the Japanese behavior, and perhaps sooner rather than later, because the German economy and energy minister recently stated in simple and unambiguous German that without nuclear, the German economy can go no further. You got that right, Mister Minister, and you can add the following: *more pollution originates from electricity production in Germany at the present time than when Germany was divided, and East Germany binged on soft/ brown coal!***

**Somewhere in my forthcoming energy economics book (2014) I discuss a load of stale untruths about energy economics and the Swedish energy future delivered by the prominent anti-nuclear physicist Amory Lovins, and I would do the same thing for the opinions of Professor Kåberger if he were still active in Japan. This is because as part of his duties at the aforementioned foundation, Kåberger informed the persons who paid his salary, as well as the members of the Japanese branch of the anti-nuclear booster club, that "IT IS SENSATIONAL THAT A COUNTRY CAN CLOSE DOWN 30 PERCENT OF ITS ELECTRICTY PRODUCTION, AND STILL MANAGE".**

**A translation to English might help. What Mr Kåberger wants you to believe is that the Japanese can junk all or a part of their nuclear assets, along with the electricity those assets produce, and still eat, drink and be as merry as if nothing has happened.**

**As much as I hate to say it, I spent almost two years in Japan, mostly teaching American soldiers how to use weapons of non-mass destruction, without gaining a suitable insight into the culture of that country, but I remember telling my international finance students in Sweden that where energy was concerned, Japanese decision makers should be counted on to do the right thing, though perhaps not in the short-run. Thus, the Japanese can eliminate 30% of their electric output and “manage”, but managing**

**does not mean the enhanced standard of living that the Japanese want as much as Swedes. and who can thus be counted on to make it clear to their government that they do not want silly departures or experiments where their energy supply is concerned. This should suffice to regain the 30% referred to by Professor Kåberger.**

**According to the journalist Ian Buruma, it was in the l950s that conservative Japanese politicians began to express a preference for nuclear. Let me make it clear though that they did not shout and cheer for nuclear because they are conservative, but because they were told by their scientists, engineers and managers that nuclear would get the Japanese people the prosperity they desired faster than anything else. To construct their nuclear sector – which eventually provided a sizable fraction of Japanese electricity – technology was initially imported from the large U.S. firm General Electric. What Mr Buruma and many other persons in his network do not know – and if they do know do not fully understand – the Japanese probably constructed some of their reactors faster than any country in the world, to include the U.S., and this achievement – *ceteris paribus* – had a very beneficial effect on the cost of electricity in that country.**

**The question that I have often asked myself in the silence of my lonely room, is why didn't the Japanese construct more reactors? After all, at least 70% of French electricity has a nuclear base. One answer is the meddling of economics amateurs like Kåberger and Buruma, because although Japan is desperately short of energy resources, they are not as short as they would be if they followed the advice of people like Mr Kåberger. But the principal answer is that a commercial breeder reactor is at most a decade away in China, and when that equipment becomes available, the Japanese government will likely take steps to have as much of it as possible rapidly adopted.**

**In the meantime I recommend that everybody – including students of nuclear like myself and the energy connoisseur Jeff Presley – should study in detail the nuclear aspects of the Fukushima tragedy, and a good approach is to peruse an article by Shehu Khaleel in *Energy Pulse* (2012), which is followed by important comments by nuclear engineers and executives like Joseph Somsel and Malcolm Rawlingson.**

**On this point it should probably be mentioned that a well known physics researcher once informed me that breeder reactors cannot be constructed, but as Professor Kenichi Matsui has noted, in one form or another they have been constructed since the l950s. At the same time it should be recognized that there are substantial political forces that keep full-scale breeder research and production programs from going forward, and not just the personal agendas of frustrated physicists. In the U.S. President Clinton stated that breeders were unnecessary, while President Carter once said that they would probably be useful sometime in the future, which is another way of saying that their presence in the U.S. could wait until he had served his term of office.**

**Apparently, the intention of the present Japanese government is to emphasize nuclear safety, and so they might appreciate knowing that of the American nuclear facilities in the path of 'Superstorm' Sandy (whose** **strength and angle of approach combined to produce a record surge of water into New York City**)**, all performed as they were designed to perform. I was recently told that there are about 2500 earthquakes a year in Japan, which is disturbing if true, but I can recall one of them when I was returning to my regiment from the U.S. military hospital in Nagoya, and its results were hardly noticeable. Actually, if that figure for earthquakes is supposed to mean severe earthquakes, it suggests – as the Swedish politician and nuclear expert Hans Blix once noted – that the destructiveness and loss of life in Fukushima was almost entirely due to the tsunami. The location of the reactors and not their existence was the problem.**

**Thomas Kåberger has apparently said that only two Japanese reactors will be restarted this year, and he also claims that among the top bureaucrats in Japan, there is increasing skepticism about nuclear. According to Kåberger, there will be more emphasis on solar cells, wind turbines, water-power, and geothermal energy.**

**But as far as I know, no Japanese economist, scientist, politician, break-dancer or moonwalker with an interest in energy issues believes that nuclear will be dumped, or more than marginal gains are possible in Japan with increased investment in geothermal energy and wind turbines. Yuko Obuchi, the daughter of a former Prime Minister, and minister of economics, trade and industry, has stated in clear Japanese that “It would be difficult to choose an energy option without nuclear reactors when we think about our energy policy in the long run”. She also notes that Japan's imports of fossil fuels have soared by 10 billion yen ($91.73 million) a day compared to pre-disaster of 2011, and that utilities costs have risen 20 percent for households and 30 percent for companies, which especially burdens small firms.(1 US dollar = 109.0100 Japanese yen.)**

**Of course, there is no reason to complain of a lack of justice in our world because Swedish ‘experts’ are sounding off in foreign lands about things that they know little or nothing about. Sweden is clearly better off with Swedish 'experts' helping to manage or mismanage foreign energy affairs, than preaching their wacko messages in Stockholm.**

**3I will finish this section by mentioning a paper by the eminent energy scholar Professor Kenichi Matsui (2013) in which he mentions what he calls *The Second Era of Nuclear Energy*, and for Japan ‘*Quasi* *Independence’*. In my first energy economics textbook (2000) I mentioned his reference to the *Seventh Energy Revolution*, which to me means not just the use of nuclear energy, but eventually the introduction of the breeder reactor and the closing of the nuclear cycle. Accepting this option means not only being able to employ the most plentiful isotope of uranium (U-238) instead of U-235, but also recycling ‘spent´ uranium to an extent that the ‘bugaboo’ of nuclear waste disappears in rational discourse. As for ‘Quasi Independence’, this is simply taking Independence as far as it can go, given technological, geological, political and economic constraints.**

**To repeat, for Japan, nuclear cannot be avoided, and it will be the same for many other countries. When I think of the others I think first of Germany, where as in every industrial country, engineers and managers are lining up to inform up-scale politicians that in the long run they have no choice but to employ nuclear. The problem is that even politicians who love nuclear often prefer silence or denial when this topic is broached. There is a section later in this book where I discuss Japan and population, but there is a number that should be circulated now. Japan accounts for 4.8% of the global macro-economy: *more than Germany and almost as much France and the UK combined!***

**AN UNWELCOME NOTE ON EUROPEAN NATURAL GAS**

**At the bottom of page 79 in my book “*The Political Economy of Natural Gas* (1987), you will find the following warning: “There is also the possibility that an outright rejection of Soviet (= Russian”) gas on political grounds would mean that trade that might be carried out with Western Europe would then take place between the Soviets (Russians) and the countries of East Asia”.**

**Not a possibility, Professor Banks, but as things have turned out a certainty – and incidentally, congratulations on your foresight. Moreover, a few pages earlier, I began a discussion of what some Russian official later called “the deal of the century”. As in my talks at Cambridge and the Australian National University, I stressed that the so-called ‘intolerable level of Western European energy dependence actually ran in the other direction”: to be explicit, Western Europe was in the drivers’ seat, because for them the purchase of that gas was a convenience, while Russia was desperate for the money they received from selling it, due to their being without affluent customers elsewhere.**

**As several gentlemen in business suits assured me after my long and brilliant Cambridge lecture, “if the issue is natural gas, the Soviets play by Capitalistic rules”, and they did not lower their voices when providing me with some examples to use in future lectures, examples that I have unfortunately forgotten.**

**When it comes to the organization and publication of information about energy economics, nothing beats the site *321* *Energy*. However since they do not have what is called an ‘agenda’, occasionally an oddball opinion turns up among the wealth of informative articles they reproduce. One of these off-the-wall contributions carried news of a war between the U.S. and Russia – a trade war – in which American liquefied natural gas (LNG) locked horns (or some other part of the anatomy) with Russian pipeline gas over a bounty of more than ten billion dollars a year that supposedly was up for grabs, with China on the buy side of this arrangement.**

**I suppose that if the Russians were not well along in their pipeline construction toward China, and the papers for another ‘deal of the century’ between Russia and China signed, sealed and delivered, there might be some sort of logic in the U.S. accepting a (hypothetical) challenge on the energy field of honor, but in the circumstances, neither talking or thinking about a ‘rumble’ between these two countries makes the slightest bit of economic sense. And if the numbers that we sometimes see about the depreciation of shale natural gas deposits are only *approximately* correct, then for the U.S. to ‘gear up’ for a brawl with Russia is counter-productive. (And here I must admit that the depletion ‘rates’ that I constantly see for both shale oil and gas are so large that I am reluctant to mention them to my students for fear of being called a fool.)**

**Thus we come to what I call the bottom line, which is that the natural gas that should go to Europe, as Lord Howell (of the UK) made clear, will now go to East Asia (i.e. China, and probably later also Japan). It will not make the return journey.**

**To replace this gas, Chancellor Merkel is apparently in the process of allowing (and perhaps even encouraging) fracking to take place in her country (Germany). This could undoubtedly be called the correct decision were it not for the fact that the CEO of ExxonMobil has publicly stated that the “clays” in Europe do not seem to be very productive where fracking is concerned. Just as important, Mr CEO gave thumbs down on some shale deposits in the U.S., and I am sure that Madame Merkel has been informed of disappointments often experienced by enthusiastic ‘frackers’ in Russia and China, where reserves are the largest in the world. Here though I make a prediction: Russia will likely experience a success with fracking similar to that of the U.S.**

**Accordingly, what Madame Merkel and her foot soldiers may not be aware of is that in abandoning nuclear, and ‘bad-mouthing’ Mr Putin’s natural gas, she has done exactly what folks like the gambler and money-waster Nathan Detroit (in the musical show ‘*Guys and Dolls’*) suggested not doing: given the odds, trading a certainty (nuclear and Russian gas) for an uncertainty (a fracking *breakthrough* that can compensate for the failed experiment she is almost certain to experience with wind and solar). In fact Germany is experiencing it now, and according to Professor Claudia Kempfert, the shaky German Economy is increasing the disbelief in Merkel’s ‘Energiewende’.**

**The point is that Russian natural gas, and especially the next generation of nuclear, were/are the way ahead for the people of Northern Europe, and without these items pleasures like long vacations on the sunny beaches of Southern Europe will progressively grow more expensive. Here I can claim that it would take more than a platoon of economists to explain the attitudes of many European politicians where Russian energy resources are concerned. A regiment of psychiatrists is a better choice.**

**SOME ECONOMIC ASPECTS OF AMERICA’S ENERGY**

**A *Wall Street Journal* analysis of global data has apparently resulted in the claim that the United States (U.S.) will soon surpass Russia as the largest (combined) producer of oil and natural gas in the world. Normally I would pass this information to my energy economics students the next time I teach that subject, but why should I bother those young ladies and gentlemen with foolishness. For example, consider the following absurdity by one of their employees.**

 **Yet, beyond our merits, the Lord has recently smiled on us in**

 **in the form of shale gas…..Don’t bet on Mr Medvedev. Bet on**

 **the crude logic of Russia’s declining energy power, which**

 **Western policy should do everything possible to exploit, to**

 **deliver better behavior in Moscow.**

**“*The crude logic of Russia’s declining energy power*”. My response to that astonishing deceit at a conference or upper-echelon meeting, after ridiculing its author, would be that somebody has also smiled on Russia where energy is concerned, and after viewing the magnificent opening and closing ceremonies of the 2014 Winter Olympics, and being informed in detail about Russia’s expanding nuclear intentions, the rich Northern Energy Frontier of that country where Russian and American drillers just uncovered a rich prize in offshore waters, and the potentially enormous supply of Russian shale resources, I conclude that a bet on Medvedev and Putin might make a lot of sense for Americans. What it will make for somebody else I neither know nor care.**

**As it happens, the U.S. also has superior cards to play. One of these will be the revitalization of the nuclear sector, especially with the new equipment that should be ready in another decade or earlier. In addition, as my energy economics students will be informed, the major advantage of the U.S. is its technical and organizational skills, which were demonstrated in full during World War Two, (WW2), and which could be demonstrated again if the right people were giving the orders in Washington. Unfortunately, I do not know who the right people are, but I know who they are not, although I will keep this information to myself for the time being.**

**In one of his last articles, the late editor of the *Energy Tribune* concluded that the U.S. government should leave the working of energy markets to the private sector, and should not continue with the present practice of interfering with the export of natural gas and crude oil. The same message has been pronounced by economists at the liberal Brookings Institute. As far as I am concerned, Professor Economides and the Brookings people were wrong to approve of the exporting of any part of America’s energy advantage, because energy assets like oil, gas and coal are very different from the items discussed in the paragraphs on ‘free trade’ in your international trade textbook – *as different as the blood in your veins is from the ink in your fountain pen*. *Put another way, it is not acceptable that short-term economic opportunity should become the engine of action for U.S. decision makers, because it might involve a highly unacceptable long-term cost*?**

 **One of the crank arguments in favor of increased American energy exports is that oil and gas reserves have become virtually *unlimited* in and around America, primarily because of the ‘shale revolution’. There is no point in denying America’s good luck in hosting this revolution, because oil output from *major* shale plays (= Bakken in North Dakota, Eagle Ford in Texas and the Permian Basin in West Texas and New Mexico) increased by almost 90,000 barrels per day (= 90,000bpd) in September of 2014. (This figure includes *condensate* production, where condensate is ultralight oil. When underground it is mostly a gas, but in some way ‘condenses’ into oil or the equivalent of oil when pumped to the surface.)**

**The problem for me here is the expression “unlimited energy resources”, because if this were correct – which it isn’t – then I would suggest that the one-sixth of Americans who are poor, and the one-sixth who are almost poor (or *disadvantaged*) can perhaps be saved from the misfortune of living in an America in which conditions for 100 million poor and disadvantaged Americans clearly show a tendency to worsen in one way or another. In case you doubt this, check the gloomy movement of the ‘share’ of gross domestic product for these 100 million Americans over the last decade or two.**

**But in any case, every readily available barrel of oil and cubic foot of natural gas increases in value for Americans as time goes by. In case you didn’t know, 49% of American households use gas for heating, and American families with modest incomes will gain if they do not have to compete with foreigners for an essential resource.**

**There are several ways to attack the present subject, and one of them is to proceed with the aid of some complicated mathematics, which I mistakenly did many years ago. Of course, the paradox is that where many economics topics are concerned, heavyweight mathematics often confuses rather than clarifies, and so I avoid it when teaching energy economics. Mathematical skill is useful and admirable, but a shortage of basic economic knowledge is why physicists like the former and present U.S. Energy Secretaries should be kept as far away as possible from the Washington (DC) decision-making apparatus.**

**The new Secretary, Dr Moniz, claims that the time has come to allow America’s energy advantage to be put on the block. ''Those restrictions on exports were born, as was the Department of Energy and Strategic Petroleum Reserve, from oil disruptions,'' Then he goes off the deep end. ''Lots of energy issues deserve new analysis and examination in the context of what is now an energy** **world no longer like the 1970s.''**

***How would he know, and who would be responsible for those analyses and examinations*? To quote Asjylyn Loder’s timely article in *Bloomberg Business Week* 2014), “*There’s a lot of Kool-Aid being drunk now*.” Speaking of an over-indulgence in Kool-Aid, I remember putting a Catalan grandee with an advanced degree from MIT in his place when he displayed a remarkable ignorance of what nuclear energy has meant for countries like Sweden and Japan (and also Germany, as we now see with its grotesque *Energiewende*). I particularly remember that gentleman citing some bizarre opinions about nuclear that he claimed originated with Dr Moniz. Once again I was forced to point out that the construction of the Swedish nuclear sector – 12 reactors is just under 14 years – provided Sweden with an electricity price that was almost the lowest in the world, and the correct utilization of this relatively inexpensive energy resulted in an enormous boost for the Swedish economy, to include the Swedish welfare system, by which I especially mean primary and secondary schools and hospitals. (A boost that was later lost due to lies circulated about the efficacy of electric deregulation.)**

**Adequate and high quality schools and hospitals, almost full employment, long vacations and an efficient pensions system, as well as benefits and special consideration for the physically, mentally and socially handicapped. Things began to change for Sweden when ignorant claims about the advantages from electricity exports were disseminated by *lowbrow academics with ‘runaway’ inferiority complexes*, which were accepted by politicians and voters, which in turn allowed a sub-optimal alteration of the Swedish electric sector to begin. The ulterior result of exporting Swedish energy was a large financial gain for a small group of Swedish insiders, as well as varying degrees of economic discomfort for many households and small businesses.**

**In the U.S. The (Federal) Treasury says that about half of employed American have no pension saving plan. According to Stephen Foley, The Treasury hopes that “persuading low-income households to save even small sums will be habit-forming, and they might then graduate to more realistic retirement planning.” This is a superb idea if it had been offered decades ago, before the U.S. became overpopulated, and before the jobs for low-income men and women were taken by immigrants, *just as many jobs for higher income families will someday be lost to immigrants.* And in case President Obama does not know, which is very likely, the top 5 or 10 percent of earners were responsible for a huge chunk of the consumption of goods and services in the U.S. in 2012 and 2013. For those lucky citizens, the share of national income apparently increases all the time.**

**It might be useful to refer to a recent article in the (London) *Financial Times* which pointed out that regardless of what is commonly believed about the fair or so-called ‘egalitarian income distribution’ in the U.S., the top 10 percent of U.S. earners are more favorably compensated than in any industrial (and possibly semi-industrial) country in the world, while 49 million Americans experience some degree of uncertainty where the satisfaction of their food requirements are concerned.**

**What about the rest? The only thing I know about those ladies and gentlemen is that many would vote in favor of exporting more oil and natural gas if given the opportunity, and they would also accept an incorrect argument recently offered in the *Bloomberg Business Week* called “FACTORY JOBS ARE GONE. GET OVER IT”. It would take more than a regiment of Ivy League psychiatry professors to explain what has gone wrong with American voters, and in particular their inability to comprehend that energy (and technological efficiency) and good schools go together with good paying factory jobs, and these in turn lead to good jobs in other sectors of the economy. It is also the case that legislators in the nation’s capital see nothing wrong in assuring American voters that selling oil and gas to motorists and factory owners in Asia will benefit all Americans, and not just the energy company executives who might add millions to their annual incomes if the ‘free’ export of energy resources is allowed.**

**An oil company executive in the U.S. once said that ''I think we should keep national security first, but we should export oil just like anything else.'' *Unfortunately, oil is not like “anything else”, and in addition oil and gas and national security might be inseparable, so why take chances?* Instead, as people like U.S. Senator Edward Markey implied, American oil should be kept in America in order to benefit American consumers, and as he neither implied nor stated, *anybody else who wants or needs oil can get it from someplace else or learn to do without.* Add to that Michael Levi’s statement: “Something seems upside-down when we say energy security means producing oil and sending it somewhere.” Not upside down Michael, but just plain stupid, because it insinuates that the future has no value for American voters.**

**Many Americans in the large percentage of the population who are falling behind, strangely want restrictions on exporting things like oil and gas to be removed. What are they thinking about? Why do they play the fool for what George Packer (2013) calls “organized money”? Isn’t it clear that shipping coal and natural gas and oil to foreign countries to help them fuel their factories, and to out-compete American industry, is grossly self-destructive. (The same applies to Swedish electricity exports.) Some Americans would gain, but increased exports of energy resources threatens aggregate American incomes and welfare. If the U.S. really has an enormous amount of e.g. shale oil and gas, it is needed to ensure that no American will have to worry about his or her country facing an energy shortage in the future, to upgrade the U.S. educational system, to provide the loans and subsidies that the U.S. industrial sector might need, and to make it unnecessary for Americans to participate in stupid wars for energy.**

**Geoffrey Styles has always impressed me as a knowledgeable student of the energy markets, but not when he thinks that the argument for keeping oil and gas in the U.S. to use in e.g. domestic refining and the production of petrochemicals does *not* make economic sense. (But please note that both refined products and petrochemicals can be exported without restrictions if the price is right.) He states that OPEC countries preferring domestic investment in physical capital (e.g. refining and petrochemicals) should instead have bought shares (i.e. stocks) and bonds in North America. I’m sorry Mr Styles, *but unfortunately that is completely wrong*, as I make clear in my forthcoming textbook (2014). Worse, it is illogical! Investing in (physical) capital assets is and always has been the road to economic development. That lesson is taught in the first course in economics, and it applies to the United States of America as well as OPEC countries.**

**MY FAVORITE FUTURES MARKETS EXAMPLE**

**We can start by modifying an elementary example – some fiction – that proved extremely useful when I was teaching first year students of Financial Economics at Uppsala University, and also in Prague. Among other things, I suggested that they should give some extra attention to the terminology. Having this terminology at your fingertips is crucial for impressing colleagues, friends, employers and potential employers. *It is much more important than being familiar with a few equations.***

**Millicent Koslowski is an undergraduate at the University of Pittsburgh, and a financial superstar in the making. She already has an innovative way of regarding the mechanics of her career: never buy when you should sell, and never sell when you should simply go home and take a shower! Most important, her radar is never turned off. She knows that what it takes to become a ‘rocket scientist’, a superstar, is more than a perfect knowledge of *derivative* markets (e.g. futures and options markets) and a sincere belief that more money is better than less money. The most important things are an iron concentration and something they repeatedly told her brother during his basic training in the American army: *stay alert stay alive*!**

**While eating breakfast one day, her father mentioned that a friend’s Uncle Charlie phoned the friend from Genoa (Italy) and told him that all the oil tanker crews in the Gulf were talking about going on strike. That was enough to cause Millie to immediately leave the table, and before ten minutes had passed she discovered – with the aid of her computer – that this information had not reached the media. In other words, assuming that Uncle Charlie was sober, if she were prepared to place what was almost a certain bet, the means for financing her graduate studies at Harvard’s School of Business had probably made an entrance into her young life. She picked up the phone and called a mentor and former teacher, Condi Montana, who is a commodities broker. (“*Almost* a certain bet”. Formally speaking, since this wager was not 100 percent certain, it would make her a speculator, but that is mostly academic ‘nit-picking’.)**

**She informed Condi that the time had arrived to buy some futures contracts for crude oil. This is usually called ‘going *long* in *paper* *barrels’*, as compared to the ‘*wet* (i.e. physical) barrels’ aboard the oil tankers that might soon be lying idle: physical oil is also referred to as the *underlying*, but this term will not be used in the following. “How many?” inquired Condi, and so Millie informed her of the developing situation in the Gulf as explained by somebody’s Uncle Charlie, and told her to use her judgement.**

**Ms Montana immediately replied that she was going to buy 100,000 barrels (of paper oil) for Millie, which meant 100 contracts, because *all* oil futures contracts are for 1000 barrels, and since a *maturity* had to be specified for the contract, she was going to choose thirty days: after thirty days, if these (long) contracts had not been *offset* with a sell contract (i.e. a *short*), and thus her *position closed*, Millicent would be the proud owner of 100,000 barrels of physical oil in the middle of Texas or somewhere, and will also have the pleasure of paying for them. (*This is a very important observation, and it should be carefully noted and remembered.*) By entering into this arrangement (i.e. *opening a position*), Millicent has the right to call herself a speculator if she wants, *but she is NOT a speculator in physical oil*. In any event, speculation is not what Millicent aspires to, nor does she want her name associated with that line of work, even if (or when) she happens to be doing it. Readers should be clear on this point, because unfortunately a lot of people aren’t.**

**Moreover, strictly speaking, she may not be a speculator in paper oil, because if the information that is in her possession is the real deal, there is no speculation in her actions. It is a sure thing *if the strike takes place, and maybe if there is just a rumour of a likely strike that gets extensive circulation*!**

**Millie glanced at the latest edition of the *Wall Street Chronicle*, and noticed that the price of *oil futures* (with a maturity of 30 days) were $70/b, which meant that Ms Montana would be ordering about 7 million dollars (= $70 x 100,000 = $7 x 106) worth of these paper assets for her friend (and client). That number – 7 million – had a nice ring to Millie, as it would to anyone living in one of the less distinguished residential districts of Pittsburgh. The procedure usually is that she would have been asked by Condi for a (security) deposit – from 5 to 10 percent of the value of transaction, which is called *margin* – but today Condi Montana does not bother. She is quite aware that Millie does not possess that kind of money, but more important she is too busy buying barrels of paper oil for herself and her employers – probably a few million (or more) to be exact.**

**In addition, given the value of this information to Condi’s employers, they would have no problem in lending Millie this margin if it was necessary.**

**Margin enters the picture in a perfectly logical way. Millie is able to buy these contracts because someone else is willing to sell, and in a highly *liquid* market, that “someone” will always be available at the latest quoted price. Moreover, the exchange where the transaction takes place has a *Clearing House* that functions as the *counterparty* in Millie’s transaction, which means that she had no dealings at all with the person on the other side of the contract (the seller in this example), just as they have no dealings with Millie. In order to ensure that there is no non-performance risk for buyer or seller or the Clearing House, margin is required by the Clearing House (via the broker) to eliminate the risk that a buyer or seller will be unable to perform under the terms of the contract in the event of an adverse price movement. (For instance, if the price of oil fell instead of increased, then Millie might owe the clearing house money.)**

**Millicent also has every intention of reversing (going short) her initial position long before the expiry (or maturity) date of the contract (= 30 days in this example), and she should have no trouble doing this because of the adequate liquidity that characterizes the oil futures market – at one time referred to as “*the best game in town*”. In fact, with luck she might be able to close her position in a few hours (if the strike begins, or news of a possible strike gets out), but if for some reason she does not reverse (close) her position by the end of trading that day, then that night her contract will be *marked-to-the-market* by the Clearing House. This involves the daily revaluation of contracts by the Clearing House, so that if the price moves in the favour of the buyer or seller, he or she is credited with the amount (and can obtain it immediately if so desired), while if the price moved against the buyer or seller, then he or she might – *might* – have to provide more margin, which *must* be provided on request. (“Might”, because it may happen that there is sufficient money in a transactor’s account at her broker to pay the margin call.)**

**Condi Montana leans back in her chair, and with a smile on her face sips her coffee. Today is a big day in her life too, because she is aware that even a rumour of this strike could send the oil price upward and perhaps off the Richter Scale, and knowing that she also understands that, like Millie, she has been presented with the opportunity of a lifetime: the chance to change her name from Condi to Condo, in recognition of the kind of property she intends to purchase in quiet places like New Zealand or the south of Argentina – localities that would be without interest to the new crews of hijacked planes.**

**Moreover, it hardly would have made any difference if Millie and Condi and some others had bought ten million paper barrels. Even in a highly liquid market like the oil futures market, the price of futures (i.e. paper) contracts might have increased somewhat in order for a much larger order to be absorbed, but this does not necessarily mean that a drastic interpretation of this increased interest in oil futures (paper oil) would have been made by brokers and traders and analysts in the major financial institutions: large buy or sell orders are often placed because of rumours, ‘hunches’, gossip or hangovers. The important thing is realizing that where the oil price is concerned, purchasing five or ten million more barrels of paper oil would hardly have the impact on the oil price as a decline, or perhaps suspected decline, in the availability of e.g. 2 million barrels a day of physical oil that might be out of the picture for an undefined period – perhaps just a short period. That kind of event could unleash a demand for available oil that caused all prices to rise. ( Think about the war in Libya!)**

**Something that needs to be emphasized at this point is that Millie is buying *futures* and not *forward* contracts. True, a futures contract can be regarded as a forward because the delivery of the physical commodity (e.g. oil) is usually specified on the contract, but as compared to a forward contract, *delivery does not have to take place*, and indeed scarcely takes place. Instead, in a highly *liquid* futures market, if the opening transaction was buying (or going long), then a contract can be *offset* (or reversed) by just picking up the telephone and selling (or going short). As an example readers can think of the share/stock market, where e.g. a position can be opened in the stock of the firm Easy Oil by calling your broker and buying, and an hour later your position in Easy Oil can be closed by calling your broker again and selling the same amount.**

**Transactions in the futures markets for oil (and oil products) are easy to carry out because futures contracts are standard contracts, for a specific amount of a commodity, and should delivery take place because the holder of a long contract keeps the contract until the *maturity* (or *expiry*) date, which is 30 days in this example, then delivery takes place to only a few specific locations. (In the U.S. the stipulated delivery locations are (or were) New York Harbour and West Texas.) However it has become very popular to settle contracts that are *open* at the expiry date of the contract with money instead of taking (or making) delivery. This is called ‘*cash settlement’*, and is a simple matter as long as a price is available at the maturity date which both longs and shorts can use to determine which of the two is the receiver of the cash, and who has to pay. Customarily, that price is announced by the exchange, and is related to actual market conditions.**

**That afternoon, when Millie returned from the university, she switched on the television, and heard that tanker crews in the Gulf were indeed going on strike. Already the *spot* price (i.e. the price for immediate delivery) of physical oil on both the New York Mercantile Exchange (NYMEX), and (Brent oil) on the International Petroleum Exchange in London had jumped up several dollars. It was being quoted in both places as $72.5/b, but spokespersons for the oil companies are claiming that everything humanly possible was being done to reach an agreement with the tanker crews. This wasn’t easy because floating objects had been observed in Gulf waters, and when representatives of these crews questioned their employers and asked if minesweepers were available, they were told by one of those gentlemen that “every ship is capable of serving as a mine sweeper…once”. That person was only joking, but this was not the kind of humour that their employees appreciated.**

**Millie called Condi again. The price of physical oil has gone up, she told her, and once she read a brilliant energy economics textbook by a great teacher who claimed that when the price of physical oil rises, it was very likely that the price of oil on futures contracts – i.e. paper oil – would also increase.**

**“Yes”, Condi Montana told her. “I know that great book, and as usual that gentleman was correct. The price of paper barrels just moved to 73 dollars, but there is an ugly rumour going around that the strike may be settled very soon, perhaps in a few hours. In addition, although this is not always the case, the fact that the futures price is below the price of physical oil is not a good sign at the present time”.**

**“Sell my contracts now,” Millie said. “Dump them all”. Everything considered it had been a sweet ride, and although it had ended in 6 hours, she increased her ‘wealth’ (before taxes) by about $300,000 [ = 100,000 (73 – 70) ]. Normally there would also be a broker’s fee, but not on this beautiful day, because Millie’s information had made Condi rich, and the owners of Condi’s firm even richer. Something that should be noted here is that the price of futures and physicals do not have to be equal when the transaction was initiated, and the same was true when the position was closed, assuming that it was not closed on the expiry (i.e. maturity) date of the futures. (*Remember, the paper and the physical markets are different markets!* You need to understand that before you start working on Wall Street, the City of London, or reading the rest of this book.)**

**One more question needs to be asked here: why did Condi choose a contract maturity of 30 days? One reason could be that the strike mentioned by Uncle Charlie may not take place, but even so the tanker crews obviously did not like sailing around in waters in which there were or might have been mines, and they wanted more money for taking what was or might have been a risk. Accordingly, this issue was not off the table, which could be reflected in an upward spike of the oil price at any time. If that happened, you wanted to possess a few long contracts. Assuming that the oil market demonstrated more ‘bull’ (or rising) than ‘bear’ (or declining) tendencies, then holding a contract with a 30 day maturity seemed to the very smart Condi to be a good choice.**

**Now let’s turn this delightful exercise around. An acquaintance calls Condi Montana from Rome and tells her that a large oilfield has just been discovered in Western Egypt next to existing oilfields in Libya. In other words, in order to get the oil to market hardly any new pipelines will have to be constructed. Supply up, price down, as Condi (and Millie) learned in Economics 101. Condi immediately went short (sold) a very large number of contracts for herself, expecting to close her position by the end of the day with a buy that was much lower. She then called Millicent Koslowski, and gave her the news. She suggested that Millie should also make a substantial investment – for instance, sell (go short) 100,000 barrels, or 100 contracts with maturities of 1 week!**

**Readers can complete this example after reading the next paragraph. Assume that the exercise had a happy ending and explain why Millie and Condi made money!**

**Where’s the oil? How can you sell something that you don’t have, which is what my students asked me the first time that I lectured on futures markets. The answer is that if you open a futures position by selling (paper) oil (i.e. going short), you can close it at any time before the expiry date by buying the same amount (i.e. going long) in the futures market. In the situation being described the ‘ownership’ or location of physical oil is irrelevant. The important thing is that the market is ‘liquid’. (Now explain what happens if a market is not liquid for a big-time player?) If, however, the contract remains open until the closing of the exchange on the expiry date, then conventionally 100,000 barrels would have to be purchased from some source and delivered to a designated delivery point – unless of course the transaction can be cash settled!.**

**If the contract could be *cash settled*, and positions that were opened and held open until the expiry date, then persons with these open contracts would either have to pay something or receive something. The way this might go is as follows. If for some odd reason Millie’s long contracts in the first example above are not offset by closing time on the last trading day for these contracts, her position is declared closed by the exchange, and the price for her contracts is recorded as the closing price for long contracts with a 30 day maturity that are eligible for trading as near as possible to closing time. In order to find out whether Millie pays or receives money, we need another price, and that (*reference*) price is provided by the futures exchange or an adjunct of the exchange – for example the exchange’s *clearing house*, which handles its accounting, and acts as a *middleman* – i.e. a buyer to sellers, and a seller to buyers.**

**That price might be the spot price of physical oil if there is a spot market for oil, or it might be a price put together by the exchange on the basis of activities in the futures market earlier that day, or something of this sort. If the reference price is higher than the closing price on Millie’s (long) contract, then she receives the difference between that reference price and the closing price on her contract. If the reference price was lower than the price on her long contract, she pays the difference. The key thing is that persons using the exchange who do not want to deal in physical oil are not put in a position where they must buy or sell physical oil if for some reason they did not close their contracts (i.e. close their positions) before the expiration date on the contract.**

**That brings us to *hedging* – i.e. a sort of insurance against unpleasant (or undesirable) price movements up or down. And observe: we are not talking about hedge *funds* , because in reality these are speculative funds, and apparently some of these fail every year. Over recent years, with the economies of the U.S. and Europe in often deep trouble, perhaps many of these hedge funds failed, and many of the others have probably lost a lot of money. Of course, some of these may already be back in business under another firm name, and in some other part of the country. After all, it didn’t take the directors of *Long Term Capital Management* many months after their fund ‘tanked’ before they were merrily practicing their trade in new offices.**

**In any event, suppose that two weeks ago you concluded that the price of physical oil was going to rise to $80/b or above, and so you went down to the local 7-11 and bought two thousand barrels of *physical* oil for $70/b, which was the price for oil at that time. But now you are not so sure as you were then that the oil price is going to rise, and so you find yourself with an overwhelming urge to hedge your investment. How would you initiate this particular risk management exercise?**

**One way is to call Condi Montana and tell her that you wanted to sell (i.e. go short) two futures contracts (= 2000 barrels). Then, if the price falls, what you lose on physical oil that you are holding will be approximately gained on a futures transaction, because later you can close your futures position with a ‘buy’ at a lower price than the price you received when you went short. Moreover, if it appears that certain so-called experts were right and the bottom is going to fall out of the oil market, you should find it easy to sell the small amount of physical oil that you are storing in every square meter of your home, while perhaps keeping your futures contracts, which – since you opened your position by going short – become more valuable with every decrease in their price. Or, if things went the other way, or if indications were that the oil price would go up, *reverse* (i.e. *offset*) your short futures position by going long two contracts, and retain your physical oil. Maybe the price will break the $100/b barrier, and in the ensuing buying spree, you can make some serious money. If you can’t make up your mind, you can call Millie, who will soon be on her way to a corner office on Wall Street.**

**At this point readers should take a deep breath, and ‘accessing’ a pen and paper, make sure that they understand the previous paragraph perfectly.**

**Something else worth understanding before turning to the delicate topic of speculation (gambling) versus fundamentals (supply and demand) for the oil market is that Condi Montana works as a broker because she wants to avoid some of the stress that is endemic in high-pressure financial institutions. But earlier she did *proprietary trading* in an investment bank, which means that she traded for them, and in return received a large salary and – if things went well – a nice bonus. And things usually did go well, because as Gordon Gekko explained to Bud Fox in the film *Wall Street*, the key thing in his business was information, and the trading departments in the major investment banks have access to a very large amount. At the same time they employed people like Condi who knew how to interpret and use this information.**

 **Something else: at the bank at which Ms Montana worked, at no time did anyone call themselves speculators. Her firm makes it clear to its employees that they do not hire *speculators*, although speculating is what these employees mostly do or advise their clients to do. The title on their business cards is trader, and when asked they sometimes tell people that they do proprietary trading. In appearance they resembled the ladies and gentlemen in front of the screens in the film *Wall Street*, and they have comparable backgrounds. Condi Montana, when she was working for an investment bank, would be a good example. The traders in her department at the bank really and truly understood the dynamics of oil markets, because if they don’t they were encouraged by their superiors – at e.g. investment banks and other financial institutions – to transfer their activities to bar stools at the nearest pub, and let someone who knows what they are doing take their place in front of a computer in one of the firm’s trading rooms.**

**Exactly what the persons on CNN and Bloomberg know about the oil market at the present time is uncertain, but Condi and her colleagues understand that we have come to a point in history where demand might outrun supply, and OPEC has its act together. (You might understand that too, if it wasn’t for all the talk about shale.) That makes it plain what actions they should always be prepared to take. In other words, if Ms Sally tells them that the oil price is liable to go up later that week, and Mr Bill insists that it is going to go down, Ms Sally is the person that you talk to if your time is limited.**

**In my course on oil and gas economics at the Asian Institute of Technology (Bangkok) several years ago, two oil price escalations were discussed at great length. One ‘about’ 1979-80, when the Shah said goodbye to Iran, while the next was in l990-91, during the run-up to the first Gulf War. Readers should learn something about escalations of this nature, and what they meant for the global macro-economy. Not too long ago, attention was concentrated on the movement of the oil price to $147/b. The *finale* of that breath-taking escalation began in 2008, and somewhat earlier a journalist in *Le Monde*, Jean-Michel Bezat, had some very disturbing information to present his readers about the intentions of King Abdullah of Saudi Arabia where the supply of oil was concerned. Among other things, His Majesty said that when there were new discoveries, they should be left in the ground for the children *(les enfants*) of the Kingdom. That was no news to many of us, because 35 years earlier another king of Saudi Arabia said almost the same thing.**

**Let’s look at several of these upward oil price movements, namely *spikes*. The first mentioned above (1980) raised the price several hundred percent before it swung back, and if you examine a plot of oil prices during that period, you would use the expression ‘spike’ to describe what was taking place: the oil price jumped up and fell back in a fairly short time. The second drama, at the beginning of the First Gulf War, was very definitely a spike of about one-hundred percent. The question asked at that time was ‘why did things move so fast?’ At no time did it appear to professionals like Condi – before or after the results were in and analysed – that these spikes could be turned into sustainable price rises, even if they and hundreds like them bought futures contracts and contracts for physical oil day and night. *The objective market conditions were not right*!**

**The lesson here was the same one that Condi received in graduate school, and later when she began to earn her living in the financial district: except for very special occasions, it makes sense to believe that the market is *bigger* and smarter than any individual or comparatively small group of individuals. Those spikes were caused by special events, and the players that got in early made a bundle if they did not try to prolong their windfalls, while many of those who came in late took a fall. They took a fall because, as Condi and her colleagues understood, there was a great deal of easily obtainable oil in the crust of the earth, and in addition oil producers possessed considerable spare capacity – definitely several million barrels per day. It has also been claimed – though not by reliable sources – that there was considerable ‘cheating’ by OPEC producers who ignored OPEC quotas. In any event, the price had to fall.**

**The price rise that began in 2002-04 , and accelerated in 2008, was not a spike. Condi understood that very early. It was a sustained price rise in which the latter phase continued for several months, and she made a lot of money for her firm – and herself – because she understood that demand was outrunning supply. Specifically, OPEC restrained supply, and the faster the price increased the more reluctant some OPEC countries became to increase their supply of oil, or to increase the mere 2 mb/d of spare producing capacity. *You would have behaved the same way if you had been in their place*! Condi was paid by her firm to trade – or if you want to call it speculate, please do so – but the reason she made this money was because she knew more about oil market fundamentals than traders/speculators whose grasp of fundamentals was inadequate.**

**In the objective circumstances prevailing in 2008, speculators, anti-speculators, traders, neighbourhood betting syndicates, moonwalkers, day-trippers or anybody with an urge to make some quick cash went long in oil (by which I mean that they purchased oil futures, but not for the most part physical oil). This was the period when the billionaire investor T. Boone Pickens predicted that oil was on its way to $200/b, and he might have been correct if the macroeconomic and financial market meltdowns had not commenced. It should also have been clear at a fairly early stage that this (outrageously) high oil price could lead to some very bad macroeconomic news.**

**Notice the statement above about speculators and others going long. Condi Montana analysed the situation correctly, and she and the people in the trading rooms went long in oil futures. Then who went short? The answer is traders and speculators and others who initially did not believe that the oil price was going to rise, or who paid the wrong people for investment advice, or who were willing to bet that the moment of truth would not arrive as fast as it did, and just as important, if for some reason the market started to move in an unexpected way, they would be warned by their firm’s analysts, or somebody’s analysts, and could get out the emergency exit before suffering a great deal of damage. Many traders went short because they had been badly burned earlier when they went long, and later, some of these short speculators might have closed their positions and went net long. In that case, who goes short for them? Maybe some of Millicent’s classmates, along with some people at various investment banks who had been watching developments in the oil market, and impetuously concluded that the sweet ride was over and they should close long positions and go short *(in oil futures*).**

**Suppose there is nobody to go short – *everybody* wants to go long. Then the price of futures contracts races up until a big subset of speculators and others change their mind, explaining to themselves and everybody around them that all good things eventually come to an end.**

 **Perhaps the price of physical oil at NYMEX reaches $140/b, at which height it continues to rise, but slowly, and a large group of traders and others decide that the good times are going to stop rolling for oil futures, and it was time to head for the door. The same might be true for oil firms and others who were speculating in physical oil – yes, in physical oil, since they were in possession of warehouses, and railroad tank cars, and other properties on which oil could be stored. Why would they decide this? Maybe it was because they or their ‘strategists’ heard that a large part of the macro-economy was on its way into the ‘tank’, which meant that it was very likely that the bottom was going to fall out of the market for physical oil (as well as paper oil – oil futures – in case they were also active in that market).**

**Important in this oil escalation drama was the visit of President Bush to Saudi Arabia in May (2008), when he requested some assistance with the oil price from King Abdullah, preferably in the form of more output and also investment in new capacity. The well known outcome of that episode was that his host graciously thanked him for his concern, and wished him a safe flight back to Washington. Please note again that the president went to Saudi Arabia to talk to the king of that country about *physical oil*, and not to Wall Street to plead his case to ‘masters of the universe’ who were dealing in *paper oil* (i.e. futures). One reason he did that was because his Secretary of the Treasury, Henry Paulson – a Wall Street veteran – informed him that it was fundamentals in the form of insufficient physical oil that was the villain in this price escalation. Mr Paulson had earlier been the CEO of perhaps the most successful investment bank in the world, Goldman Sachs, and he almost certainly still talked to their oil experts and strategists, who were not in the business of making mistakes.**

**According to some information once published by Murray Duffin, an important contributor to *Energy Pulse*, it was possible that there was no shortage of oil during the second quarter of 2008, and speculators – or *noise speculators* as they would be called in academia – accounted for the rise in the oil price above $110/b in that same year. Maybe they did, but that figure sounds wrong to me, although it doesn’t really make any difference. The key thing is that without demand outrunning supply, and OPEC playing the game the way that smart people are supposed to play it, the sustained oil price escalation during 2008 that accounted for enormous revenues for some OPEC countries could not have taken place, and the rise in price during 2008 would have shown up on the charts as a spike. I can add that according to the United States Energy Information Agency, OPEC raked in more than 900 billion dollars in 2008. *This could never have happened if they (and perhaps big oil firms) had not restricted the supply of physical oil*!**

**In his testimony before a congressional committee, Michael Masters took what was virtually a sacred oath that speculators were responsible for the big oil price upswing in 2008. He undoubtedly acquired some sympathisers, though his logic was very different from that in the above discussion, where the point is that the price rise originated with fundamentals in which demand was outrunning supply in the physical market, and to which speculators reacted in the paper market – and probably to a certain extent in the physical market *on that occasion*. *There is no need to claim that speculators are always losers in the long run, and for the most part are impotent in the short run, but successful speculators specialize in understanding and reacting to the fundamentals*. Mr Masters also seemed to be in favour of not interfering with the market except to ban or restrain speculation. That would be something like banning the musical background in a Fred Astaire or Gene Kelly film, or perhaps limiting it to a harmonica.**

 **OPEC weighed in on discussions about the oil price rise by claiming that speculators were running wild, although to my way of thinking OPEC’s (sophisticated) supply policy is perhaps the cornerstone of today’s oil market fundamentals. Even if Mr Masters and his distinguished interrogators did not understand this rather unique situation, intelligent traders and the analysts and managers with whom they work did.**

 **And finally, it should be noted that a partial or full reduction in speculation in oil futures would have drastic (negative) consequences for the hedging of (oil) price risk – a hedging by consumers and producers of physical oil. If Mr Masters had been aware of this, and what it would mean for future investment and production in the oil sector, he might have tried to be less dramatic in his condemnation of speculation.**

**Here we have a problem, because there is not enough liquidity in contracts of that maturity (i.e. 2 or 3 years) to exploit the supposed wisdom of the market. This point is not adequately understood, despite its importance. What might be called optimal market wisdom is available only with the interaction of large numbers of market actors in a highly liquid market, and preferably where these actors are mostly rational and not ‘noise traders’, and trading is in contracts with comparatively short maturities! Given that background, a futures price is sometimes thought of as a sort of ‘average’ expected price. Moreover, as they sometimes say on Wall Street, ‘the market knows more than any one player’, although in the example above it didn’t know more than Millicent and Condi, because these two ‘stars’ had access to crucial private information.**

**Incidentally, shortly after he became chairman of the US Federal Reserve System, Professor Ben Bernanke (of Princeton University), remarked that he could not detect any danger of a spectacular oil price escalation. He had somehow come to the conclusion, or been informed, that long-term futures contracts can provide valid information about long-term oil prices. Sorry Professor Bernanke, but you were wrong.**

**The thing to understand here is that there is not enough liquidity in contracts of that maturity (i.e. 2 or 3 years) to exploit the supposed wisdom of the market. This point is not adequately understood, despite its importance. What might be called optimal market wisdom is available only with the interaction of large numbers of market actors in a highly liquid market, and preferably where these actors are mostly rational and not ‘noise traders’, and in addition are trading is in contracts with comparatively short maturities! Moreover, as they sometimes say on Wall Street, ‘the market knows more than any one player’, although in the example above it didn’t know more than Millicent and Condi. Of course, in that example these two ‘stars’ had access to *crucial* private information. *The kind of information that makes people rich*!**

 **Some very smart persons have informed me that it is a statistical fact that severe oil price escalations have never been indicated by movements in futures prices, but instead tend to be the result of anomalous events (such as rifle-play in certain sensitive regions of the world). Of course, in terms of financial theory, futures prices are *not* ‘efficient’ estimators of physical oil prices in the future, and *long-term futures prices* have absolutely no explanatory power. Make an effort to remember this!**

**One of the directors of Shell (the third largest of the Non-OPEC majors), claimed that the blame for high oil (and gasoline) prices should be placed on the financial markets. But when he expanded on this hypothesis, he got just about everything wrong. He said “So if inventories are normal, why should the price be so high?” He answered his own question by saying “I know various pension funds that had money in bonds, in shares. Now they went into commodities.” I don’t think so, Mr van der Veer. Actually, most of the money that you are talking about went into paper commodities (i.e. futures and options on oil). Another ‘expert’ on this topic is the Fox News story-teller, Mr Bill O’Reilly. His genius led him to provide the following reason for high oil and gas prices: “those Vegas type people who sit in front of their computers and bid on futures contracts” (*Fortune*, May 29, 2006, page 28). “Vegas type people” indeed.**

**One more point. A young lady named Chloe once informed Professor Banks that he did not know what he was talking about when he said that speculation had not brought the world economy to its knees. Didn’t he know that for every barrel of oil traded in the physical market, more than twenty were traded in the paper market.**

**The good Professor may or may not have known this Chloe, but it wasn’t the trading/gambling at NYMEX in New York that put the blocks to the world economy, nor gambling in Vegas. It was the rising price of physical oil due to demand outrunning supply. Also, when demand fell, supply was carefully adjusted downward by OPEC. By how much? Well, if a decline of 1.7 mb/d can raise the price of oil by 17%, as happened when the war in Libya began, it wouldn’t take much more to get the price climb we saw in 2008, when real experts said the oil price might go to 200 dollars or more, and gossip said that every oil storage tank in the world was being filled as a precaution.**

**If you read my energy economics books and articles, you will be told that inventories, as they are explained in this book, are important in the oil pricing process. Try to understand this if you have an ambition to impress the folks in the executive suites when you go hunting for a job with a high salary.**

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**AN ENERGY ECONOMICS TRUTH GAME**

***The Atlantic* is an important United States (U.S.) publication, and those of us who occasionally read it like to think that they only publish authors who know what they are talking about. One of their favorite contributors is Charles C. Mann, but a recent issue (May 2013) featured an article he wrote about oil (and some other aspects of energy) that hardly deserves to be called worthless. Moreover, when challenged about nuclear the following month by Professor (of physics) Kevin Cahill of the University of New Mexico, Mr Mann responded with "it seems to me that the world has chosen, for better or worse, not to use nuclear power."**

**With all due respect, it seems clear to this humble teacher of energy economics that "the world" has not chosen anything of the sort. Germany was of course noted by Mr Mann in his reply to Professor Cahill, and he could have also mentioned Japan, although the attitude toward nuclear in those two countries has nothing to do with engineering or economics. The truth is that it has everything to do with politics. By that I mean obtaining or not losing the votes of environmentalists and their sympathizers. *What readers should concentrate on, and should never forget, is that globally more than 60 nuclear facilities are or soon will be in the process of construction, between 50 and 100 are somewhere in the planning stage (mostly in China), and more than 400 are in operation.* Japan is reconsidering its position on nuclear, and according to yours truly will return to – or exceed – its former nuclear intensity. Nuclear produces 11% of the world’s electricity, but 21% in the OECD countries (mostly Europe and North America).**

**Something that deserves attention here is the failure of Mr Mann to access this information about the nuclear future, because twenty minutes spent with the discussions about energy on the superb site *EnergyPulse*, and energy reports from all over the world on the site *321 Energy*, would make it virtually impossible for an intelligent person to entertain the kind of statement that Charles Mann made above, and in addition to magnify this misunderstanding by acting as a propagandist for methane hydrate, which for many years has been an energy source with a looney-tune patronage.**

**In the same issue as the 'piece' by Charles Mann, there is an article called 'Learning to Live with Fossil Fuels', which focuses on what its authors call the capture of carbon. I don't know when this article was written, but I was of the opinion that *Carbon Capture and Sequestration* (CCS) was a lost cause - or "thermodynamic travesty", as it was labeled by the MIT graduate and energy economist in Germany, Jeffrey Michel. I occasionally extend this judgment by claiming that CCS is recognized as a loser by almost everybody not participating in some version of a CCS scam.**

**Unfortunately those last remarks require amplification, because everyone has not had the opportunity to enjoy a course in thermodynamics at MIT or at my school IIT (Illinois Institute of Technology, in Chicago), but I think that this matter can be easily clarified. The 'carbon' (or CO2)from a power plant goes to a separation facility and from there into a pipeline that with the aid of compression equipment takes it to a storage facility, that eventually – with the assistance of injection equipment – pushes it into unmined coal beds or depleted oil or gas reservoirs or deep saline aquifers or something equally as exotic, assuming that they exist and are accessible without a declaration of war. Thus, the thermodynamic travesty alluded to by Jeffrey Michel will be described to my charming students as an economics travesty, because with a few exceptions, all of this collecting, moving and (though not mentioned) *processing* of carbon could involve very serious money. So serious that some of the ladies and gentlemen in the executive suites might argue that it would be best to allow this carbon to escape into the upper atmosphere, where it may not cause you and yours any trouble for a few centuries, or if you and yours are unlucky decades.**

**During a meeting I attended of the *Network for Oil and Gas* (NOG), a Swedish forum for discussing energy problems that operates on about the same intellectual level as a Boston Public pyjama party, a young and probably honest engineer employed by the Swedish utility Vattenfall was asked what provision had been made to avoid environmental deterioration from Vattenfall's activities in the production and use of coal in Germany. His answer, which was very brief, and contained a reference to a CCS project of his firm in Germany, was delivered with such sincerity that I am sure I was not the only person among his large audience who believed that he had not bought the bizarre lie about the efficiency of CCS disseminated by the people who paid his salary. The truth is however that somebody has bought it, because the plans of Vattenfall for their CCS experiment in Germany was strictly off-the-wall.**

**Another lie that missed its mark that wonderful day concerned the prospects for wind and solar in Germany and Denmark, because before the conclusion of that meeting it was made it clear to anyone willing to listen to yours truly that the highest cost of electricity in Europe is in Denmark and Germany, and furthermore no attempt is made in those countries to conceal the fact that this burden must be foisted on businesses and households alike in order to obtain the subsidies required to support or encourage the utilization of wind in Denmark, and wind and solar in Germany.**

**What *is* concealed that a portion of this burden is unloaded on (electric) rate payers in surrounding countries, because as a Belgium researcher noted at a conference in Stockholm a few years ago, if the Germans carried out the insane nuclear downsizing they keep talking about, then electricity might have to be rationed in his country. Put more directly, the replacement in Germany for electricity from German nuclear equipment would include not just wind and solar and coal, but also imported electricity, and that would raise the price of electricity in every country whose government was not intelligent enough to prohibit the export of electricity, or to make electricity exports to Germany so expensive that they lose their taste for economic nonsense.**

**How much of the above do I expect my students to study and accept without a question? I think that I will limit it to the easily provable TRUTH that a comprehensive nuclear retreat is NOT taking place on a global scale, regardless of the lies and misunderstandings to the contrary. I would also be grateful if my students and everyone else with the opportunity to attend my lectures would accept – as I do – that *Germany and Japan will probably be the most nuclear intensive countries in the world by the middle of this century,* although if my students deny it and call me a fool for broaching this subject, I can assure them now that their grades for my course will not be influenced. After all, we Americans were once deservedly praised for our good sportsmanship.**

**What do important and articulate people - as well as the rest of us - want from renewables like wind and solar. I think it fair to assume that most people want them adopted when it makes economic sense to adopt them, and I hope that I am not departing from the truth when I say that at least a few persons like myself do not mind if this involves subsidies. Take for example the Swedish nuclear inventory. Twelve reactors were constructed in this country in just under 14 years, and for *taxpayers* *as a whole*, this did not involve a penny in subsidies. Those reactors, together with the hydro that supplied most of the remainder of Swedish electricity, gave Sweden some of the most inexpensive electricity in the world, *which in turn provided a boost to employment and incomes that more than paid for the reactors.* Of course, the curse of electric deregulation wiped out some of the gains, but that is another matter.**

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**A SHORT CONCLUSION FOR A LONG CHAPTER**

Back on Oct 8th, in Richard (Vesel)'s comment telling us how renewables can become the principle supply of energy, he tells us renewables in 2013 were already 22% of our supply.

He does not tell us that this rosy figure includes Hydro, nor that tripling Hydro output would not be so easy. I'll bet that most folks think wind and solar and not Hoover or Aswan Dams when they hear renewable. The figure I recall for 2013 is 0.53% furnished by PV solar. Fossil fuels supplied about 66%. So he might have mentioned fossil fuels supplied about 125 times as much energy as did solar PV. in 2013.

 – Don Hirschberg (On *Energy Pulse*, October 16)

**Richard Vesel and Don Hirshberg are both brilliant commentators on the site *Energy Pulse*, but where energy is concerned people have a tendency to make mistake, and even worse not to learn from those mistakes. The biggest (and perhaps eventually the costliest) mistakes are about nuclear, but wind and solar collect their share.**

**According to a recent issue of *The Economist* (January 4, 2014), Britain obtains more electricity from *off-shore* wind farms than all other countries combined, and they give as the reason the European law which states that 30% of that country’s electricity must be generated from renewable sources by 2020. According to that publication, nuclear energy is excluded from this accounting, and since Britain is – in their words – behind on solar power, more wind turbines and biomass will be required.**

**Now we see why this book is required. Professor Dieter Helm of Oxford University calls offshore wind power “among the most expensive ways of marginally reducing carbon emissions known to man”, by which he is referring to subsidies required to obtain investment in some renewables, (to include wind power), and the sad fact that wind turbines only produce power about a third of the time. Translation: the average CAPACITY FACTOR (CF) of wind power is about 33 percent for offshore wind power, although for onshore installations it is usually less, and sometimes much less. Look at it this way, if the electricity for the bulbs in your town house or castle were only supplied by off-shore wind turbines, then on the average, two of three times when you press the light switch, nothing would happen. By the same token, if the *CAPACITY* of all the wind turbines in the UK – in watts , or megawatts (where 1 megawatt = 1 million watts), or gigawatts (where 1 gigawatt = 1 billion watts) was about the same as that of the nine nuclear power stations in the UK, the *ENERGY* delivered (in watt hours, or megawatt hours, or gigawatt hours) would be just slightly more than a third of that from the nine nuclear facilities, since the average CF of nuclear facilities is also less than 100%, but probably above 90%. (Once Swedish nuclear had the highest CF (94%) in the world, but this disturbed the ladies and gentlemen who equate excellence to arrogance.)**

**Readers should take this business of capacity factors seriously, and if they have further questions look for answers in GOOGLE. Something else they should be aware of is that the presence of electricity from renewables in a *grid* – i.e. a collection of wires carrying electricity – can mean serious *instability* for that grid. Guarding against instability can be expensive, and perhaps the best non-technical discussion of this matter can be found on the site *Energy Pulse* in an article by Davis Swan (2014). As for easily finding out important things about nuclear, see the book by Anthony D. Owen (1985).**

**With luck, readers now have a good start in learning a few very important things about energy economics. Perhaps one of the most important of these ‘things’ is that the persons who decided that Britain must get 30% of its electricity from renewables by 2030, excluding nuclear, are out of step with economic reality, and the talented advisers of those upper-echelon ladies and gentlemen prefer not to be messengers who bring the bad news about what might become a deteriorating energy situation for that country, or for that matter any country that becomes careless about its energy supply.**

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**3. THE WORLD OIL MARKET**

**INTRODUCTION: OIL AND THE FUTURE**

**According to Professor Vaclav Smil, (2002) “Most discussions of the earth’s energy resources and their use by modern societies betray a widespread lack of scientific literacy, and abound in misinformation, biases, and proffers of dubious solutions driven by various special-interest agendas.”**

**Unfortunately, I think that this magnificently perceptive observation is blemished by that scholar later referring to oil pessimists as “Cassandras”, and in the course of his presentation, heavily endorsing such things as an evaluation of global oil reserves by the United States Geological Survey (USGS), which estimated that *undiscovered* conventional oil reserves were plentiful, and 20 percent or higher than that agency’s previous assessment, which immediately leads to the question of how those ladies and gentlemen arrived at the estimate of 20%. (It can be added that in Greek mythology, Cassandra, the daughter of Priam, actually possessed the gift of prophecy, but it was her fate never to be believed. For some reason, her name has come to mean someone who predicts misfortune.)**

**There is also a cheerful reference to the value of the unconventional oil that is “locked” in tar sands (or ‘oil sands’) and oil shale, and it was duly noted that these resources were already being exploited in Canada and Venezuela. Where the latter is concerned, he probably meant ‘heavy oil’, which is oil that belongs in a very different category from the highly desirable ‘light oils’, and here it pays to notice that *oil reserves* consist of oil that can be extracted at a cost that is approximately the same as the oil that is presently being exploited. This is reportedly *not* the case with most of the heavy oil in Venezuela, because a few years ago an oil company executive took virtually a sacred vow that his firm would find some way to increase the output from heavy oil deposits.**

**Shale oil (and shale gas) have turned out to be a big deal in the United States (U.S.), particularly the Bakken, Eagle Ford, and Marcellus shale deposits. Eagle Ford shale in Texas is receiving a great deal of attention, and across the U.S. the number of oil rigs is now about 1,550, which is the highest level since record keeping began 26 years ago. (The expression ‘oil rig’ may refer to a drilling rig or oil platform, where the former is an apparatus for on-land oil drilling and extraction, while the latter is a facility for offshore drilling and extraction. )**

**These and other oil rigs in the U.S. are being financed by some of the 165 billion dollars scheduled to go into (probably new) oil production and exploration this year (2014). It is difficult to ignore however a statement by the CEO of ExxonMobil, often the most profitable of all the firms in the U.S., that it has not been possible to exploit shale outside the U.S. with the same facility as within, and there are even some shale deposits in the U.S. which have been extremely disappointing. He should very definitely know, because that brilliant firm paid 41 billion dollars for shale properties that, in his words, have left his firm ‘in a world of hurt’.**

**At the present time (2014), the largest oil producers in the world, in millions of barrels a day (= Mb/d), are Saudi Arabia (10-11), Russia (10), U.S. ( 9-10+), China (4), Canada (3.7), Iran (3.7), United Arab Emirates (3.4), Iraq (3), Kuwait (3), Mexico (2.9). Venezuela (2.7). Two decades ago Norway and the U.K. might have been on this roster, but output in these countries peaked about the turn of the century, and there is no sign of recovery. It can also be noted that oil production in the U.S. peaked in late 1970, but due to the exploitation of shale oil, a new peak may be realized. Even so, there is no reason to be over-optimistic, because despite the talk of the U.S. becoming a major oil and natural gas exporter, that country is still an importer of these items. The U.S. imports 7+ mb/d of oil, and the biggest U.S. suppliers are Canada, Mexico, Venezuela and Nigeria. Nigeria though has said that they will not export any longer to the U.S.**

**Many persons who read this book might already have a modest acquaintance with academic energy economics, and this acquaintance may have convinced them that when considering oil and oil-type markets, and the price of these commodities, the work of Harold Hotelling (1931) should be carefully scrutinized. Hotelling was a brilliant economist, and it is easy to believe – as Professor Hotelling told us to believe – that if it appears that the oil price is going to rise, and we are in possession of oil that could be extracted and sold tomorrow or today, then if there was an *expected* price rise that was very large, we should wait and sell tomorrow. But merely accepting this does not tell us what we need to know in order to think and talk in a logical and impressive manner about oil and gas, and also other resources (like copper). We need to know more, and the purpose of this book is to provide a part of that ‘more’ in simple terms, employing orthodox terminology from academic economics.**

**One final remark before getting down to serious business. If the opinion of the present author is that Hotelling’s work on resource extraction is ‘lightweight’, then how did Robert Solow – outstanding teacher and Nobel Laureate – become involved with it. The key observation here is that Solow’s brilliant article (1974) was not concerned with more than a presentation, simplification and extension of Hotelling’s theory of resource extraction at a time when the pedagogical literature was *exclusively* in an elementary ‘Hotellian’ mode. The belief that Hotelling’s model or any embellishment thereof could interpret or predict supply and price movements in real world energy markets – especially oil markets – made its appearance a few years later. Furthermore, it is difficult to understand the popularity of Hotelling’s work, or why it received a respect that it did not deserve. A respect that prevented an earlier introduction of more sophisticated modes, by which I am NOT referring to my own work.**

**It is here that alert students should take special note of some valuable advice from physics: the important thing is not to come up with new ideas – there are always plenty of those available – but to get rid of defective notions as rapidly as possible.**

**Another example might be useful. Serious fighting may be taking place again in Iraq, production trends have been pronounced as weak or downward in Venezuela and Mexico, the oil sector in Nigeria is ostensibly in trouble from well-organized theft, and bad things are happening in Libya, where a war was once started by the NATO ‘president’ to ostensibly protect civilians, but was actually aimed at providing increased access for somebody to the oil in that country, which has the largest confirmed reserves in Africa.**

**These ‘irregularities’ ostensibly attached a *risk* *premium* to the (‘appropriate’ or ‘relevant’ or ‘equilibrium’ or ‘competitive or ‘whatever’) world oil price, causing – in June of 2014 – that price to begin rising at an unexpected rate. A theory has been launched that without that risk premium, and taking into consideration ‘bad vibes’ from the direction of the Ukraine, the (average) world price of oil would or should descend from its present value – whatever that happened to be – to something much lower. Perhaps down to the ‘eighties’. Consequently, we are sometimes told, that the oil importing countries should to everything possible to weaken OPEC, and where weakening OPEC is concerned, Iraq – which is sometimes called ‘The New Prize’ – and shale oil are usually mentioned. This is a good topic for your next lecture, especially if a collection of self-appointed energy experts are sitting in the first row.**

**With all due respect, I don’t have much confidence in analyses and predictions about shale resources, nor fantasies about the defection of Iraq from The *Organization of Oil Exporting Countries* (OPEC). That organization may or may not control the oil price, but in the immediate future it has enough ‘juice’ to put a ‘floor’ under the oil price of around $100/b, which at the present time suffices to provide OPEC with an annual income of approximately a trillion dollars (= $1,000,000,000,000 = 1012 dollars). This might also be the place to quote the often quoted T. Boone Pickens: “OPEC sets the price for oil. Of the 92 Mb produced every day in the world, OPEC is producing a third of it. It is big enough, and it is organized and credible. It is a cartel. 30% of oil can set the price by adjusting their ‘spot’ sales**.” **Good for you Mister Pickens! This is a judgment that merits the widest possible circulation, and you deserve our thanks, even if it happens that as these lines are being written, the oil price may be falling. There is a reason for that, and readers should be able to determine that reason for themselves.**

**THE PRODUCTION OF CRUDE OIL**

**Crude oil is unprocessed oil – or oil in the form that it comes out of the ground. As it happens, Hollywood has provided a dramatic look at production processes in the first part of the 20th Century with its films ‘*Giant*’ and ‘*There Will be Blood’*. In Giant the erratic Jett Rink is a parody of ‘Dad’ Joiner, who in l930 brought in the first gusher of the huge East Texas oil field. As for later activities in the U.S. oil sector, readers should turn to Google and the topics ‘Oil production’, ‘Nodding Donkeys’ and ‘Oil Towers.’ An investment of 20 minutes should provide all you need to know about these expressions.**

**Dad Joiner and Daniel Plainview (from ‘Blood’) were very different from Edwin L. Drake, a former conductor on the New York and New Haven Railroad, who some observers believe drilled the world’s first oil well in northeastern Pennsylvania (U.S.). Other observers say that the first well was probably drilled in Southern Russia – probably around Baku or Batum. Apparently it was ‘party time’ almost every night in and around those two Russian localities, while Drake had to content himself with the bogus title of Colonel, and a torrent of alcohol that eventually destroyed his health.**

**As for Dad Joiner, he eventually fell afoul of the machinations of Harold Lafayette Hunt, who in addition to being a billionaire and spectacular poker player, was the father of Lamar and Nelson Bunker Hunt, who both became well-known Americans. The first in professional football, where he founded the American Football League, and the second as the proprietor of a brilliant (but eventually faulty) scheme to corner the world silver market. Bunker Hunt also became involved with oil in Libya, and had to stand helplessly by when his oil properties were nationalized by Muammar (Colonel) Gadaffi.**

**People like Dad Joiner, or for that matter Jett Rink and Daniel Plainview, would not have much to contribute to the oil scene today. The emphasis now is on skilled engineering and innovative management, and the largest oil firms are among the richest firms (in *all* categories) in the world. Moreover, a large part of oil production has moved offshore, where the money needed to locate and produce oil is beyond the means of all except the largest enterprises. One point that deserves to be emphasized is that oil should already be considered scarce in relation to the future demand for this commodity. The talk about reducing the demand for fossil fuels thus has a tendency to stress coal and to exclude oil, from which motor and aviation fuels are manufactured.**

**This situation has undoubtedly been recognized by the OPEC directorate, which explains why they are not making an effort to get their members to expand their (production) capacity. Instead, many OPEC investments are (or will be) directed into the processing of crude oil into oil products (e.g. motor fuels, kerosene, fuel oil, etc), and once these products are available, a portion of them will be used as inputs in the production of petrochemicals.**

 **It has now become clear to a large number of concerned observers that October, 1973, and the nationalization of many oil properties by OPEC countries, was a turning point in modern economic history. Aside from the near panic that accompanied these nationalizations and the following oil price escalation (or ‘*shock’* as it is usually called), perhaps the most vivid recollection of that dramatic period was the general failure by economists and politicians to comprehend the character and significance of OPEC, and what the logical and legitimate ambitions of certain key OPEC countries could or would eventually mean for the politics, philosophy and economics of virtually every country in the world, regardless of their access to oil or other energy resources.**

**Somewhat earlier, Enrico Mattei had coined the phrase “the Seven Sisters” to describe the petroleum world’s ‘movers and shakers’. (Petroleum is oil, but sometimes it means oil *and* natural gas.) The Seven have now morphed into Four – ExxonMobil and Chevron of the US, and Europe’s British Petroleum (BP) and Royal Dutch Shell. According to a recent article in the *Financial Times* (March 12, 2007), there is a new Seven that deserves at least a modicum of attention: Saudi (Arabia) Aramco, Russia’s Gazprom, CNPC of China, NIOC of Iran, Venezuela’s PDVSA, Brazil’s Petrobras and Petronas of Malaysia. These are important enterprises, and CNPC and Petronas are – or have been – particularly aggressive, but with the exception of Aramco and Gazprom, not quite in the ‘class’ of the Big Four.**

**According to the International Energy Agency (IEA), ninety percent of new oil supplies in the next 35 or 40 years will come from developing countries. Ordinarily this could be regarded as a cheerful piece of news, however careful readers have learned to ignore the often flawed IEA prognoses that are taken so seriously by reporters, certain news magazines, and of course television outlets such as CNN and BBC. I suggest that you should be careful with those sources, because their ‘experts’ are often prone to confuse gossip with economic logic.**

**For example, Saudi Arabia (owner of a large slice of world oil reserves) once convinced the IEA and a few other organization that they would boost production capacity to 15 mb/d, or thereabouts, and would do so in the not too distant future. It was obvious that this was not going to happen, because since the first oil price shock the governments of that country have assured all who are interested that their production will never exceed 10 or 11 million barrels of oil a day, and even if they occasionally exceeded this number, it would not make the forecasts of the IEA and the United States Department of Energy (USDOE) more palatable. In the executive suites of Big Oil, an implied or shouted belief by OPEC that they will greatly increase their sustainable output of conventional oil in the near or distant future is regarded as being without any economic, geological or political feasibility, regardless of what spokespersons of e.g. the ‘Big Four’ say when the TV cameras are turned in their direction.**

**It has been suggested to me that a portion of this book should be devoted to arguing that more attention should be paid the macroeconomic and political situations that could unfold in the event of explosive oil price rises of the kind that took place in 2008, when the demand for oil ‘outran’ the supply, and some predictions about future oil prices were literally unreal. (For example, up to $250/b). I have lectured on this extensively, and in my opinion the key point is that the price of oil determines the price of most energy resources, and definitely the other fossil fuels – natural gas and coal.**

**And surprisingly for some, though not for me I must confess, when the oil price escalates, the thoughts of intelligent politicians turn toward nuclear. As far as I can tell, this *always* happens, and it happens because an abrupt energy price escalation could have a sharp impact on productivity, and thus employment and the incomes of voters. It might also lead to a belief by large numbers of voters in the energy importing world that military action launched to obtain energy supplies is preferable to a decline in their living standards that has the possibility of being irreversible.**

**Something else that it could mean is an additional resort to coal that would cancel out all the fine theories and intentions expressed in the Kyoto Protocol and its spinoffs. The USDOE has estimated that electricity demand in the US will increase by 45% between now and 2030. Coal usage is scheduled to grow by between five to ten percent because of its availability and price, but a sustained escalation of the oil price would be certain to boost the price of natural gas, which according to a study by Sanford C. Bernstein & Co., already costs more than coal on the U.S. electricity generation front, even if the cost of suppressing a fraction of carbon emissions is taken into consideration. Coal might then attain more than 50% of the energy mix, with ‘clean coal’ playing only a minor role. As for the kind of coal-burning scheme called ‘FutureGen’, which would trap carbon dioxide before it reaches the atmosphere and bury it below ground, if it corresponds to the efforts associated with operations by the Swedish firm Vattenfall in Germany, it is just another fraudulent play for the gallery.**

**The above themes will be touched on later in this book, but before that readers will be offered two analytical challenges. Despite appearances, these are mostly on the Economics 101 level, and mastering them is both important and easy.**

**INVENTORIES (= STOCKS) AND SHORT RUN PRICING**

**The first genuinely analytical challenge offered readers of this book, regardless of their academic level, begins with a very careful look at Figure 1-3. At the same time remembering that Figure 1 is NOT related to the diagrams in your favourite electrical engineering textbooks, although I can remember a lecture that I gave at the business school in Grenoble when the director of that establishment pointed out that there was a feed-back circuit in the diagram that corresponded to a first-order ‘servomechanism’.**

pe = f (p)

h

s

Income (Y)

AI

DI

p

pe, r

Figure 1

s: flow supply

h: flow demand

p: price

AI: actual stocks

DI: desired stocks

r: interest rate

pe: expected price

Commodity (oil)

**If you studied Economics 101, then you know about s and h. These are *flow* supply and *flow* demand variables respectively, and ‘h’ is used instead of ‘d’ because when using mathematical symbols, ‘d’ has a special function. As for the units of s and h, these were alluded to earlier: they are barrels per day (b/d). In Economics 101, as well as advanced courses, we use s and h to obtain what is called the *equilibrium* price, and income Y (which is in the box to the right of h) sometimes enters the discussion as an influence on consumption. In physics equilibrium generally signifies a ‘state-of-rest’, while in game theory it signifies the best response by each of the set of players to the actions of the others.**

 **In your earlier microeconomics courses, where you mostly worked with flow models, equilibrium was obtained when flow supply is equal to flow demand, but in the present analysis equilibrium is determined when actual stocks (= inventories) AI are equal to desired stocks (inventories) DI, or AI = DI. Note what we are saying: *even if flow supply equals flow demand, we have an equilibrium only when the demand for inventories is equal to the amount in possession of inventory holders.* Instead of having a flow model, we have a stock-flow model, where the extension here is derived from the work of the brilliant MIT econometrician Franklin Fisher. In case you want a taste of the relevant mathematics for the present discussion, let me suggest the first chapter in the book *Mathematical Economics* by R.G. D Allen (1960).**

**And please note something else before we continue: if you look at actual statistics of flows and stocks, these are estimates (approximations), and often not perfect. However as one of the great mathematicians of the 20th Century, Bertrand Russell once pointed out, ”Although this may seem a paradox, all science is dominated by the idea of approximation”.**

**Accordingly, we arrive at the position of having to manipulate a *stock-flow model* instead of the simple flow model you learned to love in Econ 101. Before we continue, we should note the variable *expected price* (pe). You should have no difficulty understanding the part that this item plays. If, for example, consumers of oil believe that the price of oil will greatly increase, many of them will increase their inventories (= stocks). This kind of reaction is perfectly understandable. Consumers here are mostly industries and not households, but also speculators who, if possible, put large numbers of barrels of oil into storage (which are extracted when the oil price rises). Similarly, observing the heavy arrows leaving and going into AI, if it is believed that the price of oil will fall by a large amount in the near future, many inventory holders will sell some of the barrels of oil they are holding. You should think about and elaborate on this kind of behaviour!**

**In Figure 1 just above, expected price is shown to be influenced by the present price. Even better, recent *changes* in price might be important where this variable is concerned, and also income (Y) or expected income. As this is being written, serious fighting has broken out in Iraq, and this could have and maybe has influenced pe. There is also some tension in and around the Ukraine, and some observers are claiming that this has an effect on the oil price. Would you like to comment on this?**

***As an exercise*, readers should think about the adjustments necessary in Figure 1 to account for contingencies such as the expected price being influence by the income, or for that matter changes in the income. (The mathematical symbol for changes in income is** $∆Y).$ **You can also observe the situation around ‘p’ and DI. In the terminology of electrical engineering, what we have here is a *feedback circuit*, or as I was informed when I lectured in France a *first-order* *servomechanism*. This influences the movement of prices, and often leads to large oscillations. Dealing with this issue has no place in the present book, and in fact too much is often made of it in mathematical economics textbooks. What readers should do now is to make sure that they understand the discussion just above, and aim at always being able to draw Figure 1 from memory.**

**Please notice that what we are talking about is short-run pricing. Then what about long-run pricing? Long run pricing is a function of the movement of flow supply (s) and flow demand (h) over time. In your courses in Economics 101 you had in algebraic form s = s(p) and h = h(p), although it might be better to write s = f(p) and h = g(p), since e.g. (for example) s and h are dependent variables, and not (as in mathematics) ‘arguments’. The arguments here are represented by ‘f’ and ‘g’, and these can be very simple or very complicated. In any event, as time passes we expect both the demand and supply of oil to gradually increase, but in the period 2007-2008 demand began to increase much faster than supply, and as a result the price ‘escalated’. The effect of this oil price escalation on the global macro-economy was devastating (as you probably know).**

**A much less drastic example of the same happened during the Libyan crisis. Demand suddenly speeded up as consumers moved to increase their inventories, while the supply of Libyan oil (about 1.7% of the global supply) fell to almost zero. The global price of oil immediately increased by between 15 percent and 17 percent. Readers should ALWAYS have these numbers at their disposal because they are important. Now to conclude this discussion: s and h are *flows* whose units are the same as in your Economics 101 textbook (e.g. barrels/year, or perhaps metric tons (=tonnes) per year, where 1 tonne = 1t = 7.33 barrels). AI and DI are *stocks* (i.e. inventories), and do not contain a time dimension. For instance, they might simply be barrels (or tonnes) of oil.**

**Suppose that something happens so that DI > AI (desired inventories are greater than actual inventories). For instance, word goes out that oil prices are certain to skyrocket, and it would be nice to have more barrels of oil to sell when that happens. As indicated, the ‘stock’ market is out of equilibrium, and to restore equilibrium (by increasing AI ), a ‘gap’ must be created between flow supply and flow demand, or (s > h) which signifies that a portion of current production goes into inventories instead of being consumed. To bring this about – with s = f(p), and h = g(p), the oil price must rise. This is the explanation that all students should understand and be able to repeat verbatim, and if I were their teacher, they should not allow me to rest until I explained it so that they and their colleagues understand it perfectly.**

**Notice something else, if s = f(p) = a + bp, we have a linear (flow) supply curve that ‘goes up’ to the right, with ‘b’ as its slope. The intersection of this curve with the vertical axis is called ‘a’. Now draw this curve, and provide a full explanation of ‘b’. The variables in this case are s, the dependent variable, and p the independent variable. ‘f’ in this case signified a linear supply curve, although it could have signified something more complicated, such as s = f(p) = a + bp2. Make sure you comprehend that although we changed the argument from a+bp to a+bp2, we still use f(p), which in the second case indicates a quadratic supply curve. The slope of this curve though is not ‘b’. (From the calculus we calculate that it is 2bp.)**

**Readers should now assume that DI is less than AI – that is DI < AI. They should then go through an argument of the sort given above, preferably standing in front of a black or white board, with a piece of chalk in your hand, and a smile on your face, because this is not a difficult assignment, regardless of what you and your colleagues think that it is. As strange as it sounds, my students in Sweden were always willing to go to the black or whiteboard, but not my students in Singapore. They were more modest.**

 **THE OIL PRICE GOES INTO ORBIT: 2008 AND BEYOND**

 **“…in order to keep prices up the Arabs would have to curtail their**

 **output by ever larger amounts. But even if they cut their output to**

 **zero they could not for long keep the world price of crude at $10 per**

 **barrel. Well before that point the cartel would collapse….World oil**

 **prices are weakening. They will soon tumble.”**

 **– Professor Milton Friedman (*Newsweek*, 4 March, 1974)**

**If you happened to be in Paris (France) in 2008, and you were reading French newspapers, and watching French television, you might have concluded that the end of the world was approaching. The slow-motion oil price escalation that began about 2005 and continued into 2007, suddenly accelerated, and it was not long before the price was almost at $150/b. Certified oil experts were talking about it exceeding $200/b.**

**In case you are interested, the global macro-economy could not function at that time with an oil price above $200/b, nor could it function at the price it eventually reached on July 3, 2008, which at $147/b was probably the highest in modern times. But what I call *the moment of truth* had not arrived. That price ($147/b) threw the global macro-economy into disarray, which in turn caused the average global oil price to eventually fall to about $32/b. Students, colleagues, and soul brothers and sisters of Professor Friedman pictured it descending to the price of a barrel of Coca-Cola, and it was then that the moment of truth appeared in what some of us considered an unmistakable form, even though others still have not got the message. OPEC sponsored a program for disbelievers that they never thought they would or could experience: they cut their production by an amount that cannot be mentioned in this book, because neither I nor anybody else in the major oil consuming countries has the ability to say, except possibly the CIA, and the oil price was soon above $70/b, and slowly climbing.**

**There is little or no doubt in my mind that Professor James Hamilton is an outstanding oil economist, and his belief that income rather the price of oil is the key determinant of the quantity of oil demanded is worth consideration, but it was not income changes that led to the near recession in the global economy that followed the oil price escalation in 2007-2008. It was the volatile effects of an oil price driven by expectations, as well as OPEC’s proved ability to defend their ‘turf’ that accounted for the outcome, and when the non-linear feedback effects implicit in the servo-mechanism circuit shown in Figure 1-3 reached a certain amplitude, my residual knowledge of differential equations told me that oil consumers were in a lot of trouble.**

**What was not understood by Professor Hamilton, nor many others, was that OPEC has the right medicine for dealing with persons and governments who attempt to put them in their place. They did not resort to pretentious statistical exercises (i.e. econometrics) to formulate their strategy, nor did they encourage their governments to respect President George W. Bush’s wishes, and increase production. They already knew what the rest of us only fully grasped years later at the time of the Libyan ‘war’, when the loss of Libya’s output of about a paltry 1.7 percent of the global oil production caused the global oil price to increase by almost 17 percent.**

**The price elasticities calculated by Hamilton and others, and shown in Hamilton’s most important article (2009), might also have been capable of revealing the bad news inflicted on oil consumers if properly interpreted. I don’t know, nor am I interested, because there is no point in being concerned with those and other numbers when OPEC is taking care of business by restricting production – and/or not finding (or looking for) some way to increase their output. As implied in the work of Hamilton, and made explicit in this book, it was this kind of behaviour, and NOT speculation nor the absence of oil refining capacity that was the cause of the ensuing global macroeconomic slump.**

**A slight extension might be useful here. The power of OPEC was not revealed when the price of oil began accelerating upward, but when it declined and we were once more informed almost daily that OPEC was a lost cause. What the work of Hamilton and many of the economists he cites who have studied the oil price amounts to is a short and easily understandable story that, in the opinion of Yours Truly, has been made unnecessarily long. In my version of that story the Chinese deserve the attention given them for their influence on the demand side of the world oil market, but he forgot to mention the support that OPEC’s price strategy almost certainly obtains from large oil firms, whose main interest is the maximization of profits and not punishing OPEC for the success that people like Professor Friedman thought they would never obtain, and also thought that they didn’t deserve due to the capital sin of forming a successful cartel.**

**Even with the deficiencies mentioned here, students with a deep background in conventional economic theory, and a growing interest in energy economics, should read both the empirical and non-technical work of Professor Hamilton. There are important observations in his work that cannot be found elsewhere. There is however a very special observation that is absent, and should be brought to the attention of everyone interested in the global oil market. One of the main causes of the oil price recovery in the early years of the 21st Century was the drastic oil price decline in the closing years of the 20th Century. It was then that the OPEC directors, and the governments of the OPEC members, accepted that without a heightened and sincere cooperation, they were heading toward a situation where their irreplaceable oil reserves would be gone, and they would find themselves in precisely the inferior position that persons like Milton Friedman and his stooges wanted them to be.**

**As Winston Churchill pointed out, coalition efforts have always been a tricky business, but OPEC has gradually evolved into an organization whose members have not only learned how to work together in fact, but also in theory. That provides them with real strength, and as a result they deserve the success they have achieved.**

**ANOTHER ANALYTICAL CHALLENGE: THE R/P RATIO**

**There are many economists, executives and journalists whose speciality is energy, but who constantly fail to understand what is taking place in the markets for various energy resources. In general, a shocking majority of those ladies and gentlemen do not comprehend that when dealing with certain types of forecasts, it pays to begin by getting the economics right. What does this mean? It means for example that irrational behaviour by market actors can result in markets like the oil market exhibiting price movements that many reputable economics textbooks tend to classify as unreasonable, and in those sensitive moments there is a strong need for the presence of decision makers and analysts who possess a demonstrable ability to add and subtract.**

**One well known oil optimist made quite an acceptable career for himself by constantly insisting that “we keep looking for more oil, and finding more oil”. He was absolutely correct, except that he forgot to notice that the quantity of oil being discovered was on a falling trend, as shown by data collected by the international oil economist Dr Mamdouh Salameh. The basic issue here was the intense desire to believe that Colin Campbell was mistaken when he said that “the production peak for oil will be a mirror image of the peak of discoveries.” If we exclude the term “mirror image” which is a little too precise for my taste, it would be difficult to derive a theory of oil (or natural gas) production that is capable of casting aspersions on this assessment.**

**Oil discovery in the U.S. peaked in l930, and 40 years later oil production peaked. Discovery in the North Sea peaked in l974, and peaking took place around the turn of the century. Let me also claim that people like myself were correct in concluding that it was the peaking of oil production in the North Sea that informed OPEC economists and decision makers that *their* time would soon arrive, and when it did arrive in 2008 as I was giving a guest lecture at the Ecole Normale Superieure (in Paris), there were people in my large audience who believed that I had lost my mind when I insisted that no other outcome was conceivable, given the trend movements of supply and demand.**

**World oil discovery peaked in 1964, which suggested to many researchers that it was unlikely that a global peaking could be delayed much past 2010. In fact it was obvious in 2010 that globally oil production curves were flattening, but suddenly and unexpectedly technology came to the aid of the U.S. in the form of providing means for boosting the output of shale oil and gas. It will come to the aid of other countries too, and eventually may provide a number of lucky countries with a few decades of high prosperity, but there are reasons to believe that the story of shale oil will not match that of conventional oil. One of these reasons is the rapid depreciation of shale oil deposits.**

**Questions are being asked about shale oil and shale natural gas that were never raised about conventional oil, especially about the depreciation (= natural depletion) taking place in known deposits of these resources. Readers of this elementary book should pay close attention to this matter, and perhaps learn enough applicable mathematics to decide for yourselves exactly what this depreciation signifies in economic terms, because it is not easy – and perhaps not wise – to place too much confidence in persons who have made large investments in these resources, and would stand to suffer considerable losses if shale received a bad press**

**Now for our main topic. The story of the reserve-production ratio (R/q) is a story that deserves a more sophisticated setting than it has received from the President of the United States, and presumably his advisers. The most sophisticated rendition can be found in a brilliant but unfortunately neglected article of Andrew Flower (1978).**

**First of all though, make sure that you understand the insignificance of a statement such as “with all the reserves in place now, we have a 40 year supply of oil even if we do not find another drop.” This statement originates with observing that the global reserve-production (R/q) ratio is 40, however the important issue is not the R/q ratio, but when production in a field, region, or for that matter the entire oil producing world moves toward a situation in which it ‘plateaus’ (flattens) or turns down. As should be obvious from a consideration of the example below, oil could be present and exploited hundreds or even thousands of years in the future, however once the global production peak has been reached, the ‘age of oil’ will probably – but not certainly – be on its way out.**

**This is not to say that the R/q ratio should be ignored, but a statement such as the above (which postulates a 40 year availability for global reserves) is scientifically meaningless. In looking at a deposit or field the important thing is that if the R/q ratio falls below a certain level – probably somewhere between 10 and 15 – then the deposit is being ‘damaged’ in the same manner that sucking too hard on a straw will damage an ice-cream soda. This particular R/q ratio can be designated the *critical* R/q ratio, or θ\*, and for simplicity I always take it as 10 – although Flower (1978) prefers a higher figure. The damage being referred to will be manifested by a reduction in the total amount of oil that can ultimately be removed from the deposit.**

**Now for the important point. *When the R/q ( = θ) ratio reaches the critical value ( = θ\*), the critical value will determine production in the sense that production should be adjusted in such a way as to hold the critical value approximately constant.* (S*hould* and not *will*, because there might be valid economic reasons for hastening depletion. Moreover, this is a theoretical point in economics rather than physics, and so from time to time it may be possible to see and accept large exceptions.)**

**A simple numerical example is useful. Assume that we have a field with 225 units (= R) of oil reserves, and we desire to lift 15 units per year, and our critical R/q ratio (θ\*) is 10. Using the logic expressed in the previous paragraph, it is obvious that we can have an output of 15 units/year for five years. During this period the R/q ratio falls from 14 (at the end of the first year) to 10 at the end of the fifth year, while reserves fall to 150 units. After that, however, if we continue to remove q = 15 units/year, we are violating our constraint: the R/q ratio will fall under ten. For instance, if we removed 15 more units (q = 15), then reserves would fall to 135, and R/q decreases to 135/15 = 9. This is not good, because it means that we are ‘overworking/damaging’ the deposit.**

**To keep this ratio at 10 (= θ\*), production in the sixth year should not be larger than 13.64. (Thus R/q = (150 – 13.64)/13.64 = 10.) Continuing, in the seventh year production cannot be larger than 12.4. Readers should be able to get these results by simple trial and error, however this exercise may be generalized to show that 10 ≤ Rt/qt  ≤ (Rt-1 – qt)/qt. In turn this expression may be solved to give qt ≤ Rt-1/11 (or, more generally, qt ≤ Rt-1/1+θ\*). As explained with some elementary algebra in my forthcoming textbook (*ENERGY AND ECONOMIC THEORY*) an operation of this nature is another way of saying that in any year, the percentage of reserves extracted should be less than or equal to 10%. (To get this result, remember that q = ΔR, and if you don’t remember ask your teacher – and keep asking – until you get a usable answer.)**

**The above is an important exercise, and after making sure that they understand it perfectly, readers should note that there is a large amount of oil in the ground when output turned down. Moreover, when we look at the production profiles of e.g. wells in major oil or gas regions like the United States, what we see is that when peaking takes place (and production sooner or later begins to decline), there is still a huge amount of the resource in the ground. In addition – if economic considerations are ignored – much of this is immediately extractable.**

**The interpretation here is as follows: *the peak is explained by economics and not geology*. *More is not extracted – and the peak delayed – because in the interests of profit maximization, the optimal behaviour is to extract it later!* As explained in Banks (2000, 2007), geology functions as a constraint. This is something that everyone reading this book should make every effort to understand.**

***But another crucial point is missing, and that is the natural decline*! In the above example, sufficient investment was made to obtain an output of 15 units/year for 5 years, but what would the situation be if there was a natural decline of 5 units a year (due e.g. to a reducing of pressure in the deposit as production took place). Then, instead of the sequence of reserves being 225, 210, 195, 180, 165, and finally 150 at the end of the fifth year, it would be 225, 205, 185, 165, 145 at the end of the fourth year. Thus we would arrive at what might be called the critical reserve level just before the end of the fourth year. Moreover, the decline in output after that would be steeper than in the previous case. But what would happen if we had this decline ‘pattern’ and the intention was to maintain an output of 15 units. This is possible, though perhaps more investment would be necessary, and in addition there would probably be a more rapid ‘depreciation’ of the *deposit*, unless associated reserves could be increased. The decline rate above is probably excessive, and was chosen to make the arithmetic simple, but it did not show is that *natural decline* is often influenced by the extraction program.**

**SOME ASPECTS OF THE FUTURE SUPPLY OF MIDDLE EAST OIL**

 **“The will to win sweeps all before it”**

 **– General Ferdinand Foch**

**Several years ago, in his ‘blog’, one of the authors of *Freakonomics* (2005) – Professor Stephen Levitt of the University of Chicago – made a few comments about his short stay in the United Arab Emirates [UAE] state of Dubai. As most viewers of CNN are aware, luxury is an important feature of that lucky nation, however in mulling over the details of this condition, Professor Levitt failed to emphasize the key economic mechanism behind Dubai’s rise from a fishing village to a middle eastern version of Monaco. That mechanism is systematic diversification, which in this case means that emphasis is unambiguously being put on tourism, business and finance rather than the production and export of natural gas and crude oil – where as noted crude oil is oil as it is found underground, i.e. not processed into e.g. motor and aviation fuel, petrochemical inputs, agricultural chemicals, and other *oil products*. Dubai’s supply of oil and gas is also not particularly impressive when compared to a few neighboring countries, but it was large enough for the country to give a valuable lesson to amateur development experts.**

**In writing ‘agricultural chemicals’ I immediately think of Sir Harry Kroto, Nobel laureate in chemistry, who participated in a discussion with other laureates shortly after receiving his Nobel Prize, and made it clear that a shortage of agricultural chemicals (e.g. fertilizers that have oil as an input) would have a disastrous effect on Third World agriculture, and possibly agriculture elsewhere. In fact there are persons who say that the consumption of fossil fuels should be reduced in order that they may be available as petrochemical inputs for future generations. I think it safe to assume that this is something that will not happen unless the mentality of the present generation undergoes a drastic change.**

 **In any event, at the present time under 10% of Dubai’s GNP is now directly attributable to oil and natural gas, and as trade and the provision of services (i.e. diversification) increases, measures will probably be introduced in other states of the United Arab Emirates to reduce their output and/or export of crude and natural gas, which makes economic sense. Here I can report that, like Professor Levitt, I too have paid a visit to Dubai, or to be more precise the airport in Dubai, because I was inaccurately informed on the plane that carried me there that there was nothing in that Emirate (or state) that would interest a person like myself.**

 **That was 30 years ago, when I was hurrying from Australia to the skiing in France (at La Clusaz), and never at that time did I or anybody else imagine that in Dubai an indoor ‘winter wonderland’ would be created, where both skiing and snowboarding could take place. Another attraction of Dubai – in addition to items like golf and sun – is personal security, which is going to become even more valuable later in this century, and for which there is going to be a large market everywhere.**

**Unfortunately, I probably know less about the behavior and intentions of Dubai’s government than most of the persons who generously commented on and extended Professor Levitt’s observations, however unlike many of them I understand that in the Gulf (and perhaps elsewhere), policies that are a sophisticated version of the laws of mainstream economics have superseded ad-hoc or knee-jerk responses to shifts in oil supply and demand, and consequently could have a profound effect on the future (global) availability of that indispensable commodity. To get some idea of what we are dealing with, I can sketch the argument that I imposed on students in my course on oil and gas economics at the Asian Institute of Economics [AIT] during the spring term of 2007, but first you need to have a brief knowledge of OPEC at your fingertips.**

**OPEC was created in l960 with a treaty among five countries: Iran, Iraq, Saudi Arabia, Kuwait and Venezuela. The other countries Qatar, Libya, United Arab Emirates (UAE), Algeria, Nigeria, Angola, and Ecuador joined later. While working in Geneva at UNCTAD, I was asked about OPEC, My reply was that it was no more than an over-ambitious talk-shop. That statement was incorrect: OPEC is the real deal, and bad enough to prove it. The source of this ‘badness’ is that they own a very large share of world oil reserves, and their oil output is about a third of the present global oil production. Just as important, world oil consumption has occasionally grown faster than world production, and may still be the case that the least expensive and highest quality oil is – on average – in OPEC countries. These advantages now provide OPEC with an annual income of about a trillion dollars.**

**I must confess however that I am curious as to the strategy of OPEC in case shale oil is more than a bubble. I do not want to claim that I am smarter than OPEC’s ‘brain trust’, but probably that organization still has the upper hand in the oil market.**

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**One of the prerequisites for successfully completing any course in energy economics that I teach is to understand perfectly the situation in the key oil exporting country, Saudi Arabia, in the early 1970s – specifically, just before and just after the nationalization of oil production facilities that were owned or controlled by foreigners.**

**The intention by foreign managers was to raise production (in phase with increasing demand) to a peak of about twenty million barrels per day (= 20mb/d), and to keep it at or close to that level for as long as possible. Eventually, for economic or geological reasons, or both, it would decline. Once it is understood that cost is the most important variable for producers, the relevant algebra is straightforward: cost is a function of present and past production, with the latter a determinant of what is known as natural depletion (or natural decline) due to its negative effect on deposit pressure.**

**As explained in my energy economics textbooks (2000, 2007 and 2014), and also in the best intermediate/advanced microeconomics textbook, Henderson and Quant (1995), what we are dealing with is inter-temporal profit maximization in the presence of a constraint. The constraint is the (estimated) total amount of reserves to be exploited, with these being parceled out over a certain number of periods (e.g. years) on the basis of expected future prices and costs. The costs are opportunity costs: the sacrifice of producing a barrel of oil in a given period rather than in some other period when it could be consumed, exported as crude or oil products, or e.g. used to produce petrochemicals.**

**The thing that made (or should have made) this exercise exceptional is that oil is an exhaustible resource: oil that is removed from a deposit in the present period is unavailable later. The major non-OPEC producers (and in particular those who were called the ‘majors’ or ‘Seven Sisters’) recognized this, but initially they believed that when oil began showing signs of exhaustion in one locality, it would always be possible to begin or expand operations elsewhere. For this and other reasons, until recently, several influential researchers found some of my lectures highly objectionable, since they preferred to assume that the global output of oil in a given year would always be a trivial or uninteresting fraction of the total in the earth’s crust. The way they sometimes put it was that we were *running into* rather than running out of oil! But the appearance of an oil price that suddenly and unexpectedly exceeded $90/b concentrated many prestigious minds, and so now it takes a brave scholar to disregard the tribulations that oil depletion might eventually bring to those of us on the buy side of the energy market.**

**Conceptually, things were not so easy for the new owners of oil in places like Saudi Arabia. Their aim was/is to maximize ‘welfare’, and to do so over a very long time horizon. Expressing welfare in a serviceable mathematical form would probably overtax the ingenuity of Albert Einstein or John von Neumann, but it definitely means more than profits and ‘transfers’. Probably the best description is *sustainable prosperity in the widest possible sense* – i.e. not just for the oil sector. The rigors of maximizing welfare were undoubtedly brought to the attention of people like the late Major Chavez (in Venezuela), and I gained a small insight into these matters when I taught development economics in Dakar (Senegal) as an offshoot of my course in mathematical economics for students from many countries. However, as I enjoy arguing, the oil states in the Gulf possess the wherewithal and managerial skill to ultimately provide a commendable example. A display of this capacity is sometimes labeled ‘resource nationalism’, and as Edward Morse pointed out (2005), it could entail “much lower oil supplies than would otherwise be available.”**

**In the termination of a not so friendly discussion, I was once grandly informed by a well-known academic that Saudi Arabia had 4 new large deposits in the initial phase of exploitation. If that were true, which it wasn’t, then the present discussion *might* take a different course (and note, *might* and not would). Saudi Arabia is one of the primary exporters of oil to the main oil importing countries, and my contention over a number of years has been that a conjectured willingness on their part to steadily increase output over the foreseeable future is perhaps the most bizarre fantasy ever put into circulation by the International Energy Agency [IEA] or researchers with the same analytic shortcomings. Why should they increase output – would you if you were in their place?**

**Arguably, the most provocative writer on this topic was the late Matthew Simmons, an investment banker and former advisor to President Bush, whose work implies that the forecasts of the IEA cannot be taken seriously. He maintained that Saudi Arabia (and probably other Gulf states) are either incapable or unwilling to produce and export an amount of oil that could turn the pipe-dreams of the IEA into reality. Best to think of a sustainable output for the rest of the present decade in the vicinity of 9-11 mb/d for that country, while the OPEC output ceiling will probably remain at about 30 mb/d.**

**If OPEC were a single private firm, some question might be raised about the strategy adopted by its directors, but OPEC is not a private firm. It is a cartel, with many cartel members thinking in terms of the distant future rather than short-run profits. At the present time, in my opinion, that thinking focuses on obtaining a trillion dollars per year by influencing the price of oil, and if possible NOT to influence that price in such a way that the global economy is upset, and the demand for oil falls.**

**Similarly, in both my lectures and written work, I have claimed that important exporters like Saudi Arabia and Russia will do everything possible to reduce their export of unprocessed oil. In line with the teachings of orthodox development economics, ‘value will be added’ by using much of the crude they lift as inputs for refinery products, which in turn would go into the production of petrochemicals. In addition, with continued economic growth in exporting countries, additional oil will be required for domestic consumption. A good example is Tartarstan, which is or was in the Russian Federation. Their output of oil will be held constant, but much of it is destined as an input for a new petrochemical installation. (It is frequently claimed that Brazil also has impressive ambitions where petrochemicals are concerned.) Simple arithmetic then suggests that the availability of exports from these regions will decline, because it might be true that it is a mistake to make expensive investments in e.g. petrochemical facilities if the inputs (i.e. feed-stocks) for the resulting facilities are very expensive.**

**Here it is interesting to cite an important contribution of Professor Morris Adelman and his colleague Martin B. Zimmerman, who more than 30 years ago perceived a portion of the handwriting on the wall. They wrote:**

**“When it comes to feed-stocks for the production of petrochemicals, most LDCs are at a severe and permanent disadvantage for lack of know-how, and the high opportunity cost of capital and feed-stocks. Other countries, particularly OPEC members who do not face these obstacles, are expanding their petrochemical capacities. This too will drive prices down, lower the profitability of many plants built today, and force losses on a large number of investors. Few can compete with those that get their feed-stocks at a fraction of world prices, and are willing to earn low or negative rates of return.”**

**Facing a ‘low’ profitability’ is not (and probably never was) an outcome that the new OPEC petrochemical producers need to give much thought to experiencing: they not only will obtain their feed-stocks at a low price, but their new plants are state-of-the-art in regard to cost and flexibility. It can also be appreciated that what is said in this contribution or elsewhere about petrochemicals applies to refining. Returning to Saudi Arabia, one of the indicators of their confidence is not just a rapid expansion in oil products and petrochemicals investment, but the intention to expand other enterprises that can provide employment for an expanding population. These plans include modern and favorably located new cities, power stations, and smelters and facilities for producing and exporting large amounts of various industrial products. Furthermore, as Neil King of the *Wall Street Journal* pointed out (December 12, 2007), the Saudi industrial “drive” will strain their oil export role.**

**OIL PRODUCTS, PETROCHEMICALS AND ‘CRACK SPREADS’**

**Recently, in a Gulf publication, an important writer stated that his country was headed for trouble unless they placed less emphasis on the export of crude oil, and shifted their attention to oil products and petrochemicals – or as it is sometimes put, shifted their attention *downstream*. This was touched on earlier, but a little repetition will not hurt if readers are keen on impressing friends and neighbors. By oil products it is meant the output of refineries, such as kerosene and motor fuel (e.g. gasoline and diesel) and products that can be used as inputs for the production of petrochemicals. For those of us in the major developed parts of the world, the main concern has always been or appeared to be motor and aviation fuel, and with the unexpected appearance of high oil prices, which suggested future oil shortages, some perceptive observers began to talk about a shortage of petrochemicals.**

**We don’t want a shortage of petrochemicals, because they are too important. If you want to know exactly how important go to GOOGLE, and don’t overlook the mention of agricultural chemicals. In a world in which population increases by at least three-quarters of a billion persons every decade, those chemicals are going to become increasingly important.**

**Hardly any discussion was necessary as a result of the above observation, at least in most OPEC countries. What might be remembered though is that certain executives and technicians in Europe and America believed that most OPEC managers and engineers were unable to go beyond the production of crude oil because of being disadvantaged racially OR culturally. This skepticism was true even when the skyscrapers started to go up in the Middle East, although I doubt whether opinions of that nature have much popularity at the present time.**

**Perhaps the next step in this part of the exposition is to describe a refinery. A refinery is an installation for turning crude oil (which Professor Carol Dahl has labeled a mix of chemical compounds) into a *slate* of various products, and in an intermediate course in microeconomics, refining might be described as a variable-proportions, joint product industry or operation. By convention, these products are divided into three ‘cuts’ or fractions: moving from top to bottom, gas and gasoline (light products), middle distillates (e.g. kerosene), and fuel oil and residuals (heavy products).**

**In one sense or another refiners buy crude and sell refined products. What they want is a low price for crude and a high price for the products that constitute their refined output – with this ‘interval’ usually called a *refinery* *margin*, or sometimes a *crack* *spread*. Disappointment is sometimes experienced in this industry because input and output prices can move in unfavorable directions (e.g. price down and cost up).**

**It usually happens that the most valuable barrel of oil is one that contains the lightest oil, and as a result can provide a large amount of so-called white products: aviation fuels, motor fuels, and some feed-stocks (e.g. raw materials) for the petrochemical industry. Naptha, which is important for the improvement of gasoline quality and is also a valuable petrochemical input, is extracted from both the light and middle range of cuts. The other middle distillates are kerosene, paraffin, and light gas-oil, while the rest of the refinery output consists of heavy lubrication oils and residues.**

**The production scheme functions as follows. Crude oil is heated and pumped into a tall *distillation tower* that is pressurized and is hotter at the bottom than at the top. The various oil products have different boiling points, with those that are lightest having the lowest. When crude enters a tower, the heaviest part remains in liquid form and falls to the bottom. The rest is vaporized, but the various constituent products return to liquid form as they reach the lower temperatures higher up the column. As a result they can be piped away,**

**The amount of each product that can be obtained from a refinery can be altered somewhat by changing the temperature and pressure in the tower, but the difficulty with the basic arrangement is that ad-hoc adjustments cannot always result in obtaining the desired quantity of each product. Major changes that involve getting e.g. more light products require investment in upgrading equipment such as *catalytic crackers*. These ‘crackers’, together with a catalyst, crack apart the chains of molecules in one or more of the heavier products to form lighter products.**

**Needless to say, installing cracking equipment can sometimes be an expensive proposition, and so it is best to have some decent estimates of forthcoming demand patterns before construction begins on a refinery. Strangely enough, it can happen that market situations exist in which the emphasis is on heavy products. That is usually dealt with by sending a higher proportion of the materials in the distillation unit to a ‘vacuum flasher’, whose reduced pressure prevents undesired cracking.**

**Refining is one of the most competitive industries in the world, and the many ‘independent’ refiners throughout the world – those *without* an assured source of crude – are accustomed to thinking of themselves as an endangered species. Refineries are an important source of petrochemical inputs, to include fuel to operate petrochemical facilities, and so it may be true that the center-of-gravity of industrialized hydrocarbons belongs in the Gulf, and could eventually end up there.**

**In my book on oil (1980), I made it quite clear that the OPEC countries – or at least a majority of them – do not have as an ulterior goal the raising of the oil price as rapidly as possible. What they want is to transform their oil assets into other forms of assets, particularly reproducible (physical) capital that includes educational facilities that are capable of training their populations in such a way that they can work in modern facilities and with modern equipment in order to build societies with a high and sustainable material standard. Intentions of this nature should also be relevant for other countries, to include the U.S., where large numbers of influential persons are working night and day to convince friends, neighbors, colleagues, constituents and anyone who will listen to their pseudo-scientific reasoning that it makes economic sense to put a large portion of their new energy wealth into exports), and even worse, to accept a shrinking of the energy intensive manufacturing sector, and accept larger immigration.**

**Now for a few words about *crack spreads*, which is an expression that we see quite often, and which perhaps deserves much more attention than it has received, especially by those of us who teach energy economics. We can begin by repeating something about the refining of oil. In my previous energy economics textbooks I avoided this subject, but it is extremely important. For instance, when the oil price escalated in 2008, some oil producers in OPEC suggested that it was because of the lack of refining capacity.**

**As already noted, an oil refinery is an installation for turning crude oil into a *slate* of various products. By convention these products are divided into three *cuts* or *fractions*: gas and gasoline (light products), middle distillates of various types, and fuel oil and residual cuts (i.e. heavy products). Usually the most valuable oil products are the *white* products: domestic gases, aviation fuels, motor fuels, and some feedstocks for the petrochemical industry. (For example naptha, which is extracted from both the light and middle ranges of distillate cuts). The other middle distillates are kerosene, paraffin and light gas oil, while the rest of the refinery output consists of heavy lubrication oils and residues.**

**Once again, crude oil is pumped into a tall distillation tower that is pressurized and is hotter at the bottom than at the top. The various oil products have different boiling points, with those that are the lightest having the lowest. When the crude enters the tower, the heaviest part remains in liquid form and falls to the bottom. The rest is vaporized, but the various constituent products return to liquid form as they reach the lower temperatures higher up the column. As a result they can be piped away. Given the dominant preference for light (i.e. white) products, the most valuable input is light oil, and here Libyan oil has occasionally been designated the most preferable.**

**Libya has the largest oil reserves in Africa, but its production tends to be low, and as a result, in many countries, a great deal of expensive upgrading has been necessary in order for existing refineries to handle the more prevalent heavier grades of crude. As this takes place smaller refineries are at an increased disadvantage relative to the refineries operated by the oil majors, who can finance this upgrading with profits from the sales of crude.**

**The *crack spread* has to do with the profit margin associated with refining crude oil, and that expression generally considers movements in the price of an oil product such as motor fuel relative to the cost of crude oil. To paraphrase some remarks in an excellent introduction to this topic by Richard Bloch (2011), ‘this oil is refined to make it less crude’. As alluded to above, the firms doing this are ‘independents’, or more successfully large integrated companies such as Exxon and Shell. For the independents, bad news is often the outcome, because as noted one of the key factors in obtaining a profit is making expensive investments that provide the technology required to deal with unexpected changes in the pattern of demand, as well as changes in the quality (e.g. weight) of the crude input. *A change in the pattern of demand is taking place now, with diesel drastically increasing in popularity relative to gasoline (i.e. petrol),***

**As you found out in Economics 101, refineries are like other businesses in that they are first and foremost concerned with selling the products mentioned above, as well as others, and at a price that exceeds the cost of the crude. (Of course, there are also the costs of the production factors (e.g. labor and capital) required to transform the crude into oil products, and as a result the often used expression ‘*refinery margin’* seems more appropriate to me.) It is easy to deduce that when the oil price increases, it costs more to drive your car, and in Sweden the price of motor fuel often increases the same day the price of crude increases. The oil price rise due to the troubles in Libya a few years ago raised motor fuel prices over ten percent in both the U.S. and western Europe.**

**The crack spread is often described as the difference between the price received for an oil product and the cost of ‘cracking’ the raw materials into oil products. The way this issue is often approached is by examining something called the 3-2-1 spread, where three barrels of crude oil are transformed into two barrels of gasoline (petrol) and one barrel of heating oil, and the ‘spread’ calculated from the cost of the crude, and the prices received for gasoline and heating oil.**

**Suppose though that the intention is to obtain a different set of oil products, for example gasoline and jet fuel. Assuming a comprehensive knowledge of the relevant technologies, determining the cost is not a difficult calculation, but when amateurs on this topic like myself think about refining, I think of the *expected* yield of the 3-2-1 crack spread as a kind of *opportunity cost*, or the foregone earnings if the 3 barrels of oil are turned into other spreads (e.g. 3-1.5-1.5, involving oil, gasoline and heating oil).**

**Put almost the same way, you conclude that the earnings on the 3-2-1 spread provide the foregone gain if instead you choose the 3-1.5-1.5 spread. Some probabilities enter into consideration here, and an example from financial economics might be useful. If you are in possession of a thousand dollars and are considering an investment in some financial asset, the purchase of a government bond provides an opportunity cost, or a guarantee of almost a certain return (or *yield*), given the risk associated with a private bond or a share.) Of course, your calculation of the risk might be faulty, and cause you to do something that (*ex-post*, or after the fact) you shouldn’t have done.**

**One of the most informative articles about refining recently appeared in the *Financial Times* (2014), written by Ed Crooks, and focusing on the attempt of refiners to keep the oil and natural gas components of what some of us call ‘America’s Energy Advantage’ from being made available to – i.e. exported – to foreigners.**

**I think that I have already made it clear that the kind of economics that I have studied and taught makes it easy for me to believe that from the point of view of ‘social profits’ – i.e. the ‘common good’ – U.S. oil refiners should be allowed to maintain their present ‘edge’ where obtaining comparatively inexpensive refinery inputs (such as oil) are concerned, and will not have to return to “grubbing for pennies in the street”, to use the ‘lingo’ of Rob Routs, a former managing director of Royal Dutch Shell.**

**Needless to say, precious little grubbing in the streets was carried out by people like John D. Rockefeller – the founder of Standard Oil, and who during his prime was the richest man in the U.S., and some claimed the world. Mr Rockefeller believed that searching for and producing crude oil was a waste of time for anyone who wanted to become rich, and refining was the best game in town. Refining crude oil into oil products is straightforward from an engineering point of view, although the margins for error allotted refiner managers are often exceptionally slender.**

**RUSSIAN OIL**

**Russian oil is one of my favorite subjects, because when I discussed it in my book ‘*The Political Economy of Oil’* (1980), I got everything right, and in my lectures at various seminars and conferences, I never hesitated to mention that I had a hard time understanding what those ‘pundits’ who got most things wrong were trying to prove.**

**My basic argument in that book was that “Given the comparatively small amount of exploration that has taken place in Russia in relation to its size, as well as the historical rate at which ‘Soviet’ production appeared capable of expanding, it would be surprising if their output of oil suddenly changed direction”. The spirit of that contention is at least as true today as it was then.**

**In case you have forgotten, about 1980 certain oil ‘experts’ believed that Russia would be a net oil importer before many years passed, and the CIA was among those who claimed that Russian oil reserves were much smaller than generally believed. What happened however was that less than ten year later, Western Siberia alone contributed almost 14 percent of global oil production, which put that region in the same category as Saudi Arabia. In addition, about the same time, several Russians informed me that their country was easily capable of producing ten million barrels per day (= 10 Mb/d), but for various reasons would never produce more. The Kings of Saudi Arabia have promised the same thing – the last time I know of being 2008 – and the approximate average in both countries at the present time is almost 10.5 Mb/d, measured over this year. It is also true that Russia has some of the largest oil and gas reserves in the world.**

**A surprising number of energy experts are prone to make mistakes when considering the oil future, but there are several fundamental facts that need to be understood about Russian oil. Their recent ‘strike’ in the Kara Sea – above Russia’s northern boundary – is believed to contain at least 1 billion barrels of (reportedly) super-light oil, which means that when it is refined into oil products it will feature a high proportion of gasoline and diesel*. Ceteris paribus*, that makes it more valuable than the oil the Russian firm Rosneft is now exporting, and Rosneft’s American partner Exxon-Mobil should also be congratulated. Congratulated because while the Kara Sea success is an enormous prize, there is almost certainly much more oil in Arctic waters, and Exxon-Mobil appears to have a preferential position in its exploitation, having been openly designated Rosneft’s “partner of choice”.**

**There does, however, seem to be a small problem. Ed Crooks, an outstanding energy journalist with the *Financial Times* speaks in terms “tantalizing *prospects”* for the Russians and their American partner instead of the correct *exciting discoveries*, because sanctions imposed by the U.S. and EU *ostensibly* prevent the export of technology and services needed to develop the oil that has been discovered (2014).**

**Just where did that terminology (i.e. “tantalizing”) and the antiquated idea about technology come from? If technology is the problem, the Russians will ‘sort’ it out in the fairly near future, while if necessary their Asian customers could give them the financial help they need. After all, when President Ronald Reagan organized a boycott of the compressors needed by the Russians to pump natural gas to Europe, the first Russian made compressors were ready in about 6 months, and the Chinese have recently demonstrated that they are ready and able to pay ‘present’ dollars to obtain ‘future’ oil and gas.**

**In considering this new discovery of Russian oil in the Arctic, as well as the belief that where shale oil is concerned, Russia may be the best endowed country in the world, it might be useful to peruse this issue from another angle. Between 1914 and 2014, global population increased by a factor of approximately six. If a similar growth rate prevails between now and 2114, neither Russia nor Exxon Mobil nor any other actual or likely oil exporter needs to be alarmed because of the possible imposition of sanctions – sanctions that a Russian government has less reason to fear than when Mr Reagan and/or his experts were making goofy suggestions to European governments that it made economic sense if they obtained the natural gas they needed from Argentina instead of Soviet troublemakers.**

**Put another way, this business of sanctions is little better than a sanctimonious absurdity. Edward Chow, a fellow at the Center for Strategic and International Studies in Washington, has apparently said that the American government will “not sacrifice foreign policy goals to help American businesses” but what he doesn’t realize is that the hullabaloo about the Ukraine will accelerate the movement of Russian energy exports from Europe to Asia, and as a result the burden of U.S. and EU restrictions will fall on Europe, and perhaps to a certain extent on the U.S. He also fails to emphasize that it have been better for President Obama and his associates to deal with Mr Putin on the plane of leadership, and to patiently explain to him the offense felt in many countries by what is taking place on the border between Russia and the Ukraine, than to threaten him with innocuous penalties.**

**Just as Exxon Mobil has been inconvenienced by the sanctions against Russia, France’s Total has been told to end its collaboration with Russia’s Lukoil in the exploration for shale oil in Siberia. This will not be a problem for Total, because as Total’s CEO Christopher de Margerie has noted, the Lukoil venture hadn’t really started, and so it has no impact on his firm. It will however have an effect on Lukoil: *it will make them stronger*, because it will help to free them from a spurious or superfluous dependence on foreign ‘expertise’ and capital.**

**GUESSES AND GAMBLES**

**These days I make an effort to believe that most people have an ‘inkling’ of the situation with oil, even though their opinions of natural gas and nuclear might be off the mark. I assume that with the ‘average’ oil price (West Texas Intermediate (WTI), or Brent often exceeding a hundred dollars a barrel (= $100/b), while there is constant and often suspicious talk of shale revolutions, the more vulgar forms of optimism will soon be discarded or toned down. (I should perhaps remind you that WTI is generally regarded as the North American price, while Brent mostly applies to Europe, however both of these prices are *benchmarks*, (or *markers*) and there might be other prices which employ premiums to or discounts from these two. Brent is sometimes referred to as the ‘global benchmark’. (The ‘Dubai’ price is at a premium or discount to one of these, and GOOGLE might be able to tell you more about the Dubai price, because I can’t.)**

**Amazingly, there are highly educated persons with backgrounds in energy matters who are unable to deal with the realities of the international oil markets. One of these harbingers of bad good news made herself known to me a few years ago.**

**Where that person was concerned, the outcome from using seismic technology (for locating oil and natural gas) was instantly characterized as a “guess and a gamble”. Furthermore, I was told that even when drilling you can miss a mega-sized oil field by a matter of “feet” (or meters). With all due respect, I interpret this kind of wisdom as no less than contempt for mainstream science and technology, as well as the men and women who sometimes sacrifice life and health for it.**

**I was informed by the same person that the attempt to assess oil reserves should be characterized as “guesswork” – which to a certain extent it is, though it has many of the characteristics of a genuine science – and so “the stuff written today about peak oil is a bit like the usual nonsense about climate change. It is written by people who know nothing about it”.**

**Really, Madame. Can we poor ignoramuses take that contention to the bank and draw a decent rate of interest on it? If so, then what is wrong with poor benighted me that I continue to believe that on the average, the rank and file of oil geologists, petroleum engineers and managers now accept the peak oil thesis? And how can they do otherwise, since the output of conventional oil has peaked in oil powerhouses like the U.S., perhaps Russia, and definitely the English and Norwegian North Seas, and the same cannot be avoided in the Middle East for many more decades. (In explaining peaking to students, I suggest that they look at production curves for the 100 largest oil deposits, which tells the entire story.) I have also heard from associates that a large percentage of genuine climatologists attach a high probability to climate change taking place that is influenced to some extent by human behaviour.**

**Personally, I don’t have the slightest idea as to what the climate outcome is going to be, or whether the people dealing with it are genuine scientists or charlatans, even after being informed about what is happening on the climate and environmental front in many parts of the world, particularly the Arctic, But what I do know is that the skiing at the ski area 10 minutes from where I live is not as predictable as it once was, and in gorgeous Kitzbühel (Austria) – called ‘Kitz’ by ‘hipsters’ and Kitzbühel regulars – helicopters have been chartered to fly in enough snow to keep various ski runs open. As a result, I no longer tune out when I hear or read or dream that some sort of climate change is actually taking place, and I might be better off if smart people were asked by policy makers to figure out how to protect us from its protectable aspects, regardless of the cause. By that I am not talking about skiing, but e.g. where to construct and how to pay for very high and thick concrete walls, and where to locate nuclear power stations so that they will not be interfered with by tsunamis.**

**I also decided to reject the hypothesis offered by that young lady that 80 percent (or more) was the correct figure for the recovery factor of oil. In other words, 80 percent of the ‘*oil in place’* could be classified as *reserves* (i.e. oil that could be removed at an acceptable cost). Even if this were correct, our oil worries might not be over, because on a global basis only about one barrel of conventional new oil is discovered for every three barrels consumed. I also wouldn’t advise wasting valuable time mulling over the above recovery factor, and wondering when it will be raised by a large amount.**

 **When I gave my first lecture on oil in Australia, the average global recovery factor for conventional oil was about 32%, and on several occasions I have been told that it may have reached 35%. Successful producers have understood for many years that talk about very high recovery factors is mostly nonsense, and thus it often makes economic sense to *reinject* a portion of the natural gas that may accompany the oil they produce in order to maintain or increase the pressure in oil deposits, and therefore the flow rate of oil being extracted.**

 **Of course, there are always ‘unconventional’ resources (as shale oil in the U.S. is sometimes designated), oil sands (or tar sands) of the variety found in Canada, and ‘heavy oil’ of the kind located in Venezuela. Where the first of these is concerned, at a workshop in Vienna many years ago, an American business executive called me a fool because of the enthusiasm I showed for this resource, saying that in his part of the U.S., there wasn’t enough water to economically obtain large quantities of shale oil. (Actually he was more correct than he knew, because the availability of water for *all* uses is apparently going to be a major problem in the coming decades.)**

 **At the present time the belief in shale oil is almost sanctified, unshakable, because it is pictured as an antidote against the potential ravages of OPEC – ravages which have not taken place in the past in the manner believed, even though gross inconveniences that have been suffered because the laws of supply and demand have not been understood the way that they should have been understood by the high and mighty and their experts, given the simplicity of these laws. For instance, when the price of oil (in 2008) reached $147/b, and certified experts spoke of it reaching and likely passing $200/b, a light panic was experienced that contributed to the rising price of both physical oil and ‘paper oil’, where the latter has to do with the prices of financial assets like futures and options, and often is confused with the price of the former.**

**The oil futures market was discussed in the previous chapter, along with an elementary treatment of options, but in case the expression ‘futures and options’ causes you a problem, you should realize that you already know more about these topics than most people, and that includes persons with a taste for irrelevant mathematics.**

**As for Canadian oil sand or tar sand reserves, these are valuable resources, but after remembering some of the research of Professor Douglas Reynolds (of the University of Alaska), I don’t have much faith in them or in ‘heavy oil’ where changing the *international* oil picture is concerned, at least in the near future. At the same time it might happen that unconventional oils will provide us with all the motor fuel we need to keep our autos moving toward the skiing and partying in the resorts of Middle Sweden, and even further North in the Midnight Sun later in the year, although I have some doubts about the quantity and quality of the motor fuel *or* the ski slopes that will be available in the last half of this century.**

**Quite obviously, if there were as much oil in this old world of ours as the young lady above thinks, or thought, then we would never have to worry again about oil prices escalating the way they did in 2008. That price was catastrophic for much of the global economy, although wish-fulfilment for several countries in the Middle East. Perhaps another point of some importance is that that oil price escalation initiated some undesired (or unwholesome) changes in the international economy that still exist.**

**FINAL STATEMENTS**

**I never tire of reminding my students how Professor Milton Friedman foolishly predicted the downfall of OPEC in the weekly publication NEWSWEEK, and also predicted the collapse of the oil price to $5/b or lower. He convinced a number of his fans that he knew what he was talking about, but as things stand at the present time, we will be extremely lucky not to confront a sustainable oil price *well above* $100/b before the end of the present decade, which could mean a reintroduction of the macro-economic and share market discomforts that were so acute only a few years ago. Think about it: a price of $115/b, or perhaps more for an item that cost $25/b a decade ago, and not too long before the Second World War, in California, was selling for less than 10 cents (=$0.10/b), or a tenth of a dollar! Of course, in 2008 that price touched $147/b**

**I also suspect that it might be wise to correct those persons who insist that things are different from the way they are described in this book because the *real value* of the dollar has decreased due to inflation and exchange rate changes. For instance, although a declining dollar is annoying for oil exporters in general, their situation is actually not so unfavorable as often alleged. As clarified in my new energy economics textbook (2014), the superb present (and future) physical transformation of the Gulf states alluded to above would have been impossible if the dollar decline was as malicious for oil exporters as often maintained by academic cranks and know-nothings in the business press. The reason is simple: comparing the oil price in l980 with the oil price today – as the pompous Josh in the TV series *The West Wing* attempted to do – is as scientifically inconsequential as comparing a rap standard to a rendition of ‘*Hail to the Chief’* by the U.S. Army Chorale. The base year for calculating the real price of oil is something that I never think about, but given the miraculous economic progress that has taken place in some of the OPEC countries, I am unable to believe that the real price has decreased, or that it is meaningful to devote time and energy to its consideration.**

**The problem with many observers, to include teachers of energy economics, is that they cannot comprehend the power of oil, which derives from its usefulness. Consider for instance Norway, whose government was not intelligent enough to reduce their output of oil when – about 1999 – the price seemed to be heading for the dumps. They were later able to ride the oil price rise that began early this this century up to a position where, in theory at least, if the ‘oil-fund’ of that country – which is managed by the government, and used to buy financial assets and property in various parts of the world – was sold and the proceeds distributed, every resident of Norway – adults and children – could be awarded a million Norwegian crowns (or at the present rate of exchange, about 150 thousand dollars).**

**This Oil Fund (= *Oljefondet*), consists of income received by the government from taxing the profits made from the sale of oil and natural gas that is produced in Norway, or in the water around Norway, and also income from investments in stocks, bonds and property by that fund, which apparently amounts to more than 40 billion dollars a year. This good luck has made Norway one of the richest countries in the world, or by my standards the richest (together with Switzerland), because the wealthy OPEC countries often have to deal with various kinds of international and internal tensions.**

**Last but not least, a short mention of PEAK OIL seems in order, where an important analysis is provided by one of the leading oil economists in the world, Dr Mamdouh G. Salameh (2007). Peak oil is not about the future, but about the past! It’s about the (generally unspoken) intention – formulated many years ago by the most important countries in OPEC – to reduce the ‘rate’ at which their invaluable oil (and probably also gas) is produced when they got the opportunity. The present high oil price has given them the opportunity. In simpler terms, it’s not about the kind of run-of-the-mill profit maximization you studied in the course in Economics 101 that you may or may not have taken, but formulating a strategy in which attention is being paid to the future as well as the present. The kind of approach alluded to in the last chapter of the superb microeconomics textbook by James Henderson and Richard Quandt (1980). In other words, the OPEC countries prefer *smart* to other options where oil is concerned.**

**As might be shown by serious teachers with a serious interest in the so-called dismal science, it’s about obtaining or enjoying what is likely a controlling interest in the global supply curve, which to me is reflected in their ability to obtain the oil price they feel they need – the price that will provide an annual income of one trillion U.S. dollars. Basically, for an organization like OPEC just now, it’s less about geology than economics, and they have a much more thorough knowledge of the oil under their control than hackneyed researchers and busybodies at elite American universities who once preached to students and colleagues that OPEC is a lost cause, and deservedly so.**

**A slight addition to the above presentation is probably useful, and this has to do with how the OPEC countries in the Middle East feel about the increased supply of world oil due to ‘fracking’ – i.e. exploiting on a much larger scale shale oil, as a result of dramatic improvements in the technology for obtaining this oil. On the surface at least they do not seem worried, and sometimes refer to it as a ‘bubble’ ( = a deviation from fundamentals). There is no reason to comment on that judgment at this point in the exposition, however there are many observers who refuse to be impressed by fracking and its alleged potentialities. Moreover, the OPEC countries almost certainly realize that the large oil companies do not intend to do anything foolish that would reduce the price of oil, nor to prevent that price from increasing if buyers increase the rate at which they are taking their requirements. After all, they have many shareholders to satisfy.**

**The thing to remember here is the situation when an oil company executive made it quite clear that if forced to choose between his firm and his country, his country would come in second place. If he was serious, and his colleagues felt the same way, then they have no choice but to work with OPEC, although probably as silent partners.**

**MATHEMATICAL APPENDIX: A SIMPLE TOPIC MADE DIFFICULT**

**In my first energy economics textbook, I derived an equation that related the rate of growth of oil consumption with the rate of growth of reserves, and which displeased certain bystanders because of an approximation that was employed. I will now present a completely formal derivation in which no approximations are necessary, to include the one that I employed in my lectures in Paris and Bangkok, In the discussion directly below, the following notation is used: Q is reserves (a stock), while q is production (a flow). ‘n’ is the rate of growth of consumption, while ‘g’ is the rate of growth of reserves. T and ‘t’ refer to time. (θ will be defined as the reserve-production ratio, or Q/q. The background to this discussion however is the brilliant article by Andrew Flower (1978) and the book by Mamdouh Salameh (2004).**

**But before turning to the integrals, I would like to present a simple numerical example. Suppose that reserves are 150 units, and output is 15 units per period. The reserve production ratio ( θ = Q/q) is thus 10. Now let us assume that n = 0%, and g = 5% = (0.05), and see what happens to reserves. Q at the beginning of the next period is 150 – 15 + [150 x 0.05] = 142. 5. Both reserves and the reserve production ratio have fallen: the latter is now 142.5/15 = 9.5.**

**In the same vein, we can start with a value of θ = 40, and so with q = 15 (and thus Q = 600), and the same values for n and g, we get for the beginning of the next period Q = 600 – 15 + [600 x 0.05] = 615, and so as opposed to the earlier example, θ has increased to 615/15 = 41. The next step is to generalize these results using some calculus. We start with the relationship for Q at time t = T, having commenced with a value of Q(0) at time t = 0.**

 **Q(T) = Q(0) –  (1)**

**We should recognize that q(t) = q(0)ent and g = 1/Q[dQ/dt]. Now we can write:**

 **Q(T) = Q(0) –  (2)**

**This expression can immediately be differentiated to give dQ(T)/dT = – q(T) + gQ(T). Continuing, with θ(T) = Q(T)/q(T), we can write:**

 ** (3)**

**The penultimate move in this derivation is to substitute dQ/dT in (3), and to use θ = Q/q where it is appropriate:**

 **[ – q(T) + gQ(T)] – θn = – 1 + θ(g – n) (4)**

**Thus, for dθ/dT > 0 we need θ(g – n) > 1. For the values in the previous example, with n = 0 and g = 5%, for θ to increase we must have θ > 1/0.05 = 20. This is the same outcome as informally obtained in my earlier energy textbook (2000).**

**For this teacher, the use of calculus is always a big deal, having failed college algebra my first year in engineering school, whereupon I was expelled from Illinois Institute of Technology. But in point of truth, it is only marginally important than the secondary school algebra that I employ to extend Andrew Flower’s important contribution, and which my students are told to learn, because unfortunately many of them have not been taught how to differentiate integrals.**

**Something else that they have not been taught is to read the business sections of their local newspapers. If however they did on March 4, 2014, they might had been told that because yesterday Russia informed the government of the Ukraine that if they did not comply with Russian instructions by 4 O’Clock the following morning, then by breakfast they might be under attack. That threat caused a general rise in oil prices, to include those thousands of miles away from the Ukraine, which says more about the importance of oil than all the loose talk in circulation about shale resources.**

**This chapter will be concluded with a very long list of references, and eventually I will add questions and exercises for all except the last chapter. I get the impression that many students of energy economics have not read what they should have read, and even worse, they have wasted their time with literature that should have been ignored. It is possible that some of the following references should have been eliminated, but frankly I do not know where to begin. I can however point out a few of my favourites. The article by Andrew Flower (1978) in *Scientific America* comes first, and forms the basis for the mathematics dealing with oil in my textbooks, articles, and lectures. The results in that article also correspond to those in the mathematics above. The books by Donald E. Carr, David Bodanis and Earl Cook come next, and then the book by Bertrand Barre and Pierre-Rene Bauquis on nuclear. The best microeconomics textbook is Henderson and Quant (1980). Articles such as those written by David Teece on natural gas, Mamdouh Salameh on peak oil, Fred Pearce on the German nuclear retreat, and also the work of Jeffrey Michel, an MIT graduate and prominent energy economist living in Hamburg are essential, especially for students who want and deserve reading materials that are free of irrelevant mathematics. It might also be a good idea to check out M. King Hubbert on GOOGLE!**

**Not long ago I took part in a net debate arranged by *CrossTalk*, which is a current affairs debate program associated with Russian Television (RT), and hosted by the American journalist Peter Lavelle. Many of the debaters are important politicians and academics from Europe and North America, and appearing with me were the economists Kurt Cobb and Sohbet Karbuz. Cobb is the author of ‘Prelude’ a peak oil novel, whose important blog is *Resource* *Insights*, and Sohbet Karbuz is Director of Hydrocarbons at the Observatoire Meditteranéen de l’Energie (Paris), and a foremost researcher into the mysteries of oil pricing.**

**With a bit of luck, serious readers of this book will eventually be ready to cross (verbal) swords with experts like Messrs Cobb and Karbuz, as well as other genuine experts, and with luck demonstrate to onlookers and themselves that they are getting somewhere in this matter of energy economics. By serious readers I mean people who read this book or books like it until they are convinced that they understand *some* of it perfectly, and *all of it* better than people who are forced or force themselves into contact with the wrong kind of energy literature.**

**Before finishing this chapter, I want to refer again to the site 321 Energy. If you desire up-to-date information on energy resources – oil, natural gas, nuclear, coal, solar and wind energy – it is a mistake to overlook that site. The persons publishing there are often the cream of energy journalists, and as far as I am concerned the site is *Number* One in the energy information business. You should also be aware that if you want to debate energy matters, Energy Pulse will provide you with a suitable outlet.**

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**4. ECONOMICS AND NATURAL GAS**

**INTRODUCTION**

**In general, natural gas is found in an environment similar to that in which crude oil originates, and on occasion it has been called gaseous petroleum. (There are also occasions when lecturers refer to petroleum as oil + natural gas.) Surprisingly, natural gas was initially produced from coal, and its primary use was lighting. Although many people believe that gas and oil are found in reservoirs, or huge underground caverns, they actually originate in water coated pore spaces in rocks – for the most part sedimentary rock classified as organic shale. This shale originated as the remains of prehistoric plants and animals, and was ‘cooked into oil and gas’ by heat, the pressure of the earth acting over millions of year, and various chemical reactions.**

**Some hydrocarbon deposits contain oil but no natural gas, while others – where the cooking referred to above continued until the hydrocarbons were reduced from liquid oil to molecules of natural gas – contain natural gas but no oil. This latter category is called non-associated gas. A very common arrangement is the presence of gas and oil in the same deposit, and in this situation the gas is referred to as *associated gas*. Associated gas is non-discretionary, because it becomes available whenever the associated crude oil is produced, and thus if it is not piped away to be sold it might be reinjected in order to maintain the pressure of the reservoir, or flared (i.e. burned up in the air). There was a time when a ‘light show’ took place almost every night over the Middle East oil fields, due to enormous flaring.**

**I once thought that flaring was a thing of the past, but I was definitely mistaken. When I was sitting in the library at the Australian National University (in Canberra), someone told me that ‘gas gathering systems’ were being constructed in his country, but even so more than 100 billion cubic meters (100 Bcm** $≡$ **100 Gcm) of gas was being flared annually, most of it in the Middle East and Africa. About the same time 8 percent of gross production was being reinjected, and I eventually found out that – in theory – a large fraction of reinjected gas can be recovered after oil production has ceased. This might also be the right place to inform readers that a natural gas (or oil) *well* is roughly a hole in the ground, out of which comes gas or oil, while a *deposit* is a ‘property’ that often contains considerable gas or oil, and usually featuring many wells! A deposit with a collection of wells and accoutrements is often labelled a ‘field’.)**

**I perhaps should also mention that while some mathematics might be useful in this chapter, many readers and potential readers have made it clear that they do not want to be served any, and I don’t blame them. The highly mathematical approach to academic economic theory is sometimes fascinating and useful, but often an unproductive and tiresome waste of time. In case you are interested in this topic, I happen to believe that the intermediate courses in economics are the most important, and in a university in which I was in a position to give the orders, students majoring in economics would not be allowed to attend higher courses unless they proved beyond the shadow of a doubt that they understood several of the intermediate courses *perfectly*!**

**To continue, if there is no math in this chapter, then what is there? There are words and several diagrams, one of which everyone should be aware of in case the next president of the U.S. also tries to convince his countrymen and countrywomen that the U.S. is the proud possessor of 100 years of natural gas at the present consumption rate. As it happens, the important thing with gas (and oil) is not the ‘life’ of the well or deposit, but the time to when it peaks. Discussing this issue is probably best done with an analysis based on ‘The Logistic Distribution’ (Figure 2 below), for which there are some beautiful mathematics and statistics that were used by Marion King Hubbert to predict that oil in the U.S. would peak in l970, To the great disgust of his peers he was correct, and jealous colleagues and observers did everything possible to misinterpret the peak.**

**About the peaking of oil and natural gas output. The unexpected technological improvements for obtaining oil and gas via ‘fracking’ have probably – but not *certainly* – made forecasting the amount of oil and gas in the crust of the earth considerably more complicated. This is an issue that I do not feel qualified to confront, but I don’t hesitate to say that something is definitely wrong in the presentations about shale gas. Something doesn’t fit, and I suspect that *caution* should be the byword for students and researchers. We need less guesswork where this and other energy topics are concerned, and that includes guesswork by so-called experts who answer to our decision makers.**

**Before we move on, I want to provide some aspects of shale production to remember and think about. Ivan Sandrea, a senior partner in oil and gas at the consultancy Ernst & Young, declared that although *initial production* rates from shale investments seem to have improved, the *natural depreciation* (= the partially autonomous ‘wearing out’ and/or ‘decline in productivity’) of shale deposits makes it more expensive to produce a given output from shale oil and shale gas deposits than from conventional deposits, and this might be one of the reasons for shale deposits’ *recovery factors* remaining low. Moreover, the high variability of the (per ‘unit’) cost of extraction makes it difficult to plan operations and predict profits.**

**THE PRESENT NATURAL GAS SCENE**

**The president of the United States, Barack Obama, recently notified his countrymen that the U.S. is now in possession of 100 years of natural gas, and every effort should be made to turn this bounty into the energy basis of a new American industrial renaissance. As an American citizen, I am definitely impressed by the concept of an American industrial renaissance, but as far as I can interpret the existing evidence on all natural gas reserves, the estimated amount of natural gas located within or near the boundaries of the U.S. will not provide 100 years of gas production at or greater than the present annual output of natural gas. (U.S. coal reserves may meet this criteria, but few observers want to talk about that.) The assertion about natural gas is primarily based on the characteristics of the logistic distribution function, which will be referred to later.**

**There are certainly people in the United States Department of Energy (USDOE) who are as familiar with this issue as I am, or more familiar, but they have also probably discovered that – for career reasons – it makes sense to keep any non-conformist knowledge of and beliefs about this topic to themselves and their closest associates. That, incidentally, is why I was cashiered from a site called *‘Oil Price Com’*: I presented the wrong judgement on a preposterous article in which it was claimed that the U.S. possessed more energy resources than the entire remainder of the world.**

**Where conventional gas is concerned, the 2011 *British Petroleum Statistical Review of World Energy* lists 6,608 trillion cubic feet of conventional gas, with the top three being Russia with 1,580 Tcf, Iran 1,045 Tcf and Qatar 894 Tcf. Saudi Arabia and Turkmenistan are next with about 283 Tcf each. I will not challenge those numbers, however I have grave doubts concerning some of the information being disseminated about shale gas, since that resource is not economically identical to conventional gas in so far as the mechanics of production are concerned. I therefore did not bother to attempt to bring those numbers up to date, and I very seldom refer to the size of natural gas reserves. In addition, because of a more rapid ‘natural decline’ (= natural depreciation), environmental issues, and perhaps other production quirks, shale gas (like shale oil) belongs in a different category, although this might be a case in which – if shale gas statistics are correct or nearly correct – it might be time for partial sceptics like myself to accept that a fortuitous technological breakthrough has taken place.**

**Moving from 2011 to the middle of 2014, what we find is that U.S. and Russia are often referred to as the largest owners of natural gas reserves, with Iran in third place (although, according to BP, that country is also a net importer of gas, despite recent large increases in production). This riddle is ostensibly due to various ‘sanctions’. In any event – and this is important – the proven gas reserves of that country are/were 33.8 trillion cubic meters, or 18.2 percent of the world’s total proven reserves.**

**An interesting paradox is that according to the BP’s latest “Statistical Review of World Energy”, Iran only accounted for 0.5 percent of global natural gas production, at 166.6 billion cubic meters in 2013. I can remember lectures that I gave 20 years ago when I suggested that the future should see Iranian natural gas being imported by many countries in Europe. Apparently we will have to wait at least another 20 years for that to happen.**

**The latest surmise about Iranian natural gas has to do with the South Pars/North Dome gas field—the world’s largest, alone accounting for 8 percent of global reserves—which it shares with Qatar. A deal has ostensibly been struck to supply three power plants in Iraq with the equivalent of 7 million cubic meters of natural gas per day, to be increased to 40 million by 2020, and there has also been talk about supplying natural gas to Jordan, Syria and Lebanon. More than talk however is a deal worth 60 billion dollars that was signed with Oman to supply 10 billion cubic meters of natural gas per year over a period of 25 years via a 1-billion-dollar, 162-mile (260-kilometer) pipeline.**

**Despite the boisterous talk about shale gas revolutions and ‘game changers’, there are many observers who are cautious about that resource. Some very smart people claim that it is not a ‘cure-all’ or silver bullet, and one of them, Murray Duffin, in the forum *Energy Pulse* (www.energypulse.net), has claimed that the average “sweet spot” in shale gas properties – the area in which the concentration of the resource is relatively large – amounts to no more than a modest 30% of the total area. Put another way, within a given property containing shale gas, a more intensive drilling may have to take place in order to obtain (*and maintain*) the same flow of the resource that would be possible if that or an equivalent ‘tract’ contained conventional gas – i.e. natural gas that was extracted in the conventional manner. Bill Payne, on the same site, notes that higher depletion rates mean more drilling to obtain previous outputs. *Ceteris paribus*, more drilling means higher costs.**

 **Murray Duffin – like many others – also made a quite conventional observation about the extremely large (*natural*) physical depreciation/decline taking place in shale deposits, and this is an accusation that convinced shale partisans have not bothered to deny. Moreover, it is possible that only the presence of valuable natural gas liquids in shale deposits assures that those deposits can be profitably exploited at natural gas prices in the vicinity of those now prevailing in e.g. the U.S.**

**On this score – at least until recently – much effort has gone into boosting the selling price for properties containing shale gas to a level that some observers feel is manifestly incorrect, given the (low) price of U.S. natural gas prevailing at the time. But that of course is the point! Some firms and persons who have invested considerable amounts of money in shale deposits expect (or expected) to increase their fortunes as a result of the appreciation of property values rather than the production of natural gas. Students and observers of the natural gas scene should always keep this in mind, and they should also be aware that the reporting of natural gas reserves (in a particular deposit) to potential investors as compared to reporting the amount of reserves in the same deposit to the authorities can show striking differences!**

**The discussion just above can be summed up with the following comment: shale gas is characterized by rapidly depleting wells that require expensive and complicated inputs. This is not an economic disaster for producers unless natural gas prices collapse, however present U.S. gas prices have often been judged comparatively unhealthy For instance, during the last few months those prices in the U.S. have moved from a healthy six dollars per million cubic feet (= $6/mcf) to something around $4/mcf. Even so, for a number of reasons, shale gas may be a very valuable resource for the countries in which it is found in large quantities. As Lord Browne (formerly of BP) noted, domestic (natural) resources increase (energy) security, tax revenues and jobs, and in the long run might play a major role in reducing power prices.**

**Environmental doubts (associated e.g. with possible ground water pollution and methane leakage) have caused the French government to ban the exploitation of what may be the largest shale deposits in Europe, with the possible exception of Poland, although it should be kept in mind that attempts to obtain the same scale of results in Poland as in the U.S. have failed, and some firms apparently want nothing more to do with shale gas exploration or promotion in that country.**

**As for France, it would be very fortunate for the French economy and their president if – *ceteris paribus* – a large-scale extraction of shale gas were possible in reality as well as theory. An argument commonly heard in the U.S. is that massive investments in shale gas could be instrumental in curing certain macroeconomic ailments with which many countries are plagued, however rather than accepting the risk of being harassed by environmentalists if they lobbied the French government for permission to undertake the production of large quantities of shale gas, the French energy ‘major’ *Total* has apparently elected to deepen its acquaintance with shale gas in other parts of the world. Things may change though, because the present government in France appears to be breaking down because of its economic failures.**

**Many students have difficulty understanding why, in a country as large and well supplied with technical expertise as France, and where a large portion of shale gas reserves might be located in districts where they arguably cannot do any environmental harm if exploited, a nation-wide production ban has been imposed. In my opinion it is a political gesture similar to the outlandish nuclear retreat proposed for Germany, whose purpose is to entice voters with a strong environmental focus to support a particular political party. I will admit though that as long as France sticks with its traditional nuclear policy, shale gas is unnecessary. However, as in Germany, the only policy that the present government in France is interested in is one that will make fools of voters.**

**A similar problem arises in trying to figure out why the Chinese firm *Sinopec* has apparently invested several billion dollars in foreign shale deposits, since estimates are that Chinese shale resources are the largest in the world. One reason might be the presence of valuable (natural gas) liquids in their foreign acquisitions. (The worth of these liquids is constantly cited!) Another might be that given the extent of various energy investments in China and elsewhere, Chinese managers regard the opportunity cost of additional domestic energy commitments as too high just now, even though China seems to be in the process of becoming the most enthusiastic purchaser/developer of energy resources in the world, and does not lack the billions of dollars needed to finance what it regards as attractive acquisitions. Something that deserves repeating is that despite the presence of millionaires, luxury automobiles and high fashion, the Chinese economy is managed in a very different way from that of the U.S. or Europe.**

**Somewhat more abstract, the Chinese might regard domestic energy supplies as an energy reserve, and find it preferable to help exhaust foreign resources. After all, China undoubtedly has intentions to challenge the U.S. for the top position in the global economy, although many observers refuse to acknowledge this situation, though not so many as was the case a few years ago. . Or, as once suggested in the (London) *Financial Times*, the Chinese are not sufficiently competent yet to master the technology required to obtain large amounts of shale gas. If the sponsor (or sponsors) of that bizarre belief were sober, they hardly deserve to be called ignorant.**

**I sincerely hope that shale gas will live up to expectations in the energy future of North America and elsewhere, because as I enjoyed pointing out in lectures many years ago, it may be true that economic progress can best be described as an increasing function of technological development and the accessibility of economical energy resources. At the same time I feel it best to ignore (or partially ignore) some of the rosier estimates that one encounters almost daily about the merit of various non-conventional energy resources and alternatives, by which I especially mean wind, solar and perhaps even shale gas.**

**Something worth noting here is that because turbines burning natural gas can rapidly vary their output, and it may be that the availability of natural gas has drastically increased for some countries, this equipment is ideal for complementing the large number of wind farms and solar panels that someday might be featured in various energy undertakings, but whose output of electricity tends to be irregular because of occasional shortages of wind and sun. Fast-start gas turbines might have a prominent role to play in districts where gusts of wind not only lose their force suddenly, but occasionally become so strong that wind turbines must be shut down for safety, and also the stability of the grid. Of course, when dealing with this subject, attention should be paid to the additional expense associated with installing gas turbines, and providing infrastructure to transport gas.**

 **FURTHER INTRODUCTORY OBSERVATIONS**

**As already pointed out, when shale gas appeared on the scene in a spectacular manner, it became necessary to emphasize that a natural gas deposit consists of more than methane (or CH4), which (quantitatively) is the major component of a deposit. Methane is colourless, odourless, widely found in nature, and according to some environmentalists and others, more dangerous than carbon dioxide (CO2). But regardless of the advantages or faults of natural gas, it is an excellent fuel, and it plays an important role in the electric generation ‘merit order’. (The merit order is a way of ranking energy sources – especially those generating electricity – so that the source with the lowest *marginal* cost delivers the *next* unit of electricity.) Thus if we have nuclear and gas, where gas has low capital costs but perhaps a high variable cost, while the opposite is true for nuclear, for peak loads (or loads lasting only a short time) gas would be preferable, but for base loads nuclear would be preferable, because base loads are on the line for long period, and so a very expensive reactor should not be idle for long periods.**

**Natural gas from a well consists of methane (on the average 85%), heavier hydrocarbons collectively known as natural gas liquids (and composed of ethane, propane, butane, pentane, and some heavier fractions), water, carbon dioxide (CO2), nitrogen, and some other hydrocarbons. (And, note here, that gas is *not* free of carbon dioxide. It merely has less than oil and coal.) Before dry natural gas can be distributed to consumers, some undesirable components must be removed and, by decreasing the share of heavier hydrocarbons, a uniform quality attained.**

**The last-mentioned operation takes place either at or near the gas well itself, or in special installations farther away. It is at this point that the natural gas liquids (NGL) can be separated out. (NGL should not be confused with liquefied natural gas (LNG), which mostly consists of methane and ethane.) The most important constituents of NGL are butane and propane, which I have heard called ‘wet gases’, and in liquid form these are called liquefied petroleum gas (LPG). In many countries, LPG is sold under the name gasol or bottled gas, and when I taught in Australia I remember hearing that the government wanted a greatly increased use of LPG, although I never heard anyone say how or why this made economic sense in that energy-rich land, with its huge reserves of inexpensive coal. What did not make sense was to export instead of keeping uranium.**

**Before turning to less provocative aspects of this topic, something should be made clear. According to Robert Bryce, an editor of the *Energy Tribune Magazine*, coal dominated the energy picture in the 19th century, oil the 20th, and – in his opinion – natural gas will be the dominant “fuel” of the 21st century. Whether he was thinking of the U.S. or the world is unclear. In the U.S., when his article was published, natural gas accounted for 23% of domestic electric power, while coal generated about 40%, wind and solar only about 3%, and nuclear about 20%. With power demand scheduled to increase between 15 and 20 percent over the present decade, and the looney belief expressed by many prominent and highly educated Americans that the U.S. possesses a 100 year supply of natural gas (ostensibly at the present level of consumption), it might be easy to believe that – in the U.S. at least – natural gas is capable of outshining coal and nuclear as, e.g., a source of (base load) electricity throughout the entire 21st century. I have very strong doubts about this contention however. Actually, it sounds completely wrong, and the persons flaunting this belief should move to other newspapers and television stations.**

**One reason for doubt is because on the basis of present known reserves, the U.S. almost certainly does not have a 100 year supply (at the present consumption level) that we constantly hear about, and definitely not if consumption escalates. What it has is a reserve-production ratio of about 100, which suggests that (at the present consummation level), in about 50 or so years, a ‘peaking’ of the natural gas output may take place. This is considered below. Moreover, in China and India natural gas consumption has increased by 376 percent and 131 percent respectively over the past decade, and there is no indication that it will decrease, since the rate of macroeconomic growth in these two countries is expected to remain in the 7-8 percent range during the present decade.**

**ENERGY UNITS AND HEAT EQUIVALENTS**

**Please read this section. Reading and understanding it will probably make you feel better about yourself, as it does for me when I lecture on this topic. Besides, you are already familiar with some of it.**

 **One of the problems with academic economics is that too much emphasis is placed on elegant trivia, while really important themes are sometimes given a superficial treatment. Accordingly, some – and perhaps many – readers will choose to skip this section. Needless to say, any of my students who favour that option will not find it easy to pass my next course in energy economics, because there is nothing in this section that requires more concentration than that associated with the first weeks of a secondary school lesson in physics.**

**In the most elementary, yet most comprehensive sense, energy can be defined as anything that makes it possible to do work – i.e. directly or indirectly bring about movement against resistance. Energy takes many forms, and one of its most interesting characteristics is that all aspects of motion, all physical processes, involve to one degree or another the conversion of energy from one state to another. For example, the chemical energy that is found in natural gas can be converted to active heat, which in combination with water will generate steam in a boiler. This steam can then be used to drive a turbine which, in turn, rotates the shaft of an electric generator, and thus produces electricity. Note that the rotating shaft implies the ability to do physical work.**

**All this is perfectly straightforward, but unfortunately heat cannot be converted into work without loss, and the loss takes the form of heat transposing (or descending) to a temperature closer to that of the surroundings, and away from that of the heat source that made the work possible. Once heat has descended to the *ambient* (i.e. surrounding) temperature, it is no longer available to do useful work. What we are dealing with here is a highly abstract concept from thermodynamics known as *entropy*, sometimes called “time’s arrow”, which signifies energy going down the thermal hill and being diffused into space. Lost forever in the sense of doing or being able to work we can truthfully say, which in turn implies that the universe itself is in danger of ‘running down’ (in e.g. a few million or so years).**

**As pointed out in the first chapter of this book, John von Neumann was sometimes referred to as ‘the best brain of the 20th century’, and one of his advantages was to have virtually every physical constant known to mankind stored in his brain, and available for instant recall. That sort of achievement is not normally required to convince friends and neighbours of your acumen, but it is always useful to have a few numbers at hand when studying the present topic. The numbers below were given earlier, but there is no harm in repeating them. First of all I suggest again the value of knowing that one metric ton (= 1 *tonne* = 1t) equals 2,205 pounds, and that 2.2 pounds = 1 kilogram (= 1000 grams), Similarly, 1 inch = 2.54 centimetres, 12 inches = 1 foot, 100 centimetres = 1 meter and thus 1 meter is approximately equal to 3.28 feet (ft) = 39.37 inches. One cubic meter (= 1 m3) is therefore equal to 3.283 = 35.3 ft3. In everyday life the usual ton is the *short ton*, or simply *ton*, which equals 2,000 pounds. Thus 1t = 1 tonne = 1.103 tons.**

**When dealing with energy we are often interested in heat equivalents, and when the topic is natural gas the most favoured unit is the British thermal unit, or Btu, which is the amount of heat required to increase the temperature of one pound of water by 1 degree Fahrenheit. (1 pound of water is approximately equal to one *pint*.) Here it might also be useful to remind readers that with F Fahrenheit, and C Centigrade (or Celsius), we go from C to F with the equation F = (9/5)C +32. In scientific work, and in certain countries, *joules* are preferred to the Btu as a unit of heat energy, however since the price of natural gas is often given in dollars per million Btu (= $/mBtu = $/MBtu), there is no reason in energy economics to spend a great deal of time pondering the utility of the joule or for that matter the calorie or kilocalorie (= 1000 calories = 3.968 Btu), which are other heat units. (Gas prices are sometimes given in dollars per thousand cubic feet.)**

 **That brings us to a key observation, which is that 1000 cubic feet (= 1000 cf = 1000 ft3) of natural gas has an approximate energy content of 1,000,000 Btu. (To be exact, 1 ft3 of natural gas has an average heating value of 1035 Btu, but 1000 Btu is almost always used.) Though not especially important, it is useful to know that the *average* energy content of natural gas varies from a low of 845 British Thermal Units per cubic foot (845 Btu/cf = 845 Btu/ft3) in Holland to 1300 Btu/ft3 in Ecuador.)**

**Now let us make a calculation involving natural gas and crude oil, where one barrel (= 1 b) of oil has an average energy content of 5,686,470 Btu (≈ 5.686 MBtu). If we assume the price of oil to be $100/b, and the price of natural gas about $5 per million Btu (= $5/MBtu ≡ $5/mBtu ≡ $5/MMBtu), then it is easy to compare Btu prices of these two energy resources. The cost of a *million* Btu of oil is thus 100/5.686 = $17.587/MBtu (as compared to $6/MBtu for natural gas in the U.S.). There is a large difference between these two prices, and it has occasionally been suggested that this difference will result in the (dollar) price of oil falling by a great deal. I do not share this belief.**

**Persons who find this approach interesting or important can turn to trivial articles in the academic literature whose authors are of the strange opinion that the *burner tip parity rules’*, which have to do with an inevitable convergence of oil and gas prices (in Btu terms), possess virtually the same authority as Albert Einstein’s ‘equivalence theorem/principle’. (In case you forgot, that theorem says that if two phenomena produce equivalent effects, they must be manifestations of the same fundamental law.) Thermodynamically – and especially in a laboratory – the equivalence theorem holds everywhere, but a substantial decline in the oil price is out of the question as long as OPEC retains its present unity, and its ‘quasi-invisible’ hand functions as it has during the last decade. As for natural gas prices, they appear to mostly follow conventional supply-demand relationship (but perhaps with a stochastic (i.e. random) component).**

**It is possible that the economics of natural gas markets will eventually be transformed by the kind of sophisticated technological advances that made the exploitation of large amounts of shale gas possible, although the character (or details) of this transformation cannot be ascertained at present. In the U.S. the availability of large amounts of shale gas once depressed the gas price to an unexpectedly low level (≈4 dollars per million BTU), while at the same time the price of natural gas averages about 14-15 dollars/MBTU in much of Asia. This Asian gas consists largely of LNG imports.**

**The technological advances that are necessary to liquidate these differences (or as we sometimes say, to ‘*arbitrage’* away these differences) have to do with the processing of natural gas so that it can be transported between continents. (In other words, to buy inexpensive gas in North America and sell it at the elevated prices in Asia, which by the usual supply-demand mechanisms may bring about something close to a price equality). Here it might be useful to mention that oil is generally rated a more ‘efficient’ resource than gas, because on a Btu basis it is more economical to transport in its ‘raw’ form, or as oil products (e.g. motor fuel), or even petrochemicals (e.g. fertilizers).**

**Now let us consider an example that involves two light bulbs. One of these produces a great deal of illumination, and has a power rating of 500 watts, while the other is considerably weaker, and has a rating of only 50 watts. If the heat energy in coal (or oil or natural gas) is totally and *perfectly* transformed into electrical energy (i.e. with 100 percent efficiency), then 3,412 Btu are required to generate a kilowatt-hour (kWh) of electrical energy (where the kWh is the unit in which *electrical energy* – as distinguished from *power* (in e.g. watts or kilowatts) – is measured. Note that a kilowatt is 1000 watts, a megawatt is 1,000,000 watts or a thousand kilowatts, a ‘gigawatt’ is a billion watts, and a terawatt is a trillion watts.**

**The power rating of the bulbs – 500 and 50 watts – informs us of the rate at which the energy potential of the coal is consumed, and so if the 27, 000,000 Btu in an average tonne of coal is transformed into electricity in a *perfect* system, then it could provide exactly 27,000,000/3412 = 8,090 kilowatt hours of electrical energy. In other words, in a *perfect* system the stronger of the two bulbs, which consumes power at the rate of 500 watts (= 0.5 kW) could function for 8090/0.5 = 16,180 hours. The other bulb would require 8,090/0.05 = 161,800 hours to consume a tonne of coal. (Readers should now make a similar calculation involving a large amount of natural gas.)**

**In reality, the efficiency with which fossil fuel can be converted to electrical energy is well under 100 percent. An efficiency of about 33 percent seems typical for much of the industrial world, and so on average it would require 3412/0.33, or 10,339 Btu to obtain a kWh of electrical energy. A number of this type is conventionally referred to as a *heat rate*, and is sometimes defined as the utilizable energy content of a fuel! Using the above numbers, this can be put another way: 1 kWh(e) = 3.12 kWh (fossil fuel). Some time ago the UN and OECD calculated that 1 kWh(e) = 2.6 kWh (oil). Naturally, we are dealing in averages here.**

**As simple as all this seems, many readers may feel that something is missing. While electric power is defined as a ‘rate’, it is not always explicitly associated with a time dimension: for instance, the ‘rating’ of a power station is likely to be in megawatts. However in the example above with the bulbs, we saw that a large bulb exhausted the energy potential of a tonne of coal more rapidly than a small bulb, which trenchantly suggests that the dimension for power is energy per unit of time. Furthermore, a watt is one joule per second (which is immediately recognized as a rate) or 3,600 joules per hour, and since 1,055 joules is one Btu, one watt is 3.412 Btu/hour (which is more easily recognized as a (time) ‘rate’ by those of us accustomed to working with the Btu). Observe that 1 kW = 1,000 J/second, where J signifies joules.**

**Finally, there is the very small unit called a calorie, and here we have 1000 calories equal one kilocalorie (kcal), and 1 kcal = 3.968 Btu. Where equivalencies of this nature are concerned, we are of talking about the outcome of perfect experiments in a perfect laboratory. This kind of perfection is not easy to achieve in the real world however, which is why the term ‘heat rate’ had to be introduced.**

**Let’s conclude this discussion two simple examples. For the first, the fuel in the tank of a vehicle may be reduced by 10 million Btu (= 10 MBtu) during an hour of driving. A portion of this energy – for example 3.5 MBtu – might be transformed into work in the form of rotating a shaft that turns the wheels of a vehicle. The rest of the energy is discharged as heat into the air (or perhaps into cooling water). Fuel efficiency in this case is only 35%, which is the percentage of the fuel that is actually transformed into useful work. Just as unfortunate, as the temperature of the ‘non-useful’ work falls, we are losing forever its availability to do work: its unavailability is increasing. As alluded to earlier, this is what *entropy* is all about: the permanent degradation of energy.**

**To continue, once we have the *heat rate*, obtaining an estimate of the fuel cost is elementary. For instance, if we have a natural gas turbine with a heat rate of e.g. 10,000 Btu per kilowatt hour (= 10,000 Btu/kWh), and in addition a fuel (i.e. natural gas) cost that at the present time is about $3/MBtu, the *fuel* cost of the electric output is clearly:**

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 **In the U.S. this would be called three cents per kilowatt hour. This is not a very sophisticated estimate of the fuel cost of electricity generated with a natural gas turbine, but it can be regarded as a satisfactory first step for this exposition. In my forthcoming energy economics textbook, an important calculation will be presented dealing with the capital cost, but next readers are invited to example several diagrams.**

**RISE AND FALL, AND A FEW WORDS ABOUT DEPRECIATION**

**It often happens that academic energy experts fail to recognize the advantages of a constant flow of natural gas e.g. from a deposit and through a pipeline, and from the pipeline to a buyer who has a contract for a constant flow of gas. Given the cost of pipes, compressors and other equipment, thinking about and planning for a constant flow of gas can often make a great deal of economic sense. (*Compressors* are like pumps in that they push gas through a pipe. Like pumps they too require fuel, and their fuel is often a small fraction of the gas they push.)**

**The problem is that the productive power of deposits have a tendency to decline. What happens of course is that production – the removal of gas from the deposit – causes the pressure pushing gas out of the deposit to decline. When dealing with oil, pressure is often maintained by inserting natural gas into the deposit, especially *if their is ‘associated natural gas’*. Moreover, up to now the evidence shows that there are much steeper decline rates for shale gas (and perhaps also shale oil) than is the case for conventional gas and oil production. I have treated this matter at considerable length in my latest textbook, but a slight extension might be useful.**

**Before beginning I can remind readers that Figure 1 is a typical production curve, with output per unit of time q(t) on the vertical axis and time (t) on the horizontal. axis. Figure 1**

q(t)

Costs

Additional investment

(in e.g. compressors)

‘Clean-up costs’

Decline

Plateau

Buildup

**While perusing the above diagram, readers can think about something I was told many years ago by the late Paul Samuelsson, the first American to receive the Nobel Prize for economics, and often regarded as the most brilliant American economist of the 20th Century. According to him, economics was basically about choice theory, and if you were fanatically interested in industrial processes, then you should study engineering. Accordingly, there is no point in resorting to mathematical overkill when considering Figure 1. Put another way, this is a case in which a picture is of more value than a thousand mathematical symbols.**

 **As you might have been informed in Economics 101, producers of various items have a great deal of authority over what and how much they can produce, but geology enters the picture in a decisive manner where the production of fossil fuels (oil, gas and coal) are concerned, and this can definitely complicate the analysis of academic economists, as well as the decision making by engineers and managers operating in corporate space. Of course, when managers have to decide how much to produce, then if they are competent they will think dynamically, in that they will consider the future as well as the present, but often their dynamism decreases as they approach retirement and they have access to their lavish survivor’s benefits.**

**Geology functions as what is known in economic theory as a constraint: no matter what the manager plans, he or she must work with the resources (the deposit or deposits) and the technologies that are available. As far as I can tell, the managers and engineers of energy companies know a great deal about things like geology, and also the technology of the present and future, while the voters in their countries know very little, and many of them are not interested in improving their knowledge where this subject is concerned. The upshot of this arrangement is that voters and their families end up as members of the loser’s club, though perhaps later rather than sooner.**

**Before concluding this exercise, I would like to squeeze in one semi-technical technical topic. It has to do with the following diagram, and my goal is to deal with the silly claim that the U.S. can expect to enjoy 100 years of shale gas *AT THE PRESENT LEVEL OF CONSUMPTION*. This issue has been dealt with in the important (but non-technical) book by David Goodstein (2004), professor of thermodynamics at California Institute of Technology, and I sincerely believe that Professor Goodstein’s book is simple enough so that everyone reading this book or any book that I have written should go to their favourite library or bookstore and obtain a copy. And in case you are interested in the logic behind that statement, it is this: voters as a group do not know enough about energy, and as a result things can happen in their future and the future of their descendants that they do not want to happen!**

**Now for the diagram, and let me note here that if you look at analogous diagrams for a few hundred oil or gas wells/deposits, most of them will look like 2-c. In fact it is absolutely amazing that when discussions about the peaking of oil and natural gas in various regions began, attention was not directed at the production records for some of the largest oil and gas deposits.**

**Going to the figures just below, a problem is that it is easy to approximate a bell curve or bell-like curve of the type we have in 2-b, but not 2-c, and so we cannot carry out the mathematical manipulations that sometimes pass for proofs in the faculties of economics. At the same time we needed no proofs: the evidence was right before our eyes, although there was no army of volunteers rushing forward to interpret this evidence, and draw the conclusions that later became trivial.**

**This is probably also the place to mention that the best mathematics book for dealing with this issue is CALCULUS FOR THE LIFE SCIENCES, by Rodolfo de Sapio (1976). Moreover, much of that book is concerned with building up the mathematical skill of readers so that they can deal with the following diagrams, although in point of truth this might be a situation where there is too much mathematics, given the result.**

**In any case, along with the diagrams in Figure 2, you might be interested to know that the mathematical representation of the logistic ‘plot’ in Figure 2a is Q = Q’/1+be-at, and it might also be useful to remember that you can differentiate this expression with respect to ‘t’ and obtain q (i.e. q = dQ/dt). Please take my word that it pays to be aware of this ‘equation’, and to be able to identify it as a logistic function. Remember also that q is output, and as shown in the diagram, Q’ is the amount of the gas (or for that matter oil if the discussion is about oil) that is usually classified as the amount discovered.**



**Figure 2**

**To repeat, the diagram in Figure 2-a is a logistic curve. What happens in that diagram is that the total amount of the resource that has been discovered Q', and as production (q) takes place we move up the vertical axis toward Q' (and the exhaustion of the resource). As is the situation with logistic curves, for mathematical convenience we never reach Q', but that is unimportant. Now the slope of this curve (which is output per time period, or q) is shown in the normal-like curve in Figure 2-b, and at time t\* the output of the resource peaks. This peaking is discussed in in my forthcoming textbook with the help of some mathematics, and it has taken place in a number of important oil producing regions (such as the U.S., and more recently the UK-Norwegian North Sea).
 If Figure 2 is applicable for the entire world, with Q' the estimated amount of the resource global reserves, then we are somewhere below Q\*, and to the left of t\*. If we limit our consideration to the situation with natural gas in the U.S., and calculate the reserve-production ratio, that might well be 100, but that does not mean that gas will be available at the present or a higher output for 100 years. Instead, for geological and economic reasons, a peaking of the output should be considered, and continuing to think about the U.S. and its reserve-production ratio of 100 years, an approximation for the time to peaking (t\*) in the situation in Figure 2 is 50 years, because logistic curves work that way, and more important geology and profit maximization work that way. Moreover, if q (= annual output) is increasing, which it usually is, then the approximate time to peaking is less than 50 years.**

**Let’s put this another way, given geology and profit maximization realities, and observing that annual consumption (and production) are increasing, the talk about another 100 years of gas or oil at the present output is irresponsible.**

**A LOOK AT PIPELINES**

**If you are desperate to show friends and neighbors how pipelines and economic theory go together, you can examine the article ‘Engineering Production Functions’ (1949), by the late Hollis B. Chenery. Hollis Chenery was one of the most important applied economists of the post WW2 period, and having met him during a ‘workshop’ in Paris many years ago, I wonder what he would think of some of the politics surrounding this subject at the present time. In any event, as you might suspect from Figure 3, it may not be too difficult to comprehend the engineering or economics of one of these structures.**

 **This is a simple case of ‘what you see is what you get’. There are two factors of production, compressors and the pipelines, and the mathematics dealing with this structure has to take into consideration the pressures at which natural gas enter and emerge from the pipeline, which means that the length of the pipeline between compressors cannot be ignored, as is often done in the economics literature in order to keep things simple. Reality is different, as made clear to the engineers considering a Kazakhstan offer to allow a Russia-China pipeline through its territory.**

**Pipeline**

**Pipeline**

**Compressor**

**Compressor**

P0

P1

P2

**P1**

**P0**

‘**Loop**’

D

**Figure 3**

**In any event, I show natural gas coming out of a well with a pressure of P0, and perhaps unrealistically show it entering a compressor – which is a kind of pump that transfers mechanical energy from e.g. a motor to the gas being transported. Schematically, what happens then is that the compressor raises the pressure from P0 to P1, and as the gas moves along the pipeline toward the next compressor, the pressure falls due to pipe friction. When it reaches P2 it enters another compressor and perhaps – perhaps - is raised to P1 again.**

**Hollis Chenery presents a very elegant analysis in order to reach the familiar q = f(C, D) type production function, where q is the amount of gas being transported, C is compressor size and D is the pipe diameter. As for the energy ‘driving’ the compressor, that can be obtained from the gas being transported. The assumption made by Professor Chenery is that the greater the pipe diameter the smaller is the required compressor capacity to pump a given amount of a gas a specified distance, and so we obtain the familiar mechanism of substitution between pipes and compressors, although this applies only over a limited range. (In terms of intermediate economic theory, the C-D isoquants eventually ‘flatten’ at both ends.)**

**The loop shown in the diagram is a way to expand the capacity of a pipeline. The compressors might be supercharged, and a new pipe laid parallel to the existing pipeline. The existing economics discussions of this arrangement, to include mine, are not very sophisticated if the intention is to analyse the maximization of profit, rather than to obtain some equations familiar to students of intermediate economic theory. Readers should also understand the expression *sunk costs*. Sunk costs are expenditures that, once made, cannot be recovered: they are associated with decisions that cannot be reversed later. A pipeline that costs a few hundred million dollars can later be chopped up and sold to scrap dealers for a few thousand or few hundred thousand dollars, but conceptually it seems appropriate to regard the main gas transmission lines as sunk investments. (On the other hand, a *fixed cost* is a cost that may or may not be fixed in the short run. For instance, ‘crack houses’ can be renovated and turned into a luxurious town houses – at least in theory.)**

**The most important costs associated with a natural gas pipeline are planning and design, acquisition and clearing of right-of-way, construction and material costs (e.g. labour costs, the cost of pipes and compressors, etc), the cost of monitoring the pipeline and performing maintenance, and energy to power the *compressors* (which are analogous to pumps in an oil pipeline, in that they transfer mechanical energy from e.g. a motor to the gas that is to be transported). As already noted several times. the energy to power the compressors usually comes from the gas that is being pumped.**

**The expected life of a gas pipeline can exceed 30 years, and it could be argued that an expensive pipeline should not be constructed if there is not enough gas to keep it operating for about that length of time. Russia has elected to build (at least) two pipelines to China, and their cost is estimated at 10 billion dollars. This sounds like a lot, but it may be less than the estimated cost of a pipeline from northern Canada or Alaska to the US Midwest. In addition, if Europe does not want Russian gas, these pipelines should ensure that Russia can continue to acquire a large income from its gas.**

**In designing a gas pipeline, engineers tend to think in terms of varying the pipeline diameter and the number and size of compressors, as well as things like the amount of maintenance that will be required. Increasing the size (and energy output) of a compressor, without changing the pipe diameter, raises the speed at which the commodity goes through the line, and thus increases the ‘*throughput’* of a given size pipe. Similarly, increasing the diameter of a line with the compressor size constant, might also raise throughput, since there is less resistance to flow (per cubic feet of gas) in a larger pipeline, but please allow me to repeat the following: *substitution is possible between compressor size (i.e. power or horsepower) and pipe size (i.e. diameter) only within strict limits.* Which is why isoquants representing the transmission of natural gas equation q = f(C,D) eventually flatten at both ends.**

**One of the things I attempted to make clear in my natural gas book was that the construction of natural gas pipelines is something that requires detailed planning, both for the sellers and the buyers, and one of the things that should prevail is a large supply of gas. What has happened in Europe of late is a perfect example of action without thinking. Billions of dollars have been spent to construct pipelines from Russia – or the Soviet Union as Russia was called when the construction of these pipelines were taking place – to Western Europe, and the presence of those pipelines helped to provide a high standard of living for many of the countries receiving Russian gas. Among others, Lord Howell has made this clear.**

 **What has happened now is that persons who can hardly spell pipelines have concluded that Russia should be punished by not using these pipelines. But in my book, and a dozen papers, and dozens of lectures I have informed the high and mighty that Russia no longer needs the Western Europe natural gas market. Instead they can sell gas to China, Japan and South Korea – to begin with – and sell as much as they want.**

**Politicians and their advisers with limited imaginations and foresight have started to talk about a Southern Gas Corridor. This involves the movement of natural gas from the Caspian Sea to Turkey, connecting to the Trans-Anatolia natural gas pipeline via Georgia, and from there to southern Europe, which in this case means the ‘heel’ of Italy.**

**Where costs are concerned, the latest figure that I have seen is 45 billion U.S. dollars for the project, which will require about two years of construction, and the amount of gas – or capacity – is said to be 16 billion cubic meters. My question upon hearing this was “16 billion cubic meters over what temporal period?” I received no answer to my question, nor did I expect one on that occasion, but I was informed that gas would begin to flow about 2018.**

**What a waste, I found myself thinking, but then I tuned out, because I wondered if Angela Merkel and her foot soldiers would join in this ‘punishing of Russia’ farce. My conclusion was that while they may want to join in, they would never join in the natural gas phase, because while the voters in her country might buy her nuclear ambitions, they would never buy into any natural gas illusions. And so the Northern Gas Corridor will continue to function as in the past, though possibly with an increased price.**

**As for the Southern Corridor, the less said about it the better at the present time.**

**FINAL OBSERVATIONS**

. If you are a believer in climate change you will note that methane gas is 24 times more effective than Carbon dioxide in trapping heat in the atmosphere. Even in the best designed systems about 4% of it leaks out. That means even if methane burning is more efficient and reduces the amount of CO2 produced we are still worse off because we put tons more methane in the atmosphere.

 – Malcolm Rawlingson

**The analysis of shale gas by Professor Paul Stevens is called ‘*The Shale Gas Revolution: Hype and Reality’* (2010). Anther distinguished contributor to natural gas economics is Jude Clemente (http: www. judeclemente.com), who finds shale useful and considers some geopolitics of shale gas production. Dave Cohen (of ASPO) could not be called a friend of shale, and neither is the economist Kurt Cobb, I have made my position clear, but I repeat: it is a valuable resource, but probably not as valuable as certain persons believe or pretend to believe.**

**There are some rather strange opinions of this resource. For instance, “Shale Gas will Rock your World” is the title of an article (in the *New York Times*) by a young lady (Professor Amy Jaffe) who – 9 years earlier – had the poor taste to question my knowledge of the world oil market and its future. This was during the International Association of Energy Economics (IAEE) conference in Rome. The chief economist of the IEA was the Boss of that session, and he also had some doubts about my wisdom, but I made it clear to him and Ms Jaffe that I was probably the only person in a large room who understood that OPEC was tired of playing games with the buyers of its oil, and was finally in position to launch the strategy that started the oil price to its 2008 crest of $147/b. That price was sufficient to help propel the global macro-economy into a partial meltdown, from which it has yet to fully recover.**

**Now we have been told that shale gas will not only “rock our world”, but ‘change our game’. I certainly hope this is true, although I suspect that many of the promoters of shale gas have adopted some propaganda tricks similar to those employed by Joseph Goebbels before and during WW2, or the persons from whom I once purchased my electricity, and who apparently are still able to convince a portion of their drowsy clientele that the truth is anything that does not sound like a lie.**

**As mentioned earlier, we are constantly informed that thanks to the exploitation of a revolutionary new technology on a very old resource (shale gas), the U.S. possesses a “hundred year” supply of at present consumption rates. As far as I am concerned, the way to deal with this claim is to ignore it, because demonstrating that it is probably complete nonsense only requires some mathematics that Dr Strangelove would have described as “simple”, and even within the scope of university students like the young and foolish Ferdinand E. Banks – just before he was pronounced as “hopeless” by the Dean of Engineering at Illinois Institute of Technology (Chicago, Illinois), and summarily expelled from that excellent seat of higher learning. That happening temporarily quashed Mr Banks’ plans for an engineering career, but fortunately he soon realized that the Cold War had made its dramatic appearance, and as a result the United States Army was prepared to greet Mr Banks with open arms.**

**In any event, I believe that the same kind of logic is appropriate here as I employed in the chapters on oil in my energy economics textbooks (2014, 2007, 2000). *For example, one hundred years of oil (at a given or increasing level of consumption) – as calculated from the present reserve-production ratio – actually becomes something quite smaller when such nuisances as profit maximization and natural decline are taken into consideration. This is because of the cost increases required to raise or maintain output as deposits are depleted and deposit pressures are decreased.***

**Readers should examine the above paragraph for as long as it takes to understand it perfectly, and if they cannot understand it here, they should turn to my forthcoming textbook (2014), where I expand this reasoning in my discussion of oil. What I say is that the Hotelling-type approach that they were introduced to in the oil or gas portions of the energy economics courses they may or may not have taken is mostly without any scientific value, and does not deserve the attention that it has been given. It does not treat costs and investment practices in a meaningful fashion.**

**A few years ago I attended a boring and pretentious meeting on natural gas at the Stockholm School of Economics. I thought that the emphasis would be on shale gas, but that turned out to be only a digression, and I ended up listening to half-baked lectures and comments by self-appointed experts that, I find it correct to say, were received by many members of the audience as if they were holy writ. As to be expected, though perhaps not appreciated, when the Q & A began, I attempted to set everybody straight on the past, present and likely future of shale gas, supplying both answers as well as questions, but I am afraid that my efforts were not accorded the admiration they deserved by the sponsors of that tiresome episode.**

**In considering this topic, I remember that one of my students at the Asian Institute of Technology (Bangkok), in 2007, insisted that a peaking of conventional natural gas output could take place in the U.S. in the not too distant future. Now we see where the mathematics alluded to above comes into the picture. Shale gas will have to compensate for a fall or levelling off of the output of conventional natural gas in the U.S., as well as the ‘natural decline’ (assuming that this is as relevant for gas deposits as it is for oil). In addition it must help to provide an expected increase in natural gas consumption – an increase that will be influenced by what might be incorrect predictions of the future price of gas, which in turn is due to upbeat and unreal forecasts of the domestic availability of shale gas resources.**

**I can finish this ‘exercise’ by saying that a graduate student at the University of Chicago once published a paper saying that an OPEC type approach for natural gas – a GAS-PEC called OGEC (for Organization of Gas Exporting Countries) could not take place. That belief strikes me as wrong, and on the basis of some information that I received from Professor Alberto Clo of Bologna University (Italy) about new and proposed gas pipelines in Southern Europe, and also the possible structure of a gas cartel, the likely members of OGEC, are Algeria, Qatar, Venezuela, Libya, Iran, Nigeria, Russia, The United Arab Emirates, and Trinidad-Tobago. These countries controlled well over 66 per-cent of natural gas reserves the last time I gave a lecture on this topic, and when I can muster enough energy to examine the latest gas statistics, I expect to find that members or potential members of that forum now control more.**

**Of course, it may be the case that present teachers at the University of Chicago student know less about energy economics than I do about brain surgery, however if it happens that they and their students are really and sincerely interested, the only reason that a GAS-PEC of the OPEC variety is not being formed today is because gas producers *outside* the U.S. can sell their gas at a much higher price than obtained by U.S. producers who cater to the domestic market. The price of natural gas in Europe is twice that in North America, and in Asia it is at least three times, and faced with that situation I have no difficulty believing that nobody wants a GASPEC more than U.S. sellers of natural gas.**

**I would love to do some serious research on that matter, but I have something better to do. According to the experts, who aired their beliefs at a recent World Petroleum Conference in Moscow, shale oil and shale gas have a great deal to offer Russia, and according to BP Executive Director Robert Dudley, Russia is one of four countries (along with Algeria, China, and Argentina) outside the U.S. in which production from shale resources should eventually have a bright future.**

**One certainly hopes so, because in conjunction with that conference, talk emerged that there is only 50-55 years of oil and gas left - by which of course the forecasters were referring either directly or indirectly to a likely peaking of global oil and natural gas later this century. Is there any reason to worry? Well, when I abandoned my teaching of mathematical economics in order to take an interest in natural resources, I was informed by assorted experts that if I were smart I would abandon that pursuit also, because despite occasional upward ‘spikes’ the trend prices of these items had been declining for a century, and that was really all that you needed to know if you wanted to become deeply involved in ‘scientific’ economics. Most of that kind of half-baked thinking apparently ended about 2003-04, and four years later the demand for oil outran the supply. The price of oil began climbing at a record rate, and the international macro-economy was in the worst trouble since the great depression 70 years earlier.**

**APPENDIX: SOME MATHEMATICAL ASPECTS OF INVESTMENT AND PRODUCTION**

**It seems to be the case that in considering the cost of obtaining oil and natural gas, some economists have recently discovered that this cost should be taken as a function of the amount extracted to date as well as current production. This concept has been mentioned above, although it is not spelled out in detail. However, as it happens, I emphasized a volume effect in my book on natural gas (1987). Although I may not have emphasized it as clearly as I should. The mathematics of this arrangement was not included in my energy economics textbooks (2007,2000), because I wanted to limit the amount of calculus employed in that work, however a shortened version might fit in here. Once again though let me suggest that readers who are uninterested in this kind of presentation should not try to develop an interest here, because a lot of the mathematics that accompanies discussions of energy economics is unnecessary and distracting.**

**We can start by considering a situation in which we have two production factors, a single output, and no taxes or depletion allowances. The (inter-temporal) expression for the cost of a continuous-input, continuous output scheme might then be:**

 ** (1)**

**C is the present value of cost over the time horizon T. Similarly, C0(q) is the investment at time t = 0 for a facility with an annual output of q. CT is the salvage value of the installation at time T, while r is a discount rate, which is taken as constant over the time horizon T. X(q) = X(q(t)) represents the amount of the variable factor employed at time t, in association with production q(t), while ’w’ is the (constant) unit cost of the variable factor. It is also important to be aware that this single (present value) cost C for an annual output q over a time horizon T can be turned into an annual cost (designated as A for each time period over T) by annuitizing C. There are essentially two ways to write this expression for A, where the continuous one is simply A = 1/(1 – e-rT). The marginal cost can be obtained from (1) by evaluating the integral and then making a straightforward differentiation. We then get:**

 ** (2)**

**This expression is unambiguously positive, but unfortunately the effect of volume (V) is not readily apparent. Volume is introduced via the manipulations shown directly below, and the correct interpretation of the preceding equation:**

 ** (3)**

**The question that can now be asked is where did we get the ∂C/∂V. The answer is that when the change in the variable cost (for each period) that is associated with a change in the volume [= w(ΔX/ΔV)] is taken as the value of an annuity payment, and multiplied by the expression in the large parenthesis, we get the present value of these changes (over the period T). Equation (2) then becomes:**

 ** (4)**

**This is obviously a more complicated expression than the usual equation for marginal cost. In case the reader has some problem with the sign of (4), it should be remembered that on the basis of the previous discussion, the cost goes up when the volume trmaing in a deposit goes down, while the volume (from a given deposit) goes down when q (output) goes up.**

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 ***Policy***

**5. ANOTHER KNOW-IT-ALL LECTURE ON THE ELEMENTARY ECONOMICS OF NUCLEAR ENERGY**

**First some numbers that you may or may not like. If global energy use follows the present trend and predictions, it will increase by about 50 percent in the next 50 years. According to Professor Terry Klieg, 15 percent of the electricity that is generated today is accounted for by nuclear, 66 percent by fossil fuels, 2 percent by renewables, and 17 percent by hydro. I call these ‘ball-park’ numbers, in that renewables and nuclear are probably too low, but that number cannot be more than 5 percent, and the other numbers must be adjusted. I have also seen other estimates, but they are similar to this. According to the Japanese government there were *no* casualties at Fukushima that can be attributed to nuclear failure, and according to the U.S. government, none at all at Three-Mile Island. As for Chernobyl, the casualty count is not something that I repeat because it sounds too low. Finally, there are more than 400 reactors in operation today, more than 60 are being constructed, and a prediction I find it easy to accept is that there will be well over 500 in a decade…**

**INTRODUCTION**

**By know-it-all I am referring to a special kind of article or comment that I have published on many sites, and in the spirit of which I have given many lectures. Articles and comments about nuclear that occasionally so offended various persons that they referred to me as stupid or ignorant or both, and in addition sometimes suggested that I exhibited deviant psychological tendencies. Thus far, however, the latter characteristic only surfaces when I merrily refer to being expelled from engineering school in my first semester for failing mathematics and physics twice, and from Infantry Leadership School (at Fort Ord, California) for some unnamed deficiency or defect.**

**I’ll use this introduction to get into the rhythm of the present chapter. *The International Handbook on the Economics of Energy* (2009), which is more than 800 pages, and contains many articles, does not possess a paragraph on nuclear energy. Of course, if it did possess a paragraph or article on that subject, they would probably be pedagogically worthless, and I would do everything possible to keep them from being referred to in my classroom. Half of the articles in that volume are without any pedagogical value, and a half of the remainder could be described as uninspired.**

 **Thus I begin this chapter with the following cheerful message: the nuclear facility at Fukushima was constructed about 40 years ago from blueprints prepared another 5 or 10 years earlier. Suddenly it was a victim of one of the most powerful earthquakes ever experienced in Japan (or a Class 9 earthquake), and also in the path of a destructive tsunami that sent waves 40 meters high along a 100 kilometer stretch of the coastline.. To some extent the survival of the Fukushima nuclear facility could be described as a structural miracle, and as indicated by the testimony of Swedish diplomat and nuclear expert Hans Blix, its survival was a demonstration of what we have the right to expect from future generations of nuclear equipment that undergo the improvements in technological sophistication associated with time.**

**As a result, I feel that I should be allowed to continue making exuberant claims about the utility of nuclear energy, although I happen to believe that where the teaching of this subject is concerned, as much emphasis should be put on history as on economics. Moreover, Sweden is the perfect country in which to study both disciplines. About 45 percent of the electric production *capacity* in Sweden (in Megawatts, or MW) can be attributed to nuclear, although annually – at various times in the past – nuclear probably provided at least fifty percent of the *electric* *energy* (in Megawatt-hours, or MWh) produced in Sweden. Initially, nuclear and hydro gave Sweden some of the lowest cost (and lowest output of CO2) electricity in the world. The pointless deregulation of electricity put an end to that very favourable arrangement for Swedish industries and, especially, households.**

**More significant, the Swedish nuclear inventory of 12 reactors was installed in slightly less than 14 years, which was a feat of technological brilliance that in some respects was analogous to the expansion of the United States Navy and Air Force in the years immediately after the attack on Pearl Harbor. (At least eight of these Swedish reactors were produced by ASEA, which was a Swedish firm that was moved from Sweden to Switzerland in 1988, becoming the A in ABB, or Asea Brown-Boveri.**

**Something I never fail to stress in my formal lectures or informal harangues is the importance of moderately priced electricity in an industrial economy, and on this score Sweden was once in the forefront of world economies.**

**Unfortunately, that lovely arrangement turned out to be unacceptable to the local anti-nuclear booster clubs, who together with self-appointed energy experts have unleashed a torrent of lies and misunderstandings about nuclear energy that eventually resulted in the bad news for consumers of electricity that sometimes characterizes the Swedish electric market. During the last few years, the price of electricity to households in Sweden has occasionally been extremely high, although – wisely – electricity may still be sold to Swedish industries at a lower price.**

**If we take a careful look at the time series of global macroeconomic growth from the end of the second world war (WW2) to the present, we can distinguish two distinct segments. The first is comparatively smooth, and stretches from the end of WW2 until the middle of the l970s, or shortly after oil prices began to increase in an unaccustomed and threatening manner.**

**The second segment, from the middle l970s to the present, which I discuss briefly in my forthcoming energy economics textbook (2014), featured an irregular growth that doubtlessly resulted from the occasional drastic increases in energy prices that began with the first oil price shock, and whose impact effect was a slowdown in the rate of productivity growth in almost every industrial country. A kind of ‘sneak preview’ of the macroeconomic meltdown that would take place in 2008. Another consequence of the energy price rise – i.e. oil *plus* other energy resources – was *stagflation*, or the simultaneous occurrence of inflation and increased unemployment.**

**Unless national energy structures are ‘adjusted’, these miseries might accelerate if the prices of the main fossil fuels begin to escalate, which is a misfortune that I consider likely, though perhaps not in the short run, and which I prefer not to elaborate on here. I will suggest however that t*his judgement particularly applies to oil and natural gas, and will likely be due to geopolitical rather than geological causes*.**

**The optimal ‘adjustment’ would involve introducing a large amount of *efficient* renewables and alternatives, as well as maintaining the presence of nuclear, increasing its efficiency, and eventually adopting the next generation of reactors and its variants in both present and smaller sizes. I also think it ‘politic’ to assume that nuclear will be an indispensable *complement* *to* (and not *substitute* *for*) any conceivable mix of renewables and alternatives, although the optimal or nearly optimal mix of renewables and alternatives is completely unknown to this humble teacher of energy economics, and is something that readers of this book, as well as their friends and political representatives, should think about investigating in depth as soon as possible. .**

**As Sigmar Gabriel, Germany’s economy and energy minister, made clear, “we have reached the limit of what we can ask of our economy.” What he meant – but perhaps could not say – was the limit of what could be asked if the proposed liquidation of nuclear energy in his country becomes a reality. Gabriel also said that energy generated from biomass was too expensive, which it might be for Germany, but not for every other country, and he also claimed that “Germany had been financing the learning curve on renewable energy for other European countries”. That was a cute observation, following which he implied that the cost of this activity was no longer bearable for German voters.**

**If that is true, then other countries should not make the mistake of trying to assist them. Instead, exporters of electricity to Germany should attempt to reintroduce German voters to reality rather than prolong the senseless fantasy of their counter-productive *energiwende*. According to a Belgium researcher who visited Sweden, a fulfilled German nuclear retreat could mean electricity rationing in countries exporting electricity to Germany. Thanks for nothing, Germany, and regards should also go to local politicians who have decided that half-baked trivialities are more important than dealing with this menace to incomes and welfare in their countries!**

**SMOKE AND MIRRORS**

 **It’s interesting to note that the Russians have several new nuclear plants**

 **under construction, including a fast breeder, despite their enormous fossil**

 **fuel resources. What do they know that we don’t know?**

**- Jack Ellis**

**Nothing at all Jack, but unfortunately there is a difference between knowing and doing, and as a result, as I stare at the blazing sun think about the brilliant lectures that I may or may not be asked to give, I often participate in long-winded *imaginary* conversations about nuclear with various energy celebrities. For instance, a few years ago, after the publication of several of my articles, Dr Amory Lovins challenged me to an online debate about nuclear. I reacted by explaining to him that an online ‘gig’ was not to my taste, but if he or his admirers could provide me with a plane ticket, hotel accommodation and some walking-around money, I would leave for the airport that evening if that was required in order to provide him with the opportunity to attain the satisfaction that he felt he deserved.**

**Dr Lovins was in Sweden several years ago, and I contacted the organization – The Tallberg Forum – that invited him here, offering (in vain) to give that gentleman a chance to clarify his anti-nuclear logic for both me and an audience of his peers. I had in mind those occasions when the boss of the (U.S.) Federal Reserve System, Alan Greenspan, appeared on the same stage in New York City – and playing the same instrument – as the great jazz saxophonist Stan Getz. I predicted to friends and neighbours that the outcome of my encounter with Lovins would be comparable to the Getz-Greenspan sessions, with Lovins playing the Greenspan role.**

**By way of providing an example of what I would have to deal with, and overcome, I have selected a few lines from one of the most outlandish articles ever published in a major ‘learned’ journal (*Foreign Affairs*, 1992-93). Amory Lovins and Joseph Romm signed their names to the following fallacious statement.**

 **“For example, the Swedish State Power Board found that doubling**

 **electricity efficiency, switching generators to natural gas and**

 **biomass fuels and relying upon the cleanest power plants would**

 **support a 54 percent increase in real GNP from 1987 to 2010 –**

 **while phasing out all nuclear power. Additionally, the heat**

 **and power sector’s carbon dioxide output would fall by one-third,**

 **and the costs of electrical services by nearly $1 billion per year.**

 **Sweden is already among the world’s most energy-efficient**

 **countries, even though it is cold, cloudy and heavily industrialized.**

 **Other countries should be able to do better.**

**This is flagrant bunkum, nonsense – a figment of the imagination of Messrs Lovins and Romm, and especially of their Swedish informants. If the present estimates of world population growth are even approximately correct, then unless per-capita energy requirements sink drastically, or some developments in the near-miracle class take place with unconventional energy resources, a systematic wave of reactor construction is unavoidable. *Although generally denied, in almost every country in the world, scientists, engineers and industrial managers are attempting to convince their governments of the futility of attempting to maintain or raise standards of living without more nuclear!***

 **In addition, many observers refuse to understand the deleterious macroeconomic implications associated with investing in *excessive – EXCESSIVE –* amounts of renewables and alternatives. Countries that make this mistake will find their international competitiveness steadily decreasing relative to those countries with another point of view. Here I merely refer to a recent article by Amaha and Wilson (2013), and leave interpretation of its important content to readers.**

**Returning to the clumsy falsifications of Lovins and Romm, neither those gentlemen nor many other commentators on energy economics understand the flexibility of nuclear energy – *a flexibility based on the perfection and exploitation of future nuclear technologies.* There will be multiple auto-shutoff and control systems capable of minimizing human error, the use of gravity instead of electricity to flood overheated reactor cores with huge amounts of water, small-and-medium-sized reactors (SMR – or modular – reactors) specifically designed to eliminate any shortcomings of existing larger equipment, ‘pebble bed’ reactors in which the reactor fuel is encased in graphite ‘pebbles’, which makes meltdowns nearly impossible, etc.**

**Disposal of nuclear ‘waste’ remains an issue, but only because political expediency has kept governments from organizing the least-cost and secure storage of this ‘dross’, and the same apparently applies to restrictions against nuclear fuel being continuously reprocessed/recycled until it is ‘clean’. The latter is inevitable though, because in the long run reprocessing/recycling will be essential to maximize the energy output of nuclear fuel. Incidentally, this is the argument that will lead to a general adoption of breeders, and not a sudden love of plutonium.**

**At some point last year, several compositions were published that turned thumbs down on nuclear energy. Among these were one by Dr Benjamin Sovacool (2010), who provided a pseudo-scientific argument as to why a nuclear renaissance should be aborted. Similarly, in the *New York Times*, Diana Powers (2010) reviewed the work of Professor (of economics) John O. Blackburn of Duke University (USA), who was assisted by a graduate student named Sam Cunningham. The conclusion Blackburn and Cunningham arrived at was that a crossover point has been reached for the cost of electricity generated by nuclear and Solar Voltaic systems. The figure they gave was sixteen cents per kilowatt-hour (=16 c/kWh) for both. A diagram in their work showed the cost of nuclear rising, and that of solar falling. That diagram should be ignored.**

**Under the heading of cost, Dr Sovacool has some interesting information for amateurs and non-thinkers. His levelized cost figures include 3-7 c/kWh for hydro, 5-12 c/kWh for wind, 18-30 c/kWh for nuclear, and 20-80 c/kWh for solar voltaics. For what it is worth, his figure for solar voltaics does not match that cited by Ms Powers.**

**The important thing above is that, on the average, hydro is often considered the lowest cost source of electricity, which I make a point of telling my students to remember. Without knowing (or being interested in) the exact cost figure for hydro, I can use Swedish and Norwegian data to show that employing nuclear and hydro results in the same unit costs for electricity. I get this because Norway has *almost* 100 percent hydro, and Sweden has *almost* 50-50 hydro and nuclear, and since (before deregulation) Sweden and Norway had about the same (aggregate) electric cost, the cost of nuclear must have been approximately the same as the cost of hydro. As far as I can tell, the average cost for nuclear in BEST-PRACTICE facilities is about 9 cents/kWh.**

**What about wind generated electric power? Again Sweden provides a beautiful example. The Swedish utility Vattenfall – the 5th largest in Europe – deals in hydro, nuclear, soft coal and wind. According to the last published financial report of that firm, the first three of these made a profit, but wind made a loss. Vattenfall was/is a boisterous advocate of Carbon Capture and Sequestration (CCS), especially in Germany, and what they make it their business *not* to discuss is that if they decide to go into CCS in a big way, only hydro and nuclear will guarantee a profit. In addition, nobody in their right mind should expect wind to guarantee a profit (unless heavily subsidized), although it may be true that occasionally acceptable profits will be registered by wind parks in favourable localities. Tierra del Fuego, for instance, but not Copenhagen or Berlin.**

**THE NUCLEAR RENAISSANCE IS NOT BEING TELEVISED**

**According to the United Nations energy organization (IAEA), statistics indicate that for 2009 and 2010, nuclear reactors in Sweden and Germany managed by the Swedish firm Vattenfall had the lowest capacity factors in the (nuclear) world. 55% was the shocking figure given by that organization for the average availability of Swedish equipment, which is very different from the up-beat impression I attempt to provide of the Swedish nuclear sector in my lectures and books, to include the present contribution.
 'My goodness, but how the mighty have fallen", to paraphrase an observation by a high ranking German officer in Theodor Plievier's brilliant war novel *Stalingrad* (1949). You said it brother, because the construction of the Swedish nuclear sector was nothing less than a minor miracle, almost in the class of the construction of the American Navy and Air Force during WW2, and it achieved for the Swedish macro-economy and Swedish welfare what the American Navy and Air Force achieved for our war effort.
 It should be noted though, that the availability cited above may not be true. That in reality it is nonsense. "Figures never lie, but liars sometimes figure," I seem to remember my teacher of structural analysis saying. In fact so many lies have been put into circulation about nuclear and its proposed replacement by wind and solar, that I am forced to ask the following question: Who do you believe: Swedish engineers or anti-nuclear groupies who regard engineering and social excellence as arrogance.**

 **That brings us to Germany, and the intentions of the government of that country to liquidate their nuclear assets. Many years ago I read a publication of some sort called 'Wir Werden Wiedermal Marschieren', in which a gentleman from the part of Czechoslovakia known at the Sudetenland was doing some heavy duty publicity (or promotion) for the Third World War. He argued for a more or less immediate return of German 'properties' in the 'East' to their former West German owners, and he claimed that this could easily be brought about by a full-scale NATO military commitment, supported by an eager and fully resuscitated German army and Luftwaffe.
 On what I remember as the last day of the longest military exercise of its kind held in Germany up to that time, which was called \*Apple Harvest', and about the hour of the evening when a wonderful jazz program called 'Munich at Midnight' was aired, a colonel or general or something entered the operations van of the 35th Field Artillery Group, and ordered me to plot a *simulated* fire mission - employing tactical nuclear ammunition - that was supposed to deal with 'enemy forces' that had broken through the Fulda Gap. As a result, instead of listening to Miles or 'Bird' or Bill Evans, I made use of my superb knowledge of addition and subtraction to complete this assignment.
 *Had that been a real instead of a simulated mission, the eastern suburbs of Nuremberg would have been blown off the face of the earth!* As I have made it my business to point out on numerous occasions, when that insane option reached German journalists, officers, politicians, hustlers, hippies, know-it-alls etc, the ‘Wir Werden Wiedermal Marschieren’ fantasy came to a screeching halt.**

**I don't know who leaked that classified information, nor did I inquire, nor did I care, but I can state here and now that it wasn't me, although a few weeks later my military career was informally brought to an end. I spent my remaining year in Europe enjoying the great night presence of those European cities that provided deserving American soldiers like myself with some of the best R&R (Rest and Relaxation) in the world, although we had a unique way of describing those advantages. I also did some writing for the military newspaper *Stars and Stripes*, which was published globally.
 Now for a short explanation of what this part of the chapter is all about. To my way of thinking it is about what will happen when German voters discover the cost of the nuclear foolishness launched by Ms Merkel and her government. As I once informed delegates at a large conference in Stockholm – most of whom were not happy to hear my opinion – the German nuclear retreat is a short-term burlesque, designed to return the present German government to office. In the long run, Germans voters will get the cost-benefit message, and in order to protect their standard of living pass it to journalists, officers, politicians, hustlers, hippies, rappers, break dancers and maybe their political masters.**

**In case you haven’t been told, or if you were told and don’t remember, globally there are well over 400 reactors in operation, at least 65 are under construction and more than a hundred are ordered or planned. Even so, in every corner of the world there are highly educated persons, highly paid and in enviable professions, who will take a sacred oath that electricity from nuclear reactors is a lost cause, and nuclear reactors are being dismantled. It is likely that some of these persons are sitting in front of computers on Wall Street or in the City of London, but the explanation here is simple. Financially, and career-wise, it makes more sense to shove money in the direction of renewable technology that at the present time is fairly heavily subsidized, even though it is hopelessly suboptimal for producing low cost electric power, rather than to think about raising the standard of living of persons who live in the less distinguished neighborhoods of New York and London.**

**The belief expressed by the present Swedish Minister of Energy that renewables should replace nuclear would unambiguously result in rising costs of energy. and a decline in Swedish industrial competitiveness. Please excuse me if I admit that I am amazed by the failure of students and teachers of economics in Sweden, and elsewhere, to study and then predict that this would be the inescapable result of playing games with the supply of energy. After all, without energy, technology, and a superior educational strategy, Sweden would still be competing for the title of The Poor Man of Europe.**

**As you probably know, Norway is an extremely rich country, but in one of the newspapers in which I read about policy ‘rethinks’ in Europe where green energy is concerned, there was an article about rising tensions in that country as a result of increasing immigration, with many Norwegians claiming that too much immigration threatens their welfare. If persons in that rich country are concerned about welfare, think of how they are going to feel in countries like Germany when they get the ‘decline in welfare message’ that is certain to eventually result from a nuclear retreat.**

**As for the cost of a large nuclear reactor of, for instance, somewhere between 1000 and 1600 megawatts, my estimate is usually 5 billion U.S. dollars for a 5 year construction program. This number met the approval of Professor Anthony (Tony) Owen, the leading academic energy economist in Australia, and the next time we meet I’ll ask him to explain to me how the payments are made, or maybe I will try to figure this out myself on a rainy day in Stockholm or Uppsala.**

**I can mention though that the 1300 (or 1600) megawatt facility in Finland was supposed to cost 5 billion dollars, but the last I heard about that project, the cost had reached 8 billion. The contract had been for 5 billion though, and so apparently the French firm constructing the facility (Areva) had to ‘eat’ the extra 3 billion.**

**Similarly, the reactors that will be constructed in the United Arab Emirates (UAE) by a South Korean firm are scheduled to cost 5 billion dollars each. Cost overruns will almost certainly be experienced there, however for those wealthy states, cost overruns are in the same category as lunch money. The first of the UAE's four planned nuclear reactors at Barakah in the Western Region of Abu Dhabi is more than halfway complete, and a second reactor is due to come on stream in 2019. In case you have forgotten, being wealthy, they are in no hurry.**

**I can close by mentioning that Kazakhstan is the largest global producer of uranium, with 38% of the global total, and the U.S., which once led the world in uranium production has slipped to about eighth.**

**A FINAL COMMENT**

**In my book  *The Political Economy of Coal* (1985), I stated that France and the Soviet Union (= Russia) were the most determined nuclear advocates in Europe. Needless to say, a statement like this was neither popular nor believed in many countries, nor was my claim that their sophistication in this field would increase.**

**If I ever doubt my ability to deal with future technologies and the turn of events, that doubt would disappear when I note what is happening in Russia today with nuclear technology. The intention of Mr Putin and/or his colleagues is to raise the amount of electric power generated by nuclear from its present 16 percent to 50 percent by mid-century. If anything, I predict that it will increase by more. One of the reported goals there, and also in China, is to maintain the rate of growth without violating the environmental standards established in the Kyoto Protocol and similar documents.**

**The main reason however, as I have pointed out in books, articles, countless lectures and impromptu conversations in discos and coffee bars – as well as discussions with myself in my daydreams – is to reduce the domestic consumption of oil and natural gas, and not just to free more for export purposes, but because the value of those items will increase because of their global depreciation or scarcity.**

**In the book mentioned above, I stated that Russia constructed the world’s first commercial reactor in l956. That was wrong: a reactor that generated electricity was constructed by the Russians in l954, but it was not until 1963-64 that a commercial scale reactor became available in Russia. Moreover, my mention of plotting a simulated ‘nuclear’ fire mission employing large calibre artillery during a very large military exercise in Germany (called *Apple Harvest*) assumed – on my insignificant part – that the Russians did not possess military assets containing nuclear explosives (e.g. bombs or artillery). That assumption was completely wrong, and so the firing of a single nuclear shell by the artillery of any country in Europe would have led to the disruption or destruction of European civilization, because next would have been hydrogen bombs.**

**What has happened of late is that an irrational verbal war is taking place against Russia because of the strange behaviour of the Russians in the Ukraine. The ignorant politicians of the European Union want Russia punished, but they don’t know how. The thing to never forget is that the natural gas contracts that Russia had with a number of countries in Europe have been or will be abrogated, and so the Russians have signed long term contracts with China, and eventually could make similar arrangements with Japan. Russian sales of natural gas to European countries will then be history.**

**There has also been some talk about the Russian supply of nuclear fuel to countries like Hungary, Slovakia, Bulgaria, the Czech Republic and others. Leading the charge here is Westinghouse, the Japanese-U.S. nuclear firm, whose directors are attempting to convince EU big-wigs that it makes economic sense to deny Russian sellers access to the nuclear fuel market, and at the present time undoubtedly feel that taking an aggressive attitude toward Russia will enhance their career prospects.**

**The thing to remember here is that this kind of thinking will not enhance the career prospects of ordinary people in the countries of Europe, because China can absorb all of the energy materials that Russia is capable of providing. Of course, in the long run Russian fuel will mostly be an input for Russian reactors, because Messrs Putin and Medvedev have a growth and development agenda which they intend to follow regardless the opinions and behaviour of parasites and charlatans in Brussels and elsewhere. What needs to be understood is that Russia is a fabulously rich country, perhaps underpopulated – which is probably a lot better than being overpopulated – and as for the persons giving the orders, I prefer Messrs Medvedev and Putin to certain others in the Northern Hemisphere, and so would you if you thought about it,**

 **The same is true in the Middle East, where the construction of nuclear reactors in the UAE is proceeding on schedule, and more of the same will probably begin elsewhere in the same part of the world.**

**And finally, there is one thing that everybody should remember, nuclear is a part of the energy future, and this cannot be avoided. For that reason I would like to make it clear that often I mistakenly say that nuclear energy should be the basis for the generation of electricity in all or most industrial countries. What I should say, and say now, is that both economics and politics will make this a certainty in almost all industrial countries, and so the essential thing here is that nuclear equipment is scrupulously regulated, guarded, and understood. And it can be understood by everybody, and not just ‘school stars’, as they are called in Sweden. EVERYBODY!**

**At the present time, there is not an extensive discussion about the breeder reactor, In many countries there will not be one until reactors of that nature appear, and they will appear. A majority of the physicists that I have talked to say that it is a huge mistake not to install breeder reactors as soon as possible, and many of them say that breeders will reduce rather than increase the presence of plutonium, because it is consumed in the electricity production process. Or at least I think that is what they said.**

**I remember writing a book or article in which I more or less said that the use of breeder reactors was insanity, but they are inevitable. The Swedish ‘leftists’ and environmentalists who predict the demise of nuclear based electricity are without a clue as to how the real world works. What they fail to understand is that in the world of the future, the *rich* – who are also the best educated – will alw*a*ys have access to electricity, and by that I mean electricity generated with nuclear equipment or oil stoves.**

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**6. ECONOMICS AND ELECTRICITY: AN ELEMENTARY APPROACH**

**The flow of energy should be the primary concern of economics**

 **−Frederick Soddy (1933)**

**INTRODUCTION**

**Hopefully your taste for energy economics is now close to ‘criticality’ (which is the point when a *chain reaction* becomes self-sustaining), and which will make the more complicated chapters of future energy economics books more palatable, in case those chapters are written some day, which unfortunately is uncertain.**

**One thing though is certain. The present book contains most of the things that beginning students of energy economics need and deserve, and also – considering the lack of literature dealing with this topic – many things that fit into the study programs of intermediate and advanced readers. Readers of this book should now have a rudimentary insight into the logic of energy economics, but even so read this chapter (and the remainder of the book) carefully, and make an effort to remember those portions that you are especially interested in. You should also get into the habit of thinking about these materials several times a day, and if possible having short conversations about them with friends and neighbors.**

**A question might be asked as to what you should do if you cannot remember what you feel that you need to remember. Then you should simply turn to the first page and start over, with the intention of rereading the entire book. As you were informed in the introduction, the purpose of this book is to help make you a star, and so repetition is essential regardless of how much you remember.**

**At this point you should carefully examine and make sure that you understand Figure 1, which deals with the generation of electricity in the U.S., *and* read the ensuing explanation. Your goal should be to draw it from memory, and when you do note that the block designated *heat-mechanical* refers to e.g. a *boiler-turbine-electric generator* arrangement where energy from various fuels creates steam that makes possible the rotating armature of generating equipment, and thus produces electricity. I can confess that I sometimes experience the same difficulties as students when drawing diagrams from memory, but the diagrams in this chapter are important.**

**And once again, never hesitate to turn to GOOGLE if or when you require more information, and do so immediately. GOOGLE is an enormous help, as many of us who did not have it when we were in school should understand. Also, notice the word immediately! In the present context it means exactly that.**

(b)

Nuclear 6

Hydro 8

Other(d)

Generator

 System

THERMAL:
Oil (4)

Coal (13)
Gas (4)

Heat and/or

Mechanical

Energy
(+Condenser)
‘C

Combustion

bustion

Fission

Photovoltaic Cell

Fuel Cell

(e)

(c)

(a)

ELECTRICITY

INPUT: 35 Mboe/d OUTPUT: 11 Mboe/d =

 Electric Output = 6825 Twh/year

1. Solar-Thermal: Biomass, Geothermal, Solar
2. Wind, Tidal, Wave
3. Solar Source: Shell Briefing Service, 1986
4. Negligible
5. Hydrogen-Oxygen

**Figure 1: Energy input-output system for U.S. (1986)**

**Figure 1 shows energy put into the U.S. electric system in 1986 by oil, coal, gas, nuclear, hydro, fuel cells, etc, and the amount ultimately available in the form of electric energy. Energy to the extent of 35 million barrels of oil *equivalent* per day (= 35 Mboe/d) on the average was put into the U.S. electricity generating system in 1986, and the output was 11 Mboe/d (= 6825 Terrawatt Hours (Electric) = 6825 Twh(e)), where the ‘e’ in the parenthesis signifies *electric* (and *not* equivalent), and Terrawatt is a trillion watts. On the basis of inputs and the output measured in millions of barrels of oil *equivalent*, this indicates a production (and transmission) efficiency of approximately 31.5 percent: only about one-third of the energy in the inputs was available to final consumers. Please note that the photoelectric cell converts sunlight directly to electricity, while the fuel cell converts the energy in hydrogen and a few liquids into electricity.**

**Two things need to be clarified immediately. Electricity obtained from resources like natural gas or coal, etc, is a *secondary* energy source, because some other energy source must be consumed in order to obtain it, while *primary energy* is energy obtained from the *direct* burning of coal, natural gas, oil, as well as electricity having a hydro or nuclear origin. I have a suggestion for readers here: if you think that secondary energy is wasteful compared to primary energy, keep this opinion to yourself in seminars, at conferences, in my classrooms, and during your appearances on national TV, unless you are specifically talking about nuclear or hydro.**

**The expression *equivalent* deserves careful consideration. It means that the heating value (= energy content) of e.g. a ‘pile’ of coal – can be measured in e.g. British Thermal Units (Btu) – and thus is the same as the heating value of a *certain amount* of oil or natural gas. Or to take another example, we could describe the heating value possessed by the natural gas in the tanks of an LNG (*liquefied natural gas*) carrier (e.g. ship) as being equivalent to a certain number of barrels of oil or tonnes of coal. *The energy content of all of these things can be measured in Btu, and thus (if desired) compared on the basis of cost.* (Please remember though, that a certain Btu from e.g. coal or nuclear can be turned into barrels of oil.) This means that, wherever there is a source of heat, it can in theory be represented or described in terms of a certain amount of oil or coal or natural gas. (Note: e.g.signifies *for example!*)**

**You will be pleased to know that calculations involving equivalency are extremely simple for everything except hydro. The heat rate (= applicable energy content) e.g. of oil, coal and natural gas (in *Btu per kilowatt-hour*) is easily measured or estimated, while that of hydro is usually treated as equivalent to the fuel in a power station (e.g. coal or natural) that would be required to do the same amount of work being done by e.g. water falling over a dam (i.e. Hydro).**

**In the book by John Fisher (1974) he uses 10,500 Btu as the *input* necessary for an *output* of a kilowatt-hour of electricity that is produced by hydro (as compared to the theoretical value that you were taught in your physics class of 3413 Btu per kilowatt hour). But having once been stationed for several months next to a dam at Atsugi Japan, I wonder if it is possible (or necessary) to be heartbreakingly accurate where hydro inputs (measured in Btu) are concerned.**

**With the exception of the photovoltaic and fuel cells, and hydro (water and dams), and maybe a few other items not shown in Figure 1 because of their insignificance, the ‘inputs’ on the left hand side of the diagram aim at ‘raising’ steam in a *boiler*, and using the energy obtained thereby to rotate the blades of a *turbine*. The mechanical (work) output of the turbine then turns (or rotates) the shaft of a generator, and thus electricity is produced. Also indicated above in the block with heat and ‘mechanical’ is ‘condensation’. Condensers are important equipment in fossil fuel and conventional nuclear plants, because in both they turn cold steam back to water, which can then be fed back into the system in a manner that contributes to a raising efficiency.**

**Voters and their political masters have a great many opinions about what is going on in the great world of energy, but it might be helpful if they were informed by readers of this book that coal’s annual share of world energy demand is at a higher level than it has been since 1970, and it is easily the fossil fuel whose consumption is growing the fastest, even though still characterized as the dirtiest. Of course, wind and solar are also providing increasing amounts of electricity, but hardly fast enough to balance the greenhouse gas emissions of coal. Coal is relatively inexpensive, and provisions have been made to use it in many countries, and not just China, India and Ms Merkel’s Germany. Coal’s share of global energy use has reached 30 percent, which is close to the 33 percent registered for crude oil, China of course is the world’s largest coal consumer, followed by the U.S. and India. Although not often appreciated by students or teachers of energy economics, the coal reserves located in the U.S. plays – or could play – a key role in what has come to be known as ‘America’s energy advantage’, where shale oil and shale gas are the major items, at least for journalists and propagandists.**

**Surprisingly, natural gas consumption has not increased as rapidly as expected except in North America, however it accounts for about 24 percent of global primary energy use. According to Christof Ruehl, the Chief Economist of BP, global energy consumption increased by 2.3 percent in 2013, which was above the 1.8 percent of the year before, but lower than the 10-year average of 2.5 percent. China’s energy consumption grew in the same period at an annual rate of 4.7 percent, which was below the 10 year Chinese average of 8.6 percent. Let me suggest that you obtain BP’s statistical review if you want to know what is happening in the *real* Energy world.**

**Returning to Figure 1, I am *not* reminded of the house on the South Side of Chicago, where every day on winter mornings and/or evenings I spent a few minutes in the cellar, merrily shovelling coal into a furnace. As shown in the diagram, any of the INPUTS (e.g. natural gas, uranium, wind) can create an output, which in the diagram is electricity, but in my home the burning of coal generated heat, and there was no electricity produced as a result of my efforts. Instead heat from the furnace was carried by pipes into radiators in the rooms of the building. Wires and pipes from somewhere else furnished that house with electricity and natural gas (for the kitchen stove).**

**In case you are curious about these inputs, at the present time 68 percent (= 68%) of the electricity in the U.S. is provided by fossil fuels: coal, natural gas, and a comparatively small amount of oil. Coal provides 37%, natural gas 30% and nuclear 19% of the electricity. About 5% of the *energy production* in the U.S. comes from renewables and alternatives, where the largest component is wind (about 3.46%). Waterpower (or hydro) provides about 7% of the electricity, and solar less than 1%.**

**The thing to note here is that the war against fossil fuels – and particularly coal – will not be won in the present decade, nor most likely the next, although it is only a matter of time before there is a palpable growth in the output of electricity from nuclear reactors. Something else to note is that in this book as well as many other publications we often have different values for things like the percentage of electricity produced by a certain input (e.g. coal or gas). I wouldn’t worry about this: the values are roughly the same, and if you find values that you think are better, write them down in the margins of the book.**

**And what about Europe? The 28-member European Union's (EU) gross domestic product (GDP) is approximately the same as that of the U.S., or about 17 trillion dollars, although its population is much larger. The EU is the world’s third largest energy consumer, behind China and the U.S., but they are at a disadvantage because most of their vital oil and natural gas resources must be imported. Crude oil resources in the EU are only about 2 percent of global crude reserves, and natural gas about 4 percent of global conventional reserves.**

**Russia is a very large energy supplier to the EU, and the talk about voluntarily *abandoning* that source is mostly nonsense. The EU buys almost 80 percent of Russia's oil exports and more than 60 percent of its natural gas exports, and a question that needs to be asked is what happens if Russia suddenly scales down its energy exports to the EU?**.. **In fact, one of the results of the frivolous ‘abandoning’ talk about energy resources is Russia placing more emphasis on China for its energy exports, and perhaps later Japan and Korea. This is more than ‘guesswork’ – it is virtually a ‘done deal’ – because the Russian pipelines being constructed (or considered) now will have terminals in Asia. Accordingly, in the short run, from where will the EU get the energy to keep the lights on?**

**Something else needs to be pondered here: there are supposedly sizable shale reserves in the EU, but even so sizable reserves have not meant a sizable production of shale oil and gas. This observation – ample reserves but modest or no output – has led to questions about the amount of production that can or will take place in the long run from the estimated U.S. shale oil and shale gas reserves that we hear so much about.**

**Lies and misunderstandings about energy resources are plentiful in every quarter of the globe, and the contention often promulgated that the U.S. still has a technological superiority over Europe is best dismissed. Remember that President Ronald Reagan attempted to stop the flow of natural gas from Russia to Western Europe by banning the sale of compressors for natural gas pipelines. Mr Reagan seemed to have forgotten – or was never informed – or was informed but didn’t believe that the Russians constructed the world’s first nuclear power station for civilian use, and as I pointed out in a lecture at Cambridge University, they would have no problem producing all the compressors (for gas pipelines ) that they required. That soon took place through the joint efforts of Russian aircraft manufacturers and the firm Gazprom. (Incidentally, that first nuclear power station in Russia has just been turned off, and by the same man who turned it on many years ago.)**

**The most significant uses of energy in the U.S. are industrial applications (process steam, direct heat and industrial drive), transportation, and space heating. This arrangement probably applies to most industrial countries. In case you want to see the economy of the U.S. (and some other countries) deteriorate, convince the decision makers to make the kind of mistakes with their energy legislation and management that would result in the price of energy for the first two of these uses – and maybe the third – escalating. If that is too complicated, just tell them to imitate the absurd ‘*energiwende’* (= ‘energy transition’) taking place in Germany**

**Things were different at the power station in Chicago that served my district however. Large quantities of coal or oil were shoved into furnaces by humans and/or machines, and there was a collection of generators that produced electricity. Some of that electricity reached my home, and in the very late evenings – and sometimes the very early mornings – provided the illumination that made it possible for me to study my favourite subjects. I can also add that where natural gas systems are concerned, there is a transition or partial-transition taking place from the steam turbine to an arrangement that features the extremely rapid burning of natural gas in a nearly explosive manner, as in in a jet engine. The principal components of this system are fuel and air intake, combustion chamber and turbine.**

**Many things are mentioned in this book that readers are already aware of, but their knowledge should be made more systematic. For instance, it is important to appreciate that electricity is a ‘commodity’, or ‘good’ that provides ‘satisfaction’ (i.e. ‘utility’) in the form of items like heat or light, and therefore must be paid for, with the charges depending on the amount used. There is a lamp next to the computer on which I write this book, and I pay a trivial amount for the bulb in the lamp, which supplies *power* (in the form of adequate light, and whose strength is measured in *watts*). On the other hand, the largest expense is for *energy*, measured in watt-hours. Some primary school algebra might be useful here: Energy (E) = Wt, where W is watts and t is time, and thus the unit for E (Energy) is watt-hours. Your total electricity bill might be in dollars per watt hour (which is the price of a watt-hour, or $/Wh) times the number of hours for which you are ‘billed’. Never forget the distinction being pointed out here between power and energy, and make sure that you remember the units in which they are measured (watts and watt-hours, or perhaps kilowatts and kilowatt-hours).**

**The power station in Chicago that provided my electricity probably burned coal or oil, both of which were comparatively inexpensive at the time. Most likely it was coal, which was purchased by the short ton (= 2000 pounds), or the metric ton (= tonne = 2,205 pounds). If you are annoyed by the mention of pounds (instead of kilograms), then the conversion to kilograms is straightforward: 2.2 pounds = 1 kilogram.**

**Now for the real thermodynamic deal. Each tonne of coal contains on average 27,563,000 heat units called *British Thermal Units* (Btu), which will be rounded off here to 27,6 million Btu, or 27.6 MBtu. Most important, *in a perfect system*, 3,412 Btu are required to generate a kilowatt-hour (kWh) of electric *energy* (as distinguished from *power*). There is a problem however. The system of which your house is a part, or for that matter the White House (i.e. the presidential residence in Washington DC), is not perfect, and so instead of 3,412 Btu generating a kilowatt-hour of electricity, it might require e.g. 9,000 Btu to generate a kilowatt-hour of electricity, which is called the *heat rate*. (Note, the heat rate *in this example* is taken as 9000 Btu/kilowatt-hour, but it could be greater or smaller.) Accordingly, if you purchase a tonne (2205 pounds) of coal, and it contains 27,600,000 Btu, then it could generate 27,600,000/ 9,000 = 3066 = 3.066 x 103 = 3066 kilowatt hours or 3,055,000 watt hours of electricity.**

**For instance, if I had a tonne of coal to burn, and there were no other loads (e.g. lights, TV, toasters, etc) on the line, the 40 watt bulb next to my computer could supply 3,055,000/0.040 = 76,375,000 hours of light. Of course the heat rate selected above was an approximation, and so the actual heat rate for this kind of coal could have been more or less than 9,000 Btu. Similarly, the Btu per tonne of coal was an average, but still you might get some satisfaction from informing anyone who asks that a tonne of coal could – in theory at least – provide enough electricity to make the writing of a dozen books like this possible (if there were no other ‘loads’ on the line).**

**Do yourself a favour and go through the above simple calculations again, starting with the diagram that you have memorized. Then, take a deep breath and – sitting and then standing – explain to yourself or a fictional ‘audience’ the materials in the above paragraphs. *They and you will be impressed*. Of course, it is perfectly understandable if you prefer to wait until you are deeper into this book before you carry out this exercise.**

**I have made a special effort to keep complicated mathematics and concepts out of this book, except in appendices, but you should try to avoid being in a position where you do not know what a speaker is talking about when he or she uses expressions like Btu, loads, electric energy, etc., and perhaps moves to some elementary mathematics, much of which of course is unnecessary, and is presented because audiences have a way of thinking that anyone who can write and discuss an equation is highly intelligent, whether the equation is necessary or relevant.**

 **And once again, if you cannot get the definitions you need from this book, turn to GOOGLE, as I did in order to complete this chapter. Similarly, do not hesitate to employ the terminology being used above in your lectures or conversations, followed by detailed explanations if that is necessary to show friendly or unfriendly listeners what you can do. You should also try to appreciate the repetition in this book As I may have mentioned, I had the very good luck to discover the value of repetition at an early age, and I can suggest that your progress in understanding this text can be measured by the ease with which you receive, adjust to, and expand this repetition.**

**Just below is a diagram with a box at the top that says GENERATION. I could not possibly imagine that large scale generation means generating electricity with wind turbines, although when wind turbines make economic sense they should be employed. According to Mike Barnard, who is described by a *Forbes* publication as a wind expert, these turbines *always* make sense, and nuclear is being outstripped by wind. I think that readers of this book should look into this very carefully, because I happen to believe that in every industrial country in the world managers, engineers and even scientists are informing politicians and civil servants, and maybe even voters, that the attempt to replace nuclear with wind is madness, and equivalent to an attack on existing standards of living in countries where decision makers find it befitting. According to Barnard, the mathematics shows that even in China, wind energy is expanding and nuclear is losing the race, and the reason is delays, cost overruns, and unmet expectations. Check this out, because it happens to be preposterous!**

**AN ELEMENTARY LOOK AT AN ELECTRIC NETWORK**

**We can begin with the following diagram.**

Large Industries

GENERATION

TRANSMISSION

DISTRIBUTION

kV: kilovolt

V: Volts

Step-up Transformer

Step-down (SD) Transformer

 (SD)

 (SD)

Very Large Industries

 (SD)

Medium Industries

Large Service Industries

 6-20 kV

130-220 kV

 200-250+ kV

Service Industries

Residential

Commercial

220-380 V

**Figure 2**

**My tour of duty in the American army in Japan did not begin in the infantry because I felt compelled to allow my superiors to believe that I had completed one year of engineering school, which was partially correct. I had completed one year but had unfortunately failed all of my engineering courses – mathematics, physics and technical drawing – twice, and as a result was pronounced as hopeless by the Dean of Engineering at Illinois Institute of Technology (Chicago, Illinois), who then expelled me for poor scholarship. As a matter of fact, I believe that scholastically I was last in my class.**

**When I arrived in Japan, surprise-surprise, because I was first assigned to an engineering company in a small town called Atsugi, which was next to a dam. As a result I was able to get an elementary glimpse into how the system shown in the above diagram functioned, because I occasionally became involved with transformers and the distribution system. Most important, falling water and the dam supplied most – though probably not all – of the electricity for that district, and on one dramatic occasion the company I was in had to leave Atsugi because excessive rain threatened to flood our small camp.**

**During the 3 or 4 months I was in that company in Atsugi and Yokohoma, I began the reading and study of mathematics which made it possible for me to return to engineering school, and to avoid being expelled again. Of course, what I did not learn were the details of how an electric network of the type shown in Figure 2 functioned, and as a result develop a special fondness for it. Instead my first employment in engineering involved designing terminal installations for electronics on destroyer escorts at the Great Lakes Naval Training Facility (Illinois). I became familiar with the system shown in the above figure while writing my first energy economics textbook.**

**I can also admit that power line engineering involves more than what is shown in the above diagram, but that diagram and the remainder of this chapter – learned perfectly – suffices for a portion of the course in Energy Economics 101 that I hope to be invited to teach. First of all it is essential to differentiate between a transmission line and a distribution line. This terminology holds also for natural gas pipelines, and the point is that a transmission line carries a large load, while the branches of the distribution system carry a comparatively small amount. Try to be clear on what is happening in the figure: the output of the generation facility (usually in kilovolts) is increased by a *step-up transformer*, while *step-down transformers* reduce the high voltage in the power lines to the low voltage that is needed to cook your evening meal.**

 **The transmission lines are often very long, while distribution lines are comparatively short, and it does not take many lectures in your favorite electrical engineering course for you to understand that a significant part of the cost of moving electricity from one place to another is (transmission) line losses due to the heating of the wires between the input site and the output site. Thus if a large amount of electricity is required at the terminal end of a line, a great deal must be put in at the generating station to compensate for the amount that will be lost, and the wires carrying that electricity must be large enough so that they do not overheat. The next time you visit the unembellished ski area here in Uppsala, notice the large transmission towers with wires attached to them visible from the top of the lift system. These structures and the wires and the transformers hanging from them usually cost a great deal of money.**

 **Thus, what is going on in that diagram is simple, at least in theory. Different consumers are supplied with electricity at different voltage levels. In order to reduce ‘line losses’, the electricity that is produced by the source – e.g. the dam in Atsugi – is transformed to a higher voltage by step-up transformers. Various large factories or industrial undertakings may require a comparatively high voltage that is taken directly from the transmission line, and it should be clear from Figure 2 that all industries do not require the same voltage. Higher voltages are usually required by heavy industry than are required for light industry, while e.g. transportation facilities such as subways and electric trains require a higher voltage than e.g. hospitals. The lowest voltages are shown in the *distribution system* at the bottom of Figure 2.**

**Before leaving this topic, something very important deserves to be noted, and hopefully remembered. The *real* – i.e. inflation adjusted – price of electricity in the U.S. has been flat for the past 40 or 50 years, but now it is expected that it will rise. Ostensibly many or most powers plants will have to be replaced or retired in the coming 40 to 50 years, while at the same time there must be an extensive upgrading of power lines. It has been estimated that the annual capital expenditures of investor-owned utilities in the last few years have been close to 100 billion dollars, which is the largest of any sector in the country, while the Brattle Group claims that the costs of future investments up t0 2030 might be as high as two trillion dollars.**

**Maybe, but I can remember an American Energy Secretary saying the while the U.S. was a super-power, its electric power sector scarcely came up to Third World standards. This was at a time when electric deregulation in the U.S. was a scandal, and knowing what I knew about Third World power systems, that statement by Mr Energy Secretary was totally false, irrelevant and mean to attract attention.**

**Before turning to one of my favorite topics, electric deregulation, hydroelectricity deserves some attention. There is (measurable) power in flowing and/or falling water, and if it can turn an armature, there is also electric energy. On the basis of reading the previous chapters of this book you already are acquainted with the British Thermal Unit (Btu) which is a measure of energy, and according to Professor John C. Fisher of MIT (1974), it takes on the average 10,500 Btu to generate a kilowatt hour of energy in a hydroelectric installation. What is involved is the amount of (kinetic) energy in flowing and/or falling water that can e.g. be readily transformed into electricity, and moreover measured by being compared with e.g. the energy obtained from e.g. a fuel burning power-plant that was satisfying the same load.**

**The energy from a fuel burning power-plant that – in theory – could provide all the electricity needed in e.g. Atsugi Japan, and supplied by hydro, is a mystery to me. I do not know how many light bulbs, radios, electric toasters and stoves, etc formed the electric load in that charming hamlet, but a census of that load (in watts or kilowatts) – and approximately when it was on the line - would certainly have been possible. Had that census been taken – and if all the load in Atsugi had been supplied by water from the river and the dam next to our camp – then I suspect that a fairly simple calculation would have led to the kind of result provided by professor Fisher (although numerically it might have been very different from 10,500 Btu/kilowatt-hour.)**

**The point you need to absorb here is that flowing and/or falling water means energy, and once that is available, some observers say that this is the best source of both *base* *load* power (that is always on the line) and ‘*peaking’* power. Perhaps, but in the examples in my classrooms I always use natural gas to carry the peak load.**

**THE FAILURE OF ELECTRIC DEREGULATION**

**“Starting in June 2000, California’s wholesale electricity prices**

**increased to unprecedented levels. The June 2000 average of**

**$143 per MWh was more than twice as high as in any previous month**

**since the market opened in April 1998. These high prices produced**

**enormous profits for generating companies and financial crises for**

**regulated utilities.**

 **– Professor Severin Borenstein (2002)**

 **Professor Borenstein is Director of the California Energy Institute, and Professor of Business Administration and Public Policy at the University of California (Berkeley). As far as I am concerned, his word is law where this topic is concerned, and I can only express my disgust at myself for not having a version of his brilliant article ‘THE TROUBLE WITH ELECTRICITY MARKETS: UNDERSTANDING CALIFORNIA’S RESTRUCTURING DISASTER’ to study while I was presenting my lectures on electricity deregulation in Hong Kong. I was however aware that Professor John Kay – widely recognized as an important player on the upper echelon of the UK academic world, as well as a warm friend of deregulation – admitted that “electricity prices in the UK have been too high because generators were able to able to manipulate the (electric) pool to their advantage.”**

**At the same time that I tender the above confession, I feel that I should be congratulated for my alertness when I was trying to polish up my first energy economics textbook, a year or two before its publication (2000). At a time when lies and misunderstandings about electricity deregulation filled every cubic foot of the gorgeous Stockholm air, I wrote “In February, 1998, the lights went out in the central district of Auckland (New Zealand), and in one of the most modern districts of one of the most modern cities in the world, they stayed out for more than a month.” I then made it clear that ‘accidents’ of this kind can happen in any country where attempts are made to transform energy policy to competition policy, which was a travesty proposed for Sweden by some of the most influential academics, and partially adopted.**

**And not just Sweden. I gave a keynote address at a conference on electricity in Lima (Peru), during which I interrupted my prepared talk to inform the large number of energy economists and engineers from the Caribbean and South America who were present that it would be an enormous mistake to deregulate electricity.**

**Some disagreed, but fortunately not many, because in the June 18, 2002 issue of the (UK) *Financial Times*, there were two mentions of violent incidents in connection with the deregulation of electricity. One of those notices began as follows: “Some 1,700 soldiers and police poured into the Peruvian city of Arequipa yesterday after government imposed a state of emergency and curfew to quell bitter protests against two electricity privatisations.” There was also some violence in the Dominican Republic, and I heard some talk about this sort of thing being likely in other localities where politicians and their ignorant academic advisers gave deregulators permission to harass electricity consumers (i.e. ‘ratepayers’). By way of contrast, in Brazil, the CEO of a large power company apparently called deregulation a mistake.**

**The same attitude was taken by the directors of the largest power company in Hong Kong, which is why I was able to enjoy a term as a visiting professor in that marvellous city, culminating my tour with a brilliant lecture at the Hong Kong Institution of Engineers, in which – unlike my earlier performances – I reprimanded anyone who did not share my opinion of that malicious practice.**

**For readers who – unlike myself – have not been able to enjoy an engineering education, perhaps a little background might be useful. The first thing to understand is that for a long time firms that generated electric power were (correctly) treated as a natural monopoly – although deregulation ‘wonks’ (academics) had a tendency to insist that these firms belonged in the same kind of competitive setup as e.g. fast-food outlets. Moreover, having to sell electricity on a cost-plus basis, with regulators allowed to examine their every transaction if they thought it necessary, was not a situation that sweetened the careers of many power company executives. What they wanted was an arrangement such as that provided the large Swedish firm *Vattenfall*, which deregulation provided with an opportunity to squander as much money in Germany and the Netherlands as is spent annually on health care in Sweden.**

**In any event, after arriving in Hong Kong I began trying to convince students and colleagues that the point was to establish more or less centralized systems, with a vertical monopoly structure featuring generators (i.e. ‘wholesalers’) selling to or even owning utilities (i.e. retailers), who in turn sold to households and small businesses (and maybe even to very large businesses who often are in a position to buy directly from generators). If you stick with this book to the bitter end you will receive a more thorough presentation of this arrangement, though I can mention here that the key word in all this seems to be ‘integration’ – as in integrated (and regulated) monopolies that perform the full range of functions necessary to provide electricity for all categories of consumers at reasonable prices. To this should be added regulators who know that the purpose of regulation is to ensure that households and above all industries obtain the electricity they need to remain competitive!**

**Rather than go into a song-and-dance about ‘loop flow’ and Kirchoff’s Law, what happened was that with lies and cleverly constructed misunderstandings, electric deregulation made it possible for a system that satisfied most households and businesses to be transformed into one in which “market pressures” were created that gave generators the opportunity to raise prices and make enormous profits. This was almost as true in Sweden as in California, where the largest generating firm in this country was provided with what amounted to a license to make fools of the rate payers. Or, as one journalist suggested, we (households) may be destined to spend a substantial part of our working lives endeavouring to boost the incomes of electricity suppliers.**

**If you make the mistake of asking colleagues at the Stockholm School of Economics about the logic of allowing wholesalers/utilities to raise prices to very high levels, you might be told that in the long run consumers will be better off because high electric prices will mean more investment in generating facilities. This kind of reply – and possibly belief – might be called IGNORANCE IN ACTION, particularly when you consider what has actually taken place in virtually every part of the world,**

**As I informed young lecturers in Hong Kong who graciously suggested that ‘distributed generation’ (which involves favouring small rather than large generators of electricity) was the way to bring some fairness into play, the engineering literature that I am still capable of reading suggests that comparatively small generating facilities, strategically located, have enormous market power, and if freed from the interference of regulators, would use it to bleed consumers, Of course, the ‘enormous market power’ in the California fiasco was possessed by large firms that the Governor of California called “out-of-state criminals”. In case you have forgotten, a new expression entered the language as a result of the California fiasco. This expression was ‘gaming the system’, and it mostly involved pretending that something had become necessary – like unforeseen maintenance – which prevented a fraction of the usual amount of electricity from being supplied, and therefore caused the price of that being supplied to rise.**

**I have two more things to add before leaving this subject. When they began the deregulation circus in the U.S., Congressman Peter de Fazio asked “Why do we need to go through such a radical, risk-taking experiment?” His answer could hardly be misinterpreted: “Because there are people who are going to make millions or billions.” I also liked U.S. Senator Byron Dorgan’s tribute to deregulation: “I’ve had a belly full of being restructured and deregulated, only to find out that everybody else gets rich, and the rest of the people lose their shirts.” Please be assured that the “rest of the people” are not the executives of power companies like Vattenfall in Sweden, who used the freedom provided by deregulation to transfer a substantial part of their activities to Germany, where they assured everybody that they were going to pipe the carbon dioxide created by their mining activities into the deepest hole they could dig in the Baltic Sea. This is called ‘Carbon Capture and Sequestration’, or CCS, and in the case of Vattenfall was a gigantic lie or a misunderstanding or more likely both.**

**More to the point, Professor Alfred Kahn, probably the most important deregulation scholar in modern times, said that “I am worried about the uniqueness of the electricity markets. I’ve always been uncertain about eliminating vertical integration. It may be one industry in which it works reasonably well,” And it could continue to work well, assuming that the regulators do not fall asleep or receive too many gifts from the firms that they are supposed to be regulating.**

**One more item. With the deregulation of electric markets in the U.S. and Europe, several regional power exchanges were established for the buying and selling of electric power. One of these is the Nordic Power Exchange, or Nordpool, that I have discussed in my books, lectures and articles. Whenever I get the opportunity I suggest that it should be closed, and the persons responsible for its establishment investigated by the serious fraud authorities. By these ‘persons’ I do not mean academic persons, because they were too indifferent and or uneducated to realize the damage that was going to be done by an experiment whose purpose was to increase the incomes and wealth of high-income executives and shareholders.**

**Stop and think for a few minutes about the absurdity of a multinational electric exchange. If you take a country like Sweden, where nuclear and hydro produce some of the most inexpensive electric power in the world, but where it has occasionally happened that that power was very expensive, then for the most part the cause of this unexpected expense could only be an expenditure binge on electricity in one of your partner countries, or some kind of game-playing in the electric exchange by young traders and analysts with the kind of backgrounds shown in the film Wall Street, and who were inclined to refer to themselves as “masters of the universe” as a result of their high incomes.**

**As can be easily verified, electric prices in Nordpool countries escalated in l999, at which time at least a dozen persons mailed and asked me to explain what had gone wrong. My answer was frank and direct: nothing had gone wrong, except that Swedish voters, politicians, journalists, and academics who claimed that electric exchanges make life sweet and lovely for households and small business had lost their compass. Moreover, in Sweden, many executives from the Swedish industrial sector who were the most enthusiastic supporters of electric deregulation, ended up writing articles in local newspapers in which they asked that the deregulated setup should be terminated.**

**One of the reasons I wrote this book is to make it clear that even advanced degrees in economics do not qualify all students and teachers of economics to do useful work in the field of energy economics. There are important professors who endorsed the curse known as energy deregulation, although admittedly they did not do this for their health. They did it for money and exposure, and it is likely that some of those ladies and gentlemen might end up on short lists for Nobel Prizes in economics, even if their minds and hearts continue to overflow with love for electric deregulation and other screwy departures.**

**Before going to the conclusion, it is probably useful to point out a simple technical point mentioned by David Besanko and Ronald R. Braeutigam in their book *Microeconomics* (2005). They say that the decision making for electric supply involves 8760 decisions per year (or 365 days x 24 hours per day), and this requires very precise organization and management. *As it happens though, dealing with this was a ‘piece of cake’ before deregulation came on the scene, and in the name of ‘free markets’, practices were introduced that were injurious for both households and businesses!* In other words, despite their pedagogical skill, and access to students and teachers at the ‘elite’ universities in the U.S., this was overlooked by those two scholars.**

**Something most readers both know and don’t know is that suppliers of electricity must make sure that customers obtain their requirements not only every hour of the day, but virtually every minute capacity must be on hand to supply ‘spikes’ in demand. Besanko and Braeutigam point out that it is less expensive to supply electricity with nuclear than with natural gas, which is true for *base* *loads (or loads always on the line)*, but may not be the case when there are (brief) ‘peak loads’ that must be satisfied.**

**They also mention that there is a spot market for electricity that is available every hour of the day, which is correct, but the promotion of spot markets to the detriment of long-term arrangements has not worked in favour of passive electricity purchasers like myself, who though trained in electrical engineering and energy economics, only want to purchase electricity and expect that our ‘higher’ interests will be protected by the authorities. In my case purchasers who are familiar with what the electric price should be, and almost as important what it became after the ludicrous talk about “deregulation” and “liberalization” began on the part of self-proclaimed experts with only a trivial or bogus knowledge of this subject,**

**CONCLUSION: THINKING ABOUT THE ENERGY FUTURE**

 **“Energy is the major factor of social well being”**

 **– Earl Cook (1976)**

**A small increase in global renewable energy resources (to include hydroelectricity) has been predicted by the EIA, but the impression I get is that not much is expected of ‘alternatives’ such as biofuels. Where this last ‘supposition’ is concerned, I am very definitely not sure. It might also be a mistake to believe that hydrogen can *never* become an important transportation fuel, although many say so.**

**In fact Professor Malcolm Slesser, formerly Head of Systems Analysis at the European Commission research station, considered hydrogen to be the ultimate ‘backstop’ (in that if it can be obtained from seawater – employing e.g. breeder reactors and electrolysis – then (in theory at least) it might be capable of supplying an infinite amount of low-carbon transport and heating fuels. Hydrogen can also be obtained from water by thermal dissociation, as in the production of ‘water gas’, which is a combustion type fuel containing carbon monoxide (CO) and hydrogen gas (H2). Here you can remember that the formula for seawater is the same as for the water you obtain in your kitchen (H20), and use to dilute the Scotch Whiskey that you might consume or consider consuming after some of the particularly misleading lectures on energy matters that for one reason or another you were compelled (or felt compelled) to attend.**

**Dr Mamdouh Salameh examined this prospect closely due to his meeting in Iceland with Professor Bragi Arnason of Reykjavik University, whom *Newsweek Magazine* has called “Professor Hydrogen”. Professor Arnason showed Dr Salameh buses that operate on hydrogen and also a hydrogen filling station in the Icelandic capital Reykjavik. Later Dr Salameh presented a paper on hydrogen (2008) at the 28th USAEE/IAEE North American Conference. In case you haven’t heard, a decade ago the Icelandic government declared its intention to switch the entire economy over to hydrogen**

 **For long distances, hydrogen can be piped more cheaply than electricity can be transmitted in a power line, while as a fuel it produces no residues except water. Of course thermodynamically – or in terms of the relation of heat and temperature to the energy and ‘work’ obtained – there are crucial questions that must be answered before we talk about the beauty of a ‘hydrogen’ – or perhaps ‘hydrogen-nuclear’ – community, and where this topic is concerned I am completely unable to make a contribution. The main question seems to be whether it is efficient to use electricity generated by e.g. nuclear to obtain hydrogen (which is an energy carrier rather than a source of energy) or to use electricity directly to e.g. replace hydrocarbons in various uses where the former is applicable. Put another way, although hydrogen might be a clean substitute for conventional motor fuels, it requires more energy to produce than it yields. My position here is that we might get a definitive answer to this riddle when breeder reactors move into large scale use.**

**To change the subject before we go to coal, the excellent Professor Dieter Helm does not conceal his belief in the forthcoming dawn of U.S. energy independence, which is a notion that – on the basis of the present evidence – I consider preposterous, and he also has/had goofy ideas about the ability of the Russians to sell natural gas to China.**

 **The U.S. may consume about 19 mb/d of oil before the end of this year, of which *at least* 7.5 mb/d – to include ‘liquids’ – are imported. There is also considerable talk in that country about exporting natural gas to Europe and Asia, although it is easily confirmed that the U.S. is now importing about 11% of its natural gas consumption. What might be exported is more coal, which should make the politicians in Europe who want to use it to replace import of Russian natural gas happy, and perhaps in addition want more of it introduced for the purpose of replacing nuclear energy. (Incidentally, Lord Howell – the UK energy expert – has argued that Russian gas is an excellent fuel for the generation of electricity in Europe. This of course is at least partially true, but no matter how true it is, it is unlikely to increase his popularity.)**

 **In this book and elsewhere my advice to the government and voters of the U.S. is to ignore the ignorant allure that exporting oil, natural gas and perhaps various liquids seems to possess for a few members of the U.S. Congress and academia, and instead consider what the situation will be when (or if) the growth of the U.S. economy resumes the vigour that was periodically experienced prior to 2008. In other words, it might be time for influential politicians to think more of the *common good* than increasing the profits of a few large and very rich corporations, which happens to be the situation enjoyed by energy firms in the U.S. (*Liquids* are e.g. biofuels, natural gas liquids that are called condensates, etc)**

**An important topic that has and will be ignored in this book is the storage of electricity. It has been ignored because I do not know anything about it, and have always been satisfied with my ignorance on this score. However I have been informed by some very smart persons that great progress can be expected with the storage of electricity.**

**One of these persons is the nuclear engineer and executive Malcolm Rawlingson. In a comment on the site Energy Pulse he says “It is not here yet Fred.....but it is coming. About the best we can do right now is lead acid batteries. If Graphene is half what it is cracked up to be, I think that picture is going to change within the next 10 years. The preliminary studies I have seen show that it is possible to make a lightweight super-capacitor that can store very large amounts of electrons per unit volume and per unit weight. Possibly thousands of times more than current heavy lead acid batteries.”**

**He continues by saying that “No doubt there are some technical problems to getting there, but from what the engineers working on it tell me they are not show-stoppers. But that does - as I have said all along - change the entire picture with respect to solar power and other variable sources. It also changes the economics of nuclear plants that would be able to run flat out all day long above the base load and store the surplus. The advantage is definitely in favor of nuclear plants but solar and wind will benefit too.”**

***Changes the picture with respect to solar power and e.g. wind power, and also the economics of nuclear plants.* In a later chapter you will find out about these matters, where the key term will be *merit order*, which according to GOOGLE means “a way of ranking available sources of energy, especially electrical generation, in ascending order of their short-run** [**marginal costs**](http://en.wikipedia.org/wiki/Marginal_cost) **of production, so that those with the lowest marginal costs are the first ones to be brought online to meet demand, and the plants with the highest marginal costs are the last to be brought on line. Dispatching generation in this way minimizes the cost of production of electricity. Sometimes generating units must be started out of merit order, due to transmission congestion, system reliability or other reasons.”**

**The situation where merit order is concerned is not quite as simple as suggested by GOOGLE The entire story will be told in the more technical chapter on electricity, and the reason that you will have to wait in order to enjoy it is because of the mathematics and diagrams (called screening curves) that are necessary. But perhaps a few things should be said here, because *merit order* is a term that, because of deficiencies in the economics literature, might be useful to you some day if you encounter people who believe that they know more than you and attempt to show it.**

**Suppose that you decided to buy a castle in Beverly Hills (Los Angeles) that had been occupied by Count Dracula, and which did not contain any electric lights. All the lighting was supplied by candles, and as the song makes clear, ‘it never rains or gets cold in Sunny California’, and so there was no heating cost.**

**You of course are more sophisticated than the Count, and so you decide to buy some electricity generating equipment that operates on nuclear fuel, or natural gas, or – as specified by the brilliant gentleman who taught you energy economics – both. Both because hustlers in some of the less distinguished neighborhoods in the U.S. were prone to talk about ‘flashing’, by which they meant demonstrating their wealth whenever possible. Your idea of flashing is to give impromptu lectures at any hour of the day or night, anywhere – regardless of where you happen to be – on how you save money if you observe the merit order. Then you go into details.**

**The issue is simple. The small (= modular) nuclear reactor that you could buy and keep in a small building behind your house has a relatively high capital cost (associated with its complexity), but a relatively low variable cost (associated with the low cost of reactor fuel). On the other hand, a small gas generator with the same capacity has a low capital cost, but a high variable cost (= natural gas price), because a decision has been taken to export as much of the natural gas in the U.S. as possible, which has increased the domestic price.**

**As it happens, you will only spend about two hours over a 24 hour period (= one day) in your castle. The rest (= 22 hours) will be spent standing or sleeping outside the gate of one of the large movie studios in Los Angeles, trying to convince executives of that studio to give you a role as a victim in a forthcoming epic on the life of Dr. Frankenstein. The riddle with which you are faced is: which of the two pieces of equipment do you buy: the modular reactor or the gas based generator.**

**The answer is the latter. If you are cost conscious, and you bought the comparatively expensive reactor, it would go unused for 22 hours every day, to include weekends and holidays. So would the gas based generator, but it is comparatively inexpensive, and if it were unused most of the day, what difference would it make: the cost of having the equipment and its fuel available you describe to friends and neighbors as ‘lunch money’.**

**But if things were different – were opposite – and you stood outside the studio only 2 hours every day, and the rest of the time you were in your house with large numbers of guests who were singing and dancing around the clock while preparing for other Hollywood film roles, you would only buy the gas-based generator to supply electricity if not only was its price much lower than the price of a suitable reactor, but also the fuel for the gas-based generator was comparatively inexpensive. Or – and this is important – you minimized the living costs associated with your castle by having a reactor to supply the greater part of the electricity, but also a gas-based generator to supply the peak load that was forthcoming when a local band that used instruments working on electricity dropped in to play for a half hour or so, two or three times a day.**

**Finally, if you don’t understand this chapter read it again. This week I read brilliant articles about natural gas and nuclear in the *New York Times.* You should make sure that you read articles like those, because most of the people you will be competing with probably won’t, and if they do probably won’t understand them. This might also be the point to remind readers who followed my advice, and did not spend valuable time trying to decipher concepts they believed that they were not ready to understand. Take another crack at those concepts now. You might have the rhythm required to handle them and a lot more.**

**APPENDIX: JAPAN AND POPULATION**

**In the first 6 chapters of this book my intention is to cover everything that I want my students to know when they begin the rest of the book, especially the last chapter, because after that they should be ready and able to impress friends and neighbors. There are occasional remarks about population above, but these do not suffice, and because this is an important topic, I have chosen to add a few things.**

**I can start by saying once again that I know Japan, though not as well as I should. As a professor of energy economics I gave several greatly appreciated lectures in that country, while much earlier I delivered hundreds of brilliant but unfortunately unappreciated lectures/harangues to American infantry soldiers, mostly in Camp Majestic (near Gifu), but also in wonderful Kobe, and at the live firing ranges close to the base of Mount Fuji.**

**I don’t believe however that I spent a day in that country without wondering why those good people decided to challenge the United States of America, even after my company commander, Lieutenant Smith, explained it to me in one simple sentence. According to him, as a veteran of the war in the Pacific, “The key was the F-word”, by which he meant fanaticism. Further elucidation was provided by my very intelligent platoon leader, Lieutenant Garza, who one day stated that a Japanese corporal in smelly underwear was the equivalent of a foreign soldier with a Marlon Brando sneer on his lips, and a collection of medals on his breast, assuming that he had the right kind of equipment in his hands, and also at his back.**

**For individuals like my good self, fanaticism has often turned out to be a beautiful thing, especially if it is accompanied by generosity and a sense of humour. In the silence of my lonely room, to which I returned after being expelled from engineering school for poor scholarship, it was a simple matter for me to figure out the qualities I needed to emphasize in order to write the books and obtain the guest professorships that have offended so many of the Swedish academic elite. But that doesn’t explain why I am prepared to assure the academic rank and file that Japan will eventually move at a faster pace, and will reclaim or solidify their place in the winner’s club.**

**The most important thing working in Japan’s favour at the present time is the structure of their population. According to a recent *Bloomberg Business Week*, Japan is growing older too fast. There is a diagram in the same publication which shows India, Egypt, Columbia and Mexico as the four countries with the smallest fraction of their population over 65 years of age, and in the (Bloomberg) ‘jumbo’ position the diagram shows Japan, Germany, Italy and France (where the latter was tied with Spain). In other words, implicitly, because of what somebody has interpreted as a shortage of nimble brains and hands, the last four are supposed to be in serious decline. I might be able to accept this massive misconception from friends and neighbours, but never from strangers.**

**An extended misunderstanding is in the accompanying discussion. To quote the Bloomberg expert responsible for this ‘contribution’, “to offset labor shortages, Japan has begun easing immigration requirements for highly skilled workers. So far the program has fallen short of its modest target: under a quarter of the 2000 professionals it sought have come to work in Japan”.**

**The correct reaction to this information is polite disbelief. *The Japanese educational system can produce all the “professionals” needed by that country!* Moreover, the truth is that an overwhelming majority of the Japanese do not want foreign ‘workers’ in their country, highly skilled or not. What they want is for their political masters to reproduce the economic miracles that I repeatedly told my international finance students about before I decided to concentrate on energy economics – miracles that I mentioned briefly in my international finance textbook (2001). Nor does a cursory statistical analysis indicate that foreign workers are needed.**

**The economy of Japan is the third largest in the world on the basis of its nominal GDP. Japan is the world's third largest automobile manufacturing country, and has the largest electronics goods industry in the world. The Japanese firm Toyota has decided that fuel-cells are the most viable zero-emissions technology, and will focus on manufacturing cars that run on hydrogen fuel cells, even though at the present time that firm is the world’s largest manufacturer of gas-electric hybrids. (In case you don’t remember, the fuel cell converts the energy in hydrogen or liquid fuels directly into electricity, and ostensibly has twice the energy efficiency of the internal combustion engine.) Many persons are so preoccupied with assessing the amazing achievements of China over the past 25 years that they forget about Japan. Japan may well have lessons to teach the rest of the world.**

**For instance, Japan is also a country in which individuals can feel safe in their homes or on the streets at virtually any hour of the day or night, which is an advantage enjoyed by its residents that will be of increasing value in this century. You should also know that where international educational scores are concerned, Japan is Number 4 or 5 for primary or secondary education, and probably occupied one of those positions every year for a number of years. *That by itself tells me where Japan is going in the future, and it should tell you*!**

**In a short but brilliant lecture that I attended a few weeks after starting my three year ‘tour’ at the Palais des Nations (in Geneva, Switzerland), my colleagues and myself were informed that Japan’s development plans were generally regarded by economists in that noble structure as a role model for industrialisation and economic progress. They still are, and this means – as emphasized above and below – that three cheers for nuclear are appropriate. An important article on Japan has been authored by Joni Jupesta and Aki Suwa (2011), and among other things it reinforces my belief that Japan will never abandon nuclear energy.**

**You should also try to appreciate that in the near future there will be thousands – or tens of thousands – of brainy engineers roaming the streets of India, Egypt, Columbia and Mexico begging for work before their valuable  analytical skills are dissipated by idleness. Instead, imagine being a qualified engineer or technician who, after e.g. arriving at Kobe’s airport, proceeds to an apartment on or near one of the sensual hills in that exotic city, before embarking on a spell of hi-tech employment. That sort of experience is in the same class as marching down a main  thoroughfare of Kobe in the direction of the exotic ‘Motimachi’ (sic), returning from a long day of training for the next American war. It was exactly what was needed to make me think that there might be some justice in this old world of ours after all, despite being informed by the Dean of Engineering at Illinois Institute of Technology (in Chicago) that I was “a hopeless case”, and summarily expelled!**

**I’d also like to mention something that the editors and journalists of the *Bloomberg Business Week*, and many other important publications, should try to comprehend. Technology, economics, culture and geography are capable of working magnificently in Japan’s favour, assuming of course that their navy doesn’t pay another early-morning visit to Pearl Harbour. Although I doubt whether those academic careerists who are sincerely devoted to mediocrity in teaching and research will get the message, for a countries the size of Japan and Sweden, and others, they have all the people they need…thank you very much.**

**And similarly, globally, the problem in the long run – and maybe even sooner – is not too few people, but too many. I can’t remember talking to anyone in the last 25 or 30 years who believed that the more people the better, although I once heard of a prominent professor in the U.S., the late Professor Julian Simon, who accepted that crank theory. He claimed that the larger the population, the more brains would be available to solve society’s problem. Cleverly put, wasn’t it, or in my opinion unbelievably stupid. I perhaps should mention though that the benefits or curses of population increases is a topic that should not be discussed with strangers, although I can remember a dozen cities where drivers of taxis have lectured me on this subject.**

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**7. COAL, AND A FEW ASPECTS OF GAME THEORY**

**A LONG INTRODUCTION**

**First a few things for you to remember. Coal is still the fastest growing source of energy across the world, and provides 40% of the fuel for the world’s electric supply. The amount being used has increased by 60% since l990, and at the present rate of consumption there is well over a hundred years of coal left. Despite what you may have been told on CNN or Fox News, do not rely on the opinion that “despite swift gains by renewable energy, it (coal) will remain a dominant source of power for the foreseeable future”. Coal will indeed be an important source of power, but you can discount the lie or misunderstanding about “swift gains by renewable energy”. Renewable energy can be described in a number of ways, but not in terms of “swift gains”, and similar fictions.**

**The CEO of Exxon Mobil Corporation, Mr Rex Tillerson, also provided us with something to think about. He said that alternative fuels will grow – which is true, although probably not the way he would describe in a lie-detector gig – but oil will remain the world's leading source of energy for another quarter century. Mr Tillerson also said says natural gas will surpass coal as the second most heavily used fuel. But what else could he say: Exxon Mobil produces natural gas but not coal, and the stockholders at the meeting where he was going through his annual song-and-dance required a large dose of encouragement, because that venue was surrounded by environmentalists cursing the day that Exxon Mobil was incorporated.**

**Having clarified this matter, I would like to continue with some humdrum comments derived from my book *THE POLITICAL ECONOMY OF COAL* (1985). Originally my intention was to correct some mistakes and extend the work on conventional game theory in that book, but since I was unable to accord the work of Nobel laureate John Nash the usual lavish praise, I decided to merely peruse a few items of the kind I once presented in a graduate course for some non-Swedish graduate students, before discovering that their primary reason for visiting our charming seat of learning in Sweden had to do with the music and dancing at Uppsala University student clubs, and not game theory.**

**Having seen the Hollywood travesty ‘*A Beautiful Mind’*, many readers are probably annoyed to hear that the majority of Nash’s work on game theory encountered in the books I have taught from is useless for anything except plaguing innocent students. But if you are unable to trust my judgment, and are fascinated by the expression ‘Prisoners Dilemma’, please read the book by William Poundstone (1993), and also the elementary textbook by Fiona Carmichael (2006) makes sense on the academic level. I can also note that the commodity being treated in this chapter is *thermal* (and not *metallurgical*) coal. In other words, coal used in ‘raising’ steam, and not in the making of steel. It is often referred to as ‘steam’ coal.**

**Coal is formed from the remains of trees that have been preserved for millions of years under a special oxidizing condition, for the most part in swamps where, after falling, the trees either did not rot or rotted very slowly. Thus, though not widely known, *all* coal has a plant origin, and in general coal seams have their origin in the ‘carboniferous’ epoch. Top-grade coal requires a gestation period of a few hundred million years, and it has been calculated that the average time required to accumulate enough vegetable matter to form 1 meter of coal is about 1.6 million years. Similarly, a coal seam 1 meter thick would have been compacted originally from a 120 meter layer of plant remains.**

**It is possible to distinguish a spectrum of coals, ranging from peat through anthracite. *Peat*, which is brown, porous, and often contains visible plant remains, is the lowest class of coal, with an average energy content somewhat below 4,000 Btu/pound. Peat also has a high moisture content, and the same is true of lignite, which is a step up the quality trail. Where energy values are concerned we distinguish between subbituminous coal and bituminous coal proper. Finally we come to anthracite coal which is jet black and difficult to ignite, and has an average energy value of 14,000-15,000 Btu/pound. Coal produces approximately 40% of the world’s electricity and about the same amount of its CO2 emissions.**

**As various times you may have seen the expression THE WAR ON COAL. I do not pay much attention to this expression, but even so it will be the last section in this chapter. As for game theory, I mentioned it on several occasions when dealing with OPEC, but not the fascinating ‘coal game’, which has to do with pretending that coal will be eliminated from the global energy scene, while at the same time using as much or more of that resource than has been used at any time in human history. Before continuing, readers can examine of tableau below.**

**TYPE OF FUEL HEATING VALUES CO2 EMISSIONS**

 **(Btu/pound) pound CO2/MBtu)**

**Sub-bituminous coal 8300-13000 214**

**Bituminous coal 10,500-14,500 206**

**Anthracite Approximately 15,000 228**

**Lignite 4000-8300 215**

**Something important should be noticed here. Lignite appears to have a modest CO2 emission factor, but the trouble arrives because of its comparatively low heating value per tonne. To feel as comfortable in your Alaskan or Siberian hideaway as you do in a Stockholm jazz club or Uppsala student club, you would have to use a much larger quantity of coal. The presence of large quantities of coal in relation to its heat value (or content) helps to make it seem correct to insist that coal is an unpopular source for both economic and environmental reasons.**

**Here I can mention that according to one of the leading energy economists in Europe, the consultant and MIT graduate Jeffrey Michel, lignite is extremely unpopular in some parts of Germany. He points out that Bavaria is refusing to erect new high-voltage transmission corridors for transporting electricity that is generated with eastern German lignite to the Greater Munich area. I suspect that one of the reasons for this is not just that lignite is ‘dirty’, but that entire villages in the East of Germany are being ‘liquidated’ to facilitate the mining of lignite. The amazing thing about that suspicion is that it would be easy to prove, only many people would insist that it was a lie no matter how much proof was supplied. The same thing is true about what is going on at present with the construction of new nuclear facilities.**

**You have already heard coal mentioned many times already in this book, but I warned you many pages ago that I have no problems with repetition. I do however have a few new concepts to present in this chapter, and it is also necessary to confess that I was not entirely correct in my evaluation of the coal future in my first energy economics textbook (2000).**

**In that book I sometimes gave the impression that coal’s future was not promising, although I made it clear that I was impressed by the quantity available. I also stressed the likelihood that large amounts of it would be consumed, regardless of a growing belief that its use should be minimized. There was no talk of a war on coal at that time, but it was easy to get the impression that it was a resource that many decision makers thought we could find a way of doing without. I was also able to take at face value a statement by Mr Ron Knapp, chief executive of the World Coal Institute, in which he said that “Developing countries will use coal in the way that we developed countries used coal 100-150 years ago. Use it as a building block of economic development. There is enormous demand for energy.”**

**I am not certain that things have turned out exactly the way that Mr Knapp intimated, but he was at least partially correct, because the relevant “developing countries” turned out to be China and India, although they may be joined by several more in due course.**

**Another high-ranking energy economist, Kurt Cobb, substantiates some of the above. He points out that, percentagewise, increasing amounts of lignite are going to be burned. Power companies may favor bituminous and sub-bituminous coals, but according to Cobb, from 1992 through 2012 the total world heat content per ton of coal consumed globally fell by more than 10 percent. This was a measure of the transition from bituminous to lower quality coals. Something else Kurt Cobb says is that the run-up to the Third World War has begun, and he basis this contention on the lies and affronts that seem to always be associated with the great world of energy.**

**One of the things that I take pleasure in pointing out about coal is that more than economics is involved. Lies and misunderstandings are perhaps even more important than those found in the fairy tales and exaggerations about the declining prospects of nuclear energy, and increasingly the ignorance found in half-baked but serious suggestions about increasing the exports of oil and gas from the U.S. to America’s competitors. As with most energy subjects, there is almost a universal plot to confuse the issue where coal use is concerned, which means that because of its relevance, the next section had to be removed from the appendix in this chapter and given a top billing.**

**COAL AND ECONOMIC LOGIC**

**“There is no reason why institutions that have direct**

**holdings in coal, oil and gas stocks could not divest immediately.”**

**– Ian Simm (Chief executive of Impax Asset Management)**

**No reason except money, Ian, and as you probably know, there is no bigger reason than that anywhere on this or any other planet.**

**Apparently pension funds in the U.S. – and probably everywhere else – have ignored calls from mayors, city councils, break-dancers, moonwalkers, hustlers and pseudo-intellectuals to forget about the viability of their business models and – in the name of environmental soundness – divest their fossil fuel shares/stocks. As a counterexample however, Stanford University – which has an endowment fund of almost 20 billion dollars – has reportedly started to unwind its position in all publicly listed companies that focus on producing coal for energy generation, *Right on*, I’m tempted to say, especially when I read that George Serafeim, associate professor of business administration at Harvard Business School, informed his friends and neighbors that “If major pension funds and endowments divest from fossil fuel companies, this will send a very strong signal to the boards and the executives of these companies. Some changes will happen.”**

**You got that right. George, although they may not be the changes having to do with cleaning up the environment that are almost certainly bandied about in the faculty club at your establishment, or similar facilities at Stanford and Chicago and various other institutions where tenured faculty members care even less than I do about signals sent to and received from fossil fuel companies. With all due respect, I happen to know that the changes you are talking about will involve even a higher level of lies and misunderstandings about the energy future – a future in which coal is likely to be a star performers unless (or until) nuclear moves to the head of the class.**

**“Germany is winning,” according to Simone Osborne – Co-Editor of the publication *Energy* *Crunch* – noting that she is not talking about football, but renewable energy. She then goes on to say that “Germany also succeeded in avoiding a yellow card from the EU over exemptions designed to protect energy intensive German industry from the cost of the energy transition.” She also informed us that renewable energy supplied a third of Germany’s electricity in the first half of 2014, and during one day in May renewable energy supplied a “a peak of 74%, without the grid or the economy being brought to its knees”.**

**Dr. Bruno Burger of the Fraunhofer Institute explained that the gains made by renewables thus far in 2014 can be attributed to the combination of good weather and growing production of clean energy. He adds that “in the first half year 2013 we had really bad weather and the solar and wind production was below the long term average”. He concludes his analysis by saying that “In 2014 we started with more [sun] and wind, and the production is higher than in average years.”**

 **Continuing with the good news, that establishment announced that coal based generation is down for both hard and soft coals from the record levels of 2013, and in addition the decline in output for gas-based power plants was down 25% compared to the same period last year.**

**Even better, Dr. Burger says that “Despite the fact that we had high production of renewables, we did not reduce the conventional production. Therefore we achieved an export surplus of 18 Terawatt-hours. If this trend continues until the end of the year, Germany will achieve a third record in a row in electricity exports.”**

**That’s funny, or perhaps ironic, but I thought that Germany was or would be breaking records for electricity imports, and in a talk at an energy conference in Stockholm last year, a Belgium researcher claimed that if Germany goes through with its preposterous plan for abandoning nuclear, Belgium will have to ration electricity. Craig Morris at Renewables International sees a down side though in Germany’s happiness, arguing that it’s the high electricity exports that keep coal production high in Germany. He sums this up by saying that “Renewable electricity has priority on the German grid and therefore offsets conventional (fossil fuel) generation, meaning that much of conventional generation will go to neighboring countries as exports.” Logic comes into the picture when he notes that the effect of coal based exports from Germany to surrounding countries will prevent those lucky countries from also going over to renewables.**

**Well there it is folks. If the Dean of Engineering at Illinois Institute of Technology could have seen the Energy Economics 101 book that you are now reading (ENERGY ECONOMICS: A MODERN FIRST COURSE in case you have forgotten) he would have expelled me after my first semester at his establishment instead of my first year, because in this book I claim that around the beginning of this year, Germany was burning more coal than was burned when that country was divided, and East Germany binged on soft coal. Moreover the word in Germany most often applied to the *Energiewende* (= Energy Transition) is verrückt (= crazy, mad), and one of the decision makers in that country said that Germans have financed about all of the Energywende “learning curve” that is possible at the present time.**

**THANKS FOR NOTHING is my response to that admission, but before proceeding to destroy the manuscript for my new book, let me add what the World Coal Association says about that resource. ‘Coal provides around 30 percent of global primary energy needs, generates 41 percent of the world’s electricity and is used in the production of 70 percent of the world’s steel. Coal and lignite reserves are sufficient for more than 100 years at the current rate of production, and the worldwide rate of growth of coal consumption is 3.6 percent.’ Moreover, for what it is worth, which isn’t much, the International Energy Agency believes that coal may come close to surpassing oil as the world’s main energy sources by 2017.**

**I’m tempted to finish this portion of the chapter by saying that the bigger the lie, the harder people will try to believe it, but I won’t bother. When I am teaching this is an expression that I use constantly, but regardless of how skillful the lies are formulated and delivered, The *Energiewende* will be exposed before the first quarter of this century is over. Even so, as far as I am concerned, that is almost a decade too late. At the same time I want to refer to a working paper by Charles Frank, called *‘Wind and Solar are Worst* (2014).’ Yes they are, Mr Frank, but not always and everywhere, and determining the exceptions and how to exploit them is where the high-level/real-deal/top-of-the-line logic comes in.**

**WORD IS OUT**

**I often recall military exercises involving the firing of large mortars or artillery pieces, and for which I prepared myself by taking a course in surveying during my last full term in engineering school. The important thing about that preparation turned out to be extending my knowledge of trigonometry, by which I mean learning it absolutely perfectly, and ‘programming’ a pocket slide rule.**

**Before you take a front row seat among the elite in the coal session at the next energy conference you attend, you should perhaps absorb the following information. In case you are busy and might miss something important, I can mention an article in *Fortune Magazine* called ‘The Great Coal Migration’ (2014) It is about the movement of Chinese electric generation plants westward, and inland away from the large eastern cities. In that article it is pointed out that China produces and burns as much coal as the entire rest of the world, and now they are constructing ‘up to” 70 new coal-fired plants, representing “the biggest fossil-fuel development in the world”. I hear you loud and clear, author, and let’s hope that your readers ask themselves a question that many environmentalists have started asking: wouldn’t it make more sense for all of us if the Chinese forgot about coal, and concentrated on nuclear?**

1. **According to the International Energy Agency (IEA), two-thirds of the world’s already discovered reserves of oil, coal and natural gas must remain unburned if the rise in average global temperatures is to be limited to 2 degrees Celsius by 2050. This may or may not be true, but the important thing here is that this information comes from the IEA, whose opinions and research I make a point of ignoring, although I find interesting their theory that the more coal is resisted by purchasers of energy, the more there will be to fall back on if necessary. I really wonder if they know what they are saying.**
2. **Worldwide, coal has probably never been in a stronger position than it is now. According to statistics taken from the most recent *BP Statistical Review of World Energy*, coal supplied 30 percent of the global energy demand. In the vernacular: coal is not going anywhere soon, and it is a mistake to think otherwise now that there exists a supply glut of coal and its price is falling. Of course, it is reported that the burning of coal accounts for about 80 percent of China’s electricity output, and though there is talk of reducing that commitment, there is also talk of maintaining a rate of macroeconomics growth rate of 7%. That growth rate will not allow a reduction in coal use.**
3. **The annual use of coal by China is expected to reach 4.8 billion metric tons by 2020. The Chinese government is not happy to have a number like this in circulation, but there is precious little that they can do about it. Billionaires and Millionaires and high fashion aside, there are hundreds of millions of persons in China who are waiting to purchase their first Cadillac – or Kitty Cat, as it was known in certain hip circles in Chicago at one time.**
4. **Everybody is worried about climate change. But theories have been launched – probably from Copenhagen – that while climate change is real and perhaps even man-made, the estimated climate change from 1900 to 2025 will result in a net benefit for the world. The way this works is as follows. The release of CO2 into the atmosphere has increased agricultural output because it functions as a fertilizer. Fewer persons have frozen to death because on the whole the world is warmer, and the demand for heating has decreased, and thus less oil, gas, coal and uranium has been expended. Numbers have been attached to benefits of this nature, and implicitly costs, but I don’t see why they should be taken seriously: I not only cannot make these calculations, I cannot even understand them Moreover, 2026 is not the end of the world, and to my way of thinking it makes more sense to consider what kind of situation we will be facing in the last half of this century with regard to environment, energy and population.**
5. **Speaking of population, we hear a great deal about China these days, much of it unfavorable, but not a great deal about India, which is still the most populated country in the world. India’s consumption of coal is enormous, and as far as I know there have been no requests by concerned environmentalists for them to cease and desist. Moreover, although India imports large amounts of coal, there are still considerable coal reserves in that country. Perhaps, again, the thinking is that it makes more economic sense to import energy materials if possible than to deplete domestic supplies that might be crucial later in the century.**
6. **We are discussing coal here, but a few words about oil might be useful. BP’s annual report on proved global oil reserves says that as of the end of 2013, the amount of oil in the crust of the earth amounts to approximately 1.688 trillion barrels of crude, and this will last 53.3 years at current rates of extraction. This figure is 1.1 percent higher than that of the previous year, and they note that during the past 10 years proven reserves have risen by 27 percent, or more than 350 billion barrels. The big increasers seem to be Russia, with 900 million barrels, and 800 million barrels in Venezuela. The reason for mentioning oil is because oil is still the most important energy resource, and OPEC today has at least 70 percent of world oil. In case you have already forgotten the discussion in previous chapters, *53.3*  has little scientific value, As I have argued, the most important date is the date when the global oil supply peaks. *Tell us something about that please, you good people at BP!***
7. **A new report apparently ordered by the U.S. government, to include the White House and a platoon of clean-energy experts, suggests that clean-coal technology is not yet sufficiently reliable to use as a base for America’s new climate change rules for power plants. That is putting it mildly, because there is also a belief in circulation that there is no such thing as clean coal. The U.S. Environmental Protection Agency’s (EPA)  has proposed new carbon emissions standards for power plants, which would make it impossible for new coal-fired plants to be built without the implementation of carbon capture and sequestration technology (CCS, and sometimes known as “clean-coal” tech) which is of special interest to this teacher of energy economics. The Swedish firm Vattenfall made a big deal of its CCS ambitions in Germany, and my conclusion after getting some details was that the Vattenfall CCS operation was a SCAM, and should never have been tolerated by the Swedish government, which is a partial owner in that enterprise else. The tragic thing here is that the Swedish government refused to investigate Vattenfall’s activities in Germany, although of late they have found plenty of suspicious behavior by that firm.**
8. **We can finish with some statistics. For China, production and consumption in 2012 was 4 billion tons of coal. Where the rest of the world’s coal production in billion tons is concerned we have U.S. (1.0), India (0.65), Indonesia (0.49), Australia (0.46), Russia (0.39 and South Africa (0.29). The *Fortune* article referred to above used the expression “THE CHINESE GOVERNMENT’S LONG TERM ENERGY STRATEGY”, which would also apply to oil and gas producers in the Middle East, but needless to say not to North American and European Industrial countries. The decision makers in these industrial countries do not want to hear about a” long-term strategy”, but instead prefer to leave the energy future of their countries to the half-baked antics of short-term thinkers in the New York and London financial world…and elsewhere.**
9. Formulärets överkant

**If you are wise, you will add to the above list. The first step here might be the archives in *321 Energy*. Remember what we are trying to do here, which is to get to into the front row of the coal session at the next energy conference you attend. Up there with the decision makers – the movers and shakers.**

**A FEW ADDITIONAL ISSUES**

**I believe that I have explained in this book – or maybe it was in my lectures – that you never want to be in a position where you do not understand the terminology. For instance where all the buying and selling of energy materials are concerned, both *spot* (short term) and *long term* contracts are used. Over the last few years there has been a low-level war on long term contracts, because there is a mild belief in some parts of the world that since the prices in your favorite Economics 101 textbook are short term prices, there is something unholy about long term transactions. A lot of this kind of nonsense appeared when electricity was being deregulated in California.**

**You should also recognize and be able to talk about forward contracts – or contracts calling for the physical delivery of a commodity at some future date. But never forget that there is a difference between forward and futures transactions. That was mentioned earlier and will be spelled out in detail later in this book, but never forget that the futures exchange involves the buying and selling of a special type of contract on which delivery of the physical commodity (or underlying) does NOT have to made. And for instance, a great deal of the natural gas purchased by big consumers in Europe from Russia are on forward contracts with a maturity of between ten and thirty years. The proposals to change that arrangement so that all deals are spot deals are absurd.**

**For coal and many other items there are contracts written that are f.o.b., meaning free on board, or delivered onto a ship at the export terminal, as compared to c.i.f. (cost, insurance, freight,) and delivered to some point in the importing country. Readers who want to know more about this topic can turn to my book *The Political Economy of Coal*, or for that matter GOOGLE has something to offer on this and similar topics. I can confess that in my coal book I expressed a belief that the price of coal about was unlikely to rise above $50 a tonne, but it is currently at $71/t, and has been considerably higher. They will also find plenty of algebra dealing with the transportation of coal, and they will also find a fairly long discussion of coal and the environment, although I hesitate to commit myself on that topic, other than to say that despite what I once thought, it cannot be dismissed., Admittedly the large-scale burning of oil, natural gas and coal might cause bad things to happen, but the question is when.**

 **A TOUCH OF GAME THEORY**

**Many years ago I taught an introductory course in game theory, and while I do not know what my students thought about that experience, I ranked it as a failure. The only teaching failure I know of. It was a very discouraging experience.**

**In any event, since what I am after in this book is to give readers a chance to feel better about themselves, and to believe that what they have learned will make them more confident that they are in the winning corner where knowledge about the important subject of energy economics is concerned, then it is easy to offer a few remarks on the subject game theory? Since that first experience, I have taught game theory as a part of many other courses, to include energy economics, and to my way of thinking the subject has achieved a prominence it does not deserve.**

**But even so, I would not feel comfortable if I ignored this topic completely, because some very smart people have received large salaries just to know something about game theory and its application in all sorts of fields. Moreover, one of the major attractions of game theory is the part played in its development by John von Neumann, who is referred to on a number of occasions in this book, and whose sinecure – if I may call it that – at the Rand corporation I often thought of as the bus I was on passed that impressive Rand property every morning and night during the few weeks I worked at Northrup Aviation in Los Angeles. (In the film *Dr Stranglove*, the good doctor was employed by the ‘Bland’ Corporation.)**

**Anyway, in von Neumann’s book, co-authored with Oscar Morgenstern (1944), there was no explicit mention of prisoner’s dilemma games of the type that will be mentioned in this section, although a few of us believe that the reasoning behind the zero-sum type games that were the major theme in their book was just as important for several of the topics being taken up in this book. What this reasoning means to me when considering environmental – and certain other – matters is SAFETY FIRST! It means finding or at least searching for an optimal way to avoid high-risk activities as long as other choices are available.**

**“*You know that the best you can expect is to avoid the worst*”. Italo Calvino once remarked, and according to William Poundstone (1992), this epigram neatly summarizes the central paradigm of ‘The Theory of Games and Economic Behavior’, which is the widely known but not always adequately understood *minimax principle*. This can be put another way: the optimal strategy for von Neumann-Morgenstern type games turns on avoiding losing rather than insisting on winning. There is nothing wrong with winning, but such ultra-macho behavior as going after an incontrovertible win when there is a high probability of ‘ruin’ is not recommended.**

**(As an aside, the economist Erich Röpke called game theory “Viennese coffeehouse gossip”, and the Princeton mathematician Paul Halmos one announced that he was supremely unimpressed with the subject. The opinion here is that even if game theory is overrated, *and it is overrated*. it contains a number of useful insights, and elementary game theory deserves to be studied by everybody. As for advanced game theory, a day at the beach or in front of your TV makes more sense.)**

**One basic quandary that we have to deal with when considering the burning of coal (and the other fossil fuels) is that the atmosphere is communally owned, and so if a country (or community) decides to maximize the value of its communal rights, then it might over-pollute the atmosphere because some of the cost of doing so will fall on others. The capacity of the atmosphere to absorb further pollution might in this case be diminished too rapidly – which suggests that everyone, or almost everyone, could gain if pollution were decreased. Thus it may be so that the owners of the atmosphere (i.e. all countries) could determine and agree on an optimal pollution level if they entered into negotiations with each other.**

**Optimal in what sense? In the sense that historically fossil fuel use and economic growth go together, even though too much pollution via fossil fuel use could diminish the positive welfare effects that are sometimes associated with growth. (With economic growth it is possible to finance comprehensive health care and education, but as we know from a certain country in Asia there is a lot of concern that pollution will not only have a negative effect on health, but a clear and dangerous effect in the near as opposed to the uncertain future.)**

**As was the case in my first textbook (2000), and my book on coal (1985), a discussion of the above type is supposed to involve international agreements to limit pollution, and I mentioned in those books that to insure the implementation of international agreements, some threats may be necessary, along with the power to carry out threats.**

**On the basis of what has happened recently in the Ukraine and elsewhere, those threats do not need to involve paratroopers and gunships, but under certain conditions sanctions and trade restrictions might work. This kind of observation is not common in the environmental-ecological (e-e) literature, and may not be especially popular with persons who produce that literature, but once e-e concerns come to the attention of students of game theory, reference to the formulation and carrying-out of threats are not easily avoided.**

**Now I want to go to some theoretical matters, but before beginning it is necessary to make a comment on terminology that one does not often encounter outside the classroom. Primarily I am thinking of the word *equilibrium.* Mainstream economics is, for the most part, equilibrium economics: we study equilibria and not the details associated with the movement from one equilibrium to another. In the classroom, and elsewhere, I have often used a definition of equilibrium taken from physics – ‘a state of rest’, although obviously in some situations this raises more questions than it answers. I seem to remember being told or reading that equilibrium means correct expectations; a situation where the outcome of a market participant’s attempts to perform a certain action – such as buy or sell an asset – finds that the existing market allows him or her to exercise that choice at the present time or over the foreseeable future.**

**There are probably other useful definitions for equilibrium, some of them idiosyncratic (= peculiar to a specific individual), but ‘a state of rest’ is quite adequate if we are thinking about rational individuals. Of course we might want to consider being able to buy and sell what we want to buy and sell, without having to drastically change out thinking and behavior’. Moving to game theory, equilibrium in a game might be a combination of players’ strategies that are a best response to the strategies or actions employed by other players The equilibrium strategy is defined as a best strategy for a player, given that given that the player believes that it will provide him or her with the highest pay-off, given the putative strategy of other players. OPEC can be mentioned here, because it is clear – to me at least – that the often criticized OPEC strategy encountered in the learned literature is superior to the alternative proposed by Nobel Laureates like Milton Friedman or John Nash or anybody else.**

**The final problem in this part of my book before I go to a summary of the first six chapters has to do with some elementary game theory that I presented in my first textbook, but unfortunately did not present very well. As a matter of fact it was wrong. But I don’t worry much about that, because in economics – as compared to engineering – and with the subjects that one studies, it is easier to be wrong than to be correct, which is why books like this have to be written. On the surface, game theory sounds like an excellent tool with which to study an organization like OPEC – actually the perfect tool – but while PhDs and excellent teaching positions have been given to persons who call themselves game theorists, and have studied OPEC, the outcome has not been satisfactory. The success of OPEC is not based on the formulation and solution of a game, but on goals that are more noble than goals described by esoteric mathematics.**

**Now let take a brief look at a prisoner’s dilemma type game, beginning with the original anecdote. Ms Bibi Sally and Professor Bill Lather are picked up on suspicion of having robbed a parking meter of a few pennies, taken to a police station, and interrogated separately. If one confesses (C) and the other denies (D), then the one confessing receives a light sentence, while the one denying receives 12 months: the outcomes are (1/2,12) or (12, ½). If both confess the sentence is moderate (3,3), if neither confess, each gets a month in jail for jaywalking (1,1). The normal (or matrix) form of the game is give in Figure 1a, and the lengths of sentences are shown in months. For example, if Bibi denies and Bill confesses, she receives 12 months and Bill ½ months (12,1/2). The dilemma comes about because they have to make a complicated choice.**

## Bibi

## Bill

## P-P Group

C D

C

D

(a)

(b)

(c)

N

P

P

P

Max

 (M)

Limit

 (L)

M

L

3,3

15,15

20,5

5,20

17,17

1,1

12, 1 1

1

\_

2

2

## ‘Oz’ Group

## Figure 1

,12

 **If they trust each other, they would cooperate and play (D,D). If the trust were justified, they would receive light sentences. Isolated, however, cooperation/trust might seem difficult to justify and so it might be easy to be a ‘snitch’. The ‘school solution’ is that both snitch, and end up with 3 month sentences.**

**It does not have to be said that this last assumption depends on the values in the ‘boxes’. If the sentences were in days instead of months, then there is a good chance that neither would consider confessing, since there is a certain status to being regarded as a ‘stand-up guy’ by the street crowd, and to attain this distinction you cannot make a practice of ‘snitching’. If you want to see a film in which the word ‘snitch’ is used beautifully, then you should see one of the final scenes in the film ‘*Scent of a Woman’*, with Al Pachino.**

**Nest we take these concepts to the pollution arena, where the numbers shown are levels of utility/satisfaction. The assumption ins Figure 1c is that we have two groups of countries: rich countries, labeled the ‘Oz Group’, which holds most of its meetings in Sydney (Australia), and the Pago-Pago (or P-P) Group, which are poor countries, but hold most of their meetings in Monte Carlo. If both the Oz Group and the P-P Group decide to limit domestic pollution (L,L), both realize the utility (or satisfaction) level 17. That level takes a number of things into consideration, to include the global benefit of pollution abatement, less harassment from Greenpeace, intense feelings of moral superiority, an opportunity to discuss strategies – and wine and dine – in wonderful Sydney and/or wonderful Monte Carlo, etc.**

**But if both continue on their present course of maximizing personal satisfaction, then they pay a penalty in terms of higher pollution levels for both, as well as having to anticipate even higher levels in the future, which is something that could result in considerable mental and physical distress. The remaining ‘plays’ involve one party undertaking a serious pollution abatement program (L), while the other Group continues to go all out in the way of generating pollution (M). The outcomes are thus (L,M) or (M,L). As you can verify from the figure the Nash Equilibrium is (M.M), since if one Group plays M the other feels compelled to play M, while the more favorable (in terms of the aggregate satisfaction outcome) is (L,L), [But note, I am assuming that we can aggregate satisfactions: (17 + 17) is absolutely superior to the other outcomes, even though (5,20) and (20,5) are preferred by one or the other Group.]**

**The assumption in a thousand classrooms every year is that the cooperative solution (L,L) = (17,17) is unstable and will not be maintained, because one of the ‘players’ will ‘cheat’, but of course it is maintained in the case of OPEC. This is probably the thing that was so insulting to Professor Friedman: normal human beings, to his way of thinking, were not prone to favor long term considerations, but instead went for short term satisfactions when real money was on the table.**

**Put simply, with regard to Figure 1c, in trying for 20 instead of 17, a player will inevitably end up with 15. I got these numbers wrong in my first energy economics textbook, but they make sense the way they are now.**

**Finally, we can introduce an expression that you likely to have encountered early in your economic studies. The expression is *Pareto Optimal*. Pareto optimality is a situation where if *both* ‘parties’ or Groups are rational, they would not leave a ‘payoff pair’ *unless one party gained while the other did not lose.* Looking at Figure 1c, this applies to the lower left hand corner, the upper right hand corner, and the lower right hand corner. In the upper left hand corner however, both Groups would be glad to move to the lower right hand corner.**

**Clearly, the upper left hand corner is ‘different’: it is a Nash equilibrium, because if one Group choses that move, so does the other, and ‘vice versa’. The other positions in the figure are Pareto optimal: if one or both moved somebody would lose, and so at least one of them would not countenance a move. Figure 1b shows what we have with regard to Pareto Optima (P) and Nash Optima (N).**

**It perhaps should be noted that if we have a play such as (1/2,1/2), the outcome for the ‘row player’ (Bibi) comes first, while the other value is for the ‘column player’. The row player moves up and down, while the column player moves from left to right. The goal here is not money but a limitation on time served, which may seem trivial, but for some reason game theory has achieved a prominent place in academic economics, although some of it is best ignored**

**OPTIMAL THOUGHTS ABOUT ENERGY AND ENERGY POLICIES**

**An optimal policy has the property that, whatever the initial state and initial decision are, the remaining decisions must constitute an optimal policy with regard to the state resulting from the first decision.**

 **– Richard E. Bellman (1957)**

**I have finally come to the end of 7 chapters, and I feel a need to assure readers that given a choice, I prefer *optimal* energy policies to the other kind, because in the Chicago of my youth, had Professor Bellman’s instructions been known, they would have been interpreted as *‘let bygones be bygones’, and exploit present options without becoming transfixed by past failures.* I also suspect that in the textbook world everybody else has the same opinion on this subject, but unfortunately in the *real world* most people would not recognize or be interested in an optimal energy policy if its originator joined them at a corner table in the Café Rendezvous, and insisted on paying for their meal as well as any programs they intended to sponsor during the sensual Paris night.**

**In any event, on the classroom level, the issues being considered in these first 6 chapters are fairly simple, and where optimality is concerned, the American oil billionaire T. Boone Pickens probably provided a suitable first step when he calls for a NATIONAL ENERGY PLAN. According to Mr Pickens, every country except the U.S. has one of these, which is wrong, but this error can be ignored because he also seems to believe that a National Energy Plan does not make sense unless the government plays an integral part in the proceedings. Many years ago the American business executive Thornton Bradshaw expressed a similar approach, calling for an alliance of business and government where energy was concerned, however his proposal was not met by a burst of enthusiasm from his peers, nor for that matter the editors of the newspapers they and he read.**

**Notice the expression “first step” above. The United States has an Energy Department (USDOE) where the theoretical work for a National Energy Plan should and could be carried out, beginning with the assembly, organization and spreading of relevant information, however I happen to believe that the less said about the USDOE and its present and preceding directors the better. Those gentlemen are clearly not in the business of providing insights that are useful for dealing with the energy future.**

**But as good luck would have it, I am in that business, and have been in it for a long time. My favorite pursuit right now involves confirming my belief about the outcome of the energy situation in Japan, where a tsunami in the north of the country resulted in the shutdown of all the Japanese reactors, and a panic-like reaction in that country and elsewhere led to similar foolishness in Germany. Nuclear energy provided about 30% of Japan’s electricity, and to substitute for the lost nuclear output, an increased consumption of imported oil, natural gas and coal imports became necessary. These developments deserve close attention, because they led to a weakening of the Japanese yen, which in turn caused an immediate increase in fuel costs.**

**But my knowledge of Professor Bellman’s thinking tells me that all that will pass. You see, various fantasists thought that Japan would move from nuclear to renewables, but instead the use of fossil fuels (oil, gas, and coal) escalated. The Japanese government elected to spend billions every year in an attempt to compensate energy consumers for the costs imposed by the closing of nuclear facilities, but according to what I have heard and read the energy bills of Japanese households have increased by about 20%, and for industry it has been reported that the increase is approximately 30%.**

***Ceteris paribus*, the same unpleasantness is in the cards for Germany as a result of their *Energiewende* (= energy transition), although in that country a relentless circulation of lies and misunderstandings has portrayed the German rejection of nuclear as a success, and Energiewende doubters as fools. What needs to be pointed out though at the highest academic and official level, and repeatedly, is that with an average capacity factor of about 90 percent, nuclear provides benefits that cannot possibly be matched by renewables, and the next generation of nuclear equipment (Gen 4) will be even more impressive.**

**Voters everywhere – and for that matter non-voters – need and deserve to be told what is – or will be – going on behind the scenes in Japan and Germany, to include the unspoken and perhaps unconscious intention of their decision makers to be the most nuclear intensive countries in the world before the middle of the present century. How do I know this? I know it because this is what an *optimal economic policy* in the spirit of Richard Bellman is all about. In case you have not heard, the populations of those two countries have no intention to tolerate an *avoidable* decrease in their standard of living, Neither do the Swedes, even though there is nothing that they want foreigners to believe more than their eagerness to take a standard of living decline in order to make the world a better place.**

**And finally, I would like to finish this long exercise by saying something about ‘fracking’, and which is an extremely important topic in Europe. This being the case, consider the following notice: EU ENERGY EFFICIENCY GOALS TAKE AIM AT RUSSIAN GAS LINKS.**

**This unenlightened misrepresentation originated with the (UK) *Financial Times* (2014). But unfortunately the person responsible (Alan Barker) and his editors still do not understand that Russian gas links are moving out of range of what is called “EU Energy Efficiency Goals”, no matter how often and how clearly teachers like myself informed them. One might easily conclude that in an optimal setting, U.S. Energy Minister Ernest Moniz and his foot soldiers would be compelled – or compel themselves – to do everything possible to make this clear to confused journalists, as well as their readers, but this assumes that before sounding off, those ladies and gentlemen are familiar with what clarity means in scientific terms.**

**Regardless of what they are or are not familiar with. eight years ago Phillipe Norec and Fabrice Noilhan (2006) explained that Russia was in no position to supply large quantities of oil and natural gas to both Europe and Asia. Thank you very much gentlemen, because I would like to use this occasion to tender my assurances that before the next decade is over, China, Japan and possibly South Korea and India will be the main Russian gas customers, while in Europe, the burning of coal will reach record proportions, unless they come to their senses about nuclear. Perhaps this is the right place to add that the decision to interfere with the movement of energy resources from Russia to western Europe was a noteworthy exercise in stupidity. Something like the belief that the U.S. should remove restrictions from the export of crude oil.**

**Whenever the above topics are broached, shale resources and fracking enter the narrative. Here you need to appreciate that the CEO of Exxon Mobil stated that the U.S. is the only region on the face of the earth where ‘fracking’ has been unambiguously successful. This of course is also wrong, because fracking has provided Estonia with a large part of its oil for many years, if not decades. The problem here is that a discussion of fracking in that country would raise some ugly environmental issues. Then what about Poland and France, which have been judged by official American observers to contain large shale resources, and also countries like Germany and the UK which claim to be planning to replace Russian gas and oil with ‘fracked’ domestic resources?**

**Apparently about 50 wells were drilled in Polish shale before Exxon Mobil and the Italian ‘major’ ENI decided to call it quits. As for France, I know from living in that country that if it were possible to produce amounts of shale oil and/or gas that corresponded to the conventional (or average) estimated output from estimated shale reserves in France and elsewhere, *then if left to themselves*, French corporations and technicians would ensure that this extraction would take place, and once they began, raise production as fast as possible, because that makes both economic and political sense. Consequently, allow me to suggest that the ban on fracking imposed by President Hollande, and the new FRENCH Energy Plan just presented by Energy Minister Ségolène Royal made it difficult for me to conclude this book at the present time, because…..because just hearing the ballyhoo about French energy intentions badly damaged my concentration,**

**THE WAR ON COAL**

**Now for an item that I forgot to include in earlier versions of my new energy economics book (2014). I am speaking of THE WAR ON COAL, which like many wars does not always make a great deal of sense, whether in terms of intentions or methods. I certainly do not know the names, addresses and telephone numbers of most of the instigators of this proposed conflict, but I have heard people say that President Obama is one of them. I also remember seeing a statement in very large letters in the international edition of *The New York Times* stating that future energy supplies will feature a large amount of natural gas, and the accompanying exposition claimed that the present large-scale reliance on coal might soon be passé.**

**Needless to say, the *International Energy Agency* (IEA) plays a leading role in this burlesque, because just as real soldiers are told to leave their switch blades in the barracks and rely on their rifles when they go into combat, it happens to be true that in the struggle to reduce poverty and declining standards of living, coal is an invaluable weapon, though perhaps not everywhere, and if voters think that an Energiewende *a la Ms Merkel* has a future, they will eventually be taught an unpleasant lesson. The lesson turns on the indisputable fact that there is too much energy in the billions of tonnes of coal in the crust of the earth for this commodity to be dismissed like an outmoded zoot suit.**

**According to Maria van der Hoeven, executive director of the International Energy Agency (IEA), the technical advances that are being made on the ‘Carbon Capture and Sequestration (CCS) Front’ should be regarded as a “milestone” in the promotion of ‘green energy’. She says that “Carbon capture and storage is the only known technology that will enable us to continue to use fossil fuels and also decarbonize the energy sector.” That statement is illogical for a number of reasons, with one of the more obscure being that if CCS was as effective as she and some others believe, then billions or hundreds of billions of dollars would already be earmarked for it, especially in China, where the political elite has started to lose patience with the environmental shortcomings in their large cities.**

**As it happens, one of the most prominent energy consultants in Germany, the MIT graduate Jeffrey Michel, has called CCS “a thermodynamic travesty”, but as a brilliant student of thermodynamics at Illinois Institute of Technology, I prefer to label the most enthusiastic recommendations in its favor lies or misunderstandings. Moreover, as a result of living in Sweden, I have heard all that I want to hear about that subject because of the CCS and coal mining activities of the Swedish utility Vattenfall in Germany.**

 **If we look at the cost of an average CCS investment involving a new power station, one constantly hears that it can involve a doubling of capital expenditures, and ostensibly a reduction in the amount of electricity that can be produced. To be fair, this phrasing would not be encouraged in my classroom, because what has probably happened is that – if profit maximization is the object of the exercise – the increase in capital expenditures calls for a smaller amount of electric generation.**

**But that’s not all. When movers and shakers from the world’s energy industries and seats of government met in New York at the end of September, 2014, the message dispatched by some of the most influential was that coal was a scourge that should be replaced by natural gas. That kind of talk was apparently intended to increase the revenues of energy companies, as well as to help mobilize enthusiasm for a forthcoming UN summit in Paris in the early summer of 2015, when our political masters are supposed to finalize a comprehensive agreement to limit carbon dioxide emissions.**

**Whether this gas-friendly message was acceptable to the thousands or tens of thousands of folks in the streets of ‘The Big Apple’ who were demanding a fossil-free world is uncertain, nor do I have any opinions about what would have happened if I had been on the speaker’s platform on that occasion, because I would have informed the assemblage early in my world-class lecture that more nuclear was the way to go. If that had been greeted with applause, I might also have said that regardless of what happens at the Paris talk-shop, more coal is going to be burned, and nothing short of martial law can prevent it.**

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**8. ANOTHER FINAL COUNTDOWN**

 **Sun, sand and music**

**Flashing skis and winter scenes**

 **But it’s you I’m thinking of, in this Sweden of my dreams.**

 **─ Beatrice Sylvan (and colleague)**

**In my previous book, ENERGY AND ECONOMIC THEORY, the final chapter was called *THE* FINAL COUNTDOWN. I don’t recall exactly what I had in mind when I chose that title, but it was greatly appreciated by some of the persons who read it before it went to the publisher. That made a lot of sense to me, because my intention is**

**always to examine economic topics in such a way that all readers can understand them, and as a result, hold their own in any seminar or classroom or conversation in any university or on any street corner in the world.**

**There is precious little understanding in the Swedish and American governments where energy economics is concerned. In Sweden during the 2014 ‘presidential’ elections, the presidential candidate of the ‘LEFT’ (= *Vänster*) party believed that in 25 years there will not be any nuclear reactors in Sweden, which is identical to what the presidential candidate of the ENVIRONMENTAL PARTY thought. They take this absurd line for one or possibly both of two reasons: they are completely ignorant, or the persons with whom they dine, drink and dance also find it attractive. Of course, it doesn’t really matter what anyone believes, because nuclear is here to stay in Sweden, and probably elsewhere. The point is to recognize that people who are plotting against nuclear are plotting against the standard of living of the rest of us, and also themselves. Consequently, it would be best for everybody if they changed their tune before the voters get the message, because then you could see some nastiness. Anyway, let the countdown begin, and the tales that will be told are listed below! Read these carefully, because if you do you will discover most you already know most of what is enclosed before you reach the final contribution of Professor Banks.**

**10. Genius at Work Again**

**9. Energy Wars and a Rumor of Wars**

**8. Another Look at Electric Deregulation**

**7.Some Aspects of the Climate Warming Discussion**

**6.Back to Basics; Energy, Industrial Progress, Natural Gas**

**5.Energy and Macroeconomics**

**4.Myth, Meaning and Nuclear Energy**

**3.Coal and Some Economic Logic Again**

**2.Are You Afraid of a Big Bad Oil Shock, Ferdinand**

**1.Libya: But What About the Oil. Repetition**

**0. SOME FINAL COMMENTS OF PROFESSOR BANKS**

**10: GENIUS AT WORK AGAIN!**

**The genius on this occasion is provided by none other than Chancellor Angela Merkel of Germany and her foot soldiers, while the work being referred to is the slow-motion ruining of the German economy, which if it continues could result in a severe weakening of several other economies, and not just those in Europe. To use some terminology that may still be in vogue at the U.S. Military Academy at West Point, the energy travesty now being orchestrated in Germany will almost certainly be *found* (= *found wanting and dumped*) before the end of the present decade, although considering the damage being done, that may turn out to be half a decade too late.**

**SOME BACKGROUND**

**The story behind the proposed abandoning of nuclear in Germany – the *energiewende* (= energy transition) – begins with the tsunami that took place in the vicinity of Fukushima (Japan). Without that tsunami – thousands of miles from Berlin – Frau Merkel might be in or on her way to an exciting and well-paid position at the European Union (EU) headquarters in Brussels, or perhaps she would be judged a possible replacement in Hollywood for one of the two exotic German language actors Marlene Dietrich and Romy Schneider, who were such a sensation in the middle years of the 20th century.**

**In any case, there was a powerful tsunami in Northern Japan, the Fukushima reactors were in the wrong place, and as I repeatedly discovered in lectures I delivered, and conversations afterward, it was a complete waste of time to insist that in a decade or two, reactors at or near Fukushima, or for that matter next to the 'Spree' (River) in Berlin, could be 'tsunami proof'. The decision makers in many countries were 'spooked', and generally uninterested in claims by myself and Hans Blix – the Swedish international civil servant and nuclear expert – that 'The March of Technology' will work in favor of nuclear to a greater extent than any other source of energy.**

**My next course in energy economics might commence in a month or two, and if so there is one item that must be perfectly understood by every student: *although it may sound ridiculous, without the tsunami IN JAPAN, there would be no locks on reactors IN GERMANY,* and without those locks it might be possible that the European macro-economy would almost be functioning normally. Moreover, at a conference in Stockholm last week, Stanley Fisher of the (U.S.) Federal Reserve (= Central Bank) might not have felt compelled to say that with a normal functioning of the European economy, the U.S. economy would be in better shape.**

**I do not know who attended that conference, but even so I have reason to suspect that most of Mr Fisher's audience did not have the slightest idea of what he was talking about. But while a majority of the (so-called) economic expertise in Sweden is probably unaware that Germany accounts for a large slice of the Eurozone economy, and thus when the senseless order went out in that country for an immediate closure of eight of Germany's nuclear installations (and a phasing out of the rest by 2022), the more perceptive members of that audience comprehended that Europe's macroeconomic and financial market future would not improve, and would likely get worse. Moreover, I suspect that the reason why that conference was *not* discussed at great length in my morning newspaper was to avoid contributing to the bizarre lie that a nuclear retreat, accompanied by a heavy investment in wind and solar, is capable of maintaining Germany's industrial health.**

**ERSATZ GENIUS**

***The (London) Economist* was not a popular publication in my classroom during the 5 or 6 years that I taught international financial economics. It was not popular because I repeatedly called it "a compendium of London wine-bar gossip", and made it clear that items from that publication were never to be mentioned when serious work was being done by me or students at or just in front of the black or whiteboards, nor would I appreciate encountering the sick reasoning of *The Economist* on written examinations.**

**But where energy economics is concerned, I feel it necessary to be somewhat more liberal. In the near future my energy economics students will receive a long article from that publication called 'HOW TO LOSE HALF A TRILLION EUROS' (October, 2013), which is a welter of easily exposed lies and misunderstandings (= Ersatz Genius), as compared to the real deal being practiced by Merkel & Co, and which involves convincing the voters that economic nonsense is in their interest. The young ladies and gentlemen in my class will then have the pleasure of demonstrating that they understand as much about the foolishness presented on the last two pages of that article, as I understand and will explain to them about similar absurdities served up earlier.**

**Behind a barrage of lies about future intentions, the German government has recently revised its clean-energy law so that 'green' subsidies can be reduced, but at the same time the price of electricity to German households is supposed to be kept from increasing. The question is, how can this be done while a nuclear retreat is taking place? The answer is that the cost of abandoning nuclear will not be paid for by an increased investment in solar and wind power, as frequently claimed, because Chancellor Merkel knows almost as well as I do that solar and wind cannot replace nuclear in Germany, or for that matter in any industrial country. Instead there will be increased imports of electric power from countries where electricity is less expensive than in Germany (which is true in every country in Northern Europe except Denmark), an increased use of coal, and a marginal reduction in the real incomes of certain categories German employees.**

**As for the industrial sector, intensive lobbying has made it possible to weaken the EU carbon dioxide restrictions, (which, *ceteris paribus,* is equivalent to a reduction in the cost of suppressing pollution). As is clear though, this is inadequate, and so you can expect an increased movement of German manufacturing facilities to nearby countries.**

**Readers of the *Economist* article are told in the second paragraph that energy from solar and wind power is "free". Once we understand what the expression *capacity factor* means, we realize that that statement is nonsense. The capacity factor of a power source is the ratio of its actual output over a period of time to its potential output over that period if it were possible for it to operate at full nameplate capacity. Jeffrey Michel is an MIT graduate active in Germany, and he places the (average) capacity factor of wind at under 30%. The situation is much the same for solar, and so with wind and solar a costly *backup* power source could be necessary over a large fraction of a day or week.**

**Perhaps the best fast-start backup is hydro, although everything considered, equipment that burns natural gas is almost as useful. But according to the *Economist* article "gas plants (in Europe) are being shouldered aside by renewable energy sources". That statement is not wrong, nor is it nonsense – it is wacko, off-the-wall, irresponsible.**

**The German government has announced that it wants renewables to supply 35% of that country's electricity by 2035 and 80% by mid-century. Hearing that forces me to repeat a prediction from my new textbook (2014). By mid-century Germany and Japan will probably be the most nuclear intensive countries in the world, Even with the theoretical and applied evidence in front of them, many other countries may continue to entertain fantasies about the most useful sources of electricity, but in the long run those two countries will not play the fool.**

**CONCLUSION**

**On the third page of the article being discussed, you can read that "European countries are slowly piecing together a system in which there will be more low-carbon and intermittent energy sources, more energy suppliers, *more modern power stations replacing coal and nuclear and…*¦" And I think that that is enough of the silliness in a half-baked *Economist* presentation, although the following observation might be useful. About 1939 another high and mighty German pseudo-scholar, Josef Goebbels, stated that "the bigger the lie, the bigger the effort to believe it." The Cold War and the War in Korea gave me the opportunity to see a few of the results of believing in lies, and I suggest that you and** **my students should find another form of entertainment**.

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**9. ENERGY WARS AND A RUMOR OF WARS**

**“I am saddened that it is politically inconvenient to acknowledge what everyone knows: the Iraq war is largely about oil “**

 **– Alan Greenspan (2008)**

**Alan Greenspan is not my favorite macroeconomist or central bank chief, although his presence on a bandstand with the great jazz saxophonist Stan Getz deserves almost as much respect as the above citation. Of course, when he says “everyone” he means persons in his social circle. Persons with the right ‘connections’, who wine and dine and dance with similar ladies and gentlemen, and most important who were not confused by the sanctimonious pronouncements of the gentleman in the White House when the above statement was published.**

**Formulärets nederkant**

**Recently, Michael T. Klare, professor of peace and security studies at Hampshire College, published an article in the *European Energy Review* with the title ‘The New Thirty Years War’ (2011), which is supposed to say something important about “The Great Global Energy Struggle to Come.”**

**What he says is meaningless, because the conflicts he is talking about have to do with corporations, and not states: corporations come and go, and their troubles are seldom referred to as wars, even in those special cases when this designation might be appropriate. Kurt Cobb has published the article I have read about energy and war, and apparently the present Pope has similar thoughts. Clearly, the problem is the uncertain availability and price of energy as a result of the tensions ‘whipped up’ by ignorant politicians and international bureaucrats.**

**For instance, we have had energy wars in Iraq and Libya. Moreover, for teachers of energy economics like myself, the basic issue in Libya was not oil but lies and misunderstandings, which unfortunately is par for the course where half-baked energy journalism and a certain kind of low-grade economic research is concerned. In Dr Greenspan’s excellent book, a figure for predicted global oil output in 2030 of 116 million barrels per day (= 116 mb/d) was given – courtesy of the International Energy Agency (IEA) – while a large portion of one of my lectures in my course on oil and gas economics at the Asian Institute of Technology (Bangkok) was devoted to ridiculing another  IEA estimate for the same year of 121 mb/d.**

**The opinion here is that those figures will never be seen for oil, although they are not impossible for ‘liquids’ (i.e. oil plus biofuels plus natural gas liquids, etc). However if the maximum (oil-liquids) global production is in the vicinity of the one often bandied about in France, then a prophesy by an important contributor to the site *Energy Pulse* – Len Gould – deserves some attention: voters in many countries prefer or will prefer war to being deprived of  the energy – particularly in oil products – that they are used to.**

**Like Professor Klare, I refer to the disaster at Fukushima in this book, but unlike the off-the-wall analyses of that scholar, I happen to know what the Japanese nuclear future will involve. The nuclear renaissance may or may not take place in most of the industrial countries in the world, but it is certain in those countries (like Russia and China) who are playing the energy game to win. Japan belongs in this category, and the day will come when the persons who manage that country will make this clear to their foot soldiers. In fact, that day is almost here.**

**Finally, since the *European Economic Review* has its editorial offices in Holland – a country whose government recently renounced its holier-than-thou nuclear philosophy – I have no choice but to ask what the editors of that publication were thinking  when they published an article that, from a scientific point of view,  is hopelessly naïve.**

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              (5 September)**

**8. ANOTHER LOOK AT SOME ASPECTS OF ELECTRIC DEREGULATION**

***In the* summer of 2001, a few months before the 9-11 attacks on the Trade Towers and Pentagon, I was invited to Hong Kong as a visiting professor and university fellow for the purpose of lecturing on electric regulation and deregulation. What this ended up as was a handful of lectures, taking place over several months, which left me with plenty of time to read, visit athletic facilities conveniently located in the apartment complex where I lived, and to give some thought to the delusional theories accompanying deregulation.**

**My visit was apparently sponsored by one of the foremost (electric) power companies in Hong Kong, and what they wanted me to do was to inform university teachers, journalists, students, break dancers, moonwalkers and anybody else I came into contact with that electric deregulation (or ‘restructuring’ as it is also called) was a crazy and unworkable concept that would bring misery into the lives of many consumers of electricity. I have recently been invited elsewhere for the same purpose.**

**I’m glad to confess that nothing could have pleased me more, because the bottom line where this important topic is concerned is refreshingly  simple and I repeat it every chance that I get: electric deregulation has failed, is failing, and probably will fail almost everywhere, and increasing numbers of observers are now prepared to admit  that it cannot succeed in the real world, despite its occasional success in seminar rooms and conferences. For instance, in case you didn’t know, in Southern California electric deregulation led to the wholesale electric price increasing by 533% in about 8 months.**

**The question that immediately arises is what happened to the retail price in California – that is, the price charged final consumers of electricity by utilities. The answer is nothing or not much, because to avoid the risk of a recession, and perhaps a rebellion by these consumers, the California state government paid billions of dollars to firms generating electricity, with some of these firms called “out-of-the-state criminals” by California governor Gray Davis, because they gamed the system by pretending that for various technical and/or economic reasons they could not supply more electricity.**

**It may be true that something similar was experienced in Sweden last year. What many people do not realize is that in this country, where nuclear and hydro are the main generating assets, the cost of generating electricity was once among the lowest in the world. But as a result of deregulation,  the price paid by Swedish households occasionally spiked to one of the highest in Europe, and some of us believe that that price may continue to increase.**

**In my more mellow moments, I often describe deregulation as an unsuccessful attempt to rescind the laws of mainstream economics. A justification for continuing the criticism of deregulation is the large body of evidence at  variance with surviving fantasies about expected deregulation results, where by fantasies I mean academic and journalistic bunkum promising large amounts of reliable and  inexpensive electricity if deregulation (i.e. restructuring or liberalization) were allowed to proceed without the meddling of politicians or bureaucrats.**

**Almost 15 years have passed since my tour of duty in Hong Kong, and in that period electric deregulation has also failed in Alberta and Ontario Canada. It failed in South Australia.  It failed in many states in the United States of America where it was attempted, and in my former home state, Illinois, a state official – Kimery Vories – reported that deregulation resulted in the price of electricity increasing by forty percent, all at once. It failed here in Sweden, and as I told colleagues and students in Bangkok a few years ago, electric deregulation in Sweden seems to mean that the largest power company in Scandinavia has been awarded a gold-plated license to make fools of the consumers of electricity.**

**I mentioned Canada above, so let’s take a minute or so to peruse what the chairman of the independent Electricity System Operator of Ontario had to say about her experiences with that fiasco.**

**“Now before you ask whether I am still asleep or dreaming or had something extra in my coffee this morning,” she told a small audience several years ago, “let me qualify my remarks by noting that I have not given a timetable to arrive at this destination”, where by “this destination” she specifically meant  a “reliable, efficient, easily understandable, transparent, accountable, and sustained  supply of inexpensive deregulated electricity.”  That’s putting it mildly, because on the date when the contents of Madame Chairman’s morning coffee came into question,  Ontario had less generating capacity than it possessed a decade earlier, and according to the president of the Association of Major Power Consumers of Ontario, a bungled deregulation agenda  resulted in that province losing a valuable competitive advantage.**

**I remember giving one of my sermons against deregulation in Lima (Peru), and fortunately I got out of that country just in time, because when they initiated that goofy experiment some shots were fired, as was the case in the Dominican Republic.  Deregulation failed in Brazil, and a notable aspect of that particular burlesque was Lutz Trevesso, CEO of a large power company in Brazil, saying that deregulation would create more problems than it solved.**

**You’ve heard what I think of deregulation, so now let’s turn to some other opinions. The elderly U.S. Senator Ernest Hollings brusquely abandoned the deregulation sinners who had seduced him into the ways of ‘liberalization’. and began to call himself a “born-again regulator”. Another U.S. Senator, Byron Dorgan, was more explicit. He put it this way: “I’VE HAD A BELLY FULL OF BEING RESTRUCTURED AND DEREGULATED, ONLY TO FIND OUT THAT EVERYBODY ELSE GETS RICH AND THE REST OF THE PEOPLE LOSE THEIR SHIRTS!” (*Financial Times*, April 22, 2003). A headline in the *New York Times* (15 July, 1998) read as follows: “Deregulation fosters turmoil in power markets!”**

**Personally I’m very fond of Governor Gray Davis’ judgement: “At the mercy of forces that show no mercy.” Governor Gary Locke of Washington (State) offered an important thought on the bad news resulting from the deregulation travesty, concluding that since the government caused the suffering, it was up to them to cure it. And last but not least, U.S. Congressman Peter de Fazio put it this way: “Why do we need to go through such a radical, risk taking experiment”? Fortunately, I don’t have to repeat my favorite Wall Street mantra, which is ‘It’s not the money, Ingrid – it’s *only* the money’ – because Congressman de Fazio answered his own question by saying “it’s because there are people who are going to make millions or billions!”**

**There is still two items in this humble section that deserve a short comment. The first has to do with  why a large power company wanted me to come to Hong Kong and ridicule electric deregulation. In a sense, I’ve already provided the answer to that. The directors of that company knew that electric deregulation was a lost cause, a waste, a scam, a lose-lose proposition, or to quote Jean-Paul Sartre “a fire without a tomorrow”.  In California though, or for that matter here in Sweden, it wouldn’t have made any difference to the directors of the power companies what it was, because although they know the difference between right and wrong, what they were mainly concerned with was – as they say on Wall Street – putting themselves in a position where they could  take the money and run. Furthermore, for Sweden, deregulation made it possible for a large power company to shift a part of its attention to Germany, where it specializes in making  grossly unscientific claims about their program for a “green” future. A green future in which the large-scale mining of low-quality coal dominates.**

**But things are different in China. A deregulation failure in Hong Kong could mean something very different from a failure in California or Sweden. In California – and especially in Sweden – there might be a short article in a newspaper or business magazine, but the poor consumers would be left to gnash their teeth and curse, and that would be the end of it. On the other hand, in Hong Kong somebody important might confront the executives responsible for the misfortune, demand  an explanation, talk to them in a manner that sergeants in the American Army once talked to recruits, and perhaps ask to examine some bookkeeping and other paper work. I don’t think that it is necessary to tell you how this could turn out, because the Chinese government does not make a practice of  applauding incompetence.**

**And finally, when I began to study regulation and deregulation, the leading scholar in the field was Professor Alfred Kahn. Once the electric deregulation failures began, he made the following statement; “I am worried about the uniqueness of electricity markets. I’ve always been uncertain about eliminating vertical integration. It may be one industry in which it works reasonably well. “**

**I’m not worried at all ladies and gentlemen, because the main issue being discussed on this occasion is not vertical integration. It is the supreme importance of electricity as compared to, for example, natural gas, which is a topic that I once studied in some detail. There may be passable substitutes for natural gas, but – everything considered – there are no substitutes for a large supply of inexpensive and reliable electricity, especially if we are considering  modern and civilized countries whose citizens and/or voters are concerned about their futures.**

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**7.SOME ASPECTS OF THE CLIMATE WARMING DISCUSSION**

**If the world were as rational as portrayed in most conventional economics textbooks, this contribution would be quite unnecessary. But as George Monbiot (2004) informed his readers: “The dismissal of climate change by journalistic nincompoops is a danger to us all”. I think that we can remove “journalistic” from that sentence (and substitute ‘eminent’), because I doubt whether, at the present time, the ladies and gentlemen of the press are much different than most of us where this topic is concerned. They too have become more sophisticated in that they are no longer willing to believe that ‘scientific truths’ retailed by self-appointed ‘gurus’ are worthy of their attention. It might also be useful to note that while the word “nincompoops”, or its equivalent, is not unknown in my daily conversations dealing with certain persons who supervise certain aspects of the economics curriculum in various universities that I have been associated with,**

**Under no circumstances do I regard my understanding of this topic as comprehensive or special, especially after a brief lecturing appearance at Griffith University in Brisbane, Australia, But I feel that one item deserves to be repeated to acquaintances and students until it becomes as ingrained as the General Orders that infantry recruits were compelled to learn in the United States Army when my ‘friends and neighbors’ voted me into that delightful club. *There are still a few deluded scribblers in circulation who want us to believes that the many scholars who say that climate warming is the real deal are anti-American loony-tunes or phonies, while the number of academic first-raters who insist that the talk about climate warming is hysterical nonsense deserve to be honored as paragons of scientific virtue*!**

**As an example I turn to the superstar journalist Paul Johnson, whose intellectual firepower and sustained success puts him streets ahead of the know-nothings identified by Mr Monbiot as climate warming doubters. I must confess that from time to time I have greatly enjoyed what Mr Johnson has written, and strangely enough this also applied to his article in the *Spectator* about ten years ago in which he tells us to “pay no attention to scientific pontiffs” (in the matter of global warming) – unless, I suspect, they are *ersatz* scientific pontiffs. What I particularly liked about that fruitcake advice was that it furnished a modicum of proof that Johnson’s high intelligence and access to the corridors and restaurants of power did not make him a wiser human being than those of us who for one reason or another have come to roost much lower on the social scale.**

**To make a long story short, Johnson regards these scientific pontiffs as arrogant outsiders who, because of their shortcomings in things like perfect table manners and/or dress, have no right to interfere in matters dealing with the climate. His principal negative roll models are the late Oxford University scientists Henry Tizard and Lord Cherwell, both of whom were scientific advisers to the UK prime minister Winston Churchhill during World War II, but who when summarily banished to academia after the war, may have morphed into bad-tempered misfits.**

**Tizard is a man whose life and longings are a complete mystery to me, but I know – which Johnson apparently does not – that Cherwell risked his life during the first world war to show that a spinning aircraft could be pulled out of a dive, and he was also a key player in the design of the UK air defense in the crucial years before the second world war. (I won’t bother to go into here what could have happened if that air defense had failed.) Johnson’s idea of a real scientist – or “boffin”, to use his language – is Bjorn Lomborg of Copenhagen Consensus fame, who is a very smart man, though not a substantial participant in the genuine scientific literature on any level.**

**Lomborg has been mentioned favorably several times in this book, but as for The Copenhagen Consensus, this is a conclave of well-placed academics who were brought to wonderful Copenhagen on several occasions to discuss important topics about which they knew little or nothing, and given their backgrounds, cared less. The only consensus that could be associated with the participants in this half-baked charade was that travel and lodging at the expense of Danish taxpayers is even more gratifying than drinking beer in Copenhagen’s Tivoli on a summer evening.**

**Among other things, Johnson said the United States has done more research on “so-called” climate warming than the rest of the world put combined (which is almost certainly true), and this was why – he claimed – President Bush refused to comply with the Kyoto Protocol. Ostensibly, that very expensive research failed to establish a definite link between climate warming and man-made emissions.**

**Perhaps this described the situation when Johnson’s precious composition went to his editor, but it definitely is not the case at the present time. Mr Bush surprisingly said that “Science has deepened our understanding of climate change and opened new possibilities for confronting it.” It has also opened new “possibilities” for understanding certain related prospects that, according to Sir David King, once the UK government’s chief scientific adviser, might eventually have the same ruinous impact on life and property as a succession of large-scale terrorist attacks.**

**By that he was undoubtedly alluding to physical security and the overall economic outlook. This does not mean that decision makers in the U.S. and UK became partisans of the Kyoto ‘talkathon’, or accepted the scam known as ‘emissions trading’, but for one reason or another Mr Bush decided that he had enough on his plate without challenging the opinions of qualified scientific expertise who reject skepticism in this matter. This is the point, isn’t it? *Climate warming may turn out to be nonsense, but I cant help thinking that it could be a serious mistake to insist that it cannot take place.***

**Or put another way, cannot take place in a world in which the global population is 9 billion persons or more, as will be true at mid-century, doing everything possible to survive or to avoid moving south on the food chain, This is an opinion also expressed by the brilliant international lawyer John Petersen, although in point of truth I don’t need opinions from anybody after seeing what Super-storm Sandy did in New York, and being told that it cost 200 lives and 50 billion dollars.**

**One final observation needs to be made before changing the subject. Monbiot labeled the climate warming sceptics “tools of the fossil fuel lobby”. I’m not sure that he was correct with that designation, because according to the economics and finance that I teach, the oil and gas people do not need a “lobby” to go to sleep at nights with thousand watt smiles on their faces. On this point it is interesting to note how climate warming skeptics have a tendency to flaunt other strange beliefs, one of which inevitably focuses on what they think is the plenitude of energy resources. The gadfly Lomborg, for example, once declared that we do not need to start worrying about an oil shortage in the present century. That opinion is very wrong.**

**6. BACK TO BASICS: ENERGY, INDUSTRIAL PROGRESS, AND NATURAL GAS**

**“The mind that has feasted on the luxurious wonders of**

**fiction has no taste for the insipidness of truth.”**

$-$ **Samuel Johnson**

**Something I never fail to stress in my formal lectures or informal harangues is the value of moderately priced electricity in an industrial economy, and on this score Sweden was once in the forefront of world economies.**

**Unfortunately, that lovely arrangement turned out to be unacceptable to the local anti-nuclear booster clubs, who together with self-appointed energy experts have unleashed a torrent of lies and misunderstandings about both energy and nuclear energy that eventually resulted in the bad news for consumers of electricity that sometimes characterizes the Swedish electric market. During the last few years, the price of electricity to households in Sweden has occasionally been extremely high, although – wisely – electricity may still be sold to Swedish industries at a lower price.**

**What about other countries and the price of electricity to industries. Lakshmi Mittal, chairman and CEO of Arcelor-Mittal – a global steel producer – points out that while the European (EU) bosses and experts admit that manufacturing industry is a motor for economic growth in Europe, at the same time they punish the energy intensive industries by not sponsoring a comprehensive energy policy that will help promote competitiveness and growth. What in economic theory would be called an ‘optimal energy policy’, which is a policy that promotes both consumer *and* producer satisfaction, given the available technology, and also education (and motivation) of the work force, and also thinks in terms of the energy and technological future.**

**Of course they don’t sponsor one, and why should they? They don’t know what a comprehensive energy policy is, and moreover, in Mittal’s article in the *Financial Times* (2014), there was not a word about nuclear energy, but a reminder that his organization provides steel for wind farms and solar energy installations. That achievement is nothing less than wonderful, but doesn’t Mr Mittal understand that where energy matters are concerned, the majority of persons in or associated with the EU Energy Directorate are unqualified when the subject is energy economics, and it is futile to expect that they desire to absorb or are capable of absorbing the kind of background in that subject needed to understand or help his company.**

**Of course, he is not a genius. His talk about turning energy generation over to renewables a-la-Madame Merkel is best described as looney-tune.**

**In any event, the kind of dysfunction that Mr Mittal is dealing with is a world-wide phenomenon. The ignorant heads of governments in the industrial world are incapable of comprehending that first and foremost their allegiance is to the citizens of their own countries. For instance, what is the point of the United States spending two and a half trillion dollars to fight stupid wars on the other side of the world. A problem here is that many American politicians, and in particular presidents, do not understand how much primary and secondary education, and health care can be purchased with 2.5 trillion dollars. I understand however, and in conjunction with certain other policy measures, it could make the U.S. a facsimile of what it was when it had the genuine respect of friends, and even some enemies.**

**Before continuing, I would like to make it clear to Swedish readers of this book, and perhaps others, that I am not advising anyone to fall in love with nuclear energy, nor claiming that it is absolute essential for any government to adopt nuclear. What I am doing is predicting that this is what they are going to do whether they want to or not, because they place their standards of living first, and accepting the program of the present German government places those standards in dangers.**

**I also would like to inform readers in Sweden, and perhaps elsewhere, that one of the reasons why nuclear energy is so unpopular is that physicists are often (and perhaps always) rated at the top of the intellectual scale. Many of them not only possess the scientific training that impresses a majority of civilized human beings, but also – and as a result – enjoy the personalities, charisma and self-confidence that allow them to dominate both smaller and larger gatherings. They flourish the credentials of a natural elite in a world in which elite is becoming a dirty word.**

**For instance, it is difficult to associate the clumsy lies and misunderstandings about scientific topics concocted by the people that Mr Mittal must deal with at EU headquarters with the smooth delivery of conventional scientific wisdom often displayed by physics stars, or for that matter foot soldiers in that profession who have learned to walk the walk and talk the talk of Nobel Laureates. Learned it by reading the right books, and reading them over and over until they know perfectly everything in the chapters that interest them.**

**If we take a careful look at the time series of global macroeconomic growth from the end of the second world war (WW2) to the present, we can distinguish two distinct segments. The first is comparatively smooth, and stretches from the end of WW2 until the middle of the l970s, or shortly after oil prices began to increase in an unaccustomed and threatening manner.**

**The second segment, from the middle l970s to the present, which I discuss briefly in my forthcoming energy economics textbook (2014), featured an irregular growth that doubtlessly resulted from the occasional drastic increases in energy prices that began with the first oil price shock, and whose impact effect was a slowdown in the rate of productivity growth in almost every industrial country. A kind of ‘sneak preview’ of the macroeconomic meltdown that would take place in 2008. Another consequence of the energy price rise – i.e. oil *plus* other energy resources – was *stagflation*, or the simultaneous occurrence of inflation and increased unemployment.**

**Unless national energy structures are ‘adjusted’, these miseries might accelerate if the prices of the main fossil fuels begin to escalate, which is a misfortune that I consider likely, though perhaps not in the short run, and which I prefer not to elaborate on here. I will suggest however that t*his judgement particularly applies to oil and natural gas, and will likely be due to geopolitical rather than geological causes*.**

**The optimal ‘adjustment’ would involve introducing a large amount of *efficient* renewables and alternatives, as well as maintaining the presence of nuclear, increasing its efficiency, and eventually adopting the next generation of reactors and its variants in both present and smaller sizes. I also think it ‘politic’ to assume that nuclear will be an indispensable *complement* *to* (and not *substitute* *for*) any conceivable mix of renewables and alternatives, although the optimal or nearly optimal mix of renewables and alternatives is completely unknown to this humble teacher of energy economics, and is something that readers of this note, as well as their friends and political representatives, should think about investigating in depth as soon as possible. .**

**As Sigmar Gabriel, Germany’s economy and energy minister, made clear, “we have reached the limit of what we can ask of our economy.” What he meant – but perhaps could not say – was the limit of what could be asked if the proposed liquidation of nuclear energy in his country becomes a reality. Gabriel also said that energy generated from biomass was too expensive, which it might be for Germany, but not for every other country, and he also claimed that “Germany had been financing the learning curve on renewable energy for other European countries”. That was a cute observation, following which he implied that the cost of this activity was no longer bearable for German voters.**

**If that is true, then other countries should not make the mistake of trying to assist them. Instead, exporters of electricity to Germany should attempt to reintroduce German voters to reality rather than prolong the senseless fantasy of their counter-productive *energiwende*. According to a Belgium researcher who visited Sweden, a fulfilled German nuclear retreat could mean electricity rationing in countries exporting electricity to Germany. Thanks for nothing, Germany, and regards should also go to local politicians who have decided that half-baked trivialities are more important than dealing with this menace to incomes and welfare in their countries!**

**Now to natural gas, which has become a hot topic since the improvement in the U.S. of the process for exploiting shale gas. That subject has been looked at in the chapter on natural gas, and here I want to go further afield.**

**THE NATURAL GAS ELITE**

**Russia and Iran are countries that, when I started writing my book ENERGY AND ECONOMIC THEORY, had the largest confirmed gas reserves in the world. Russia had the largest, and was /and is) an extremely important producer of this commodity, particularly where the European market is concerned, despite the ‘game-playing’ that has taken place since the Russian occupation of the Crimea.**

 **Iran was in second place, and third place Qatar is a very lucky country when considering natural gas, as well as a few other things, and has become the leading producer in the world of liquefied natural gas (LNG), eclipsing such rivals as Indonesia, Algeria and Malaysia. Australia, however, has expressed a desire to take Qatar’s place in the LNG league. There are many theories about the future actions of Russia where natural gas is concerned, almost too many in fact, but the one that I believe in the strongest is that Russia will pay particular attention to the buyers of natural gas in Asia, particularly – at the present time – China and Japan. And despite what I sometimes hear, they will not have much to do with LNG,**

**A great deal of Russian gas comes from mature fields in West Siberia that, according to the IEA, are declining at a comparatively high rate. If true, this must be annoying for the Russian government, however their annoyance is almost certainly eased by the likely presence on (or offshore) their territory of a large quantity of undeveloped resources, to very likely include natural gas in one form or another, as well as the market that neighbouring China can provide (at least until the Chinese develop their own reputed huge supplies of shale gas). Russia also has large hydroelectric possibilities, and has entered into an agreement with French interests to increase the exploitation of these assets.**

**I will sum the above up by saying that with a little luck, Russia could be the richest country in the world by mid-century, or shortly after. There is a tendency of course to underestimate that country, but the Napoleonic Wars and the entry of the Russian Army into Berlin informed me of what they are capable of. As I write this there is talk of an intrusion of the Swedish Archipelago of a Russian submarine that may or may not be damaged. Of course fools, associated with NATO suspect that it is there to start the Third World War, but I doubt if the new Swedish government is prepared to entertain that kind of stupidity.**

 **Interestingly enough, in the oil-rich Middle East, only Qatar and Iran seem to have enough gas to play a pre-eminent role in local or international markets – or at least this is what certain observers think – and since Iran recently made arrangements to sell gas to the oil rich United Arab Emirates (UAE), this may well be true. Qatar is also making some arrangements along that line. Dolphin Energy, a project initiated by the government of the city state of Abu Dhabi (in the UAE), delivers Qatari gas in 364 kilometres of underwater pipelines down the Persian Gulf, with the supply of gas to Oman being a particular goal. The cost of what may be the first stage of that pipeline was about 3.5 billion dollars, and it is regarded as a project of the Gulf Cooperation Council (GCC).**

**People like myself often think of Dubai as a kind of Middle East Monaco, but as far as I can tell, Qatar also deserves that description. Out of a total population of two million, only about a quarter of a million are citizens of Kuwait, and on the average they are the world’s richest citizens, with an annual average income of about 100,000 dollars. The country has about 25 billion barrels of proven oil reserves, and almost 900 trillion cubic feet (= 900 Tft3) of natural gas reserves. There are museums, branches of American universities (e.g. Georgetown, Texas A&M, Carnegie Mellon), and the U.S. military’s ‘Centcom’ base is located in Qatar.**

**The situation seems to be that some countries in that region want to use natural gas for electric power generation, while conserving oil as the main input for the production of petrochemicals and oil products (i.e. diesel, kerosene, fuel oil, various petrochemical inputs, etc). This makes a great deal of economic sense at the present time, although some decision makers in that part of the world seem prepared to substitute uranium for natural gas in the production of electricity. According to recent information about the apparent plans of Qatar Petroleum (the national energy company), they intend to use approximately 12 billion cubic feet a day (= 12 Gft3/d) of natural gas in the production of LNG, and in addition they want to produce 300,000 barrels a day of liquids from gas-to-liquids (GTL) projects. If the latter is achieved, it will make them the largest GTL producer in the world.**

**The key market for Qatari natural gas is of course Asia, where the gas price is three times that in North America. But obviously, with that price difference, some serious arbitrage can take place. Qatar Petroleum, the state oil company, has requested permission to export American natural gas in partnership with Exxon Mobil. Gas is gas, and business is business, is the position the Exxon Mobil management seems to take, and this is a good thing if it involves helping foreign governments to exploit their energy assets, but if yours truly were asked by the American government what he thinks about exporting domestic natural gas, I would say that I would be careful, because it is likely that Americans will need that gas in a couple of decades, and Qatar and American millionaires can find some other way to become billionaires**

**According to a natural gas model developed at Rice University (Texas), Qatar will be the largest exporter of gas from the Middle East until 2030, and may have plans to become the largest exporter to Asia. What happens after that is unclear, although if the model builders were asked, they would probably say that Iran will eventually have similar intentions, and perhaps some day those intentions will be realized. At energy conferences a decade or so ago, many energy professionals and students of the gas markets felt that one of the most dramatic events in modern gas market history would feature the construction of large gas pipelines from Iran to Europe.**

**In order to make its LNG dreams come true, Qatar has started ordering QFlex and MFlex tankers, which are designed to take 210,000 and 260,000 tonnes of LNG respectively. This should be compared with the 135,000-145,000 tonnes carried in the largest earlier tankers. As economic theory often suggests, moving up in size could mean a further exploitation of ‘increasing returns to scale’, which in turn will ensure that in the near future natural gas originating in Qatar can compete with – or out-compete – any gas from any source in the world. This must sound good to some persons in Qatar, unless they conclude that selling more gas than other producers might involve accepting lower prices.**

**As I point out in my textbook ENERGY AND ECONOMIC THEORY (2014), the best expression for Qatar might be ‘a done deal’. It is a member of the very-rich club that prefers doing business the right instead of the wrong way, and so there must be some logic behind their conduct that other countries should attempt to duplicate, and not just countries in the Middle East. For instance, education plays a major role in preparing the country for the day in the future – although probably the distant future – when their gas resources are (or appear to be) in the final stages of depletion. Making the education sector as efficient as possible is the kind of action that every intelligent government facing an uncertain future should think about taking, and that includes countries like Sweden and the United States. Something of considerable interest is the extension of Kuwait’s planning horizon by the present government. Earlier a hundred years was mentioned, but why should they or any rich country, or for that matter any not-so-rich country be satisfied with placing a limit on their ambitions?**

 **Incidentally, Qatar will host the 2022 World (football/soccer) Cup, and ostensibly billions of dollars have been investigated in that project. The government of Qatar wants the rest of the world to take a look at their country, and they want to show that they have the style and rhythms that will make them valuable friends for large countries in Europe and the Americas.**

**When writing my forthcoming textbook I suggested that Qatar has indicated a strong willingness to do business with buyers in Europe and also North America, and their attitude toward e.g. China was not particularly clear, however given the rate of growth of gas consumption in China, it is almost certain that they will become an important client of a large LNG producer like Qatar.**

**As compared to Russia and Qatar, and perhaps other resource-rich countries, Iran is a country that may someday be of maximum interest to curious development economists, in case any of those still exist. Everywhere in the world it is possible to encounter highly intelligent Iranians, and some of them have superb educations, but even so the Iranian economy does not appear to be developing as fast as it should. This situation might very well change, because oil and gas prices may move in such a way as to greatly favour producers who make the right kind of investments in oil, gas, refining and petrochemicals.**

**Somewhat later, on the same day that he received the Nobel Prize in economics, Professor Gunnar Myrdal said (in a loud voice) that he did not believe in Nobel prizes in economics. In the seminar he conducted at Stockholm University, and which I was fortunate to attend, the reason he gave for this disbelief was that economists did not know how to study the most important topic in economics, which he believed to be development economics. Instead of concentrating on mainstream textbooks or articles in learned journals, he insisted that the only way to efficiently study development economics was to study in detail the dynamics of successful economies, which for every successful country meant the presence or evolution of efficient cultural patterns. It was clear that he considered the United States a very useful role model, although for pedagogical purposes he obviously thought the most useful was Sweden, which is a country where iron ore and forest products played to a certain extent the part that natural gas (perhaps in concert with oil) could play for Iran.**

**Although many economists have visited Sweden, only a few seem aware that in less than 60 years, Sweden advanced from Europe’s Third or Fourth World to perhaps the richest country in Europe, and by 1976 it was a country with one of the highest per- capita incomes in the world. As noted above, the thing that set the Swedish economy in motion were exports of iron ore and forest products (and a sophisticated apparatus for training and utilizing engineers and technicians), and if Professor Myrdal were alive I am sure he would propose that natural gas could possibly do the same thing for Iran. Moreover, when Swedish development began to accelerate, it became easier to borrow the money needed to construct an extensive electricity sector. That sector is probably the key element in the industrial development of most countries. For example, it played this part in the badly damaged post-war Finland, and it might turn out that electricity is more important in Sweden and Finland in the future than it was in the past.**

**That brings us to Russia. There should be little doubt that if Professor Myrdal was still alive and operating at maximum efficiency, he would find it possible to accept that Russia has as much or more to work with than virtually any country in the world. Not just energy resources, but enormous amounts of rich agricultural land, and an educational system that – theoretically – can be turned into the equal of any in the world.**

**The basic shortcoming seems to be that it was not until the arrival of President Putin that the Russian government began restructuring their economy in a facsimile of the way that Professor Yevsei Liberman suggested that it should be restructured many years earlier. Liberman’s position was that emphasis should be placed on individual enterprise, profits and bonuses instead of political doctrine, which at the time was not a popular line to take with many of his countrymen. Thus the ‘inevitable’ was postponed about 25 years, and except for a few researchers and journalists, Liberman’s name seems to have been forgotten.**

**But there is still a Cold War shadow dogging Russia’s footsteps. I consider this both unfortunate and absurd, although what has taken place recently on the Russian-Ukrainian border causes various Cold Warriors to begin saying things that intelligent people should not say. But if those things will result in Russia making Asia the destination for most of its energy exports, I think that it is time for Europe’s governments to get control of themselves, and learn how to think when energy matters are considered.**

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**5. ENERGY AND MACROECONOMICS**

**Many years ago, one of my international finance students at Uppsala University (Sweden) – who is a gifted musician – wrote a song called ‘MACROECONOMICS IS A WAY OF HAVING FUN’. It was dedicated to yours truly, and occasionally played on the radio in the Stockholm-Uppsala region of Sweden, as well as at some of the brilliant parties organized by my students, and which I always attended. I can begin by saying a few words about what the “fun” in the title of that delightful melody means by comparing macroeconomics with physics, since many physicists believe that economists often suffer from ‘physics envy’.**

**If you read an excellent introductory textbook in macroeconomics, and learn what you read *perfectly*, you can tell academics, business persons, journalists, break dancers and rappers that you are a brilliant and highly educated macroeconomist, and generally get away with this bluff. Try the same routine with an introductory physics book, and you will likely be called a fool – or worse. I have taught macroeconomics in many countries, enormously enjoyed teaching the elementary and intermediate courses, and eventually learned everything I wanted or needed to know about that subject. But of late I make a point of avoiding advanced macroeconomic presentations – especially mathematical macroeconomics – and keep my distance from the elegant models that fill the so-called scholarly journals, because most of them are useless, and in reality are an insult to students and teachers, although the latter are often unaware of this sad fact.**

**The last time I stood in front of a macroeconomics class was at the University of Technology in Sydney Australia, and since then I have adopted a very special approach to the topic. For me macroeconomics involves *everything* that has to do with the aggregate standard of living, and thus includes items like energy, population, and education – especially primary and secondary education. Excluded are crank lectures of the type presented in Sweden by some of the recent Nobel laureates in economics, and even more pitiful, junk science discourses on energy economics that are often delivered to graduate students at various universities, and sometimes to readers of the best known and more renowned business press. Let’s put that another way: it’s better to try to learn everything about the few things in energy economics that matter, than a lot about the trivia and bunkum that is sometimes unloaded on unsuspecting economics students in our institutions of higher learning.**

**THE OIL PRICE AND MACROECONOMICS**

**In the silence of my lonely room, and sometimes in crowded seminars, I like to call myself an accomplished energy economist, and among other things I feel that this gives me the right to describe Professor James Hamilton as the leading academic oil economist in the United States (U.S.). I want to make it clear though that I don’t know that scholar, nor do I want to know him, because although we share the same outlook on the past and future of oil, he has never mentioned me in his publications, despite my citing and alluding to his work whenever I get the opportunity.**

**Hamilton has carefully examined the relationship between increases in the oil price and the negative effect they have on the U.S. economy, beginning at the end of the second world war (WW2), until the early years of the last decade of the 20th century. His results are similar to those of Professor Andrew Oswald of Warwick University and myself, but much more thorough, and covering a longer period. The thing that my future energy economics students will kindly be asked to remember is Hamilton’s claim that “all but one of the recessions in the United States since WW2 were preceded – typically by about 9 months – by a dramatic increase in the price of oil.”**

**This is an important macroeconomic observation, and you should make every attempt to remember it. It is the kind of contention that you can take to the bank and draw interest on, although in later articles and conference papers, and of course on the blogosphere, his research likely goes as far as the present day. I might as well confess however, that for the period 1991 to the present, my own work on oil economics ranks with any that has been done anywhere in the world, and as a result I will use this opportunity to give readers a taste of exactly what has happened on the global oil market.**

**From the formation of OPEC in 1961, until the beginning of the twenty-first century, it was the intention of that organization to manage not only the oil in their countries, but also to eventually obtain a controlling interest in the global oil price. In order to do this efficiently, complete (or nearly complete) unanimity among the directors of that cartel was required, and as far as I can tell they did not obtain that like-mindedness until the price of oil fell below ten dollar a barrel (= $10/b), and the amateur energy experts – or ‘know-nothings’ and charlatans as I usually call them – in the oil importing world, began talking foolishness about it reaching $5/b. That was when even the ‘independent thinkers’ in the OPEC executive suite in Vienna saw the light, and fell into line with OPEC’s main men.**

**Econometrics is a topic that I taught for a few years in Stockholm and Uppsala, and was one of the reasons why I was given the opportunity to spend 3 years in Geneva (Switzerland) but eventually abandoned. However some simple calculations that I made about 2004 indicated that the oil price had started to accelerate upwards. A few years later, while I was giving a long talk on oil at the Ecole Normale Superieure (Paris), that price was on its way into orbit, and eventually it reached $147/b, which provided OPEC with the income they had been dreaming of since the formation of that organization. Fortunately, a high degree of intelligence and rationality prevailed in the OPEC executive suite, and so there was no attempt to over-exploit a good thing. Unfortunately however, according to myself and Professor Hamilton, the macroeconomic damage had been done. As much as I hate to say it, the machinations of speculators, and the clumsiness of bank directors and politicians had very little to do with the bad economic news that began in 2008, which is best described as the most serious economic downturn since the great depression (that began in l929).**

**Future students of mine will have to understand the above perfectly if they prefer a passing to a failing grade. They will also have to understand the power of OPEC. The recession triggered by the oil price escalation cut the ground out from under the global macroeconomy, and as a result the demand for oil fell in such a way that the oil price bottomed out at about $32/b. OPEC simply reduced production by a small amount and the oil price quickly climbed to $72/b. *This is something else for you to remember should you find yourself in a conversation on oil with persons who think that they know more than you do!* Shortly after – with the global macroeconomic apparatus still in disarray – the oil price kept moving up, until finally the aggregate oil price exceeded $100/b, although the demand for oil was not increasing rapidly.**

**It is also useful to cite what happened when the war in Libya began – a war, incidentally, that was about oil and not protecting civilians, as the ignorant NATO president claimed. Oil production in Libya almost ceased, which meant that about 1.7% of the global oil output disappeared. That loss was enough to cause the oil price to increase by approximately 17%, as you have already been informed in this book.**

 **Even students at the store-front university in Chicago from which I obtained my economics degree should be able to calculate and interpret the short-run elasticity of the oil price from those numbers, and if they are hooked on nonsense about speculation, also realize that OPEC receives all the help it needs from large oil producers who, surprisingly, prefer high to low oil prices, and understand how to make the moves that are necessary to obtain them. PLEASE REMEMBER THIS!**

**Much more will be said about oil in my forthcoming textbook (2014), but right now I want to mention some thoughts of the billionaire Canadian investor Stephen Jarislowsky, which are especially appropriate when dealing with energy economics.**

**“We’re living in just about the most dishonest time in the history of mankind. It’s theft from A to Z”. Well Steve, it’s also lies and misunderstandings, where by the latter I constantly refer to President Obama’s belief about natural gas, and where the former is concerned the persons who have provided the commander-in-chief with his counter-productive opinions about energy, since I am certain that some of them know as much or more about that issue than my good self. Actually they know a great deal more because they are in a position to obtain all the information they want or need, at any hour of the day or night, from world-class economists, managers and scientists.**

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**4. MYTH, MEANING AND NUCLEAR ENERGY**

**Berthold Brecht put it as follows: “If you don’t know the truth, you are a fool, while if you know the truth but say that it is a lie, you are a villain." I seldom object to that kind of language, because I used it all the time when I taught financial economics, but it is not appropriate when the subject is nuclear, and so I modified it somewhat: If you don’t know the truth about nuclear energy you are probably too tired or unlucky to find out, because learning what you need to feel comfortable when the conversation turns from mathematical economics or Frank Sinatra to energy is as simple as locating your name on your birth certificate. On the other hand, if you know the truth but say that it is a lie – which often happens – it generally means that you don’t want to offend certain persons. For example, persons who might not invite you to their parties and dinners if you reject their beliefs about this very touchy subject.**

**In classroom situations I have never had a problem presenting my views on oil, but it is different with nuclear energy. With nuclear there are always a few students or colleagues who are anxious to give the impression that they are experts on the subject, to include its technical aspects, but inevitably those ladies and gentlemen become careless and tend to miss a few salient points.**

**The most important project in energy economics at the present time is understanding that optimal national energy structures in at least the first half of the present century will be a mix of all sorts of items – nuclear, fossil fuels, renewables, various alternatives etc. Once this is appreciated, some effort should immediately be put into comprehending a few basic characteristics of nuclear, as well as the relationship of nuclear to other energy media. This is not always easy, even for me, however I can congratulate myself on my familiarity with a few things. For instance, I know that while some countries, to include China, make a special effort to pay tribute to renewables, where serious business is concerned they will eventually bet on nuclear. I know something even more important. I know that when dealing with *all* energy matters, you are liable to find yourself confronting a whirlwind of lies and misunderstandings.**

**Mainland China has 14 nuclear reactors in operation, more than 25 under construction, and perhaps 100 are in the planning stages. But even so, the energy directorate in that country is apparently in no hurry to increase the pace at which reactors are produced, because they possess plenty of coal to burn in a clean or dirty manner, and in addition they want to make sure that they are constructing and installing the most efficient nuclear equipment. Perhaps I should mention that the Chinese are in the nuclear business because they intend to become and/or remain the ‘workshop of the world’, and to do that an enormous amount of energy will have to be consumed. Attempting to obtain a majority of this energy from items like wind and solar would be completely and totally counterproductive.**

**Now let’s consider Sweden and Germany. A question that might have been asked at the Singapore Energy Week – but fortunately was not – was why should I spend valuable time discussing those nations and not Asian countries? After all, I was specifically requested to deal with the Asian energy future?**

 **The correct answer is that Swedish and German experiences and aspirations have *everything* to do with Asian energy! The technological and economic issues in those two European countries are almost exactly the same as those in Asia: they are operating on the same wave length. Unlike e.g. fashions and eating habits, there is only one nuclear story, and that simple story applies everywhere.**

 **I had the Japanese nuclear situation explained to me in detail by a Japanese gentleman during a long walk through Vienna about twenty years ago. What he essentially said was that contemporary nuclear technology was merely an entrée to the real deal, by which he meant fast-breeder technology. That was a discussion that I was not anxious to take part in, because for various reasons I have never found a plutonium community something to cheer about. I can also mention that when I wanted to know more about the likely present and near-future cost of nuclear energy in Europe and North America, I began my research with some questions about what is taking place in the Chinese nuclear sector. In case you are curious, what is taking place in that sector is what Anne Lauvergeon – the former director of Areva – described as “worrying”, by which she meant worrying for other reactor producers who might have to compete with the Chinese. In other words, she implied that the cost of Chinese reactors will be the lowest in the world, if they aren’t already.**

**What about going in the other direction? Fortunately or unfortunately, Sweden no longer has anything to show China on the nuclear scene, but certain aspects of the Swedish nuclear success story will be mentioned below, and I make a point of insisting that it is understood and understood perfectly by my students. And Germany? The answer is that the venture taking place under the supervision of Angela Merkel in Germany is on the level of a half-baked soap opera, since the main object of that gambit is to obtain another term in office for Frau Merkel and her foot soldiers. Governments with a genuine interest in making low-cost electricity available to their constituents should try to make certain that they never become involved in anything like the nuclear travesty called the Energiwende (= Energy Transition).**

**SWEDISH SHORTENING**

**I have never tried to guess what the important American jazz musician, composer, and producer Quincy Jones meant by his use of the expression ‘Swedish Shortening’, but a definition I obtained in GOOGLE indicates that it has to do with shortening the solos played by orchestra members to suit the mood of the audience, as well fitting into the general structure of a ‘gig’ (i.e. event).**

**When I write papers or give lectures on oil, my preparation usually begins by examining the situation in the United States, by which I mean the situation going back to about 1931, and then transposing the materials I gain access to into a short but useful survey which includes things like OPEC and the peak oil hypothesis. Where nuclear is concerned, I *always* turn to Sweden for an indication of nuclear capabilities and successes. I also try to keep my papers and sometimes my lectures on nuclear short, although I insist that my students learn what I am saying perfectly – assuming that they prefer a passing to a failing grade. This leads me to mention that during the Singapore Energy Week debate mentioned above, the renewables ‘superstar’ Jeremy Leggett stated that it takes ten years to construct a nuclear facility, which led him to ask who in their right mind would become involved in such a project.**

**My unspoken rejoinder suggested that if he were correct, nobody would or should put in a good word for nuclear, but since he didn’t really know what he was talking about (which it will be my pleasure to show some day with the help of some elementary dynamic programming or inter-temporal production theory) he should not expect that his so-called wisdom will be universally accepted and exploited, although there are always incompetent politicians and civil servants who are prepared to accept crank judgements from researchers who have attained a quasi-celebrity status. It happens to be true however that nuclear facilities can definitely be constructed in five years, and soon it should be less.**

**I have often claimed that in terms of reliability and cost, the Swedish electric sector was perhaps the most efficient in the world before the curse of (electric) deregulation arrived. Given these circumstances, it is easy to understand that when the global macro-economy began deteriorating a few years ago, the illogical nuclear 'downsizing' that had commenced in Sweden – and already involved demolishing badly situated reactors near Malmö – was at least temporarily postponed. I can hardly tell you how happy this made me, because in case you don’t know, or don’t want to know, a high electric intensity for firms, combined with a high rate of industrial investment and the various skills created by a modern educational system, generally results in a high productivity for large and small businesses. This in turn brings about a steady increase in employment, real incomes, and the most important ingredients of social security (such as pensions and comprehensive health care).**

**When a student of nuclear energy walks through the streets of beautiful summer Stockholm, he or she might conclude that without the contribution of nuclear energy, the standard of living might be lower. As for me, when I walk through the streets of summer *or* winter Stockholm, I don’t think about the standard of living as such, but the Swedish welfare system, and how my modest pension and possible future medical requirements might be influenced by a total or partial nuclear retreat. They would be influenced in such a way that while the rich citizens of this country would hardly notice the change, I could eventually be in serious trouble.**

**The nuclear downsizing I referred to above involved eliminating two of the original twelve Swedish reactors. On the other hand, the ten remaining Swedish reactors were *easily* upgraded so that they are capable of producing about the same electric energy (in kilowatt-hours = kWh) as the original twelve reactors. I can also note that the initial 12 reactors were constructed in only 13+ years, and as a result *everything* that Swedish decision makers hoped to accomplish by exploiting the nuclear option was realized. The question immediately raised is whether this marvellous outcome would have been possible had another energy alternative been exploited, and I have convinced myself that the answer is almost certainly no. This in turn should cause a few interested parties to ask what economic achievements would be possible in a future that features a decline in the use of nuclear.**

**Next we can turn to a useful pedagogical first step for working our way toward a key economic concept. This involves a two year situation in which $1000 is borrowed and used to invest in an asset, for example, a mini-reactor that will be placed in the basement of your house, and which will be amortized (i.e. paid for) in two payments over (*an amortization period of*) two years. The rate of interest (r), i.e. the discount rate, in this example will be taken as 10% (or 0.10). (Amortization means repaying a debt, which in this example is tied to the purchase and cost of a reactor.)**

**It is here that we introduce the term *annuity*, which is the amount (A) paid at the end of every period (e.g. year), and as will be calculated below, the annual amount ‘A’ is equal to $576. This means that in repaying the debt (=$1000), we pay $576 at the end of the first year, and also $576 at the end of the second year. The debt ‘today’ is $1000, and if paid at the end of two years, the lender would receive F = PV(1+r)T = 1000(1+0.1)2 =1210 dollars if 10% is the rate of interest. Let’s put this as follows: $1210 in 2 years has a PV of $1000 if r = 10%. Also, take note that $1000 is *not* the capital cost: it is the *investment* cost. On the other hand, the $576 is the *levelized* capital cost.**

**We can take a closer look at this theme, continuing with the above numbers, and then going to some algebra that systematizes the discussion. There is a payment of $576 at the end of the first year, and this is equivalent to 576(1+0.1) = $633 at the end of the second year. If we add this to the annuity payment (A) of $576 at the end of the second year, it sums to approximately $1210, or the same as the single final payment (F) above. It can thus be specified that, *ceteris paribus*, paying $1000 now for the asset, or paying $1210 (= F) at the end of two years, or paying $576 (= A) at the end of the first and second years are (in theory) equivalent, given that 10% is the applicable rate of interest.*.* Note the *ceteris paribus* criterion, because obviously in real life there are situations where this ‘equivalence’ would not be acceptable, particularly by a lender.**

**Something else that can be mentioned is that if the reactor had been paid for in cash removed from your wallet or purse at the time it was purchased, rather than borrowing, the concept of an annuity would still be valid. In this case the annuity payments represent the *opportunity cost* of purchasing this asset instead of e.g. lending the cash today and earning interest (amounting to e.g. $210 after two years).**

**Now for an algebraic generalization that you can skip if you do not like algebra. Perhaps the best way to begin is to note again that to pay a debt of PV (= present value) entered into at the beginning of the first period, is to pay PV(1+r)T at the end of T periods, or via annuities A at the end of each period, beginning with the *end* of the first period, and ending at the end of the next to the last period! Thus we get:**

 **PV (1+r)T = A + A(1+r) + A(1+r)2 +……..+ A(1+r)T-1 (1)**

**Multiplying both sides of this expression by (1+r) we obtain:**

 **(1+r)[PV(1+r)T] = A(1+r) + ………+ A(1+r)T (2)**

**Continuing by subtracting the second of these expressions from the first yields:**

 **[(1+r)T] PV[1 – (1+r)] = A – A(1+r)T  (3)**

**From this we get an equation that you will often see in all of my courses on economics, and this is:**

 **A=PV (4)**

**If we make PV = 1000, r = 0.10 (i.e. 10%) and T = 2, then we can obtain A = 576 from this relationship. The cost A, which is the annual payment on a loan, or received from an annuity, is sometimes referred to as the ‘levelized cost’, or perhaps better the levelized (annual) capital cost, which takes into consideration both interest and capital charges. Now examine the following tableau, which is self explanatory.**

**Year(T) Beginning A Interest Capital End-of-year-balance**

**\_\_\_\_\_\_\_\_\_Balance\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_charge\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

 **1 1000 576 100 476 524 ( = 1000 – 476)**

 **2 524 576 52.4 524 0\_\_\_\_\_\_\_\_\_\_\_**

**Before continuing, let me suggest that readers should repeat this exercise (i.e. produce a tableau of this nature) for a three period horizon (T = 3), and to make it exciting begin with a PV (or investment cost) of $1500, and proceed by calculating A with r =5% and T = 3. Finally, construct a tableau like the one above with your answer.**

**Now let us use the values in this table to make a very important point: one which I was once asked about, and unfortunately gave the questioner a wrong answer. To begin, we can obtain the present values of the capital charges (476 and 524). These are clearly 476/(1.1) and 524/(1.21), assuming that the ‘discount rate’ (or rate of interest ‘r’ here) is 10%. (Readers should make sure that they know what is happening, remembering that present value (PV) is is defined as future value (FV) divided by (1+r)T. The two present values are approximately 433 for both t = 1 and t = 2. Summed they equal 866.**

**Next we should obtain the present values of the interest charges. From the tableau we see that these can be calculated as 100/1.1 and 52.4/1.21, and these sum to approximately 134. Readers should attempt to make sure that they understand these calculations. Finally, if the present values of capital charges and interest charges are added, we obtain 1000, which is the investment charge. In other words, the 1000 investment charge is divided into a capital charge and an interest charge.**

**This discussion can be concluded by summarizing and expanding the fairy tale presented before the derivation of (1). The mini-reactor put in or near your house costs $1000 dollars. This is the *investment* charge (I). The *levelized capital charges* (A) are $576 for both years, and from these we compute *capital charges* for the two periods we have $476 and $524, which are obvious from the above tableau. The summation of the present values of these charges gives us approximately $866.**

**Although often not discussed properly, in this simple example the $866 is what is known as the *overnight charge*, which according to the discussion in e.g. GOOGLE is the part of the capital cost that does not include interest (or $134). Thus, when you contact the seller of the reactor who explains that he will sell you one and have it installed in two years (at which time it will be ready to deliver electri power) he or she is saying that the 1000 dollars they want from you now (or 576 at the end of each year, or 1210 at the end of two years) is for the reactor – whose purchase or construction and installing – has a present value which is called the overnight charge, and in addition there is an interest charge that is an opportunity cost, in that it is the interest income the reactor seller is giving up in order to do what is necessary to provide your reactor.**

**What about the profit of the reactor seller? That is in the capital charges, along with various other costs that may be involved in fulfilling the agreement with the buyer of the reactor. Of course there may not be a profit, because the reactor seller may have misjuged the cost of constructing or obtaining the reactor, as well as installing it. Something like this happened in Finland, where a contract for the largest reactor in the world (1600 Megawatts), which was supposed to cost 5 billion (U.S.) dollars, ended up costing 8 billion, with the reactor supplier (Areva) having to ‘eat’ 3 billion.**

 **Before continuing, a few words dealing with the above might be appropriate. I neither have nor am interested in trade secrets having to do with actual firms in the nuclear business, but I know from reading the popular press that a South Korean firm has agreed to construct 4 reactors in the United Arab Emirates (UAE) for 5 billion (U.S.) dollars each, which to me means that they promised grid power in 5 years. (This was also the case in Finland, although that deal did not work out as planned.)**

**One way that this might function is that each reactor buyer gives the constructing firm 5 billion dollars, and that firm buys (or constructs) the reactor, and does all the other work necessary to provide grid power in the agreed on time. The 5 billion must not only pay for the reactor – in whatever shape it is delivered – but also the salaries of engineers, workers, managers, technicians, and all other inputs . The profit of the firm (or firms) constructing the reactors is also included in the 5 billion, and so if they construct a reactor in less than 5 years, then (*ceteris paribus*) their profit is greater, while if it takes longer, then instead of profits they might register losses.**

**A STATEMENT ABOUT LIES AND TRUTH**

**Recently, the Swedish energy minister and the head of a Swedish labour union were brought together in a very short television debate. Almost every sentence that Madame Energy Minister uttered contained the expression *renewable energy*, and caused me to think back to something that the great American president Franklin D. Roosevelt once said: “repetition of a lie does not transform it into the truth”. Of course, in her case it was not a lie but a misunderstanding.**

**Furthermore, as the gentleman from the labour union – who is now the Swedish Prime Minister – pointed out, he grew up in Northern Sweden, and though winter temperatures in that part of the country sometimes reached *minus* twenty-five degrees centigrade, he had no memory of air currents of such strength that they would guarantee the sustained motion of wind turbines. I often skied in northern Sweden many years ago, and my son did a part of his military service in that region, but neither of us can recollect a wind strength and consistency that would justify abandoning nuclear energy in favour of wind turbines that provide rated power less than twenty five percent of the time. (In other words, their capacity factors are on average less than 0.25, and sometimes much less.)**

**There is another item that everyone everywhere should be aware of. I do not know of any country, in any part of the world, where decision makers, rank and file politicians, academics with access to the corridors and restaurants of power, break dancers, rappers, moonwalkers or anybody else have talked as much about a major expansion in the use of renewable energy as in Sweden, and in addition have tried to give foreigners the impression that much has been done and even more will be done in the near future. In reality hardly anything has been done, because suggestions for greatly modifying the present Swedish energy profile to provide for more renewable energy in conjunction with less nuclear energy are scientifically absurd.**

**I perhaps should mention that Madame Energy Minister is not a representative of the political party that I would vote for if I voted in Sweden. Of course, maybe that doesn’t make a difference, because the last Social Democratic prime minister in Sweden, Mr Persson, went so far as to call nuclear energy “obsolete”. This kind of mistake is natural or typical where the vote-getting process is concerned, because in a democracy everyone is encouraged to express their opinion on all sorts of topics, even though in this case the prime minister’s opinion overlooked the likelihood that the nuclear reactor may be the most important invention of the 20th century. I want to emphasize though, that when that eccentric and inaccurate statement about obsolescence was made, the cost and price of Swedish electricity was among the lowest in the world, while the cost and price of electricity in the promised land of wind energy, which as you probably know is Denmark, was among the highest.**

**I would like to use this opportunity to say that none of the above surprises me. As a sometimes student of European history and the Second World War, I would like to remind readers that neither Denmark or Belgium lasted more than a few days when the attack by Nazi Germany took place, and when Mr Hitler elected to declare war on the United States (on December 11, l941), millions of sensible Germans cheered like football (i.e. soccer) fans at a Manchester or Hamburg ‘derby’. My teacher of German in Vienna, who held a position during the war in which he met all sorts of important persons, said that almost every intelligent official or officer he encountered knew that Hitler lost the war for Germany on December 11, l941, but even so – usually when large quantities of alcohol were in the picture – thought that the impossible could become possible.**

**A CONCLUSION**

**If it is absolutely necessary, I might still be able to read German, however I would never consider picking up a newspaper or journal in order to find out what is going on in the heads of the German Chancellor and her foot soldiers, nor would I recommend such a move to anyone else. I constantly hear how the one time student of physical science, Angela Merkel, has at least an inkling of the economic fiasco that would result from doing away with nuclear, and replacing it with renewables and/or imported electric power. But votes are votes, and if she prefers chilling out in the Reichstag to watching (on her wide-screen TV) her political rivals staring across the table at charmers like Sarkozy and Berlusconi, she evidently feels that she has no choice but to accept what the great American songwriter Irving Berlin called ‘Doing what comes naturally’, which in this context means supporting an energy program that makes no technical or economic sense whatsoever, although politically – if German voters are sufficiently naïve – it might provide Chancellor Merkel with still another term in office.**

**I like to think that most countries, in every part of the world, at the present time, are filled with people who are intelligent and sensible enough to realize how misguided Chancellor Merkel’s nuclear initiative happens to be, however you can never be certain. What everyone reading this should remember is that where nuclear energy is concerned, even intelligent and highly educated men and women can lose their way, and not just nuclear energy. As I attempted to explain in my lecture on oil at the National University of Singapore, the war in Libya was about oil, and not protecting what the ignorant Secretary General of NATO called civilians, but I am afraid that my powers of persuasion failed me on that occasion.**

**Recently a French Prime Minister, Monsieur Fillon, reaffirmed that “France’s goal is first of all to ensure its energy independence”. The opinion here is that ensuring the energy independence of countries like France and Japan can only be done by at least retaining their nuclear inventory, assuming that independence is to be accompanied by continued prosperity. Moreover, I would like to assure a certain gentleman in a certain forum that Japan will be the last country on the face of the earth to abandon nuclear. I don’t feel a need to argue this however, because French and Japanese energy specialists are smarter and more sophisticated where their domestic energy matters are concerned than I could ever be. I have also heard that regardless of what French politicians say or think before the cognac starts going around the table, French nuclear kingpins expect to profit handsomely from the nuclear foolishness now be launched by Ms Merkel and her energy experts.**

**I engage in many polemics about energy in my articles, lectures and especially my books (2000, 2007, 2011). I also have long conversations with myself on the subject, usually in the silence of my lonely room, This might be why I received a number of strange mails from a Catalan engineer (who says that he is a PhD from the Massachusetts Institute of Technology) informing me that a large team of experts at MIT have produced research on the cost and desirability of nuclear energy that – in his opinion – casts some scepticism on my humble work on these subjects.**

**Their research casts no scepticism on my work, because I doubt whether they are capable of understanding my work. The calculations made at MIT or IIT (Illinois Institute of Technology) or CIT (California Institute of Technology) or the storefront university that gave me my economics degree may or may not be correct for the short run, but as for the long term – where the issue is mainly economics, to include energy economics – they are probably as wrong as the Dean of Engineering at Illinois Institute of Technology thought that I was when he expelled me from his school for failing physics and mathematics (twice), and told me to never come back.**

**Wrong because there are no electricity generating assets on the horizon that are as flexible as nuclear reactors when it comes to providing large amounts of reliable electric power. Flexible in what way? How can someone look at a nuclear facility and talk about flexibility? The answer is that flexibility in this context means the ability to greatly improve the technology and economics of future generations of reactors, although admittedly improvements will also be made where wind and solar equipment is concerned.**

**But there is another factor that needs to be absorbed. In the courses in electrical engineering that I busied myself with after being readmitted to IIT, I studied many fascinating topics, such as the first and second laws of thermodynamics, and of course Kirchoffs laws, which were basic for electrical circuit analysis, but there is no law or hypothesis that is more applicable to the real world than what might be regarded as the first law of neo-classical economics, *which is that most people prefer more to less*. This will ensure that a nuclear retreat by Germany and others will eventually take the form of a nuclear advance. I think that I should make it clear however, that there are aspects of nuclear advances that I find less than appetizing, because as the Japanese gentleman eagerly explained to me in Vienna, that will eventually involve a lot of plutonium, I hope that the breeder that Bill Gates is financing manages plutonium in a way that it does not interfere with his income.**

**Some observers believe that a commercial breeder will never be developed. I believe that I once heard this from Michael Dittmar, whose interesting paper is listed in the references. In my opinion it could happen that a Manhattan Project type of approach to this issue will be unleashed if things like population increases and the depletion of fossil fuels result in radical price increases for electricity. Readers with an interest in microeconomic theory should also take a look at some aspects of the paper by Fabien A. Roques et al (2006), which views nuclear as a hedge against uncertain fossil fuel prices, and also suggests that it might be fruitful to view energy as a ‘public good’ (like e.g. streetlights and defence). I certainly can accept that, since it is clear to me that investing in energy makes more economic sense than investing in stupid wars on the other side of the world.**

**For the time being I make a point of claiming that conventional reactors can be made almost completely safe, realize higher thermodynamic efficiencies (by better utilizing the heat generated by reactors), process/recycle nuclear waste more economically, and so on and so forth. Also, and please note carefully, with nuclear installations located domestically, you know almost exactly what you will get over very long time frames. With other energy resources there can be large uncertainties about fuel availability and prices. This is why Finland, with Norwegian gas on one side of that country, and Russian gas and coal on the other side, decided to buy the largest reactor in the world from Areva of France. Finland has also decided to purchase one more large reactor, and perhaps two. Finland has one of the best educated populations in the world. Why should they endanger their economic future by playing the energy fool?**

**Many people are afraid of nuclear energy, and that is why I am able to be positive to that resource. If people were not afraid, if they desired an unlimited expansion of nuclear, or a reactor on every street corner, I would have a difficult time convincing myself that I should be partial to that energy medium. One thing though is certain: I definitely would not have given a talk at the Singapore Energy Week, or any other Energy meeting, because there is enough hypocrisy in academic economics and in politics without my participation. The bottom line here is that nuclear is nothing to play games with, technically or other-wise. In the hands of the wrong people it can be very dangerous. For instance, if decision makers should make a habit of doing foolish or careless things like putting reactors in the wrong place, it could help destabilize portions of the global economy by causing the abandonment of potentially safe reactors. This could turn out to be a major outcome of the Fukushima tragedy.**

**I can close by saying that I would have preferred giving a longer lecture on nuclear than the one I gave in Singapore, and look forward to giving others in a classroom with a large black or white board, and members of the anti-nuclear booster club sitting in the front row, eager to challenge my humble arguments. I must admit however that if the lecture I gave was ten times as long, I would find it difficult to say more than I have said in the present version of my talk.**

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**3. COAL AND SOME ECONOMIC LOGIC AGAIN**

**"There is no reason why institutions that have direct holdings in coal, oil and gas stocks could not divest immediately." Ian Simm (Chief executive of Impax Asset Management)
 No reason except money, Ian, and as you probably know, there is no bigger reason than that at the present time anywhere on this or any other planet.
 Apparently pension funds in the U.S. - and probably everywhere else - have ignored calls from mayors, city councils, break-dancers, moonwalkers, hustlers and pseudo-intellectuals to forget about the viability of their business models and - in the name of environmental sanity - ditch (i.e. divest) their fossil fuel shares/stocks. As a counterexample however, Stanford University - which has an endowment fund of almost 20 billion dollars - has reportedly started to unwind its position in all publicly listed companies that focus on producing coal for energy generation, Right on, I'm tempted to say, especially when I read that George Serafeim, associate professor of business administration at Harvard Business School, informed his friends and neighbors that "If major pension funds and endowments divest from fossil fuel companies, this will send a very strong signal to the boards and the executives of these companies. changes will happen."
 You got that right George, although they may not be the changes having to do with cleaning up the environment that are almost certainly discussed in the faculty club at your establishment after the cognac has gone around the table a couple of time, or similar facilities at Stanford and various Ivy League institutions where tenured faculty members care even less than I do about signals sent to and received from fossil fuel companies. I happen to know that the changes you are talking about will involve even a higher level of lies and misunderstandings about the energy future - a future in which coal is likely to be a star performers unless (or until) nuclear moves to the head of the class. That is why this discussion repeats part of a previous chapter!
 "Germany is winning," according to Simone Osborne - Co-Editor of the publication *Energy Crunch* - noting that she is not talking about football. She then goes on to say that "Germany also succeeded in avoiding a yellow card from the EU over exemptions designed to protect energy intensive German industry from the cost of the energy transition." She also informed us that renewable energy supplied a third of Germany's electricity in the first half of 2014, and during one day in May renewable energy supplied a "a peak of 74%, without the grid or the economy being brought to its knees".
 Dr. Bruno Burger of the Fraunhofer Institute explained that the gains made by renewables thus far in 2014 can be attributed to the combination of good weather and growing production of clean energy. He adds that "in the first half year 2013 we had really bad weather and the solar and wind production was below the long term average". To this he took the liberty of adding that "In 2014 we started with more [sun] and wind and the production is higher than in average years."
 Continuing with the good news, the Fraunhofer Institute's analysis found that coal based generation is down for both hard and soft coals from the record levels of 2013, and in addition the decline in output for gas-based power plants was down 25% compared to the same period last year. Even better he says that "Despite the fact that we had high production of renewables, we did not reduce the conventional production. Therefore we achieved an export surplus of 18 Terawatt-hours. If this trend continues until the end of the year, Germany will achieve a third record in a row in electricity exports."
 That's funny, but I thought that Germany was breaking records for electricity imports, and in a talk at an energy conference in Stockholm last year, a Belgium researcher claimed that if Germany goes through with its goofy plan for abandoning nuclear, Belgium will have to ration electricity. Craig Morris at Renewables International sees a down-side though in Germany's happiness, arguing that it's the high electricity exports that keep coal production high in Germany. He sums this up by saying that "Renewable electricity has priority on the German grid and therefore offsets conventional (fossil fuel) generation, meaning that much of conventional generation will go to neighboring countries as exports." Logic comes into the picture when he brazenly notes that the effect of coal based exports from Germany to surrounding countries will prevent those unfortunate countries from also going over to renewables.
  Well there it is folks. If the Dean of Engineering at Illinois Institute of Technology could have seen this humble piece of Energy Economics 101, and if my name had been on it, he would have expelled me after the first semester instead of waiting until the end of the first year to send me on my way the U.S. Army, because in this book I have claimed that around the beginning of this year Germany was burning more coal than was burned when that country was divided, and East Germany binged on soft coal.**

 **Moreover the word in Germany most often applied to the Energiewende (= Energy Transition) is verrückt (= crazy, mad), although one of the decision makers in that country was exceptionally proud to announce that Germans have financed about all of the Energywende "learning curve" that is possible at the present time.
 THANKS FOR NOTHING, Mr Decision Maker, is my response to that admission, but before proceeding to destroy the manuscript for my new book, let me add what the World Coal Association says about that resource. 'Coal provides around 30 percent of global primary energy needs, generates 41 percent of the world's electricity and is used in the production of 70 percent of the world's steel. Coal and lignite reserves are sufficient for more than 100 years at the current rate of production, and the worldwide rate of growth of coal consumption is 3.6 percent. Moreover, for what it is worth, which isn't much, the International Energy Agency apparently believes that coal may come close to surpassing oil as the world's main energy source by 2017.
 I'm tempted to finish this note by saying that the bigger the lie, the harder people will try to believe it, but I won't bother. The Energiewende will be exposed before the first quarter of this century is over, but as far as I am concerned, that is almost a decade too late. However I want to refer to a working paper by Charles Frank, called 'Wind and Solar are Worst (2014).' Yes they are, even though this may not always be the case.**

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**2. ARE YOU AFRAID OF A BIG BAD OIL SHOCK, FERDINAND?**

**That is an interesting question, Professor William D. Nordhaus, and thanks for posing it to your many admirers, to include me. But before I answer I should perhaps say something about my international finance students, who assumed that because of their extraordinarily high IQs, they could call me anything they wanted, both in class and at the marvellous parties they sponsored, and to which yours truly was always invited.**

**As I informed those young ladies and gentlemen, usually at the briefing I present at the beginning of the first class of the new term, but sometimes near a dance floor when Frank Sinatra was singing ‘How Little we Know’, my name is Ferdinand and I have a PhD, but I prefer to be called Fred or Professor Banks, and if I am called Ferdinand or Doctor, as certain people insist on doing, I might feel compelled to reply with language they would not appreciate.**

**In any event, in 2007, in an article Professor Nordhaus published in the *Brookings Institution Papers* titled ‘Who’s Afraid of a Big Bad Oil Shock?’, his answer was that “policymakers should not be afraid of a big bad oil shock!” The argument he offered to support this belief contained some information about what was taking place during what he called an “oil shock”, which he alleged took place from the beginning of the new century to 2007, and during which period the oil price was slowly increasing, but output continued to grow, and unemployment continued to fall.” This he interpreted as a non-threatening oil shock, and as icing on the cake he accompanied his contention with some econometric results that featured what he called “an oil-shock variable.”**

**The problem here is that – like the vast majority of academics in all faculties – the**

**distinguished professor has an incomplete knowledge of global energy markets, both absolutely and as compared to my good self. The purpose of the present contribution is to clarify for readers what was taking place in the oil market from the end of the century until the middle of 2008, which includes those beautiful days in July of that year when I was preparing and then delivering a brilliant talk on oil to a large audience at the Ecole Normale Superieure (Paris). What I told them was essentially the following:**

**The *genuine* oil price escalation that was accelerating while I was strutting my stuff before a whiteboard at the Ecole Normale, was caused by the aggregate oil price falling to under ten dollars during the very hours in 1999 when wine was being purchased in France and elsewhere for the purpose of ‘drinking in’ a prosperous new century. Like Professor Nordhaus I have also taught econometrics, but I did not require an ‘oil-shock variable’ to tell me what was going on in the oil market, nor what was going to take place. *I knew that OPEC was not going to accept what had happened with the oil price during the last decade of the 20th century,* and made this clear in my lectures at a dozen conferences, nor did they intend to accept the ‘creeping’ *pace* at which the oil price was rising during the early years of the new century, nor the ignorant predictions of OPEC detractors who informed friends and neighbors that the price of a barrel of oil would soon be as low as the price of a bottle of coca-cola. A pace that Nordhaus spoke of as an “oil price shock” and which even a more credible researcher referred to as a ‘slow motion oil price shock’.**

**As you may or may not remember, Professor Milton Friedman told his students that cartels cannot succeed because of the ‘human factor’, which was his euphemism for greed. This is partially true I suppose, although I prefer the opinion of John von Neumann and Oscar Morgenstern (1944), which claims that when the formation of a cartel is legally possible, it should and would always appear if decision makers on the ‘sell’ side of a market were rational.**

 **Where energy matters are concerned, rationality has a way of being in short supply, and I can remember hearing an argument presented by a member of the OPEC directorate several decades ago that that organization should be liquidated, and instead of trying to manage the oil price, that commodity should be sold using long term contracts. I don’t know if other members were thinking in those asinine terms, but the sharp oil price decline during the 1990s, and the slow recovery early in the new century (that Nordhaus termed a shock), concentrated the minds of OPEC members, and dispelled sub-optimal approaches to the pricing of ‘crude’.**

**The Oil Minister of Nigeria once said that shale oil – particularly in North America – is the worst enemy of oil exporters like the OPEC countries, and he also announced that his country will no longer export crude oil to the U.S. Frankly, the shale oil story is not as simple as generally told, nor Mr Minister thinks. A brilliant short article on the site ‘*Talk Markets’* (originating with *EconMatters.com*) claims that the same thing might be taking place in the great world of shale as took place in the electric market during those halcyon days when the large corporation Enron was riding high. Riding high before its top executives ended up in prison for spreading lies to investors. It is far from unthinkable that now a few lies might be disseminated about shale reserves.**

**In an elementary textbook that will be available soon called ENERGY AND ECONOMIC THEORY (2014), I try to make it clear that strange things have happened in the shale world, and *‘Bloomberg’* publications have not hesitated to cite and investigate some of these ‘oddities’, going so far as to suggest that there has been an overconsumption of certain beverages by shale enthusiasts. ‘Kool Aid’ was the one they mentioned, but I can think of a few more.**

**Finally, we can turn to the question in the title of this note. Yes Professor Nordhaus, I am ready to confess I am afraid. I am afraid because like the leading oil economist in the U.S. – Professor James Hamilton of the University of California (San Diego) – I know that the macroeconomic meltdown that began in 2008 was caused by oil demand ‘outrunning’ oil supply, with the result being that oil price quickly climbed to the highest point in modern times ($147/b), with many seasoned and certifiable experts predicting that it was on its way to $200/b, or more. Incidentally, that meltdown included a financial market calamity, and believe it or not, memories of that episode have helped to generate unease about the macroeconomic/financial-market future.**

**Furthermore, and more important, the thing that my students must be totally aware of – but which their energy economics teachers generally fail to inform them – is what happened when the oil price not only fell from $147/b, but reached $32/b. On that occasion a few meetings took place in OPEC’s Vienna headquarters, and it was not long before the oil price was again approaching $100/b.**

**Given the growth of global population, and on the basis of what I believe to be the power of OPEC where the oil supply is concerned, the same thing could happen again, although hopefully later rather than sooner. Yes, I could be wrong about OPEC’s power due to the change in the oil reserves background that may – *may* – be caused by shale resources, although at the present time I think it appropriate to regard the Talk Markets/EconMatters articles as salubrious wake-up calls.**

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**1. LIBYA: BUT WHAT ABOUT THE OIL – IMPORTANT REPETITION**

**When I first penned these humble words, Swedish combat aircraft are being tuned up for the long flight from Sweden to somewhere in the Mediterranean. There was no  shortage of volunteers – pilots, mechanics and other ground crew – for this mission, because it has been a very long winter in Scandinavia, and many young Swedish men were so keen to get close to the disco and bar life in that sunny part of the world that they could almost  taste it.**

**As they used to ask in the U.S. during WW2, was that trip necessary? Well, let’s do some math. The price of oil was about eighty-eight dollars a barrel (= $88/b) when the trouble in Libya began, and the price of West Texas Intermediate (WTI) oil quickly touched $105/b – and the Brent price moved above $115/b. “Moved above” might sound like a careless approximation, but as Bertrand Russell once said, “all science is based on approximations”. Taking these prices into consideration, my ‘back-of-the-envelope’ calculations suggested that OPEC – whose exports were at least 26 million barrels of oil a day at that time– initially raked in an extra 10 billion dollars or so because of the increased tension in Libya.**

**But 10 billion dollars might turn out to be insignificant for oil importers when all the charges that will have to be faced because of the increase in the price of oil are contemplated. A palpable rise in the price of oil inevitably increases the price of other energy resources, as well as some other items. Furthermore, nobody seems to appreciate the macroeconomic damage that might be done because of the decision by Security Counsel blockheads to ‘diss’ Colonel Gaddafi,  instead of giving him the respect that he obviously felt that he deserved. Had I been doing the planning, I would have arranged  for him to visit Paris and/or Washington in order to wine, dine, exchange opinions and wheel and deal with the kind of busybodies and careerists who completely lack the ability to estimate the possible economic consequences  of the stupid venture they ended up sponsoring or approving.**

**The venture in question – or fling which it deserves to be called – is about oil, and not about providing for the safety of Libyans, as the ignorant ‘Chief Executive Officer’ of NATO kept insisting. The optimal way to provide for the safety of Libyans was to find some way to talk to the Colonel in a quiet room,  and explain to him (and his colleagues) the seriousness and unacceptability of un-business like behavior. If necessary some money could change hands.  As the CEO of the Italian corporation ENI pointed out, threatening sanctions and military action might result in the ‘peace officers’ – to use one of those lovely expressions coined in the old American West for lawmen – shooting themselves in the foot.**

**A decline in world oil production of perhaps 1.5 percent, due to a clumsy handling of the Libyan troubles, almost immediately led to an increase in the oil price of 17 percent. That is definitely not good, and somebody influential needs to look at the work of Professor James Hamilton (of the University of California, San Diego) in order to judge its macroeconomic ramifications!**

**At the present time (r, 2014) the oil price is displaying an interesting weakness. The price of both WTI and Brent oil have both fallen under $100/b. Will that continue? Well, let’s look at the situation during the last week or two. Oil prices languished around the $95 mark, but rebounded sharply when the head of OPEC indicated that his organization could reduce its production target for 2015. That lines up with the economic logic promoted in this book, and the reason it lines up is that a production cut by OPEC is a prelude to a price rise. If you think otherwise, find out what happened in 2008 and 2009.**

**Finally, it might be useful to ask what has happened in Libya in the three years since Swedish fliers, mechanics and busybodies flew down to that country to – in the words of the ignorant NATO boss – protect civilians. The answer is that a full-scale state of anarchy now prevails. Fighting is taking place in many parts of the country, and apparently the central government is losing control of the situation. As to be expected the issue is not governance, but income from oil exports. Without their share of that income, any Libyan government might as well take a long vacation.**

**Apparently dissidents from the city of Misrata have seized the Libyan capital, Tripoli, and have established an alternative government which is not recognized by the international community. One of the problems for this new government is that while they give the orders in the government buildings, they have little or no control over sources of oil and pipelines. As a student of the international oil market, the most interesting question for me at this time has to do with what would have happened if large quantities of shale oil had not been accessible. I think that I will allow readers of this book to deal with this riddle.**

BENGHAZI Libya**REFERENCES**

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**0.Final comments of Professor Banks**

**I hope that you have found this book as easy to read as I have found to write. As it happens, this is the book I should have started to write when I walked into the faculty of economics at the University of Uppsala, in l973, and from the quite special ambiance/miasma found myself thinking that the 3rd World War had started. Instead, however, I heard that the properties of large oil companies were being confiscated in many countries, and there were no offers on the table by new owners to compensate the old owners.**

**You may know of books that are superior to this book, but hardly an elementary book. And if you don’t know of any books that are superior, as is likely, one day you might. When you do tell me because I would like to read them. I was in the United States recently and enquired about book length work dealing with energy economics, but however was assured that my books are virtually alone on the energy economics shelves in your favorite book stores.**

**You might ask why I am distributing this book by E-mail, gratis, instead of having it published by somebody. The answer is that I am tired of reading and hearing energy economics tales that make no sense at all. Readers may not want or need some of the things in this book, but all readers and potential readers need and deserve some of it, whether they know it or not. Moreover, if they do not like what they get, they can always improve it and sell it to Hollywood or their favorite TV station, or maybe a Broadway producer.**

**Thank you, and now welcome to brilliant lectures presented by you and me.**