The Reliability of Oil as a Source of UK Electricity.

Prepared By

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PROFESSOR JOHN H GITTUS.

John Gittus was elected Regents' Professor at the University of California in Los Angeles in 1990. He is Visiting Professor of Nuclear Engineering at the University of Plymouth, England. He was a Director of the United Kingdom Atomic Energy Authority (later AEA Technology) and is now a Consultant to Governments and private industry on nuclear matters world-wide. His recent clients include BNFL Plc, The UK Government's Department of Trade and Industry, Serco Plc, The Sumitomo Corporation, the French nuclear company COGEMA, Amersham Plc the radio pharmaceutical company, Cox Insurance Plc, the world's largest commercial insurer of nuclear risks, Chaucer Insurance Holdings and ESKOM, the South African utility.

Professor Gittus is a Fellow of the Royal Academy of Engineering (Britain's top 1,000 engineers) and has Doctor of Science degrees from the Universities of London and Stockholm. He has held over 30 patents and published over 100 papers in learned Journals describing his personal research. He invented Nimonic 115, the strongest of the early creep-resistant alloys used for the hottest turbine blades in jet engines and went on to develop a theory of creep that forms the basis of many of his papers to the Royal Society and the Philosophical Magazine. He used this theory to develop one of the world's first computer models of nuclear fuel elements, with which he forecast that some of the fuel element designs then extant would fail as their lives were extended in a quest for cheaper power. He was able to model the failure processes and deduced remedies that have been applied throughout the world. Fuel element failures are now rare, due in part to this early work.

He held a series of senior posts in the UKAEA, where he headed the late Lord Marshall's Task Force at Harwell and produced the UK's first nuclear-reactor Probabilistic Risk Assessment, for Sizewell B. He became Director of the R&D programme that underpinned the design details of Sizewell B, then Director of Safety and Director of Communications. He left the UKAEA to become the first Director General of the British Nuclear Industry Forum, where he helped with the restructuring of the UK nuclear industry, a process that is still going on. When his term of office there was complete he became a consultant, first to his successor and then, quickly, to other nuclear companies at home and overseas. On the death of Lord Marshall of Goring, Professor Gittus was appointed to succeed him at Cox Insurance Holdings Plc, advising on the insurance of the world's nuclear power stations and other nuclear installations. Since January 2003 Professor Gittus and Mr Michael Dawson have led Syndicate 1176, the biggest commercial nuclear insurer in the world and Lloyds of London's most profitable syndicate.

Amongst his published papers are two communicated to the Royal Society by P.A.M. Dirac and describing Professor Gittus's solution of a problem with the structure of matter which Dirac said he himself had been unable to solve.

Entry From Who's Who

Name
GITTUS, John Henry.

Awards
DSc. DTech; FREng 1989.

Positions
Consultant, Amersham Plc, since 1999. Consultant, Cox Power Holdings, since 1997; Consultant, Serco Plc (formerly AEA Technology) since 1993; Senior Partner, NUSYS Consultants, Paris.

Personal Details
Born 25 July 1930; *son* of Henry Gittus and Amy Gittus; *married* 1953, Rosemary Ann Geeves; one *son* two *daughters*.

Education
BSc 1st Honours Mathematics London 1952; DSc Phys London 1976. DTech Metall Stockholm 1975. CEng, FIMechE, FIS, FIM.FREng

Work
British Cast Iron Res. Assoc., 1947-1955; Mond Nickel Co., R&D Labs, Birmingham, 1955-1960 (develt Nimonic series high temp. super alloys for aircraft gas turbine engines); United Kingdom Atomic Energy Authority, 1960-1989: Research Manager, Springfields; Head, Water Reactor fuel develt; Head, Atomic Energy Tech. Br., Harwell; Director: Water Reactor Safety Research; Safety and Reliability Directorate, Culcheth; Communication and Information; Dir Gen., British Nuclear Forum, 1990-1993. Consultant: Argonne Nat. Lab., USA, 1968; Oak Ridge Nat. Lab., 1969. Visiting Professor: Ecole Polytechnique Fédérale, Lausanne, 1976; Univ. de Nancy, 1984; Regents' Prof., UCLA, 1990-1991; Prof. of Risk Mgt, Plymouth Univ., 1997-. Editor-in-Chief, Res Mechanica, 1980-1991.

Publications
Uranium, 1962; Creep, Viscoelasticity and Creep-fracture in Solids, 1979; Irradiation Effects in Crystalline Solids, 1979; (with W. Crosbie) Medical Response to Effects of Ionizing Radiation, 1989; numerous articles in learned jls.

Recreations
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Cause of Interruption	Frequency/year	% Flow	Duration of Interruption, days
Political Risk in Middle East	0.125	0	120

Introduction.

In this Report I analyse the reliability of oil as a source of electricity in the UK in coming years.

The UK has experienced half a dozen politically-motivated interruptions in its imports of ***oil***, leading for example to the "Three Day Week". But how are these concerns to be ***quantified***?

A means of quantification does exist:

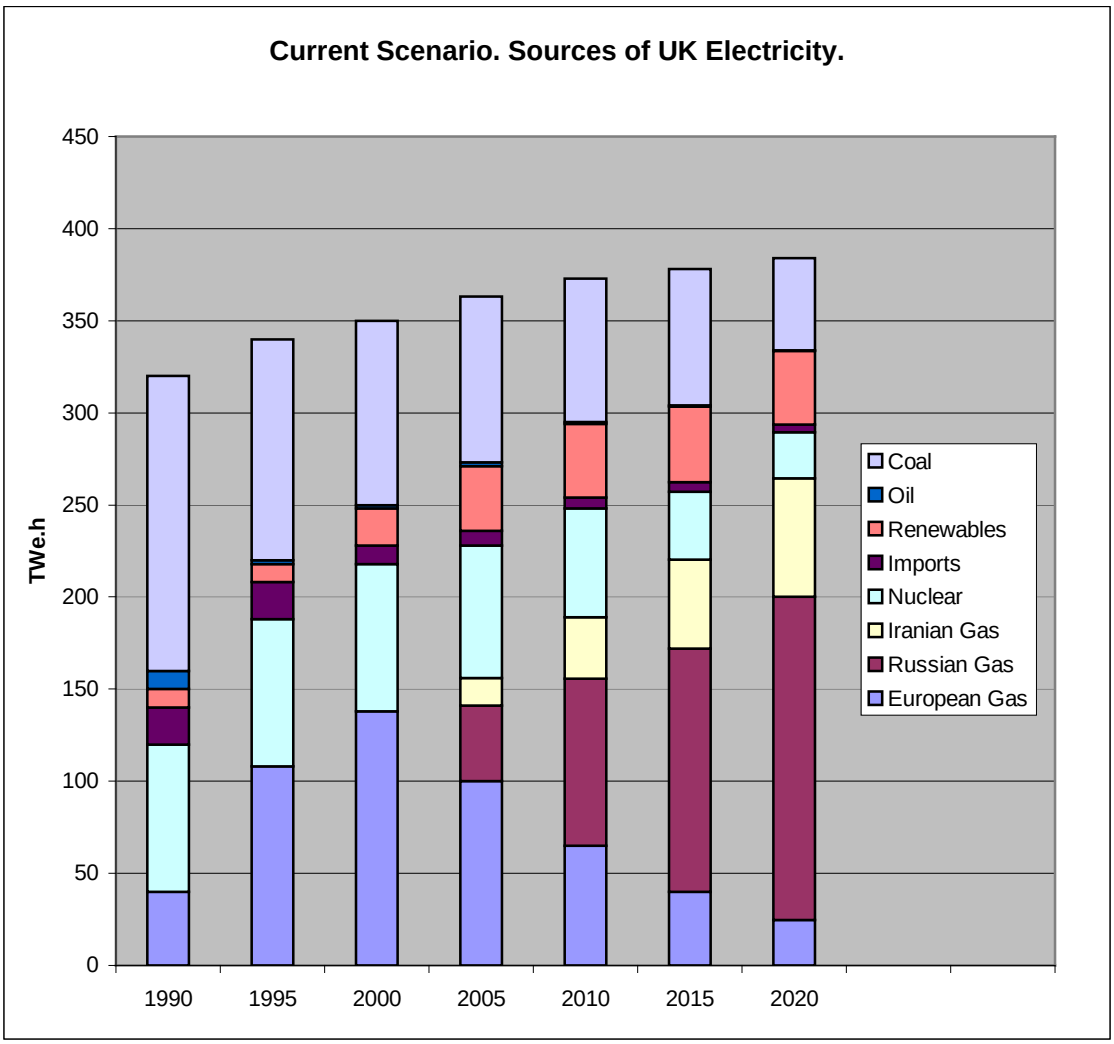
- the business world has developed data-bases on ***political risk*** for most of the countries of the world and
- the insurance companies have extensive data on the losses that have been sustained due to political action in all countries since they insure many of those risks.

In the work described in this Report these two sets of information are used to produce the first numerical estimates of the likely reliability of oil supplies in the years to 2020 and beyond.

The Part Played by Oil.

As the following Figure indicates, the part played by oil in the generation of UK electricity is expected to fall to a very low level between now and 2020.

Figure 2 Present Forecasts of Sources of UK Electricity, to 2020.



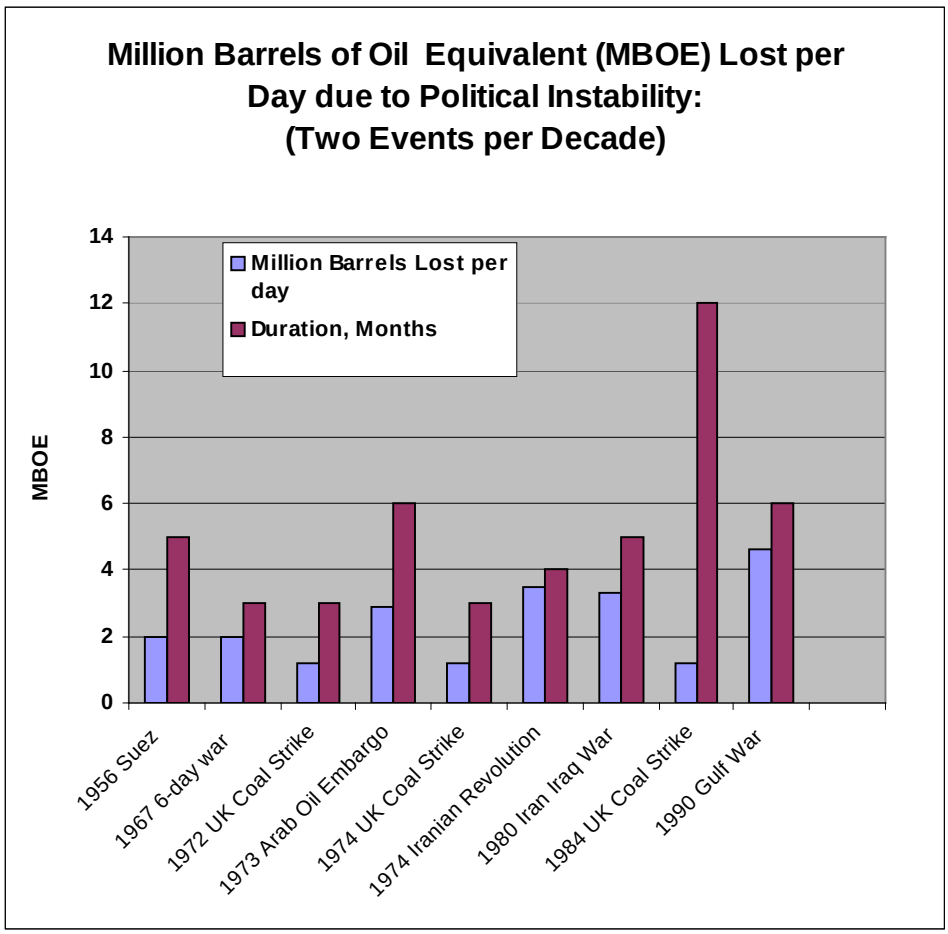
Most of our electricity is due to be generated from natural gas.

Political Disruptions of Oil Supplies.

Disruption of oil and coal supplies due to political activities has occurred twice per decade in the last 50 years. The following graph illustrates this. (Britain used more than a million barrels of oil equivalent per day throughout the period of this graph).

Now not all of the oil was destined for the UK. It may be objected that interruptions of this frequency and duration cannot be ***imagined,*** but the reality is that they have ***occurred*** for oil.

Figure 3: Politically-Motivated Interruptions to UK Fossil Fuel Supplies, 1956-2003.



Oil supplies have been interrupted about 5% of the time. As explained this does not mean that the UK's oil supplies were entirely cut off for 5% of the period, since the loss was shared by several importers and the UK will have had other sources of supply. Nevertheless it led to important economic penalties on the UK economy, such as "The Suez Shilling" (an extra payment for oil) and "The Three Day Week" (because there was insufficient energy to keep the UK factories going for a ***five*** day week).

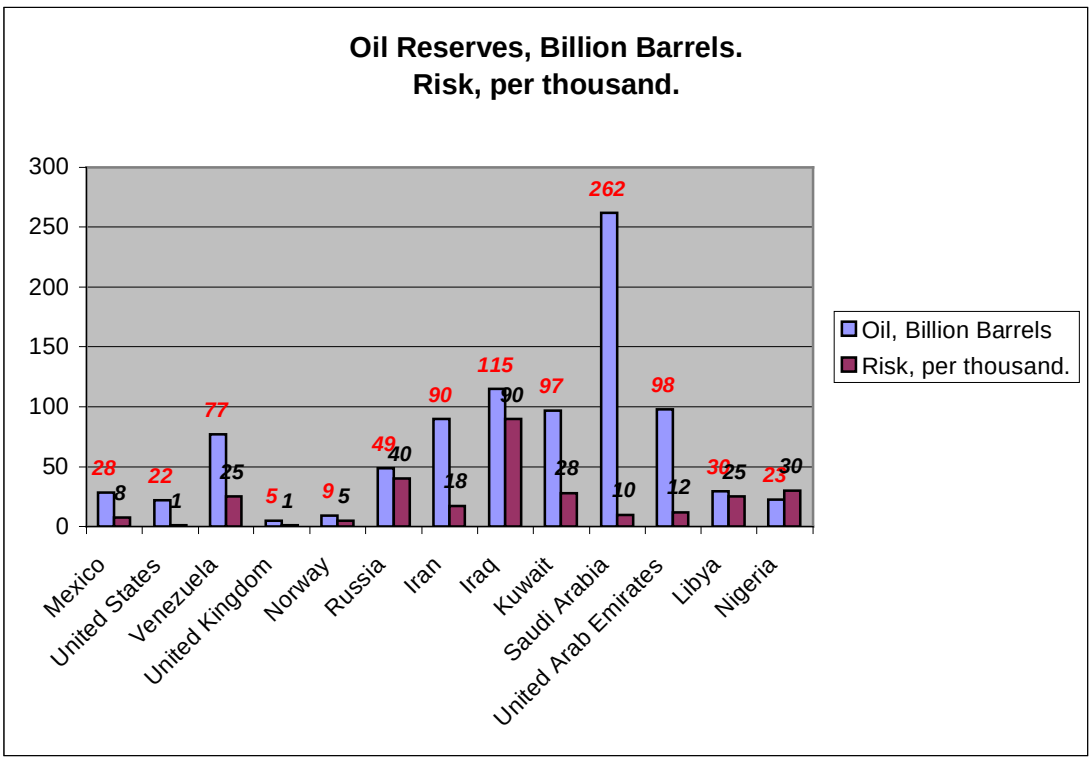
As we shall show in the next section, this figure of 5% is of the order of the Political Risk Premiums for the countries of the Middle East from which the oil came, which must be regarded as good agreement.

Political Risk for Oil Supplier Countries.

First we shall illustrate the locations of the world's main reserves of oil [1]., coupled with the Political Risk Insurance Premium for 2002 for each of those countries.

These are shown in the following figure:

Figure 4: Oil Reserves and Political Risks for various countries.



[1] *Last Updated on 5/23/03 By EIA Email: patricia.smith@eia.doe.gov*

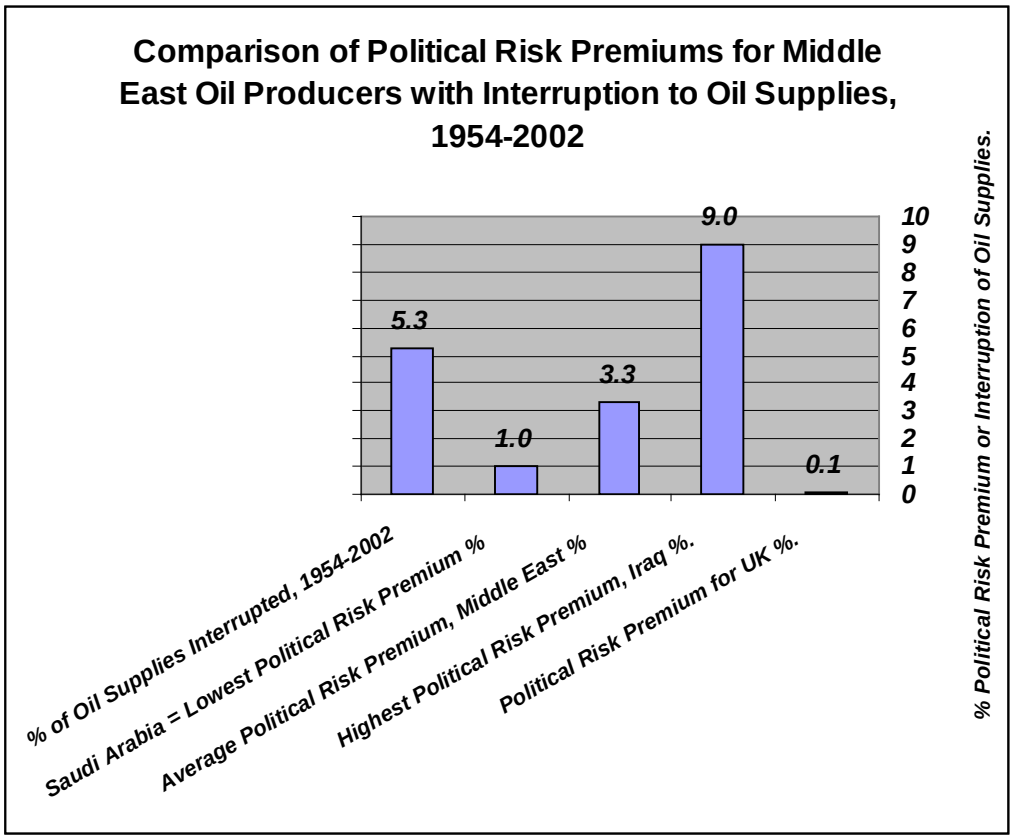
Clearly the UK's oil reserves are negligible and most of the world's oil is in the Middle East

Indeed 700 billion barrels out of the world's 1,000 billion barrels of oil reserves are in the Middle East and the UK reserves amount to no more than 5 billion barrels.

When the UK's oil imports have been cut off, historically, it has been the countries of the Middle East that have cut them off.

For the countries of the Middle East that have the greatest oil reserves and which are shown in the above figure, the average Political Risk Insurance Premium in 2002 is 3.3% and the range is from 1% for Qatar to 9% for Iran.

Figure 5: Political Risk Premiums for Main Middle East Oil Producers Compared to the Interruption of Oil Supplies, 1954-2002.



The interruptions to oil imports were of similar ***daily magnitude*** to the UK's ***daily consumption*** of oil and occurred at a frequency of 6 in 46 years or one in eight years.

We conclude, therefore, that:

- The actual Risk, in percentage terms, presented by Politically-motivated interruptions to oil supplies over the last half century is numerically similar to the Political Risk Insurance Premium for the countries of the Middle East from which this oil was imported.
- Interruptions of oil supplies occurred at intervals of order 10 years and each lasted a significant part of a year.
- We may therefore hypothesise that the frequency, per year, of interruptions to Middle East oil will be proportionate to the Political Risk Insurance Premium. We can make use of the correlation that we have found, between this Premium and the Political Risk Index to forecast Premiums for future years to 2020. A Premium of 5% would then imply, in the simplest case, that interruptions of 6 months could be expected every 10 years. This, as we have shown, is essentially the historic pattern for supplies of oil imported by the UK from countries for which the Political Risk Premium is around 5%[2].

Forecast Reliability of UK Oil Supplies, to 2020

From Political Risk and Political Insurance Premiums for Oil producers in the Middle East and other oil producing countries such as Russia, Belarus, Ukraine plus the history of interruptions of oil from Middle East over the last 50 years I arrive at the following forecast:

Figure 6: Frequency of interruption of Oil Imports to the UK, 2003 to 2020.

Cause of Interruption	Frequency/year	% Flow	Duration of Interruption, days
Political Risk in Middle East	0.125	0	120

[2] More exactly, we can expect a few longer periods of interruption and the greater the length of a given class of interruption, the less frequent such interruptions will be. This implies that if we fix on interruptions of a given length, say six months, then their frequency will be proportionate to the total annual risk, that is to say to the Political Risk Insurance Premium