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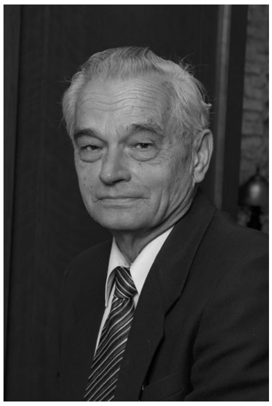
# EDITOR'S PAGE

## DOES OIL SHALE HAVE A SIGNIFICANT FUTURE?



Modern civilization and, in particular, industrial civilization, which concentrates on economic growth and improving life styles, is dependent on inexpensive energy, predominantly coal, oil and gas. Of these sources, oil has had the most pronounced effect since it is a relatively safe, transportable, storable and convertible source of energy that has enabled compound growth in oil consumption, particularly in the people and goods transportation sector. This mobility has dramatically altered the way the world's populations live and there is no turning back; so, we are faced with a series of circumstances and realities related to this energy-intensive way of living and developing into the future.

While there are numerous studies and publications available relating to the world's energy picture, it is sometimes worthwhile to take a look at past projections and interpretations of key data to see if our more recent understandings have significantly altered these trends. The following are excerpts of a series of graphs and data taken from the book titled Only One Earth by Barbara Ward and Rene Dubos (Commissioned in June 1972 by the Secretary General of the United Nations Conference on the Human Environment).

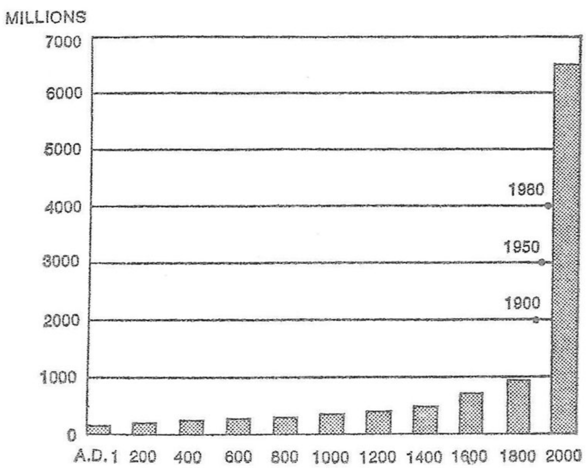



Fig. 1. World population A.D. 1–2000. Source: United Nations data.

According to this graph, the world population would have been over 6 billion by 2000, so there has been a slight reduction in actual growth rate versus this prediction. Future predictions show a gradual tapering off of the population growth rate with a levelling off in the 10 to 12 billion population range.

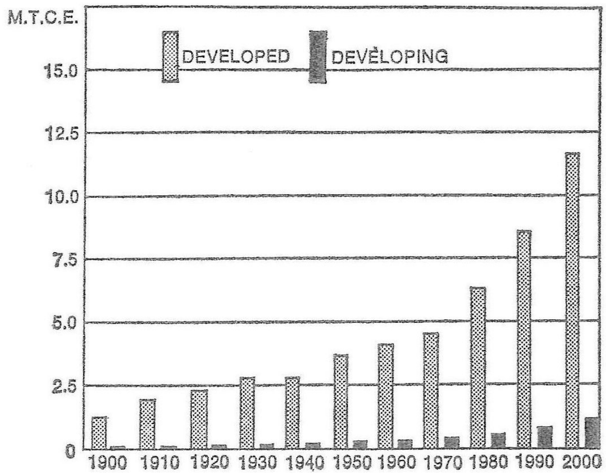



Fig. 2. Developed and developing countries energy consumption per capita in metric tons of coal equivalent. Source: United Nations data.

This graph is an indication of the growth in total energy consumption with time for "developed" and "developing" countries. The units are in metric tons of coal equivalent. Based on the projections, in the year 2000 the developed countries would have consumed per person average of 11.5 mtce/yr, while developing nations would have consumed 1.1 mtce/yr for a ratio of approximately 10:1. Recent data indicates that the energy consumption for the developing world is increasing more rapidly than this prediction.

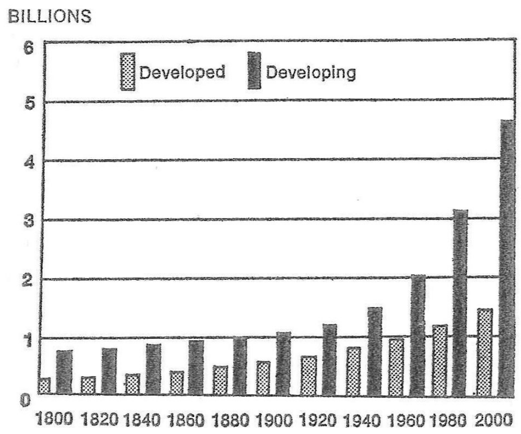



Fig. 3. Population estimates: Industrially developed and developing countries. Source: United Nations data.

This graph provides an estimated population distribution between developed and developing countries. According to the then projection, by the year 2000 the developed world would have had a population of 1.4 billion people, while the developing world's population would have been 4.7 billion people. While these projections were made 40 years ago, they have been reasonably accurate and predict that the world population and energy demand are increasing steadily and, subject to political and economic variables and the unlikely possibility of a development of a major new energy source, are likely to continue increasing.

While there are many projections for future oil demand, the following is a 1999 projection obtained from internet sources.

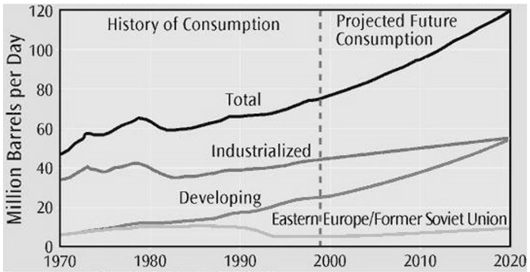



Fig. 4. World oil consumption by region 1970–2020. Source: Association for the Study of Peak Oil, www.asponews.org

Based on this projection, at the year 2010, the demand for oil would have been approximately 90 million barrels/day. The actual demand was somewhat lower, in the range of 80–85 million barrels/day. The projection also indicates a world oil demand in the range of 120 million barrels/day by 2020. While there have been many forecasts, there are no oil consumption projections that show a downward trend, and even this projected increase in consumption is insufficient to balance out the inequity in oil consumption between the developed and developing countries of the world.

So, where is the oil supply going to come from? A recent article on the internet discussing world oil reserves provides the following breakdown:

| | ZJ ($10^{21}$ J) |
|---|---|
| Proven oil reserves | 8–10 |
| Oil sands | 2–3 |
| Heavy oil | 3–5 |
| Oil shales | 10–15 |
| Future discoveries | 3–10 |
| Total | 26–43 |
| Currently unrecoverable oil remaining | 15–30 |

The annual oil consumption in 2010 was approximately 0.2 ZJ and, at this rate, all of the available oil reserves could be consumed in the next 75 to 100 years, even if oil shales development on a massive scale is undertaken since those shales represent approximately 35% of the world's reserves.

This type of development would require many billions of dollars in capital expenditures and operating costs, which have to be recovered from sale of products. Since the early 1970s, the price of oil has made dramatic swings, but the trend has been upward. With a relatively conservative projection based on oil prices rising only at a rate of inflation of 2.5% per year, the oil prices could be as follows:

| | Dollars/Barrel |
|---|---|
| 1960 | 2–15 |
| 2000 | 30–80 |
| 2010 | 90–105 |
| 2020 | 125–150 |
| 2030 | 170–210 |
| 2040 | 200–260 |

At these oil prices, the revenue streams should be able to provide the money required for rapid oil shale development.

The foregoing discussion has established that there is a definite demand for any oil products obtained from oil shales and the revenue obtained from sales is adequate to cover the costs of oil shale developments. These are the relatively simple components of the ingredients necessary for oil shale development. The more difficult components are technological, environmental and, to a certain extent, political.

Parallels have been drawn between oil shales and the oil sands in Alberta, Canada where there has been a rapid acceleration in capital projects and synthetic crude and diluted bitumen production. These oil sands are currently producing in excess of 2 million barrels per day of oil products and this production capacity is projected to increase to approximately 6 million barrels per day by 2025 before levelling off in the 6 to 8 million barrels per day range. This rapid expansion has been largely due to development of in situ techniques taking advantage of horizontal drilling along the oil sands bedding planes, and then using steam injection to heat the bitumen to reduce its viscosity and allow for it to flow by gravity to collector pipes. Various viscosity-reducing agents are being developed to further improve bitumen recovery.

In contrast, oil shales are composed of kerogen, which is essentially a solid, so that the in situ techniques developed for oil sands cannot be utilized. In order to utilize in situ techniques for oil shales, the shale formation must be heated to at least 300 °C (slow release of gases and light oils) or, preferably, closer to 500 °C (rapid thermal alteration of kerogen to produce a range of oils and gases). While a considerable amount of research and testing is being carried out to develop in situ techniques, none have proceeded to a large-scale demonstration stage. Given the attendant problems associated with oil shale in situ processing, such as oil recovery efficiency, $CO_2$ release/barrel of product and the potential for groundwater contamination due to the residues remaining from the kerogen thermal cracking, it appears to be unlikely that commercial in situ operations will be underway in the near term.

With the current knowledge and technology related to oil shales development, the only option is to use conventional open-pit or underground mining methods to extract the oil shale and then to use aboveground retorting plants to thermally crack the kerogen to produce a range of oils and gases. Retorting plants have been developed and are operating for 20 years or more in Estonia, Brazil and China. In recent years, many small-capacity vertical retorts have been constructed in China to help satisfy some of their energy demand, and several new or improved system retorting units are currently being constructed or started up. These are:

| | |
|---|---|
| VKG in Estonia | 125 t/h updated version of UTT3000 Galoter (in initial operations) |
| Eesti Energia in Estonia | Scaled-up and extensively modified version of Galoter UTT3000 (under construction) |
| FMG in China | 230 t/h rotating oil shale processor using ATP System technology (currently under start-up) |

These new plants and the vertical retort in Brazil represent the most recent process developments that will guide future developments. Given the time and resources, the process and equipment-related activities can be resolved. There are other very significant issues that need to be addressed and resolved before there is to be significant growth in oil shales processing. These relate to the following:

- $CO_2$ emission levels
- Water consumption
- Downstream processing ($H_2$ requirements)
- Other emissions related to combustion
- Disposal and storage of processed shale
- Groundwater contamination (leaching)
- Thermal efficiency
- Mining area stability
- Infrastructure requirements
- Utility requirements
- Transportation to markets (pipelines)
- People resources

Oil shale is one of the major resources from which liquid hydrocarbons can be obtained. The demand for oil on a worldwide basis is there, the financial incentives at the current and projected oil prices are there. We now need to collectively tackle and resolve the technical, environmental and political issues so that this resource can be properly utilized and can contribute to fuel security for the world's ever increasing population.

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