REFLECTIONS ON THE DYNAMICS OF OIL AND NATURAL GAS MARKETS

WEC Statement 2004

The World Energy Council (WEC) recently published *Drivers of the Energy Scene*, the first report of the 2002-2004 Work Programme leading to the 19th World Energy Congress in Sydney, Australia, in September, 2004.

This report, focussed primarily on past and current trends in oil and natural gas markets, describes how the energy system has worked in practice, what the dynamics of the energy markets have been and how energy availability and energy acceptability goals could impact on GDP growth and energy accessibility in the future.

The 2004 WEC Statement reviews the key observations of *Drivers of the Energy Scene*. It points to developments, both qualitative and quantitative, which may run counter to common knowledge or analysis.

In the pursuit of sustainable and secure access to energy services in both developed and developing countries, WEC continues to emphasise the importance of keeping all energy options open. A number of questions arise as a basis for debate at the Sydney Congress and for input to the future Work Programme of WEC.

The full set of graphs and tables and the text of *Drivers* may be obtained at www.worldenergy.org.

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SOME IMPORTANT QUESTIONS AND OBSERVATIONS

The most important factors in sustainable energy development are the prospects for global economic growth and investment, improved energy accessibility for the poor, security of supply and the local, regional or global emissions resulting from energy production and use. These issues are interlinked, and actions to address them will drive the energy sector for many years to come.

What is the rate of growth in global GDP likely to be, given the institutional barriers within economies and energy markets as well as the possible negative feedback of higher real energy prices? The evolution in energy pricing will be characterised increasingly by "stop and go" episodes, each resulting in a decline in energy prices followed by a significant rise. Such price movements will have positive and negative feedbacks on global GDP growth and on the deployment of new technologies for cleaner production and end-uses.

Taking into account economic trends and feedbacks over the last 30 years WEC has concluded that global GDP could grow at significantly less than 3% per annum for the next three decades.

How can real progress be made in providing commercial energy access for the poor and more reliable service for those who do not enjoy it now, and what will this mean for global GDP growth? Any sustained upward adjustment in real primary energy prices would benefit energy availability (including efficiency) and help achieve energy acceptability (including environmental benefits). If higher primary energy prices or other factors translate into higher real final energy service prices, however, this could impact negatively on global GDP and make universal energy accessibility more difficult to attain.

Without clear policies and targeted, temporary programmes to offset higher final energy prices, WEC doubts whether it will be possible to deliver sustainable commercial energy access for the world's poor within the period to 2030. We would miss a significant opportunity to establish a cycle of economic growth and social stability to the benefit of all people in both rich and poor countries.

If the increase in hydrocarbon supplies involves higher costs for environmental or other reasons, what are the new sources of affordable energy services likely to be? Will the balance among oil, natural gas, coal, nuclear power, hydro and other renewables shift their ranking, as they did in 1973? The outlook for hydrocarbon supplies and their prices, in particular, will continue to impact the level of energy-related GHG emissions and annual GDP growth. Technology development will be critical in determining which new energy options will be available and when, but it will also be a factor in efficiency improvements within the supply chain, within power plants and in the demand for energy services.

WEC argues that oil will continue to be the dominant marginal fuel in energy markets for many decades to come and that synthetic fuels, such as liquids from coal, will increasingly play a role as a prelude to the hydrogen economy. Without the stimulus of higher real energy prices, efficiency improvements in energy production, transportation, distribution or end use cannot be sustained.

Finally, in a world of lower economic growth and higher real energy prices, what is the precise nature of trends in global emissions, and what are the least-cost carbon mitigation strategies, technologies or regulations to address them? A range of carbon mitigation technologies is now available, including clean fossil fuel technologies, and it is possible to foresee the day when CO_2 capture and sequestration will be safe and affordable.

It is WEC's view that the number one action simultaneously to meet energy security and emissions goals is to keep all energy options open, including GHG-neutral energy sources such as nuclear and large hydro power.

LINKS BETWEEN DRIVERS AND GOALS

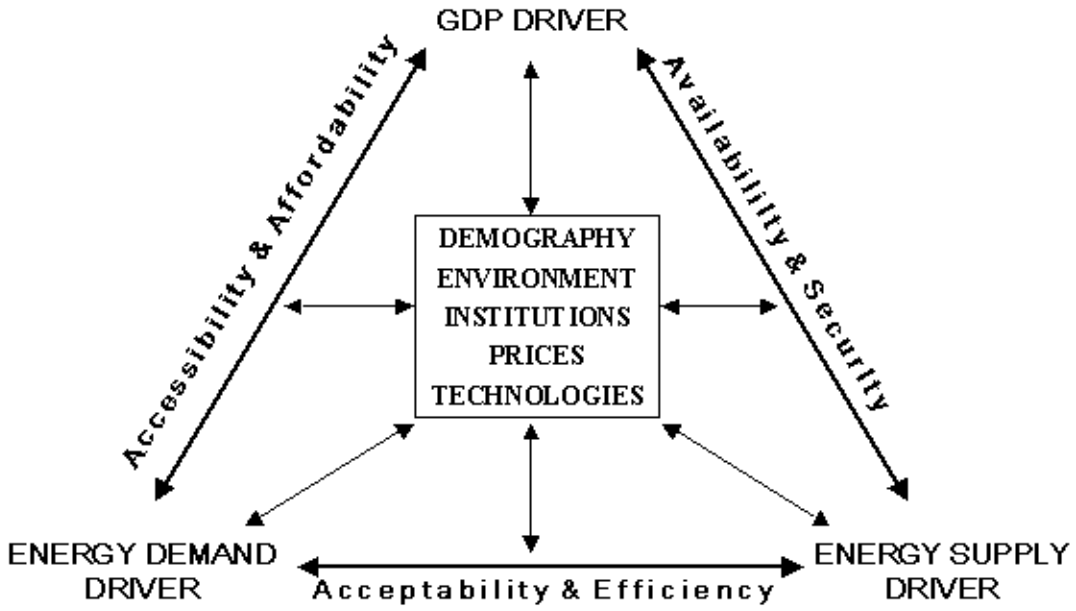
Energy drivers can be evaluated in three groups:

- The *GDP Driver*, which describes the demographic, institutional and technology feedbacks on GDP growth;
- The *Energy Demand Driver*, which covers the nature and evolution of energy consumption in stationary, mobility and electricity services and how they impact the environment; and,
- The *Energy Supply Driver*, which deals with the availability and cost of energy and their feedbacks on prices or the prospects for economic growth and energy demand.

These energy drivers play a key role in achieving the WEC mission of sustainable energy development for the greatest benefit of all. Past trends demonstrate that:

- *energy accessibility* is central to economic development, but improved access and reliability in developing countries seems to have slowed down or stopped in the last 30 years;
- *energy acceptability* is linked to energy demand. Over time, demand tends to evolve towards cleaner and more sophisticated energy uses, thus driving primary supply in the direction of cleaner and more versatile fuels; and,
- *energy availability* is the key for the first two drivers, because sustained energy supply shocks or crises hamper economic development and force societies to adapt to a more costly energy world.

The drivers, feedbacks and energy goals are interdependent and may be described using the simplified diagram which follows. There is no doubt that improved institutional capacity will foster economic growth, but it cannot prevent an economic crisis if energy prices skyrocket. New technology can result in the improved efficiency of energy services or an increased range of supply options, but it may be expensive and require the costly replacement of capital stock. In a similar way, new energy sources may be encouraged, but the full costs could be much greater than existing cheaper and abundant fuels. Last but not least, individual and collective behaviour plays an important role, for example, by favouring energy-intensive uses such as sport utility vehicles, or by opposing the further development of specific energy sources based on public perceptions which may not be well-informed (such as nuclear power in some European countries).



THE "GDP DRIVER"

The GDP driver has three key components: demographic trends, institutional capacity and technology. These components interact through primary energy supply, final prices for energy services and the quality and versatility of energy systems.

Between 1850 and 1948, average global GDP growth was about 1.7% per annum, and world population increased from about one billion to 2.5 billion people. Democracy, reliable property rights and banking systems were established in many countries. Electrification spread quickly, and technology development was strong. Primary energy (based on coal) was cheap and abundant, but the versatility and quality of energy systems suffered from this dependence and from local and regional pollution resulting from coal extraction and combustion.

From 1949 to 1973, the rapidly growing population reached 4 billion people. This, along with international recognition of trade and property rights, a high level of savings and broader technological progress in mobility and electricity use (for example, aircraft and domestic appliances) drove GDP to an exceptional world average of 5% per annum. The primary energy supply expanded rapidly, and dependence on oil increased dramatically thanks to its low and stable price. Oil's greater versatility compared with coal fostered a huge expansion of all types of energy-related services. Simultaneously, the gap between domestic oil supply and demand in the USA (which had become a net oil importer at the end of World War II) grew quickly, especially after 1970, when domestic oil production reached its peak and started to decline. This led to a growing reliance on the excess oil capacities in Middle East countries. The first oil shock of 1973 brought the cheap energy era to an end and sent a signal to energy suppliers to find new sources of oil or other competitive forms of energy to meet demand.

Since 1973, because of the large share of oil in the global energy mix (as well as natural gas, which was linked to oil in terms of pricing), each sustained oil price hike was associated with lower global GDP growth and a decline in energy intensity during the two following years. Oil became the energy at the margin, replacing coal, and it is the direct and indirect price-setter for all energy services today.

In the last quarter of the 20th century, a number of other developments are worth noting:

- World population increased from 4 to more than 6 billion, and the pace of ageing and urbanisation accelerated, while the rate of overall demographic growth began to slow down, signalling the beginning of a transition;
- With a decline of global GDP growth to about 3% per annum, serious regional economic crises led to slower progress in terms of institutional or market reforms in both developed and developing countries;
- New technologies and more efficient new equipment were deployed in response to higher energy prices, resulting in a lower level of energy consumption per unit of GDP;
- Progress in providing commercial energy access flattened out and the reliance on traditional biomass has remained a fairly constant 11% of total primary energy supply; and,
- The primary focus of energy policymakers (particularly in OECD countries) shifted from energy availability concerns to those of energy acceptability and the environment.

GDP growth does not depend solely on the behaviour of individual stakeholders – they will always draw the best from their business/institutional environment. Nor is GDP growth beholden solely to the unpredictable vagaries of "Mother Nature", with temporary energy imbalances that could affect GDP growth negatively. In our complex societies, GDP growth also depends on governments. Unless they have the courage to push the broad agenda of institutional reforms, ranging from reliable banking systems and secure property rights in the poorest countries to the management of pensions, education, health and infrastructures in the rich economies, the benefits of technology and entrepreneurship will not spread to everyone.

A number of considerations lead WEC to the view that world GDP could grow at significantly less than 3% per annum over the next three decades. These include demographic trends, the potential for higher real energy prices and the failure adequately to address institutional barriers to energy access in developing countries, but it has also been necessary to make adjustments for anomalies in some GDP methodologies, particularly those used in the USA, China and Russia. If annual global GDP growth proves to be lower than expected, WEC is of the view that the impact on investment in energy supply could be more severe than the impact on energy demand, leading to higher real energy prices.

THE "ENERGY DEMAND DRIVER"

Energy demand is made up of services for electricity, mobility and stationary fuels, each of which has followed different trends both in terms of relative growth and in sensitivity to energy prices. The main changes have occurred since 1974.

Electricity consumption follows a regular growth trend, nearly linear, compared with GDP, in purchasing power parity. There has been no apparent adverse impact on electricity demand from the energy events during the period of the oil shocks. This can be attributed to two features of electricity markets: first, they are "captive" in the sense that there is little room for users to switch back to the direct use of fossil fuels;

and, second, electricity prices have been relatively low and stable over a long period of time.

The trend in mobility service demand has been nearly as steady as that of electricity. Mobility is the "captive" sector of oil. With the exception of North America, real final gasoline prices have remained fairly steady in most regions because high fixed costs (such as transportation and refining) as well as taxes (which account for up to 80% of the final price) have cushioned any impact of oil price increases.

The trend in stationary fossil fuel end-uses (such as heating and cooking in buildings and industrial processes) is quite different from those for electricity or mobility. Each oil price shock has led to a drop in this energy service, with the result that stationary end-use today has begun to decline in developed countries and is stable for the world as a whole. This is due in part to improvements in energy efficiency in transformation and industrial processes. The "de-location" of major energy-intensive industries, such as steel, from developed to developing countries is also a significant factor in explaining the decline in stationary fossil fuel end-use in developed countries.

While different fuels may be used for electricity and stationary services, mobility services (with the exception of electric trains) are rigidly linked to the oil sector itself and account for well over 60% of total oil use. Synthetic liquid fuels (or in the more distant future, electric or hydrogen-powered vehicles) are potential competitors for oil in the mobility sector in the years to come.

These contrasting trends reflect the role of final prices and GDP in driving the demand for energy services. Consumers tend to reduce energy consumption when a price increase is sustained at a new level, but if GDP and incomes are growing, they also find new uses for energy services which result in higher consumption. Thus, energy efficiency can play different but complementary roles which are tied to technology: reducing energy consumption when prices rise, or increasing the value of a given level of energy service when energy prices decline or remain stable. Energy efficiency and technology are two sides of the same coin, but final prices and GDP are the binding agents.

Demand for mobility and electricity is relatively low in most developing countries but will increase rapidly in the coming decades. Increased energy access (especially the provision of modern energy services to the world's two billion poor people) will have a relatively small impact on global energy demand but could contribute through multiplier effects to a better than expected average rate of growth for world GDP.

Many factors, such as market reform, technological breakthroughs, environmental constraints and other policies, will have an important influence on primary energy pricing and on the cost of final energy services to consumers. WEC continues to believe that energy market reforms which promote competition will help increase efficiency and promote trade provided clear, stable regulations maintain high standards of fair pricing, reliability and quality of service. If reforms fail to achieve this, they could have a negative feedback on energy demand growth in the future.

THE "ENERGY SUPPLY DRIVER"

The uncertainties in energy markets, emanating from the long lead times for investments in new supplies or capacity to meet new demand or for infrastructure to

transport such supplies over long distances or across borders, reinforce the volatility of energy price movements. The dynamic interplay of supply and demand can be quite severe because most energy supplies (in particular, but not exclusively, oil and natural gas) have short run marginal costs much lower than long-term marginal costs. Hence, if market forces were the sole driver, energy prices would be very low as long as excess capacities exist but very high when they have been eliminated. It is the new investments in response to higher prices in times of sustained shortages which shift the ranking of primary energies.

When there was no dominant actor controlling or managing the market, the dynamics of oil and natural gas supplies explain why their price was very volatile. As long as oil and natural gas – which is priced in lock step with oil – had a small share of the world energy supply, and the energy market was dominated by coal (with its more stable price), oil/gas price volatility had little global, macroeconomic impact. This situation changed during the 1950s and 1960s because of the rapid growth of oil and gas shares in the global energy mix, but it remained unnoticed because the oil price was under the control of the Texas Railroad Commission up to 1959 before passing under the control of OPEC in 1960.

The market dominance of the TRC and subsequently, OPEC, was certainly one factor explaining the stability of oil prices prior to 1973, but it is not the only one. The industry was vertically integrated and controlled by a few companies (the majors or "seven sisters") which had agreed in 1928 to share the prolific Middle East fields and the growth in downstream markets; these arrangements were the ideal instruments to manage the smooth growth of the oil market. With the nationalisations of the 1970s and the different strategies adopted by large consuming countries, this price control disappeared, leaving OPEC alone to manage a market that had become unpredictable because of the new swing role of oil and the growing dominance of spot transactions.

A new energy story developed after 1973. The oil price today is managed by OPEC as long as capacity margins exist in order to match demand and supply: if the price of oil is too high, this will lead to lower GDP, economic recession and a shrinkage in demand for oil, coupled with the development of alternatives which ultimately have an adverse effect on the OPEC countries that are the swing producers of the swing energy; if the price is too low, as in the early 1970s, the capacity margins for producers will disappear, and they will try to withhold marginal supplies and/or reduce exploration for new supplies, eventually leading to a price rise, again lowering GDP and, in turn, to lower demand than before. Hence, what is important is the production capacity (called the "tap") and not, except in the very long run, the ultimate reserves (often called the "tank"). The growth and decline of specific primary energies over time have never resulted in the complete exhaustion of their reserves because, with the right price signals and international collaboration, new, more competitive sources of energy emerge in time to take their place.

Despite new oil production in non-OPEC countries using new exploration and production technology (such as deepwater, Caspian oil and the accelerated depletion of Russian fields), it is WEC's view that oil production outside the Middle East started to decline at the end of the 1990s. It appears that natural gas production in North America has now also peaked, and this could soon be the case in Western Europe as well. There are capacity constraints even within OPEC itself: Iraq oil

production appears to have returned to pre-war levels, but no one can predict when it will achieve its full potential of 4 or 5 Mb/d; it is hard to determine when the production of the Middle East fields, more than 50 years old on average, will begin to decline.

If cheap and versatile energy supplies were the main source of past productivity gains and higher economic growth at the world level, what are the prospects for the future? In the first years of the 21st century, with OPEC trying to balance producer and consumer interests, oil prices have stabilised in a range around US$25/b. This could bring on additional natural gas supplies in the form of LNG, but at a much higher price, thereby moving natural gas to a mid/peak load role in the energy mix. Such price effects are, in WEC's view, likely to be sustained and will therefore have feedbacks on the economics of alternative supplies and the deployment of new technologies. They would also have positive feedbacks on national or global efficiency and environmental goals.

Other constraints may impede the development of energy supply in timely fashion to meet demand, for example:

- Policies aimed at reducing GHG emissions could lead to additional costs that will affect all fossil fuels. Costs of up to US$50/t CO_2 are possible, which would add US$20 per barrel of oil.
- The peaking of natural gas production in North America and Europe will increase the demand for additional imports, mainly LNG. The high cost of new gas pipelines from Russia or Central Asia limit their potential for additional exports.
- There are political or technical limits to non-fossil fuel supply, either because of lack of public acceptance for large hydro and nuclear power or because of the intermittent and/or dispersed nature of most modern renewable energies.
- NIMBY (Not In My Backyard) attitudes may prevent the building of enough LNG re-gasification facilities, high voltage transmission lines and power plants, which could adversely impact the versatility and security of energy systems.

Such energy supply constraints may play an important role as a negative driver of the energy scene in the coming years in spite of the best efforts of governments and energy industry players. They will not generally originate from a lack of energy resources in absolute terms but will be triggered by two fundamental feedbacks working separately or together:

- A sustained shortfall in primary energy production or supply bottlenecks in key markets (such as occurred for oil in the USA in 1973 or for coal in China after 1996, and could occur for natural gas in the years to come); and
- A more fundamental shift away from one major energy source because of changes in relative costs or prices, because of external factors (e.g., wars or revolutions), because of public opinion or because of stringent environmental policies (e.g., precautionary action to address the threat of climate change).

In contrast, while the increase in energy supply to provide affordable energy services to those who now have little or no access to them would be relatively small, such

access could prove to have a more general, positive impact on the energy scene. Improved energy access in developing countries will enhance national economies and the flexibility of the global economic system to overcome new challenges, including possible future economic crises. Improved energy access could result in more peace and security in the world and, consequently, more reliable energy supplies.

WHAT ABOUT THE FUTURE?

Given the far-reaching consequences of the change in the marginal energy supply which occurred in 1973 after the first oil shock, one might wonder whether similar dramatic changes might occur in the future or whether oil will remain for decades to come the marginal fuel. Some analysts put enormous hope on natural gas, which (without intervention) is not as liquid as oil, while others point to the hydrogen economy. WEC believes the natural gas market today is to some extent mirroring the experience with oil in the 1970s. As for hydrogen, there are major hurdles in the way of its widespread development, such as the capacity to produce hydrogen cheaply, the development of new infrastructure and, ultimately, the availability of fuel cells at a competitive cost.

The gasification of coal, unconventional oil or biomass may provide, thanks to synthetic liquid fuels, a transition towards pure hydrogen. Such synthetic fuels can use existing infrastructure and devices available today, are closer than the hydrogen age and could become the next price-setter in energy markets. Many bifurcations in terms of the role of new technology at both the production and utilisation ends of the energy system exist, but WEC expects oil to retain its place in the global energy supply (largely for mobility's increasing share of energy requirements worldwide) alongside new synthetic fuels and, later, hydrogen.

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