Leo Roodhart
President, Society of Petroleum Engineers and VP Group GameChanger, Shell

Future of Energy

The Global Challenge

The global energy system sits at the nexus of some of the deepest dilemmas of our times: prosperity versus poverty; globalization versus security; and growth versus the environment. Current energy trends are patently unsustainable — socially, environmentally, economically. That said, there is still plenty of oil and gas to be found and produced, most of it is in increasingly difficult places - whether that's difficult geology, difficult environmental conditions or difficult politics.

The global energy system sits at the nexus of some of the deepest dilemmas of our times: prosperity versus poverty; globalization versus security; and growth versus the environment.

Whatever happens, supplies of easy-to-produce oil will certainly not keep up with growing energy demand. This is because, as economies grow and ascend the energy ladder, demand is likely to double over the first half of this century and we simply cannot increase (oil and gas) production that fast. Even if we produce energy from all possible sources it will be difficult to meet the world's growing needs. Within this context, while oil will remain the leading energy source and there will be some price volatility, the era of cheap oil is over. The key questions being asked here are when is global oil and gas production going to peak? This could be anytime between now and 2040 for oil and a decade later for gas. How can we take it out of the ground fast enough to meet demand? How can we fill the gap between supply and demand from renewable energy such as wind, solar, etc or from coal or nuclear energy when, historically, it has taken 25 years for new energy sources and carriers to obtain a 1 percent share of the global market following commercial introduction? And will there be one leading alternative energy source?

To add more complexity, the oil market itself is also undergoing major and lasting internal structural change, with National Oil Companies (NOCs) in the ascendancy against the Integrated Oils Companies (IOCs) such as Shell, BP and Exxon. The NOCs have different motivations for globalization: For example, as China does not have many of own resources in oil and gas (but lots of coal), the Chinese NOCs such as CNPC, CNOOC and PetroChina all have a responsibility to provide the 'motherland' with secure energy supplies. Simultaneously, the NOCs of the major resource holders such as KOC (Kuwait), Petronas (Malaysia) want to expand globally in the downstream, i.e. refineries, forecourts arenas, and so by-pass the 'middle man' (IOCs) who traditionally refine and sell their crude oil. Others, like Saudi Aramco, simply want to decrease their dependency on the technology owned by the IOCs and develop their own staff. The key questions being raised here are therefore what will the role of the IOCs be in the future? And how can they play a role in, for example, sustaining supplies of affordable and responsibly produced oil and gas, through better technology, cost reductions, more efficient operations and fresh thinking?

Lastly, turning to the major challenge of climate change, we have to be clear that emissions of CO2 and other greenhouse gases are on an unsustainable pathway. To avoid "abrupt and irreversible" climate change we need a major decarbonization of the world's energy system.

Options and Possibilities

One of the main uncertainties is around global reserves of hydrocarbons: Nobody really knows how much oil and gas Saudi Arabia or Russia has.

Over the next decade and beyond, there are three main certainties which we call the 3 hard truths - increased demand for energy, an associated struggle for supply to keep pace; and, consequently, increasing environmental stresses: We cannot stop China and India from growing. Within this context, it is evident that hydrocarbons (oil and gas) will remain the primary energy source of choice for the coming decades, gas will become more important in the mix but both will be increasingly difficult to extract. Having picked much of the low-hanging fruit, our industry is now focused on more difficult resources such as tight reservoirs, fractured carbonates, oil shale, oil sands, and ultra-heavy oil.

The other certainty is that, faced with the now fully transparent challenges ahead, the world will electrify, particularly in the mobility arena. While big-city traffic such as buses, taxis and trams will come first, developments in high-end electric cars, such as those being introduced by Tesla, may help to accelerate awareness and acceptance for the general car driving public to switch to electric. That said, the main source of electricity will continue to be from power plants burning hydrocarbons for many decades: Sufficient large-scale renewable electrons will not be available before the middle of the century.

One of the main uncertainties is around global reserves of hydrocarbons: Nobody really knows how much oil and gas Saudi Arabia or Russia has. It is therefore uncertain when global hydrocarbon production will peak, level off or start to decline. We all recognise that alternative sources of energy, renewables, coal and nuclear are needed to fill the gap: Shell's scenario experts believe that renewable sources could provide around 30% of the world's energy by the middle of this century, up from around 3% today. That would be impressive growth, but it also means that it will take forty years to get there and that fossil fuels and nuclear will supply the remaining 70% even then.

While we wait for alternative energy to reach material scale, we may well find it impossible to curb CO2 emissions in time because of the continuously increasing overall demand for energy. Therefore to prevent severe climate shocks we need to also focus on reducing the CO2 intensity of fossil fuels. However, the infrastructure required to capture and transport the CO2 we want to eliminate will be massive, roughly equal to the current infrastructure (pipelines, tankers, facilities) to extract and transport oil and gas across the globe. It is highly uncertain whether the world will be able to build that in time.

Given the long timelines involved in delivering new energy sources, CCS is a transition technology the world simply cannot do without. Indeed the Intergovernmental Panel on Climate Change (IPCC), Carbon Capture and Sequestration (CCS) states that it could provide over half of the global CO2 emissions mitigation effort until 2100. But, in the short term, while seeking to deploy CO2 Capture and Storage technologies, many of the world's energy companies are also trying to address the challenge by reducing the CO2-intensity of fossil energy by delivering more natural gas, the cleanest-burning fossil fuel and by helping the world to broaden the energy mix, with involvement in wind, solar and, in particular, bio-fuels. While the bio-fuels arena is fast developing from first to second generation and also to marine algae, there are also interesting developments around solar energy. Electricity generated by solar panels is predicted to become cheaper than electricity from large scale coal or gas burning power plants within the next 5 years, and countries like Abu Dhabi and Saudi Arabia are planning large-scale solar power plants in the desert.

At the same time, given the energy supply challenge, over the next ten years it is likely that enormous amounts of money will be invested in finding and developing new reserves, which will have an impact on the oil price. Although the price of oil will always be volatile, it is unlikely that oil will become cheap again.

The days of 'easy oil and gas' are over.

Proposed Way Forward

At Shell, we think the world could take one of two energy routes over the next 50 years, which we've called - Scramble and Blueprints. These are both challenging outlooks. Neither are ideal worlds, yet both are feasible. They describe an era of transformation. The choices made in the next five years will be critical in determining which route is taken.

- Scramble summary: In the Scramble scenario, nations will rush to secure energy resources, fearing that energy security is a zero-sum game, with clear winners and losers. The use of local coal and home grown bio-fuels will increase fast. Taking the path of least resistance, policymakers will pay little attention to curbing energy consumption - until supplies run short. Likewise, despite much rhetoric, greenhouse gas emissions are not seriously addressed until major shocks trigger political reactions. Since these responses are overdue, they are severe and lead to energy price spikes and volatility. This is a turbulent and uncomfortable world with many tensions and insufficient attention to environmental issues.
- Blueprints summary: in this scenario energy security, energy supply and environmental challenges are anticipated and coalitions emerge to take the lead in dealing with them. Much innovation occurs at the local level, as major cities develop links with industry to reduce local emissions. National governments introduce efficiency standards, taxes and other policy instruments to improve the environmental performance of buildings, vehicles and transport fuels. As calls for harmonization increase, policies converge across the globe. Cap-and-trade mechanisms that put a cost on industrial CO2 emissions gain international acceptance. Rising CO2 prices accelerate innovation, thus spawning breakthroughs. The energy system is much more stable and environmental outcomes are much better than in the Scramble world.

The best path forward would be to live and work in a "Blueprint" world of a more stable energy system and a more sustainable environment. This future offers a better pathway to provide enough energy for economic growth while managing greenhouse gas emissions.

I see three key areas where our industry can play a positive role in promoting a gradual energy transformation:

First, we need to supply sufficient amounts of affordable oil and gas to meet the world's growing energy needs. The days of 'easy oil and gas' are over. Although there are still huge reserves in the Middle East and possibly Russia, the western Integrated Oil Companies (IOCs) have little or no access to those reserves. The IOCs will focus in the coming decades

Gas will become more dominant and technologies to liquefy gas through cooling or by chemically turning gas into diesel will require massive investments for the years to come.

on the very high-tech, difficult reserves that can be found in the Arctic and ultra deep water as well as the technically challenging shale oil and ultra heavy oils found in the Canadian oil sands. Gas will become more dominant and technologies to liquefy gas through cooling (LNG) or by chemically turning gas into diesel (Gas-to-liquid) will require massive investments for the years to come (Shell will invest in excess of $30bn in 2009, and Exxon will do similar).

Secondly, we need to reduce the CO2 intensity of fossil fuels. The International Energy Authority believes that in the period to 2030 the growth in CO2 emissions from coal fired power generation in just three countries - China, India and the US - will be double the growth in emissions from all the transport worldwide. So the first priority should be to deploy CCS in the power sector, especially coal-fired power. In the transport sector, where we can't capture CO2 from billions of exhaust pipes, the challenge is to reduce the CO2-intensity on a 'wells-to-wheels' basis: We can make big gains by mixing in sustainable bio-fuels, building lighter-weight vehicles, and developing more efficient engines. In the longer term, we can add CCS to hydrocarbon fuel production to bring down well-to-wheel emissions even further. Cumulatively, these measures will allow liquid transportation fuels to compete with vehicle electrification for a long time to come, especially since electric mobility will depend for many years on coal and other non-renewable resources. The world's vehicle fleet will more than double between now and 2050. With a billion new vehicles on the world's roads there will be room and need for diverse energy sources for transportation. The oil industry may play a role in delivering more sustainable electricity, including through natural gas, the cleanest burning fossil fuel, and through CCS.

Thirdly, we can help the world to increase the share of non-fossil fuels: Most oil and gas companies are developing new areas of expertise outside of hydrocarbons. Shell has serious involvement in wind, has proprietary thin-film solar technology, and is a leading player in bio-fuels. For the next few years, for Shell it's in bio-fuels where we will concentrate our additional efforts. Bio-fuels are a natural fit with Shell's downstream capabilities in transport fuel, and, provided they are sourced sustainably, they can make a huge impact in reducing CO2 emissions from transport. Other IOCs, such as Chevron, will choose to focus on a mix of alternatives varying from solar to wind.

Impacts and Implications

The problems the world is facing around energy in the decades to come can only be solved by global cooperation at an unprecedented scale. Massive investments are required in increased efficiency in using energy and in solving the Global warming issue. The Blueprints scenario will be realized only if policymakers agree on a global approach to emissions trading and actively promote energy efficiency and new technology in four sectors: heat and power generation, industry, transport, and buildings. It is critical that the Copenhagen summit in December must deliver a credible post-2012 climate regime. Time is short and we must move fast and with the same ingenuity and persistence that put humans on the moon and created the digital age. For instance we will need to develop Carbon Capture and Storage on a large scale. The Blueprints scenarios assumes that CO2 is captured at 90% of all coal- and gas-fired power plants in developed countries by 2050, plus at least 50% of those in non-OECD countries. It is a big assumption; today, none capture CO2. Because CO2 capture and storage adds costs and yields no revenues, government support is needed to make it happen quickly on a scale large enough to affect global emissions. At the very least, companies should earn carbon credits for the CO2 they capture and store.

Because CO2 capture and storage adds costs and yields no revenues, government support is needed to make it happen quickly on a scale large enough to affect global emissions.