Fossil Energy and Environment - Solution Pathways

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Jorma Ollila (1950) has been Chairman of Royal Dutch Shell plc and Chairman of the Board of Directors of Nokia Corporation since June 2006.

Prior to his current duties he served as Chairman and CEO of Nokia (1999- 2006). He joined Nokia in 1985 and has held the following positions: Vice President, International Operations (1985-1986), Senior Vice President, Finance (1986-1989), President of Nokia Mobile Phones (1990-1992), and President and CEO (1992-1999).

Prior to joining Nokia, Jorma was Account Manager of Citibank N.A., London, Corporate Bank (1978-1980), then Account Officer and Member of the Board of Management of Citibank Oy, Helsinki (1980-1985).

Jorma holds a M.Sc. (Pol.) degree from the University of Helsinki (1976), a M.Sc. (Econ.) degree from the London School of Economics (1978), and a M.Sc. (Eng.) degree from the Helsinki University of Technology (1981).

He has been awarded a Ph.D. (Pol.Sc.) h.c. degree by the University of Helsinki (1995) and a D.Sc. (Tech.) h.c. degree by the Helsinki University of Technology (1998). In 2003, Mr. Ollila was elected an Honorary Fellow of the London School of Economics and Political Science (LSE), and was also awarded Honorary Membership of the Institute of Electrical and Electronics Engineers (IEEE).

He is a Board Member of Ford Motor Company, UPM-Kymmene and Otava Books and Magazines publishing company. He is also Chairman of the European Round Table of Industrialists (ERT) and Chairman of the Board of Directors and Supervisory Board of the Finnish Business and Policy Forum EVA and Chairman of the Board of Directors and Supervisory Board of the Research Institute of the Finnish Economy ETLA.

At Shell, we express the global energy challenge as a set of hard truths - accelerating energy demand growth, lagging supplies of "easy oil", and rising CO2 emissions - all of which need to be addressed in an integrated way. In this speech, Jorma Ollila discusses a number of solution pathways to address this challenge. These are: energy efficiency, capturing CO_2 and other intelligent CO_2 solutions, and boosting the growth of renewable energy. Royal Dutch Shell, with its long history of innovation, believes in the power of ideas and will continue to play its part in the world's search for innovative and sustainable energy solutions.

Introduction

When the comedian Bob Hope became 100 years old on the 29th of May this year, he said: "I am so old, they've cancelled my blood type."

The Finnish Academy of Sciences and Royal Dutch Shell are as old as Bob Hope, a good reason to celebrate. To the best of my knowledge, this has not led to the cancellation of any science or energy type.

I would also like to congratulate the Finnish Society of Physicists with its 60th anniversary; keep on going and you'll be part of the 100-club before you know it.

Zooming in on Shell, if you ask me to summarise in one word what has kept the company going strong, it would be imagination*,* the imagination to develop new technologies and open up new energy pathways.

The US Patent Board and the Intellectual Asset Magazine recently stated that Shell is outperforming its competitors with regard to both the growth and the impact of its intellectual property, in both energy and environmental technology.

Ever since I started working for Shell, I have noticed that people expect us to deliver energy that is Cheap, Clean and Convenient – we call them "the three Cs". For us this expectation constitutes a challenge, since the current energy types usually satisfy only one or two of these criteria. But that does not keep us from always striving to keep cost down, reduce environmental impact and find more convenient ways to make energy available to the customer.

Shell's challenge, of course, is part of a much bigger story . . . the global energy challenge. It is a challenge mankind must address together, as a global community of business people, scientists, politicians and consumers.

Three Hard Truths

The energy challenge has been a theme for Shell for quite some time, and we express it in terms of 'hard truths'.

The *first* hard truth is that global demand for primary energy is not just growing, but that demand growth is accelerating. The main causes are population growth, from six to more than nine billion people world-wide by 2050, and higher levels of prosperity, with China and India in particular entering the energy-intensive phase of their development. Energy use in 2050 may be twice as high as it is today, or higher still.

The *second* hard truth is that the growth rate of supplies of "easy oil" will struggle to keep up with accelerating demand. Just when energy demand is surging, many oil provinces are going into decline.

The *third* hard truth is that continued fossil fuel dominance in combination with a disproportionaly high use of coal will cause higher CO_2 emissions, possibly to levels scientists consider irresponsible.

Energy efficiency

This is a pretty grim picture. And it would be easy to be discouraged. But in the presence of so many of Finland's and the world's best brains, I'd rather focus on a number of "solution pathways" that both enhance energy security and help us to manage emissions.

The first and most obvious solution pathway is *energy efficiency*. In my view, energy efficiency has two closely related components. One is energy *conservation*, the other is energy *performance*.

Energy conservation essentially means that we don't use energy unless we have to, or use as little of it as possible. It involves simple decisions and choices for each and everyone of us. Billions of energy consumers make tens of billions of small decisions each day to either use or save energy.

In many cases, as research by Shell and others shows, people opt for what is most convenient. But there is another side to human nature. I have seen it at work many times. This is the desire to overcome obstacles and improve our performance.

And we must improve our performance . . . for our own sake and that of future generations. Sustainable development requires sustainable consumption.

Governments may have to stimulate behavioural change through education, incentives, taxes and regulations.

The role of industry will be to offer solutions that help people to save energy in a convenient way.

Energy *performance* is about getting the most out of the energy we use. Each day, the world generates 225-230 million barrels of oil equivalent in primary energy. Less than half of that is used in a productive way. In an average car, about 20 per cent of every unit of petrol goes into moving a car forward, the rest is lost as heat. For an aircraft during take-off, the figure is around 8 per cent. Only 35 per cent of coal burnt in many existing power plants becomes electricity; the rest, again, is lost as heat.

The law of thermodynamics dictates that there are limits to how much we can improve our performance in burning fuels, but we must improve, and we can.

Let's explore some possibilities:

In the area of *road transport*, where most of the world's oil is consumed, we are looking for more light-weight and aerodynamic vehicles, with more efficient engines and clean, high-performance fuels, be it diesel or gasoline, synthetic fuels like Gas to Liquids, biofuels, electricity, hydrogen, compressed air, or any of these combined.

It can be done:Volkswagen's Chairman Ferdinand Piech averaged less than 1 litre per 100 km when he drove an extremely light and aerodynamic diesel car from Wolfsburg to Hamburg to join his company's shareholders meeting earlier this year.

The vehicle fleet in the European Union is already nearly 40% more efficient than that of the United States, thanks mainly to higher VAT, which has driven greater car and engine efficiency. If US cars were as efficient as European cars, this could cut US oil consumption by nearly 3.5 million barrels a day . . . or the equivalent of the combined daily oil consumption of France and Britain!

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The global *residential* sector is another candidate for huge efficiency gains. It is the largest consumer of energy, with 25% of global end-use demand. So what can be done?

Take insulation of homes. Here in Finland and elsewhere in the Nordic countries, it is pretty common for houses to be equipped with *triple*-glazed windows, but elsewhere in Europe, and in other parts of the world, millions of homes are still to be equipped with *double*-glazing.

A recent McKinsey report argues that, by implementing high-insulation building shells, compact fluorescent lighting, and high-efficiency water heating, the energy demand growth in the global residential sector could be more than halved, from 2.4% per year to 1% per year.

A third candidate for better energy performance is the electricity generation and distribution sector. While thermodynamics imposes limits, the world would benefit from a higher churning rate of coal-fired power plants. New plants tend to have higher combustion temperatures to burn coal more efficiently . . . efficiency typically goes up to more than 40%.

Moreover, if you equip new power plants with gasification technology, you can further improve their efficiency. Power plants equipped with coal gasification technology typically consume less water, produce less ash and solid waste, have lower emissions of CO_2, and much lower emissions of sulphur dioxide, nitrogen oxide and particulates. They also enable the pre-combustion capture of a relatively pure stream of CO_2, facilitating CO_2 sequestration.

As an illustration of what greater efficiency in the power sector can do, the International Energy Agency tells us that if China's stack of coal plants would have the same efficiency as the average plant in Japan today, China would use 20% less coal.

Building new plants and introducing new technologies comes at a price. So societies will have to strike a balance between higher capital and operating costs on the one hand and on the other hand greater energy security and fewer emissions, and therefore lower environmental and health costs.

Regarding electricity *distribution*, various types of superconductors are being developed that will have a positive impact on efficiency and reduce the amount of raw materials used.

Another way to improve efficiency in the power sector is to stimulate Combined Heat and Power. Again, Finland is a good example, with over a third of electricity and around 80% of heat being co-generated rather than generated separately. Another good example is New York State in the US, which has roughly 5,000 MW of combined heat and power capacity installed and is actively looking for ways to expand that capacity.

The concept can be extended to refineries. A good example is Shell's Fredericia refinery in Denmark, one of the most energy efficient refineries in the world. Shell sells the surplus heat from the refinery as district heating to three cities in the vicinity. Downtime for maintenance at the refinery does not cause problems because the customers have multiple suppliers.

CO_2 capture and sequestration

Fossil fuels will remain the dominant source of energy for decades to come. So, in our battle against greenhouse gas emissions, reducing CO_2 in the fossil fuels chain, especially with regard to coal, will be crucial. That is why CO_2 capture and storage, or CCS, could become important. This process involves separating CO_2 from industrial and energy sources, transporting it to a storage location and injecting it into geological formations for the purpose of keeping it out of the atmosphere for the long term.

The Intergovernmental Panel on Climate Change has identified CCS as the most promising technology for significant and rapid reduction of emissions on a global scale, with the potential for delivering up to 55% of the mitigation effort needed for stabilisation of global CO_2 levels by the end of the century.

But it will not be easy: to keep greenhouse gases in the atmosphere at around 450 ppm, or at least well below 550 parts per million, the uppermost bound of where science tells us we should be, Shell works with theoretical models that assume carbon capture and storage is installed in 90 per cent of all the coal and gas-fired power plants in the developed countries by the year 2050, and 50 per cent of those in non-OECD countries.

The oil industry already knows how to capture naturally produced CO_2 and inject it in oil fields to enhance production. Shell pioneered this technique in Texas, USA, in the 1970s. However, more research will be needed into the infrastructure required to transport CO_2 from emission points to storage locations, especially in cases of large distances between the two.

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CCS is a climate-change driven technology and will require direct and indirect support from governments to drive implementation forward. Indirect support may take the shape of carbon credits to be gained under existing carbon emissions trading schemes. If companies like Shell are to pay a price for CO_2 emissions, oil&gas companies and utility firms need to be able to earn credits for the CO_2 they capture and store.

Smaller-scale CO_2 solutions that Shell is involved in, include supplying pure CO_2 from refineries to some greenhouses to boost the growth of vegetables and to the soft-drinks industry, and developing useful ways of turning CO_2 into solid form through our mineralisation technology.

Renewables

The third solution pathway is to stimulate the growth of *alternative energy*.

The share of renewables in the global energy mix could go up from its existing very low base of about 1 per cent to about 30 per cent by the middle of the century. The number of wind turbines, for instance, may grow from about 30,000 today to one million and their capacity will be significantly larger than the ones we have built so far.

The cost of wind energy has dropped by over 80% over the last two decades, in large part because turbine capacity has increased by a factor 50 over the last 20 years. Wind parks can be built in remote areas with harsh conditions. In *Europe*, the trend is for more *off*shore wind parks, because that is where space is more abundant and the wind tends to be stronger. In the *US*, the trend is towards large scale *on*shore projects. Shell, as one of the world's larger players in this industry, is currently involved in developing a gigawatt-sized project in Texas.

Wind turbines, of course, don't produce electricity when there is no wind. That problem will be addressed when technological improvements allow us to store excess power in cost-effective ways.

We could discuss solar energy in similar terms. For instance, solar energy is relatively clean, but it is still expensive and not competitive without subsidies, and solar panels require a large area to collect solar energy in useful quantities, because of their relatively low energy efficiency. For instance, if we would fit 20 million roofs in Northwest Europe each with 4m2 of standard silicon-based solar panels, this would generate less full time equivalent power than a typical power station fired by gas or coal. Shell is involved in next generation CIS thin film technology, which has lower production costs and uses 100 times less raw materials than silicon based solar panels . . . not a bad thing in a resource-constrained world.

Let's not discuss nuclear energy in detail, but suffice it to say that, here again, Finland is a trendsetter. Experts tell us that the world will probably need more, rather than less, nuclear energy during the transition period from a high-carbon to a lower carbon energy system.

Shell's contribution

Einstein said that problems need to be solved at different levels of awareness that created them. That is true, but in the energy industry, investments are worth many billions and made for decades. You don't build a power plant only to tear it down because your level of awareness has changed.

The up-take of new technology takes a long time too. In the consumer goods industry, the lead-time between a new idea and commercial application of a product is roughly five years. In the energy industry, historically, this has taken around twenty years.

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This may be one of the reasons why young scientists and engineers are not immediately drawn to a career in the energy industry. That has to change. We will need many good brains, and many good partnerships with academics and scientists, to make a successful energy transition possible. Without energy, the machine stops.

The history of Royal Dutch Shell is one of constant innovation, sometimes revolutionary innovation. Imagine that in 1892, a Shell tanker called the Murex shipped kerosene from Baku to Bangkok, reducing the distance for Russian crude deliveries to the Far East by thousands of kilometres. Since then, we have been at the forefront of many new technologies and applications, such as:

- Liquefied Natural Gas;
- Turning natural gas into clean transportation fuels (GTL);
- Producing gasoline from heavy tar sands.
- Converting straw and wood chips into biofuels.

- Exploring and producing oil and gas from areas covered by up to 2500 metres of water. At this level, one of the problems you run into is the cold temperature. It causes oil to congeal and natural gas to form ice-like crystals. So Shell scientists took inspiration from fish to develop a synthetic version of their proteins, which we feed into deep sea pipelines to keep the oil and gas flowing.
- Some more examples: new seismic techniques allow us to "see" hydrocarbon deposits covered by kilometres of rock.
- Applying Snake wells and smart fields technologies to enhance oil recovery. If the world could increase its recovery from mature reservoirs by only 1%, this would yield 20-30 billion barrels of additional hydrocarbons. Shell's Smart Field technology has helped increase ultimate recovery by 3 to 8% in Brunei's Champion West field.
- We have developed ways of converting surplus sulphur into durable construction materials.

And so on and so on.

To prepare for a technology-driven future, Shell has increased its investment in technology to around 1.2 billion dollars in 2006. This includes R&D and technology application through demonstration and pilot projects. Also in 2006, Jeroen van der Veer appointed a Chief Technology Officer and seven Chief Scientists who coordinate the research effort, can launch new ideas and serve as role models for our younger scientists.

A successful innovation vehicle within Shell is GameChanger - a seed-capital process that stimulates and nurtures radical ideas to proof of concept. Since it was formed in 1996, GameChanger executed an average of 120 new ideas per year, matured scores of technologies and created many new business opportunities worth considerable sums of money.

The main R&D effort is directed to fit the current business strategy. But to unleash our innovative capabilities, Shell fosters a culture of tolerance towards ideas that may not immediately meet business requirements.

To give you a few examples of some of the *exploratory* research that is going on: our researchers in Amsterdam and scientists from the Technical University of Delft are trying to find answers to questions such as:

- Could we produce liquid fuels by copying nature's process of photo synthesis?
- Could we take CO_2 out of the atmosphere with the help of sunlight?
- Could we produce hydrogen in a sustainable way by using a molten salt nuclear reactor?
- What would be the best way to produce methane from gas hydrates locked in beneath the sea, the cleanest and most abundantly available fossil fuel?

Again, I could go on, but this may be enough imagination for now.

However let me stress once again that meeting the energy challenge will have to be a collective effort, involving politicians, scientists, industry and consumers. We need a huge global public-private partnership.

Politicians will have to create standards and regulations that enable us to further explore and travel down the three solution pathways I have described. Shell, as an oil and gas company, sees a clear need for governments to create an international CO_2 policy framework.

Voluntary action by itself will not deliver the changes that are necessary. An international CO_2 policy framework will have to take account of two realities:

- first, fossil fuels will be needed for much of this century, so reducing CO_2 in the fossil fuels chain is crucial;
- second, many new low or zero-CO_2 energy technologies need further support to become commercial.

As regards the role of *scientists*, I believe much progress can and will be made through fundamental research in areas like nano-technology, robotics and bio-technology.

Industry will have to play its role in turning discoveries into usable concepts and products through testing and commercialisation – in partnership with the scientific community.

Consumers will have to become more aware of the value of energy and the need to use it sparingly.

Together, we form a global society. And that global society will shape future technology and choose solution pathways, rather than the other way around.

It is my hope that, when our descendants meet together in 2107 to celebrate the second centenary of the Finnish Academy of Sciences and Royal Dutch Shell, they will be able to praise their ancestors for leaving behind a world that is clean, secure and prosperous.

Thank you

"Consumers *will have to become more aware of the value of energy and the need to use it sparingly."*

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