

## Shell takes multi-faceted approach to energy and climate change challenge

As one of the world's leading energy groups, Shell expects to play a leading role in solutions that address climate change while also meeting rising energy demand. Investment in alternative energies, delivery of energy efficient products and services, improvements in the efficiency of its own operations and the development of key mitigation technologies such as carbon capture and storage will all be vital elements of a "Blueprint" for securing a responsible energy future.



Shell produces around 3% of the world's natural gas - the cleanest burning fossil fuel - and is a global leader in liquefied natural gas (LNG) which makes the gas easier to transport.

# Blueprint for an energy future

**S**urging demand, constrained supplies and increased stresses on the environment. These are the three hard truths about energy supply and demand the world can no longer avoid. The global energy system sits at the crossroads of deep dilemmas: prosperity versus poverty; globalisation versus national security; and growth versus the environment.

"There have always been tensions in the global energy system, but today the strains are becoming more acute," says Jeroen van der Veer, Royal Dutch plc Shell Chief Executive. "Never before has humanity faced such a challenging outlook for energy and the planet, which can be summed up in five words – 'more energy, less carbon dioxide'."

World population has more than doubled since 1950 and is set to increase by 40% by 2050. History shows that as people become richer they use more energy. Developing nations, including population giants China and India, are only just entering their most energy-intensive phase of economic development.

Production of conventional oil and gas, meanwhile, has almost reached the limits of its growth and by 2015 will not match the projected demand growth. While abundant coal exists in many parts

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Royal Dutch  
Shell plc  
Chief  
Executive.

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of the world, transportation difficulties and environmental degradation ultimately pose limits to its use.

Alternative energy sources such as biofuels may become a much more significant part of the energy mix - but there is no "silver bullet" to completely resolve supply-demand tensions.

### CARBON BALANCE

Even with moderation of fossil fuel use and effective carbon dioxide (CO<sub>2</sub>) management, the path forward is still highly challenging. The release of CO<sub>2</sub> due to the use of fossil fuels since the start of the industrial revolution, and the large-scale deforestation of the planet that began in the Middle Ages, has changed the carbon balance of the planet.

The resulting increased concentration of CO<sub>2</sub> and other greenhouse gases in the atmosphere is widely accepted as being responsible for global warming.

Shell was one of the first energy companies to acknowledge the threat of climate change; to call for action by governments, the industry and energy users; and to take action.

"For us as a company, the scientific debate about climate change is over," says van der Veer. "The debate now is about what we can do about it.

Businesses, like ours, should turn CO<sub>2</sub> management into a business opportunity and lead the search for responsible ways to manage CO<sub>2</sub>, use energy more efficiently and provide the extra energy the world needs to grow."

### TWO ALTERNATIVE FUTURES

Given that profound change is inevitable, how will it happen? To help think about the future of energy, and the choices we face, Shell has developed global energy scenarios. The two scenarios - "Scramble" and "Blueprints" - describe different routes the energy system could take between now and 2050.

In *Scramble*, policymakers pay little attention to more efficient energy use until supplies are tight. Likewise, greenhouse gas emissions are not seriously addressed until there are major climate shocks.

In *Blueprints*, growing local actions begin to address the challenges of economic development, energy security and pollution. A price is applied to emissions, giving a huge stimulus to the development of clean energy technologies, market-driven energy efficiency measures and CO<sub>2</sub> management. The result is far lower CO<sub>2</sub> emissions compared to *Scramble*.

Will national governments simply *Scramble* to secure their own energy

supplies? Or will new *Blueprints* emerge from coalitions between various levels of societies and government, ranging from the local to the international, that begin to add up to a new energy framework?

"We are determined to provide energy in responsible ways and serve our customers and investors as effectively as we can," says van der Veer. "Both these scenarios help us do that by testing our strategy against a range of possible developments over the long-term. However, in our view, *Blueprints* outcomes offer the best hope for a sustainable future, whether or not they arise exactly in the way we describe."

Shell has identified six pathways that could contribute to what it describes as a "Better Blueprints" scenario:

- Increasing the efficiency of manufacturing operations.
- Establishing substantial capability in CO<sub>2</sub> Capture and Storage (CCS) technology.
- Continuing to research and develop technologies that increase efficiency and reduce emissions in hydrocarbon production.
- Aggressively developing low-CO<sub>2</sub> sources of energy such as wind, solar and natural gas, and low CO<sub>2</sub> fuel options including hydrogen.
- Help manage energy demand by growing the market for products and services that help customers use less energy and emit less CO<sub>2</sub>.
- Working with governments and advocating the need for more effective CO<sub>2</sub> regulation.

### MANAGING EMISSIONS

It takes energy to make energy, which adds to emissions. And the amount of energy needed to produce the fuel and chemical products that people rely on is rising. Managing CO<sub>2</sub> emissions from refineries, chemical plants and other operations is both a growing challenge and a clear priority for Shell.

For example, four years ago the Geismar, Louisiana, chemicals site underwent a rigorous assessment of its efficiency. Nothing was too small or too large to check, clean or replace – every nut, valve and process came in for scrutiny. Some older technologies gave way to more efficient newer versions. →

Thanks to similar measures, Shell refineries have improved their efficiency by almost 2% since 2002 and chemicals plants by 9% since 2001. In 2007 a major energy efficiency drive was started in Exploration and Production operations that aims to put energy management systems in place at more than 50 major assets. These and other investment programmes are targeting 1st Quartile levels of energy efficiency.

While the Group has already reduced GHG emissions by nearly 25% compared to 1990 levels, making further reductions is clearly getting tougher. With continued reliance on fossil fuels until renewables take a significant share of the energy mix, other methods for reducing CO<sub>2</sub> emissions from industrial operations are needed.

## CARBON CAPTURE

Shell believes that Carbon Capture and Storage (CCS) will be critical. CCS is a set of technologies that can be used to collect CO<sub>2</sub> from industrial processes and power generation, separate and purify it, and store it indefinitely. If proved to work on a commercial scale, it could be employed at large industrial facilities including refineries and chemical plants.

A recent report by the United Nations Intergovernmental Panel on Climate Change (IPCC), says that capturing CO<sub>2</sub> may one day contribute up to 55% of the

emission reductions that scientists believe necessary to address global warming.

Along with energy efficiency measures, CCS would help allow modern societies to keep using fossil fuels while alternative energies mature, providing a bridge to a low-carbon energy future.

Shell is currently putting significant effort behind developing its own CCS capability and is involved in a number of trials around the world (see box).

It also continues to invest in the production of cleaner energy and transport fuels based on natural gas rather than oil, to promote methods for the cleaner burning of coal and to drive down the costs of renewable power.

Gas is the cleanest-burning fossil fuel, emitting on average half the CO<sub>2</sub> of coal for each unit of electricity produced.

Shell produces around 3% of the world's natural gas and is the global leader in liquefied natural gas (LNG). By 2010 it aims to have almost doubled its LNG capacity since 2004.

With coal still likely to play a key role, however, Shell scientists have also developed proprietary gasification technology which turns virtually any coal – even the dirtiest grades – into a cleaner-burning synthetic gas which can be used as fuel for power generation.

The technology creates a concentrated, high-pressure stream of CO<sub>2</sub> that is well



Shell is investing in production of cleaner transport fuels such as those produced via Gas-to-Liquids technology from natural gas.

suited for capture and underground storage. Combining CO<sub>2</sub> storage with coal gasification is nearly 30% more energy efficient than doing the same with the most modern coal-fired plant.

To date, 21 plants using Shell's gasification technology have been (or are being) built, mainly in China but also in The Netherlands, UK, USA and Vietnam.

Shell remains a major wind power developer, being involved in 11 projects with a total capacity of about 1,100 megawatts. And it is investing in solar power activities, with a focus on advancing proprietary thin-film solar technology.

Leading development of sustainable biofuels is also part of the renewable energy strategy, with investments focused on biotechnologies that use non-food organic sources such as straw residue and algae. These second-generation biofuels look promising but it will be another five to ten years before they will be available.

Hydrogen fuel for transport is a longer-term option. Shell is the first energy company to build demonstration hydrogen refuelling stations in all three key hydrogen markets: Europe, Japan and North America. Hydrogen requires a completely new distribution infrastructure, as well as more affordable fuel-cell vehicles.

## GOING UNDERGROUND WITH GREENHOUSE GASES

With the turn of a valve, carbon dioxide (CO<sub>2</sub>) captured from a German refinery is silently pumped more than 700 metres into the earth beneath a former natural gas storage reservoir (right).

Despite the lack of drama, it was an important milestone for this feasibility study for storing CO<sub>2</sub> underground - the first trial of its kind onshore in Europe.

Geologists and scientists from 18 European power producers, universities, government agencies and energy companies - including Shell - will spend the next several years steadily injecting the gas and monitoring it over time.

Various forms of permanent CO<sub>2</sub> storage have been conceived, but Shell is principally interested in geological storage, essentially using

the same mechanisms that have contained large reservoirs of oil and gas naturally for millions of years.

When the CO<sub>2</sub> is pumped deep underground it is compressed by the higher pressures and turns to liquid, which then becomes trapped in tightly-spaced pores in the rock. A layer of impermeable rock above prevents it from rising to the surface.

"We already know a lot about these reservoir rocks and the fluids in them but CCS requires long-term storage of thousands of years," says Wolf Heidug, Shell's General Manager for CO<sub>2</sub> Policy. "Extensive monitoring and simulation - both during and after injection - will help us to better understand the long-term fate of the injected CO<sub>2</sub>."

"The data collected at this and other demonstration projects is important



to help politicians and policymakers as they design a regulatory framework for CCS," he says.

With appropriate systems in place, the risks of storing CO<sub>2</sub> could be comparable to storing natural gas - a practice that is common already.

## CHEMICALS CONTRIBUTION

Apart from fuels, other Shell products have potential to help reduce energy demand and CO<sub>2</sub> emissions, including chemicals.

Shell Chemicals are leading producers of some of the key raw materials that are helping manufacturers make everyday products that use less ingredients or energy but still meet performance requirements.

For example, advanced surfactants in detergent washing powders and liquids that work at lower water temperatures, which cut the energy used by washing machines by more than half. Or more concentrated laundry detergents that reduce packaging, transport costs and energy use still further.

Other surfactants could help to increase the rate of recovery from existing oilfields, extending the life of these resources while alternative energies develop.

Phenol used to make polycarbonates is contributing to lighter car components and so to more fuel-efficient vehicles. Synthetic textiles, such as polyesters made with mono-ethylene glycol or propanediol can have life-cycle CO<sub>2</sub> advantages over their natural alternatives.

It is in insulation applications, however, where chemicals have the greatest potential

to contribute to reducing CO<sub>2</sub> emissions.

Shell is a leading supplier of raw materials used to make two of the most effective and versatile insulation materials available.

Expanded polystyrene foam made with styrene, and rigid polyurethane foam made from polyols, are among the most thermally efficient materials and can be used in a range of building insulation applications. With buildings estimated to be responsible for up to 40% of energy use globally, the potential contribution of insulation to energy efficiency, hence lower CO<sub>2</sub> emissions, is significant.

## TAKING ACTION

It is clear governments need to develop internationally aligned policies to meet the energy challenge and address climate change. No one single instrument - whether a carbon tax or emissions trading - will be effective for all sectors.

Major energy companies and other large industrial companies need clear incentives for technologies such as CCS and a simple, credible target for the share for renewable sources in the energy mix.

Shell has lobbied for robust 'cap and trade' schemes like the ETS to cover large, stationary emission sources such

as refineries. Linked to one another by tradable instruments, they will be a crucial stepping-stone to a global market for CO<sub>2</sub>.

In the meantime international cooperation is needed to avoid 'carbon leakage' - production simply moving to regions without climate change regulation.

Transport may need separate measures such as vehicle efficiency standards, vehicle/road use programmes, and incentives for use of lower CO<sub>2</sub> fuels. Similarly, the construction industry could benefit from robust energy standards for buildings and appliances, with incentives to retrofit existing infrastructure.

"Concerted action by governments is required to create market-based policies needed to make it worthwhile to invest in energy efficiency, CO<sub>2</sub> mitigation and lower carbon fuels," says van der Veer. "With fossil fuel use and CO<sub>2</sub> levels continuing to grow fast, there is no time to lose."

For more information on the energy challenge please visit: [shell.com](http://shell.com)

