2018-IP12: Shell's Vision of a Zero Emission World

Shell have produced the latest in a series of scenario publications called the *Sky* Scenario. The *Sky* Scenario illustrates a technically possible, but challenging, pathway for society to achieve the goals of the Paris Agreement. The scenario report can be found at:
https://www.shell.com/energy-and-innovation/the-energy-future/scenarios/shell-scenario-sky.html

In Shell's view, *a new energy system is emerging. The Paris Agreement sent a signal around the world: climate change is a serious issue that governments are determined to address. By 2070 there is the potential for a very different energy system to emerge.*

The ***Sky* Scenario** outlines what Shell believes is a technologically, industrially, and economically possible route forward, consistent with limiting the global average temperature rise to well below 2°C from pre-industrial levels. Shell state that it: *reveals the potential for an energy system to emerge that brings modern energy to all in the world, without delivering a climate legacy that society cannot readily adapt to.*

***The Sky* Scenario** shows a transformation to a lower-carbon energy system, with the world achieving the temperature goal of the Paris Agreement. Consumers, companies and governments will face tough choices and the paths towards lower-carbon energy will vary by country and sector. Over the course of 50 years, it transforms the way society uses and produces energy.

However, Shell note that whilst this is encouraging news, success towards the Paris Agreement aim is not guaranteed. They reinforce this point because the *Sky* Scenario relies on a complex combination of mutually reinforcing actions by society, markets and governments. It recognises that the necessary changes will unfold at different paces in different places, and must ultimately transform all sectors of economic activity. The changes are economy-wide, sector-specific, and amount to re-wiring the global economy in just 50 years.

The actions proposed in the *Sky* Scenario from now to 2070 are:

1. A change in consumer mind-set means that people preferentially choose low-carbon, high-efficiency options to meet their energy service needs.
2. A step-change in the efficiency of energy use leads to gains above historical trends.
3. Carbon-pricing mechanisms are adopted by governments globally over the 2020s, leading to a meaningful cost of CO_2 embedded within consumer goods and services.
4. The rate of electrification of final energy more than triples, with global electricity generation reaching a level nearly five times today's level.
5. New energy sources grow up to fifty-fold, with primary energy from renewables eclipsing fossil fuels in the 2050s.
6. Some 10,000 large carbon capture and storage facilities are built compared to fewer than 50 in operation in 2020.
7. Net-zero deforestation is achieved. In addition, an area the size of Brazil being reforested offers the possibility of limiting warming to 1.5°C, the ultimate ambition of the Paris Agreement

The *Sky* scenario is set against a series of challenges for the 21st century that need to be overcome to allow the Paris goal of going below 2degrees centigrade to be achieved. These challenges are:

- **Energy demand is rising** – During the 20th century, energy demand increased 10 fold, today the global average energy demand currently stands at 80GJ but factors such population growth, and increased mobility will see this grow further in the 21st century.

- **Efficiency can be a double-edged sword** - Energy demand growth can potentially be slowed by increased efficiency of supply, but lower cost more efficient services can also lead to increased uptake by consumers
- **Coal remains popular –** coal remains the fuel of choice in many emerging economies with the consequence of increased CO_2 emissions whereas in developed countries natural gas and renewables are favoured and emissions have decreased.
- **The energy system can be stubborn –** not all countries will reach net-zero emissions at the same time and low carbon solutions in sectors like aviation, shipping glass manufacture, smelting etc. are developing very slowly.
- **Some technologies are "stalled" –** electric vehicles now eclipse hydrogen once seen as the optimum choice for road transport and progress on low carbon biofuel technology has been slower than anticipated.
- **System transformations are unpredictable and take time –** the report quotes PV as an example of a long development lead-time. PV was invented in 1839, first deployed on satellites in 1962 but 4 decades later, we only have 2GW of capacity installed globally. They also consider that locks in can occur where technology investments have been made that avoid stranding assets and losing jobs
- **Given the time frame of 2070 there can be no slippage** – success needs a broad process that is embraced by society and governments and coordinated by actors like the UNFCCC etc.

One of the underpinning principles of the ***Sky* Scenario** is that Governments respond positively to the cycle of stocktakes as set out in the Paris agreement. It assumes that china will move by 2023 to a reducing emissions pledge and by the 2028 stocktake India will indicate its emissions will have plateaued by 2040. The scenario assumes that progress on emissions reduction is slow in the 2020s but then accelerates rapidly in the 2030s.

The scenario assumes the global population grows to 10 billion by 2070 (up from 7.5 billion in 2017) and then stabilises. Energy demand rises but plateaus near 2080. Per capita energy usage remains low because of significant gains in energy efficiency.

The scenario considers that the pledge by 25 countries at COP23 to power past coal will expand with other countries joining the alliance. The consequence will be coal's share of global energy demand falls to around 6% in 2070 down from 25% in 2020.

The scenario considers that targeted Government R&D in the 2020s will lead to major gains in technological options such as CCS, battery storage and biofuels helping to unblock technological lock in.

Governments around the world implement the legislative frameworks to drive efficiency and rapidly reduce CO_2 emissions, forcing out older energy technologies. Appliances, commercial and residential buildings and transport are all targeted with aggressive efficiency or emission standards.

Government led carbon pricing emerges rapidly which helps speed up the adoption of CCS for large emitters and the deployment of negative emissions technologies like BECCS. Carbon pricing also stimulates economy wide emissions reduction.

Hydrogen emerges as a material energy carrier after 2040 for industry and transport. Oil and gas use falls over time and redundant facilities are repurposed for hydrogen use. The *Sky* Scenario also speculates that hydrogen could be used in aviation.

In the *Sky* Scenario, the Paris Agreement succeeds. Most European countries reach net zero emissions by 2060, with some going negative, mostly with BECCS. These countries can then offer negative transfers to countries still with positive emissions fulfilling the global balance called for under the Paris Agreement.

Whilst the *Sky* Scenario focuses on CO_2, emissions from energy use other greenhouse gas emissions and industries are considered. Non-Energy system greenhouse gases also decline sharply in the *Sky* Scenario. The best practise measures listed in *Sky* to bring about these reductions are listed in the table below.

GAS	SECTOR	ACTION IN SKY
CO_2	Cement	Progressive substitution away from cement in buildings Some substitution away from limestone as a feedstock, e.g., using fly-ash Using carbon capture and storage (CCS)
	Industrial (process emissions)	Using CCS
	Agriculture	Eliminating deforestation for land gain Implementing soil carbon programmes, e.g., no-till farming, land-use rotation
	Urbanisation and development	Creating green cities through extensive tree planting Maintaining green belts within and around cities Avoiding city spread through higher density living Addressing traditional biomass usage through modern access to energy programmes
CH_4	Coal mining	Reducing coal consumption Implementing best practice for methane drainage and use in coal mines (e.g., UNECE Guidance) Managing abandoned mines
	Oil and Gas Industry	Reducing oil and gas consumption Oil and gas industry leaders implementing best-practice from the 2020s, and all world production meeting best-practice by 2050
	Cattle Farming	Offering alternative products to consumers Changing cattle diets to minimise methane
	Rice growing	Reducing forced flooding in rice paddies
	Urbanisation and development	Capturing methane from landfill
N_20	Agriculture	Implementing nitrogen fertiliser management, i.e., application rate, formulation (fertiliser type), timing of application, placement Industrial processes Implementing catalytic decomposition and thermal destruction techniques
F Gases	Various – IT industry, refrigeration, transformers	Progressive substitution away from PFC, HFC, and SF 6 Using best practice management Introducing recovery programmes for retired equipment (e.g., refrigerators, transformers)

In Chapter 6 Shell look at the issue of CCU. They make the point that until CCS, many processes that use CO_2 as a feedstock like urea and methanol don't store the CO_2 permanently therefore their net impact on atmospheric CO_2 emissions is zero. It is not considered that synthetic fuels made from CO_2 contribute to emissions reduction. However, some products such as plastics or building materials if they can store the CO_2 permanently can contribute to emissions reduction. The issue they then highlight is that there is no established protocol as yet to define which products do permanently store CO_2.

Comments

I have completed a synopsis of Shell's *Sky* Scenario but I would encourage people to read the full report, which can be found at the link provided earlier in this document. The main thing to take from this is that the Paris Agreement can be achieved, but this is going to be challenging. Are all the actions plausible? Yes they are but the reality is certain sectors are really lagging behind. We recently heard from the IEA that energy efficiency measures are starting to stall yet scenarios like this rely heavily on energy efficiency to allow us to get anywhere near the goals of the Paris Agreement. We know that sectors like shipping, aviation agriculture are not even on the starting blocks and many cast doubt that significant emissions mitigation in the agricultural sector can be achieved. The clock is ticking and we hope that Governments will see the need for urgent action and set themselves ambitious targets when they ramp up their emission reduction targets, in 2023 and 2028 and beyond. One other key message here is that CCU is a distraction and Governments should focus R&D spend on activities that can make significant emission cuts in the future.

John Gale
12/04/2018