Is it Possible to Achieve an Ambitious Energy Decarbonisation Scenario?

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In 2015, the Paris Agreement on climate change defined important steps to mitigate global warming by setting ambitious goals. These include holding the increase in the global average temperature to well below 2ºC above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5ºC above pre-industrial levels, reaching peaking of global greenhouse house emissions as soon as possible and achieving a balance between anthropogenic emissions by sources and removal of greenhouse gases by sinks in the second half of the century.

In 2018, the Intergovernmental Panel on Climate Change (IPCC) issued a report[1] according to which, meeting a 1.5 °C target would require 'deep emissions reductions' and 'rapid, far-reaching and unprecedented changes in all aspects of society'. The report highlighted the importance of limiting global warming to 1.5 °C versus 2 °C and pointed out that global CO_2 emissions would need to fall by about 45% from 2010 levels by 2030, reaching 'net-zero' around 2050. However, IPPC recognizes that there are many different pathways to meet the overall objective.

In the Shell Sky scenario[2], the 'well below 2ºC' target is achieved with 85% probability while the scenario reaches net-zero emissions by 2070. With the additional lever of nature based solutions, like large scale reforestation to remove an additional 10Gt of CO_2 from the atmosphere per year, there is 50% probability of staying below 1.5 °C.

Today, about half of global CO_2 emissions come from end-use and the other half from producing the fuels people need (graph 1). When the CO_2 of the production of electricity and fuels is allocated over the end-use sectors, Industry is responsible for about 42%, Buildings around 30% and Transport 28%, of which half is from heavy-duty transport Aviation, Shipping and Trucking. In Sky by 2050, these percentages will be around 33% for Industry, 17% for Buildings and 47% for Transport, of which three-quarters will come from heavy duty transport. This illustrates the more difficult to abate sectors Industry and heavy-duty Transport.

The Sky scenario describes a set of mutually reinforcing drivers being accelerated by society, market and governments from now to 2070. These drivers include a step change in the efficiency of energy use which leads to gains above historical trends, a tripling in the rate of electrification of

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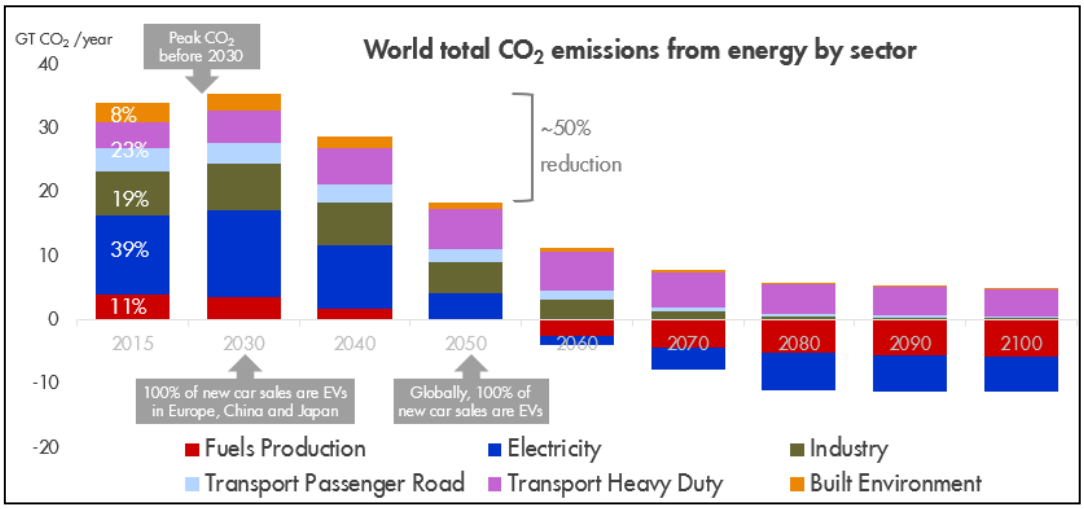
1 IPCC, 2018: Global Warming of 1.5°C

2 www.shell.com/skyscenario Scenarios are not predictions, plans, or policy proposals – they simply explore what might happen given the assumptions made in the scenario.

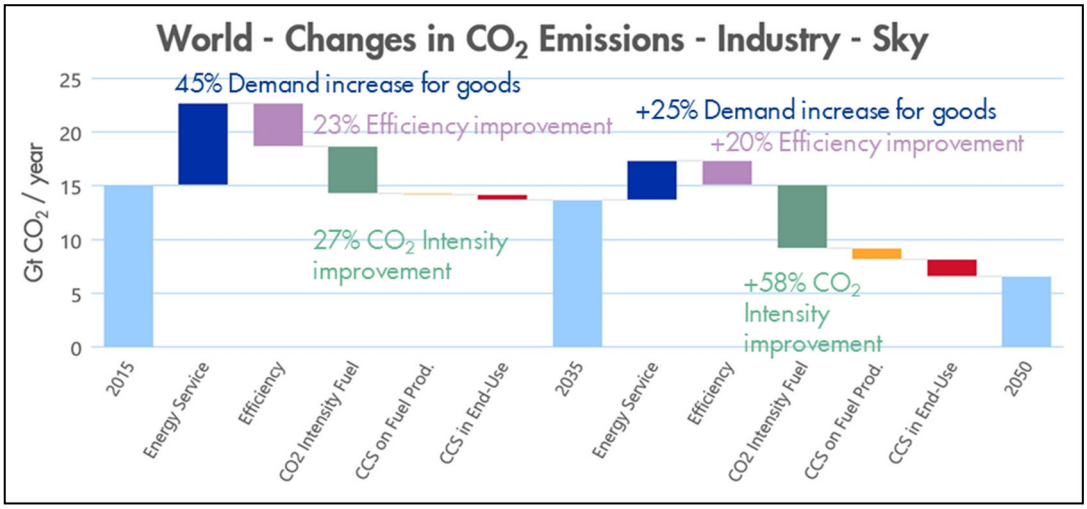
final energy, new energy sources like solar and wind growing up to fifty fold, the use of carbon pricing mechanisms adopted by governments globally in the 2020s, the wide adoption of Carbon Capture and Storage (CCS) with some 10,000 large (1 mtpa) facilities built by 2070 and the achievement of net zero deforestation. All these drivers are underpinned by a change in consumer mindset leading people to preferentially choose low-carbon, high-efficiency options to meet their energy service needs.



Graph 1 : World CO_2 emissions by sector (Source: Shell Analysis, Sky Scenario)

How to Achieve Decarbonisation

Carbon reduction needs to be pursued simultaneously in demand and supply sectors in order to achieve a 50% reduction in CO_2 emissions by 2050 and get to net-zero emissions by 2070 (graph 1). Demand management and efficiency will be crucial in managing CO_2 until changes in the fuel mix become material (graph 2).

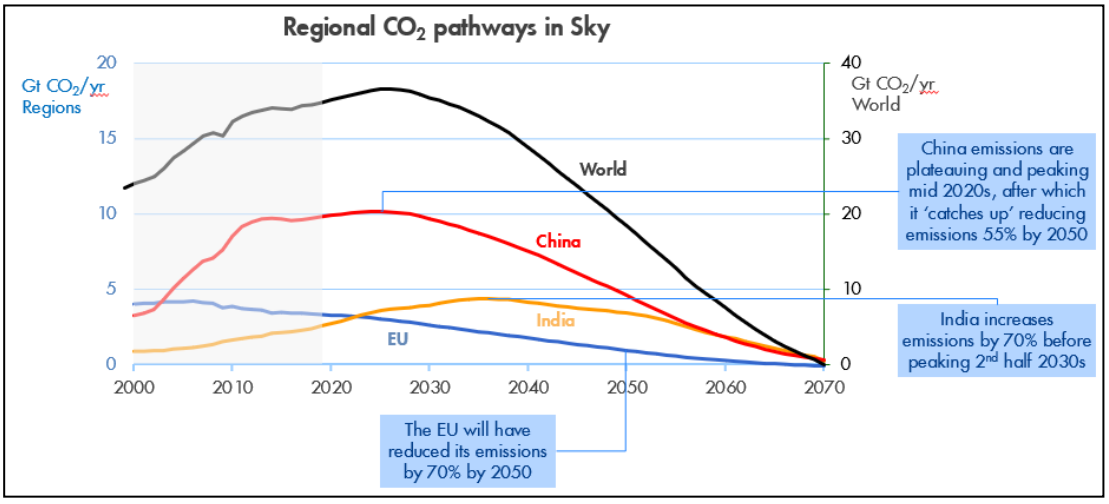


Graph 2 : World CO_2 emissions reduction pathway for Industry (Source: Shell Analysis, Sky Scenario)

There are four main mechanisms to decarbonise a sector (graph 2). First, the demand for services and goods are likely to continue to rise with economic growth, but behavioural change could reduce that. Second, the normal economic process of using best technology to increase efficiency needs to step up materially. Third, the average CO_2 intensity of the fuels used needs to significantly reduce over time. And Fourth, sinks like CCUS can offset remaining emissions. Given inertia in energy systems, the respective contributions will vary over time.

Ultimately, overarching country CO_2 reduction targets set by governments will need to be translated to sectoral targets. When these sectors are largely within a country's economy, it will likely be easier to manage such targets than for sectors that straddle global competitive boundaries, like Industry and heavy-duty transport such as aviation and shipping. Taking the industrial sector as an example, there are several actions by different actors that can pave the path to decarbonisation. Governments can set sectoral targets and use CO_2 taxes or trading schemes, offset by reducing other taxes to maintain competitiveness in industry and the purchasing power of people to maintain social cohesion. CO_2 intensity certificates is another possible lever. On the manufacturers side, higher efficiencies led by the electrification of manufacturing processes will be key, along with material efficiencies, waste reduction through co-synergies and the use of CCUS. These measures can lead to margin improvements if implemented in efficient ways. However, not all processes in industry can be electrified and the traditional fuel suppliers for high value heat need to seek ways of reducing the CO_2 intensity of these fuels by blending in biofuels or providing green hydrogen.

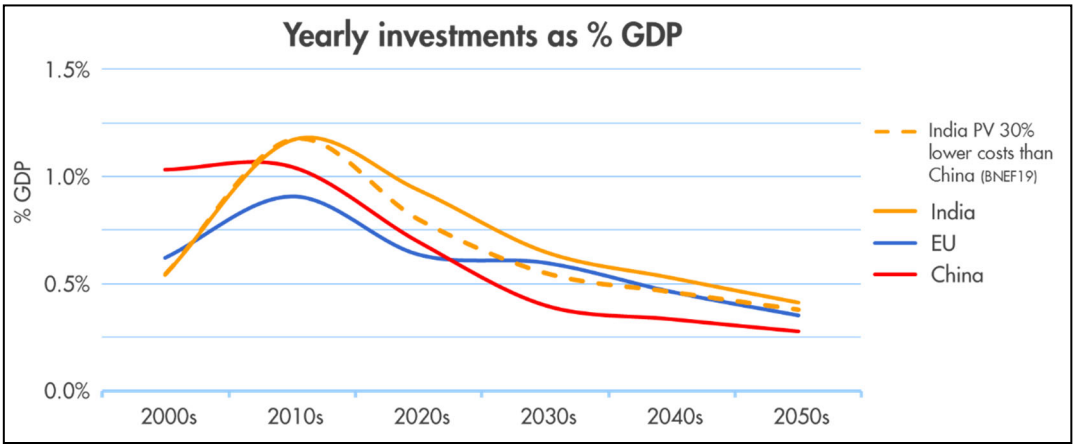
The equitable distribution of the burdens between different countries/regions will be one of the key aspects of the decarbonisation effort. In Sky, countries are decarbonising at different speeds (graph 3) but sectoral CO_2 budgets will need to be agreed and aligned in inter-governmental targets. This will be particularly challenging given that demand for goods continues to rise and industrial production shifts across regions. A key player in this might be India, which may have to balance



Graph 3 : CO_2 emission pathways are very different at country/region level (Source: Shell Analysis, Sky Scenario)

early economic gains with long-term pain if using coal fired power at large, eventually needing two times as much CCS than China in the long run for meeting the CO_2 reduction required.

This leads to the question of whether energy transition is affordable. In Sky the answer is yes, but with stretching underlying assumptions on long term cost reductions. However, investments need to step up at the onset of energy transition before it returns to long term averages long afterwards. India, for example, could be at the more demanding end of that transition with Wind and Solar PV cost structures currently estimated to be more than 40% above that of China (graph 4).



Graph 4 : Transition costs to lower carbon fuels as percentage of a country's GDP (Source: Shell Analysis, Sky Scenario)

Note : Investment costs only considers the energy system for providing fuels to end-users. It does not include upstream costs for oil, biofuels, gas and coal production, or costs made in the demand sectors to invest in different technologies and efficiency.

Overall, the Sky scenario provides a positive answer to the questions of feasibility and affordability of decarbonising energy systems globally, highlighting at the same time the significant challenges that need to be overcome for this to be realised.

Writer's Profile

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He is heading the Energy Analysis Team in Shell's Global Scenario Group, which is part of the Corporate Strategy Department. He leads a team responsible for worldwide energy analysis and long-term global energy scenarios, and advises Shell companies on a wide range of energy issues. He has been with the Shell group of companies for some 35 years, with prior positions in drilling operations, subsurface reservoir management, and commercial and regulatory affairs in gas.