2021-IP08

New IEA roadmap: Net Zero by 2050 - A Roadmap for the Global Energy Sector

On 18 May 2021, the International Energy Agency (IEA) released its anticipated net-zero emissions roadmap to make the 2020s the decade of massive clean energy expansion. This Information Paper (IP) was written by IEAGHG Executive Committee member Arthur Lee (Chevron), with minor additions at the end from Jasmin Kemper and Tim Dixon (IEAGHG), and summarises the key messages of the roadmap.

The COP26 Glasgow presidency will be taken up by the United Kingdom. In that role, the U.K. government requested eight months ago after the IEA released its World Energy Outlook 2020 and the Energy Technology Perspectives 2020, that the IEA needs to conduct a special study to lay out clearly a roadmap to achieve global net-zero emissions by 2050. IEA's Executive Director, Dr. Fatih Birol, released the study in a media event at 10 am Central European Time. He was joined by the two staff directors who led the report, Dr. Laura Cozzi, Chief Energy Modeler, and Dr. Timur Gül, Director of the Technology Programme. The study had collaborators from the integrated assessment modelling group at another expert institution, the International Institute for Applied Systems Analysis (Vienna, Austria) and the specialist analysis of international investment flows from the International Monetary Fund.

Three aims of the report

From the IEA web site, "[t]he IEA special report has three main aims:

- To examine the impacts of announced net-zero emissions pledges and what they might mean for the energy sector.
- To develop a new energy-sector pathway towards achieving net-zero emissions globally by 2050. The report will provide a detailed sector-by-sector analysis of the changes that would be needed over the next 30 years, including specific technology and policy milestones, and the wider implications for economies and society.
- To set out key policy recommendations for governments to act upon in the near-term, and a long-term agenda for change to achieve net-zero goals, including with a view to reaching other Sustainable Development Goals.

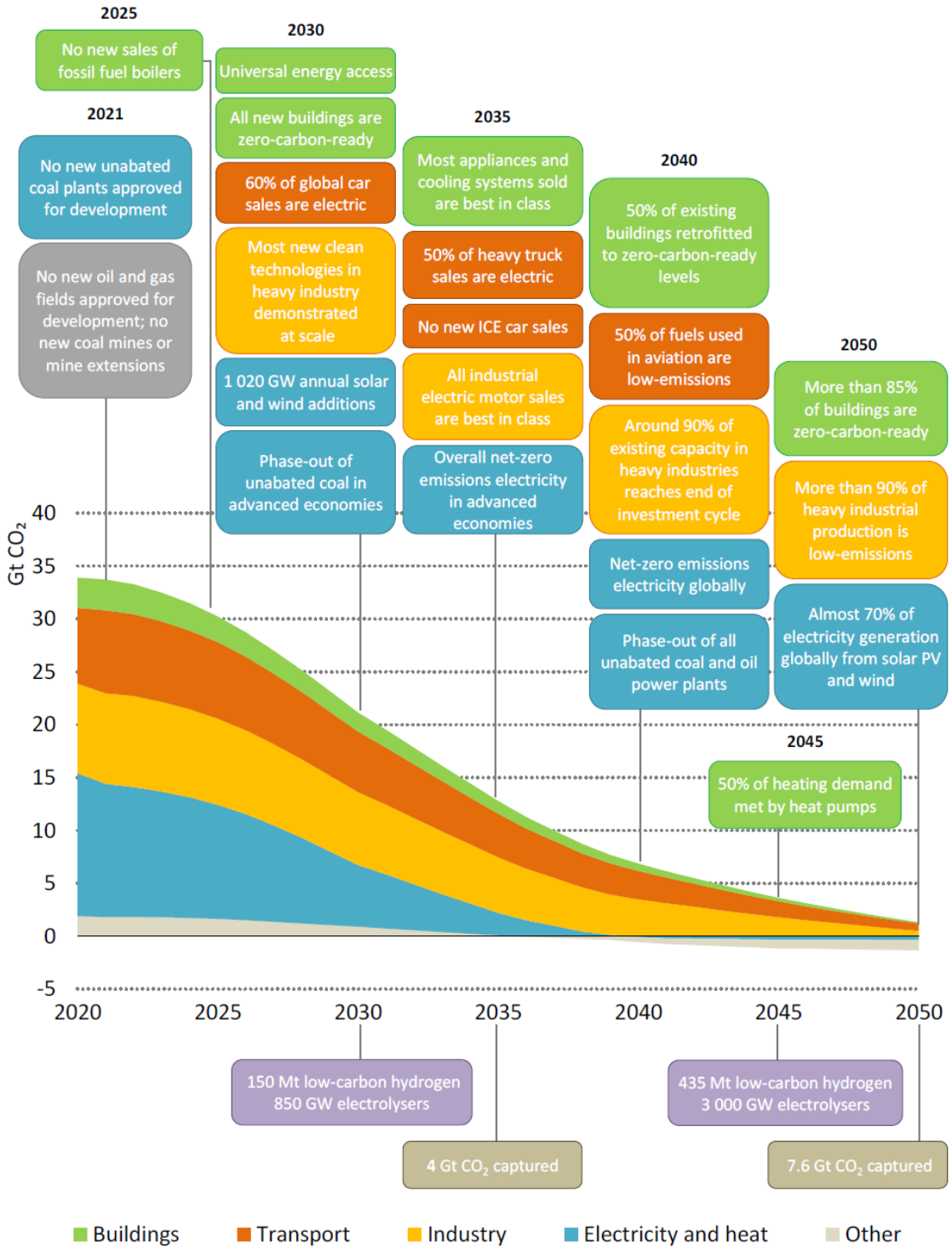
Media event

I watched the media event and noted several key messages that the three leaders of the IEA emphasized, augmented by the actual text from the report's "Summary for Policymakers." While the three leaders emphasized during the media event that this study is of a roadmap, a pathway, a scenario, and not the scenario, the pathway, or the roadmap, they were also sure to point out that the world has a very narrow pathway towards net-zero emissions by 2050, and that governments, companies, and citizens must take transformative actions now, this decade, to be able to step onto this narrow pathway towards net-zero by 2050, making the 2020s the decade of massive clean energy expansion.

Key Messages

I excerpted ten key messages of "a scenario" that were of greatest interest to me in the study, as highlighted by the three IEA leaders. A key graphic is also included here.

Key milestones in the pathway to net zero



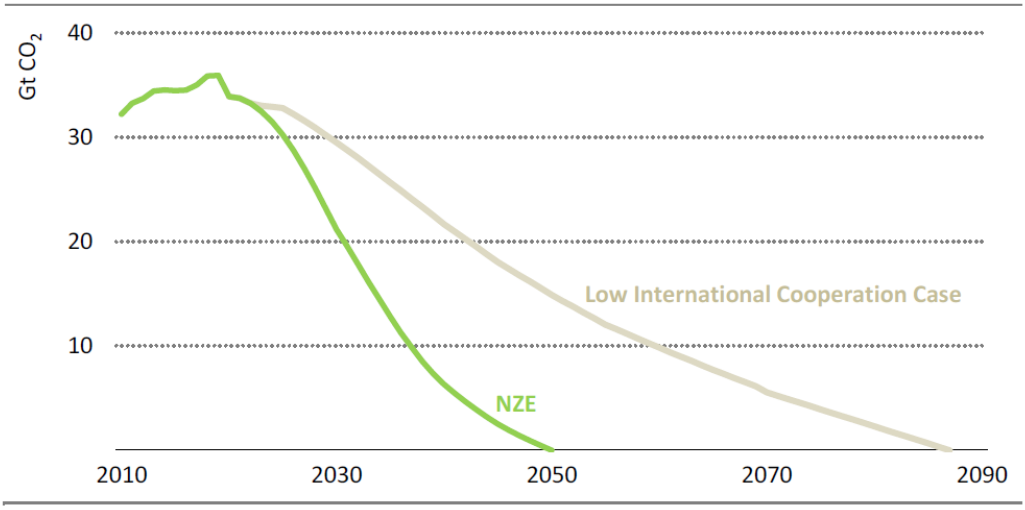
1. " … By 2030, annual investment in renewables in the electricity sector is around USD 1.3 trillion, slightly more than the highest level ever spent on fossil fuel supply (USD 1.2 trillion in 2014). Annual investment in clean energy infrastructure increases from around USD 290 billion over the past five years to about USD 880 billion in 2030. This is for electricity networks, public electric vehicle (EV) charging stations, hydrogen refuelling stations and import and export terminals, direct air capture and CO2 pipelines and storage facilities."
2. "Clean electricity generation, network infrastructure and end-use sectors are key areas for increased investment. Enabling infrastructure and technologies are vital for transforming the energy system. Annual investment in transmission and distribution grids expands from USD 260 billion today to USD 820 billion in 2030. The number of public charging points for EVs rises from around 1 million today to 40 million in 2030, requiring annual investment of almost USD 90 billion in 2030. Annual battery production for EVs leaps from 160 gigawatthours (GWh) today to 6 600 GWh in 2030 – the equivalent of adding almost 20 gigafactories each year for the next ten years. And the required roll-out of hydrogen and CCUS after 2030 means laying the groundwork now: annual investment in CO2 pipelines and hydrogen-enabling infrastructure increases from USD 1 billion today to around USD 40 billion in 2030. [Note on Gigafactory: Battery gigafactory capacity assumption = 35 gigawatt-hours per year.]"
3. Energy efficiency together with decarbonized electrification continues to play a tremendous role. For example, in the media event Dr. Cozzi highlighted that in the buildings sector alone, currently one-twentieth of buildings are considered energy efficient. By 2030, one-fifth of all buildings need to be (retrofitted as necessary) energy efficient with electric heat pumps and no more fossil-fuel fired equipment (such as coal, oil, or natural gas heating).
4. In transportation by 2035, there will be no more internal combustion passenger vehicles. This also means no new fossil fuel investments. "…There is no need for investment in new fossil fuel supply in our net zero pathway. Beyond projects already committed as of 2021, there are no new oil and gas fields approved for development in our pathway, and no new coal mines or mine extensions are required. The unwavering policy focus on climate change in the net zero pathway results in a sharp decline in fossil fuel demand, … . Unabated coal demand declines by 90% to just 1% of total energy use in 2050. Gas demand declines by 55% to 1 750 billion cubic metres and oil declines by 75% to 24 million barrels per day (mb/d), from around 90 mb/d in 2020." " … Fossil fuels that remain in 2050 are used in goods where the carbon is embodied in the product such as plastics, in facilities fitted with CCUS, and in sectors where low-emissions technology options are scarce."
5. "Emissions from industry, transport and buildings take longer to reduce. Cutting industry emissions by 95% by 2050 involves major efforts to build new infrastructure. After rapid innovation progress through R&D, demonstration and initial deployment between now and 2030 to bring new clean technologies to market, the world then has to put them into action. Every month from 2030 onwards, ten heavy industrial plants are equipped with CCUS, three new hydrogen-based industrial plants are built, and 2 GW of electrolyser capacity are added at industrial sites. Policies that end sales of new internal combustion engine cars by 2035 and boost electrification underpin the massive reduction in transport emissions. In 2050, cars on the road worldwide run on electricity or fuel cells. Low-emissions fuels are essential where energy needs cannot easily or economically be met by electricity. For example, aviation relies largely on biofuels and synthetic fuels, and ammonia is vital for shipping. In buildings, bans on

new fossil fuel boilers need to start being introduced globally in 2025, driving up sales of electric heat pumps. Most old buildings and all new ones comply with zero-carbon-ready building energy codes."

6. "New energy security concerns emerge, and old ones remain. The contraction of oil and natural gas production will have far-reaching implications for all the countries and companies that produce these fuels. No new oil and natural gas fields are needed in our pathway, and oil and natural gas supplies become increasingly concentrated in a small number of low-cost producers. For oil, the OPEC share of a much-reduced global oil supply increases from around 37% in recent years to 52% in 2050, a level higher than at any point in the history of oil markets. Yet annual per capita income from oil and natural gas in producer economies falls by about 75%, from USD 1 800 in recent years to USD 450 by the 2030s, which could have knock-on societal effects. Structural reforms and new sources of revenue are needed, even though these are unlikely to compensate fully for the drop in oil and gas income. While traditional supply activities decline, the expertise of the oil and natural gas industry fits well with technologies such as hydrogen, CCUS and offshore wind that are needed to tackle emissions in sectors where reductions are likely to be most challenging."
7. "The energy transition requires substantial quantities of critical minerals, and their supply emerges as a significant growth area. The total market size of critical minerals like copper, cobalt, manganese and various rare earth metals grows almost sevenfold between 2020 and 2030 in the net zero pathway. Revenues from those minerals are larger than revenues from coal well before 2030. This creates substantial new opportunities for mining companies. It also creates new energy security concerns, including price volatility and additional costs for transitions, if supply cannot keep up with burgeoning demand."
8. "Clean energy innovation must accelerate rapidly, with governments putting R&D, demonstration and deployment at the core of energy and climate policy. Government R&D spending needs to be increased and reprioritised. Critical areas such as electrification, hydrogen, bioenergy and carbon capture, utilisation and storage (CCUS) today receive only around one-third of the level of public R&D funding of the more established low-carbon electricity generation and energy efficiency technologies. Support is also needed to accelerate the roll-out of demonstration projects, to leverage private investment in R&D, and to boost overall deployment levels to help reduce costs. Around USD 90 billion of public money needs to be mobilised globally as soon as possible to complete a portfolio of demonstration projects before 2030. Currently, only roughly USD 25 billion is budgeted for that period. Developing and deploying these technologies would create major new industries, as well as commercial and employment opportunities."
9. "Governments need to provide credible step-by-step plans to reach their net zero goals, building confidence among investors, industry, citizens and other countries. Governments must put in place long-term policy frameworks to allow all branches of government and stakeholders to plan for change and facilitate an orderly transition. Long-term national low-emissions strategies, called for by the Paris Agreement, can set out a vision for national transitions, as this report has done on a global level. These long-term objectives need to be linked to measurable short-term targets and policies. Our pathway details more than 400 sectoral and technology milestones to guide the global journey to net zero by 2050."

10. “This is not simply a matter of all governments seeking to bring their national emissions to net zero – it means tackling global challenges through co-ordinated actions. Governments must work together in an effective and mutually beneficial manner to implement coherent measures that cross borders. This includes carefully managing domestic job creation and local commercial advantages with the collective global need for clean energy technology deployment. Accelerating innovation, developing international standards and co-ordinating to scale up clean technologies needs to be done in a way that links national markets. Without greater international co-operation, global CO2 emissions will not fall to net zero by 2050.” See figure below.

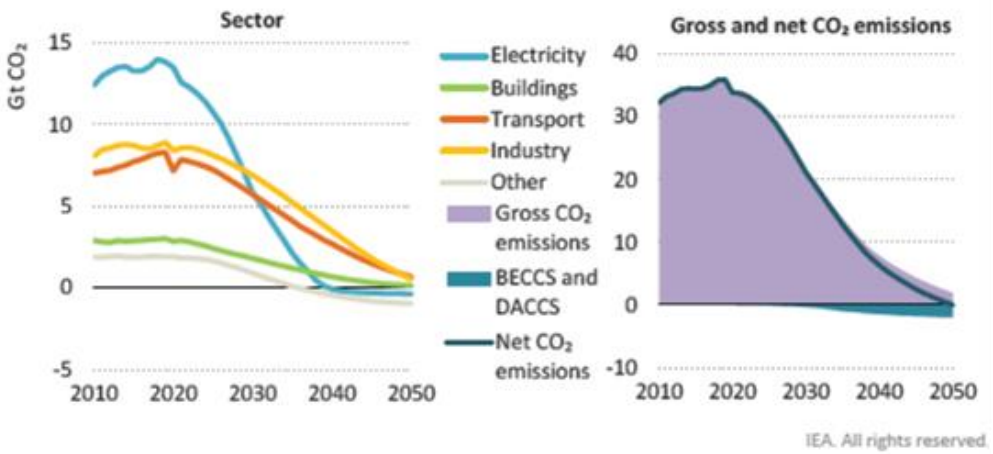
Global energy-related CO_2 emissions in the net zero pathway and Low International Co-operation Case



Note: Gt = gigatonnes.

Additions from IEAGHG

“The remaining 20% of fossil fuel use in 2050 in the NZE is in sectors where the complete elimination of emissions is particularly challenging. Mostly this is oil, as it continues to fuel aviation in particular. A small amount of unabated coal and natural gas are used in industry and in the production of energy. The unabated use of fossil fuel results in around 1.7 $GtCO_2$ emissions in 2050, which are fully offset by BECCS and DACCS”, see figure below.



Emissions from electricity fall fastest, with declines in industry and transport accelerating in the 2030s. Around 1.9 Gt CO_2 are removed in 2050 via BECCS and DACCS.

"Failure to develop CCUS for fossil fuels would also be likely to delay or prevent the development of other CCUS applications. […] A delay in the development of other CCUS technologies would have a major impact on the prospect of getting to net-zero emissions in 2050. […] If progress in these technologies were delayed and could not be deployed at scale, then achieving net-zero emissions by 2050 would be vastly more difficult."

"Failing to take timely decisions on nuclear power and CCUS [for power] would raise the costs of a net zero emissions pathway and add to the risk of not meeting the goal by placing an additional burden on wind and solar to scale up even more quickly than in the NZE. […] This would call for an additional USD 2 trillion investment in power plants and related grid assets. Taking account of avoided fuel costs, the estimated total additional cost of electricity to consumers between 2021 and 2050 is USD 260 billion."

The full roadmap can be downloaded via the following IEA page. The title of the report is *Net-Zero by 2050: A Roadmap for the Global Energy Sector*.

https://www.iea.org/reports/net-zero-by-2050

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[1] This paper summarizes publicly available information. By summarizing and distributing this information, I am not endorsing or adopting the views expressed. To the extent this paper contains opinions or assessments separate from the publicly available information being summarized, those are my own.