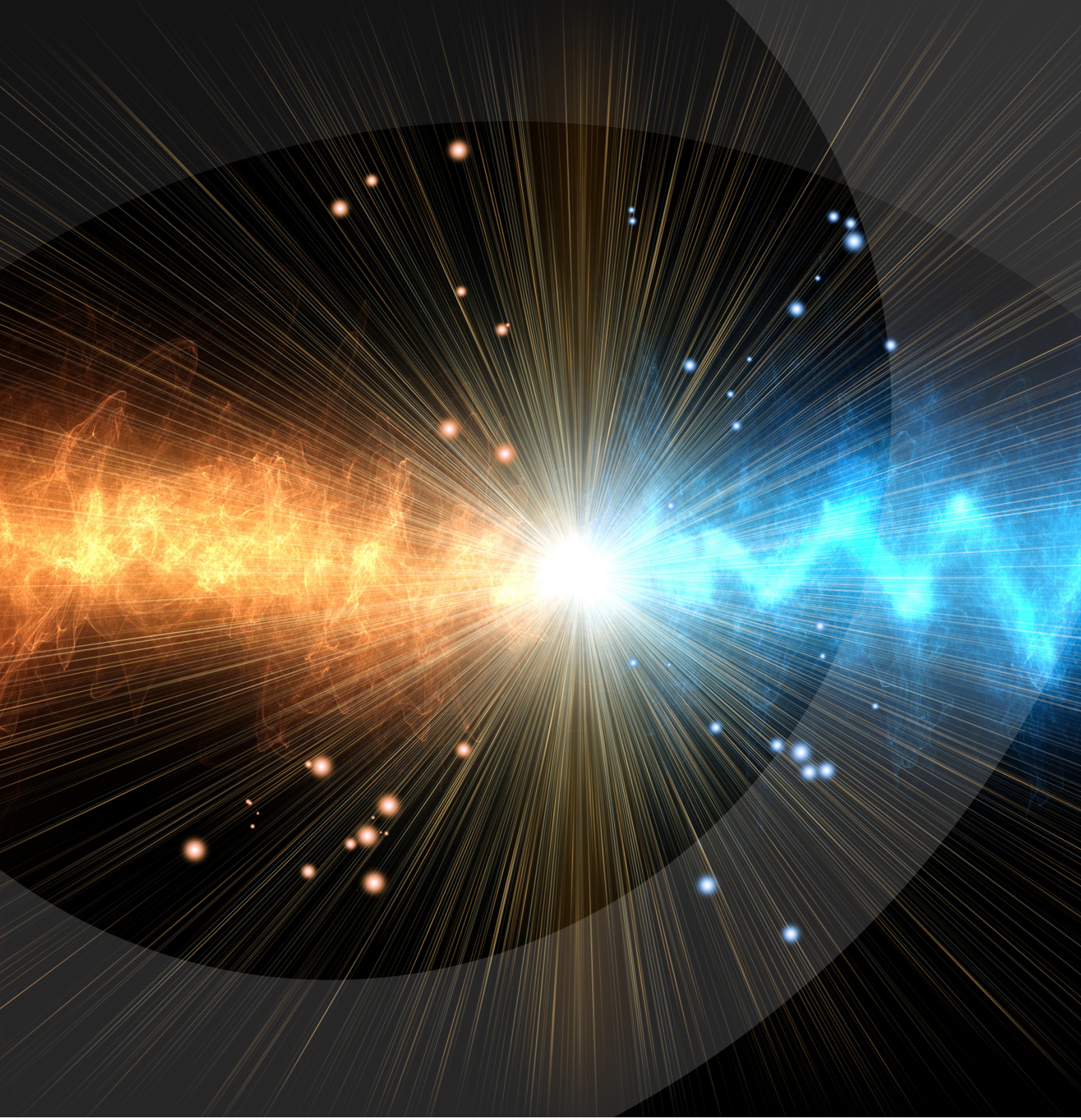

Energy Transition Outlook 2019

A call to action to the global energy industry

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A CALL TO ACTION TO THE GLOBAL ENERGY INDUSTRY

Wood Mackenzie President Neal Anderson introduces our 2019 Energy Transition Outlook and examines why the energy mix is not changing nearly as quickly as the world needs it to.

I'd like to introduce you to our 2019 Energy Transition Outlook – an assessment of how the next two decades may play out across the entire energy and natural resources value chain. We have drawn this integrated analysis from across all of Wood Mackenzie's commodity, technology, markets and segments coverage.

A number of things leap out.

First and foremost, there's resistance to achieving the aspirational targets to reduce global carbon emissions set in Paris four years ago. The energy mix is not changing nearly as quickly as the world needs it to. Despite sincere intentions, there is still no carbon price in many major consuming countries or market segments.

In addition, the technologies essential for decarbonisation remain nascent; policy and regulation lack global coordination; and investment in the production of hydrocarbons and in the sectors that consume them persists at a high rate because money can be made.

Finally, we're witnessing a trade war between the two largest global economies and a go-it-alone approach driven by populists and protectionist agendas. I see that as at odds with the collaborative, can-do spirit that emerged from Paris at the end of 2015.

The scalability challenge

I call this situation the scalability challenge. While some of the technologies required for a 2 degree future are economic, proven and scalable, many others are not. Optimists look at solar and wind costs and say we have all we need to achieve our targets. The reality is that significant additional investment and political will are needed to get them to a material scale globally. And the huge challenges that remain in sectors beyond power and road transport are often downplayed.

Our latest view – based on a bottom-up, asset-based, investor-led perspective – is something nearly no other company can do. It is based on fundamentals and objective thinking. It is supplemented by our relationships across every major asset class, government and demand segment. It is a result of our teams pushing the cost technologies and adoption rates as much as we think possible, given the inertia already embedded within multiple business cycles. What emerged is a conservative outlook: one in which the current pathway looks more like 3 degree of warming than the 2 degrees or lower advocated in Paris.

It's easy to produce a bullish forecast on the pace of the energy transition when you use a top-down approach that doesn't model at the asset level or is solely focused on renewables. Or when you don't have the proprietary data and analytics. But, because of the depth and volume of data available to us, it's clear that lack of proper incentives and regulations is resulting in each asset class operating independently to maximise its returns.

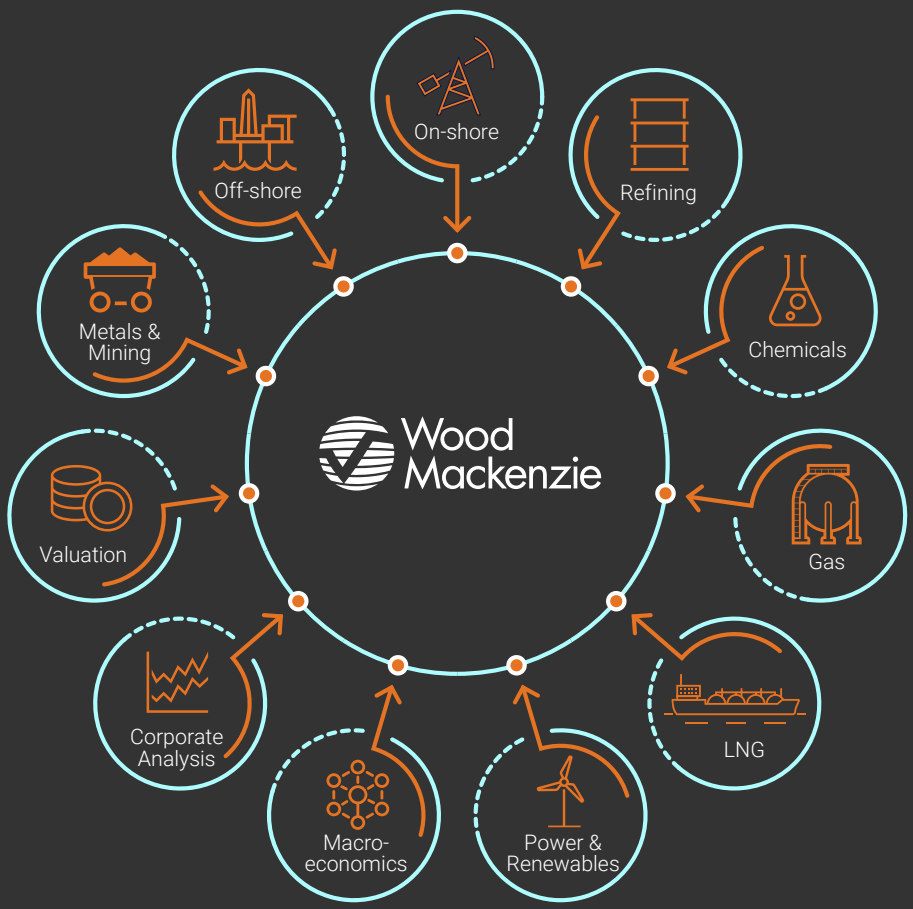
What is the energy transition?

How we define the energy transition at Wood Mackenzie?

Rapid technological advancement across a variety of industries is enabling society's quest for sustainability at an unprecedented pace. The resulting energy transition is causing an epochal shift in how the world's population consumes energy and natural resources, driven by a range of factors:

- Decarbonisation
- Economics and equity
- Energy access
- Efficiency
- Political and regulatory expectations
- Emerging Technologies
- Societal expectations around environment and climate

Our full integrated natural resources value chain



Our integrated view of three possible energy transition scenarios:

Energy Transition Outlook

Our base case view across all global commodity and technology verticals. It does not represent business as usual; it reflects an evolution of current policies and technology advancement playing out as we can foresee, expressing some degrees of business and consumer inertia. The following insights reflect this outlook and it is valid for all commodity outlooks synced with our H1 2019 research. It is broadly consistent with a ~3 degree Celsius global warming view.

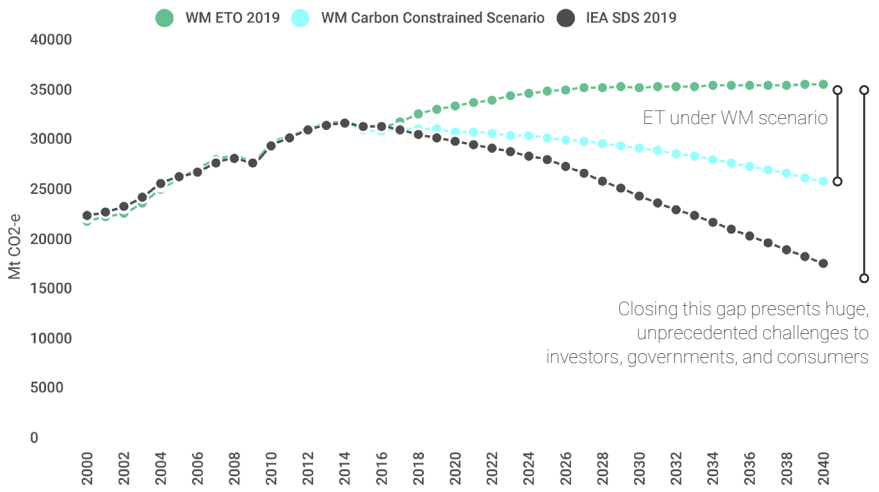
Carbon Constrained Scenario

A scenario leveraged from our base case representing an accelerated view of the Energy Transition, published in 2018. It is a much deeper view on decarbonisation and electrification, best efforts on technology, policy, and cost reduction acceleration. It also reflects heightened societal preference to rapidly meet the challenges presented today by the quest for sustainability. It is what we think could conceivably happen over the long-term, if there is more radical change in the short-term. It is broadly consistent with a ~2.5 degree Celsius global warming view. We will refresh in Q4.

2 degree scenario

Quantifies the impact of successful implementation of major climate goals limiting global warming to 2 degree Celsius. The IEA's Sustainable Development Scenario (SDS) is the most common and standardised framework for quantifying a "2 degrees or lower" outlook. We ascribe a very low degree of confidence that 2 degrees can be achieved due to the challenges across technology, policy, regulation and cost; intergovernmental constraints; trade and consumer choice; and what is built into the current energy systems of today. However, we will release an assessment of what it would mean for commodities and the technologies required to attain that trajectory later in the year.

How emissions differ by scenario, 2000 to 2040



Source: Wood Mackenzie Energy Transition Outlook

Key takeaways

1. The global energy system faces a scalability challenge.

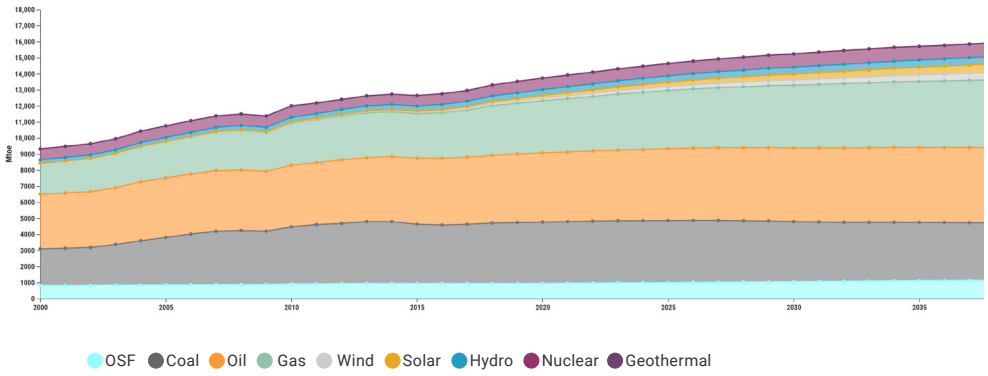
It needs to move sharply towards a global warming pathway limited to 2 degree Celsius or lower. But despite great efforts to reduce costs in renewables electricity, zero-carbon technologies and advanced transportation – not to mention burgeoning support in governmental policies – it is not enough.

What's changed since COP21?
The global backdrop has become more challenging and polarized – with less cooperation. The ongoing trade war is also impeding progress. Policies being promoted in the EU and smaller economies are helpful. But larger, energy-dense countries and energy-rich segments lack any serious progress.

2. The global energy system faces a scalability challenge.

With rising population but moderating intensities, global energy demand will slow. It increases from 13 Btoe in 2018 to 16 Btoe in 2040. That's a growth rate of just 1%, half the rate of the past decade. Since 2010, the growth in Asia Pacific has been ~35% while it has been nearly flat in North America and Europe. We do see progress in energy access through off-grid solar programmes in Sub-Saharan Africa. But in other economies, like India's, large populations will be connected to the grid using a coal-heavy fuel mix.

Total Primary Energy Demand: Hydrocarbon and zero carbon supply



Source: Wood Mackenzie Energy Transition Outlook

3. World risks relying on fossil fuels for decades to come.

The energy mix is changing only gradually and the world risks relying on fossil fuels for decades to come. We forecast coal, gas and oil will still contribute around 85% of primary energy supply by 2040, compared with 90% today. Availability of resource, infrastructure and cost competitiveness (absent a carbon price) keeps fossil fuels resilient. We also see the potential for protectionism to creep in to other areas of the economy, hastening the need to focus on domestic resources; including fo fossil fuels.

4. Renewables are the fastest-growing source of energy supply by far.

The accelerating capacity build-out is changing the power sector landscape. Wind and solar will contribute 24% of power supply by 2040 compared with 7% today. Although the competitiveness is improving, there are practical limitations to reaching a fuel mix comprised of 50% or greater share for solar and wind. We see growth in energy storage to almost 600 GW. But without long-duration storage, on a much higher scale, high solar and wind yields negative prices and grid shape, design and stability issues.

Where is value captured in 'zero carbon' economies when marginal power prices collapse? Can design change solve this? Possibly. Beyond capacity markets and auctions, value creation in renewables still doesn't look as remunerative as the best oil and gas developments. This may prompt an existential crisis for those seeking to generate comparable returns in new energy investments, although there are interesting opportunities emerging in retail models for distributed generation and grid edge technologies.

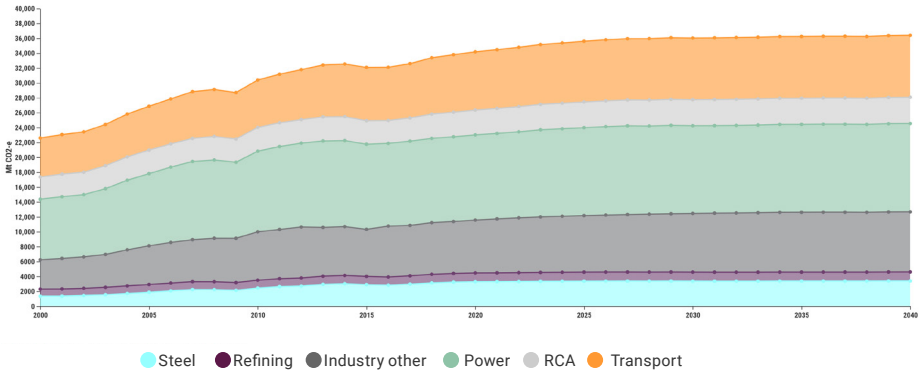
5. Electrification is the emerging transformational theme – both for power and for the transport sector.

Electric vehicles pose a significant threat in the light-duty transport sector and to oil demand within the next few years. But gains in fuel efficiency will mirror the amount of fuel lost due to substitution – in the 5-6 mb/d range. Mining has a critical role to play with much growth expected in raw materials for batteries, motors and infrastructure in transport, as well as grid infrastructure and equipment in power.

6. Decarbonisation is only slowly taking hold beyond the power sector.

The obstacles presented in industry, manufacturing, housing, aviation, shipping, agriculture and heat dwarf those in power and road transport. Little to no progress has been made in commercialising technologies in those segments and hopes are turning to hydrogen and carbon capture and storage (CCS) as the panacea. But those large industrial segments also face geopolitical problems. Take decarbonisation of an industry like steel, which is highly competitive and has 'national champions' in China, South Korea and Japan. Steel has also been at the core of trade disputes since 2014. Who will be willing to create 'green steel' first when the returns are not visible?

Emissions by key segment



Source: Wood Mackenzie Energy Transition Outlook

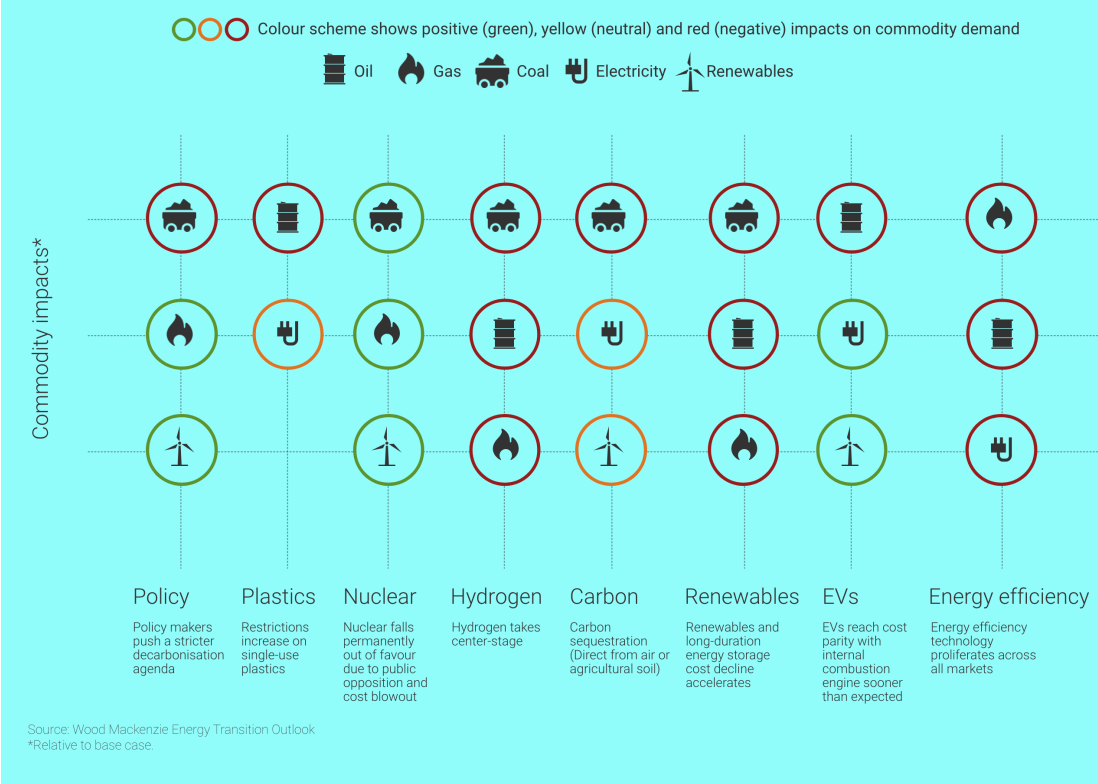
7. Carbon emissions will continue to rise, with growth slowing only in the 2030s.

Both our Energy Transition Outlook (3 degree Celsius) and Carbon-Constrained Scenario (2.5 degree Celsius) fall outside 2 degree Celsius or lower trajectories. Zero-carbon needs to be on a pathway to 40% of the total energy mix by 2040, compared with the 20% we forecast in our Energy Transition Outlook. Yes, policy is becoming supportive in some markets (the UK just legislated an economy-wide zero-carbon pathway by 2050) but other markets represent large, energy-dense segments with little-to-no progress.

8. Reducing emissions to below 2 degrees is a huge global challenge.

Achieving it requires urgent policy and regulatory initiatives in both laggard OECD but also non-OECD countries, too. These must include tax policy and subsidies that incentivise R&D and capital allocation into the zero-carbon technologies. It will need continued support for investment in renewables, as well as transforming existing technologies – carbon capture, utilisation and storage, batteries and long-duration energy storage, hydrogen and alternatives in non-power – into commercial propositions. That is the scalability challenge we see.

Risks that could threaten the pace and scale of the energy transition:



What's inside the full 100-page energy transition outlook?

1. Key Takeaways and Implications
2. Macro Economic Climate & Trade
3. Demand and Regional Themes
4. Supply and Regional Themes
5. Individual Commodities/Fuels/Technologies
6. Key Segments: Power
7. Key Segments: Transport
8. Emissions, New Technologies, Emerging Themes
9. Investment and Corporate Strategies
10. Comparisons to other outlooks
11. WM Energy Transition: Product Development Horizon
12. Author biographies

Subscribers to the Global Energy Markets Service are entitled to the full 100-page report; all other clients receive a 40-page version.

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