The economic impacts of disorderly climate transitions: how Ministries of Finance can avoid boom and bust with sound economic analysis and effective climate policy

Institute for New Economic Thinking at the Oxford Martin School

David Nelson

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Ministers of Finance face several different types of economic and fiscal impacts from climate change and actions taken to mitigate climate change. These include the following:

1. *Stranded asset risk.* The first impacts for Ministries of Finance to consider are potentially slower economic growth and lower fiscal revenues resulting from climate change mitigation actions. Reduced revenues from extracting and selling fossil fuels is the most obvious source of stranded asset risk, although there are other areas of potentially reduced revenues including power plants, factories, transportation systems and related infrastructure that may need to retire early or scale back production.

   As output and revenues decline from these assets, an MoF could experience a worse than anticipated fiscal position, including a larger budget deficit, worsening balance of payments, and decreased employment in carbon-intensive sectors. The market for some of these resources is global. Thus, MoFs need to react to global markets that might be outside of their control and need the tools to assess and manage these external risks.

   The scale of stranded asset risk depends on the country's starting position and is highly variable between countries; those dependent upon fossil fuel exports will generally face a higher potential impact than countries that import energy. MoFs can reduce the impact through careful planning based on economic modeling and scenario analysis. Planning, budget management, and borrowing plans should incorporate contingencies for potential declines in revenues and economic growth and, crucially, avoid further investment in assets that will likely experience transition-related declines in value.

2. *Transition costs.* The second type of impact is the cost of national plans to reduce greenhouse gas emissions. National plans are, arguably, easier for MoFs to control through policy and taxation. Furthermore, for many countries these plans will present a net benefit that increases economic growth, improves energy independence, improves balance of payments, creates jobs, and reduces the domestic economic volatility that spreads from global energy market volatility.

   Once again, the impact will be country specific. Nevertheless, despite having somewhat more control, countries will face economic pressures and domestic and global political forces that will influence the costs and direction of the national plans. Crucially, even countries that are poised to benefit in aggregate from a climate transition will likely see wide disparities in impact by region and sector. For example, regions dependent on fossil fuel production could see significant relative economic decline and rising unemployment, even as other regions benefit from more predictable long-term energy prices. MoFs need careful and critical analysis of transition paths, options, and costs to balance the economic and political trade-offs—both domestically and internationally.

3. *Physical risk.* The management of stranded assets and transition costs takes place within the context of the changing climate itself. Not only will climate change affect the perceptions and the politics of climate change, but the costs of managing physical risks will constrain an MoF's options for managing stranded assets and transition costs.

Physical risks include the management of potential costs of climate change-related storms, droughts, and extreme heat as well as the costs of adapting infrastructure for the chancing climate. The physical costs and the associated risks can be partly managed through expansions of disaster relief programs, infrastructure design and management, and insurance programs. MoFs will need to incorporate the costs and uncertainty related to physical risks in their analysis and managing of the other risks. Crucially, climate change risk management should be robust under any combination of physical and transition shocks.

Uncertainty and the cost of disorderly transitions

The three sources of financial risk above have been widely discussed and studied over many years. Analysts have developed models, tools, and scenarios to help MoFs evaluate these risks, and practices are evolving, albeit slowly and imperfectly, to manage these risks. However, MoFs and the analytical community are much less equipped to manage what may turn out to be the largest impacts of all: the fiscal and economic impacts of uncertainty, evolving circumstances, and mismanagement of the transition on the economy. This uncertainty can amplify each of the three other impacts, alter investment decisions to increase costs, and create economic volatility that reduces economic growth and increases interest rates, the cost of the transition, and unemployment.

This contribution focuses on a few examples of the potential impact of even small amounts of uncertainty and outlines the types of tools and policies that MoFs would need to evaluate and manage this uncertainty.

A smooth and orderly transition to a net zero economy could be relatively benign economically

At a global level, the net total economic cost of a transition to a global net zero economy by mid-century—including both stranded assets and transition costs—could be a fraction of one year's economic growth. Some estimates suggest that the net economic impact could even be positive, making the world, on average, richer—and these estimates do not even consider the benefit that slowing climate change could have on reducing the economic impact of climate disasters and lowering physical adaptation costs. This conclusion has been shared by models and analysis developed by institutions ranging from the OECD (Guillemette and Château 2023, p. 41), to the UN Intergovernmental Panel on Climate Change (IPCC, 2023), p. 88), the Energy Transition Commission (Energy Transition Commission 2020, p. 52), and the consulting firm WTW. However, each of these analyses implicitly assumes that the transition will happen in an orderly and efficient manner; that is, the new, net zero carbon economy will seamlessly replace the existing system in a timely and well managed fashion.

The reality is that the transition may not always be smooth or orderly

While the overall cost of a transition may be negligible, the costs and benefits will be distributed unevenly. The decline of specific industries, sectors, technologies, and regions that are more dependent on fossil fuels and other high-carbon processes could have economic consequences that propagate through the wider economy, magnifying the economic impact of their decline. Perhaps more significantly, the timing of the phaseout of the existing higher carbon infrastructure may not mesh with the phase-in of the new, low-carbon alternatives. The economic impacts of this mismatch could be significant, whether a delayed phaseout of existing infrastructure leads to overcapacity and stranded assets, or a delayed phase-in of the low-carbon infrastructure leads to undercapacity and shortages of key products and commodities.

Overcapacity and stranded assets could reduce investment and slow economic growth

In some sectors, companies and investors may continue to invest in high-carbon-emitting assets such as fossil fuels, or steel or cement produced with carbon-intensive processes, only to find that these assets are replaced earlier than anticipated by the newer, low-carbon alternatives. The decline in value of the high-carbon assets could lead to stranded assets. Stranded assets may decrease equity valuations and increase loan defaults, which would shrink the amount of capital available to invest in the economy and the transition itself. Lower investment and the resulting slower growth could lead to job losses on top of those caused by the mismatch of skills between existing workers and the skills required for the new, low-carbon alternatives.

MoFs need economic models of the key sectors in which overcapacity has the potential to impact the economy and fiscal revenues. Where overcapacity is certain, there are multiple policy paths to limit new investment and phase out excess capacity.

More challenging are the cases where the degree of overcapacity is uncertain, as the overcapacity may be driven by unanticipated technology development, economic growth, or geopolitics. MoFs need economic modeling and scenario analysis to assess the potential overcapacity, its likelihood, and the circumstances and contingencies that would drive the overcapacity. MoFs will need this analysis to manage the overcapacity and its economic impact. There are many options for managing potential overcapacity, including asset retirement planning, market management, flexible or contingent contracts for asset retirement, contingency funds, and other buffer arrangements.

Undercapacity driven by transition delays could create shortages, price spikes, and volatility that also slow economic growth

Conversely, concerns about imminent declines in the demand for the higher carbon products could cause financiers to stop investing in new carbon-emitting resources and infrastructure. If the lower carbon alternatives fail to materialize—for instance, due to planning delays, supply chain issues, shortages of investment capital, or shifting political landscapes—the economy could face shortages of key products and materials, including energy. These shortages could cause price spikes, price volatility, and supply chain disruption, all of which would lead to inflation, higher interest rates, lower investment, slower economic growth, and unemployment.

As with overcapacity, MoFs need economic models of key sectors—including, where possible, comprehensive scenario analyses and cross sector linkages—to identify the potential shortages, their contingencies and likelihood. This analysis can support numerous policy options to mitigate the shortages and their impact, including stockpiling and reserves, maintaining spare capacity—possibly through capacity payments and reserve contracts—demand management, international agreements, and financial hedges.

Above all, the uncertainty and the volatility itself could be a greater threat to national economies than the transition

Crucially, it is possible to have both stranded assets and shortages at the same time. One region could experience shortages of cement, while another region faces overcapacity. Stranding and early closure of coal mines, causing severe local unemployment in the regions affected, could exist even when there are shortages of petrochemicals and petrochemical workers. Trading, innovation, and market responses will moderate the impact of the shortages over time but could induce further volatility in the medium term. For example, spiking oil prices would encourage energy efficiency, accelerated renewable buildout and electric vehicle (EV) adoption, along with investment in more oil production. The additional oil production could come online just as the alternatives and efficiency hit the market, with both arriving when the economy enters a recession caused by the spike in energy prices. Together, these forces would depress demand and lead to overcapacity.

The ensuing cycle of boom and bust is nothing new; it has been faced by market economies for centuries. However, the scale of the climate-related economic transition is extraordinary and cuts across most economic sectors and all geographies. Another critical difference of the climate transition is that policy, and therefore politics, will often have a stronger influence on the climate transition. Additionally, the climate transition sits on top of other sources of economic volatility that exist beyond the transition itself. One result is that the transition can both amplify existing sources of volatility and create feedback loops that increase volatility further.

One example of this feedback is that greater uncertainty and price volatility increase the financial risk for many investments. With higher volatility, investors will require higher returns—that is, higher interest rates—to finance investments that face higher risk. Since much of the climate transition involves investment in new infrastructure, higher interest rates will increase the annual payments required to support the transition. These higher transition costs will cause policymakers and investors to either slow the transition, which could result in more shortages and further volatility, or accept the higher costs, which could lead to the crowding-out of investment in other parts of the economy, slowing economic growth.

There are two implications for MoFs. First, clear and credible transition plans and targets, supported by firm policy, will lower risk perceptions—and therefore return requirements—for investors. Second, given the inevitable volatility and uncertainty driven by technological, economic, and political developments, MoFs need contingencies to manage the volatility to the extent that investors can invest with confidence. As always, these plans, targets, and contingency arrangements need to be based on credible and robust economic modeling and analysis, both to make effective policies and to foster confidence among investors.

The uncertainty surrounding the risk of both stranded assets and shortages is already affecting investor behavior

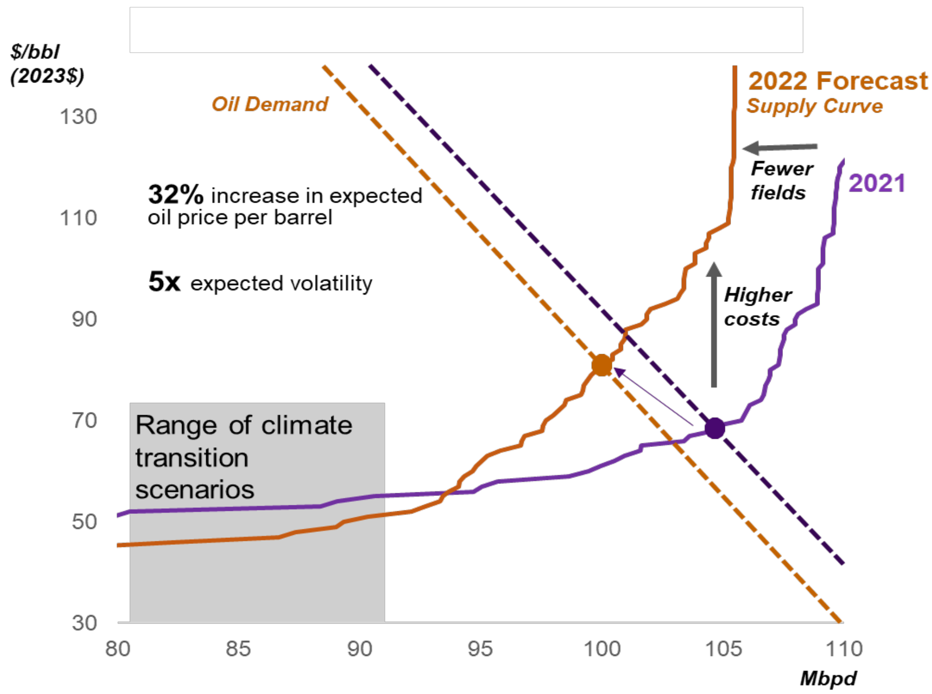
Eliminating the uncertainty by stopping or slowing the transition is unlikely to ease the worries of investors. The overwhelming evidence surrounding climate change and the popular support for action has investors and companies incorporating climate transitions in many of their decisions. With evidence continuing to grow regarding the impact of climate change, investors cannot count on climate policy disappearing. A delay or slowing of the transition could introduce yet another source of risk for many investors; that is, the uncertainty around when events or politics could cause another reversal. Changing deadlines for phasing out internal combustion engines for passenger vehicles or uncertainty around US climate policy under changing administrations are two examples of policy reversals that reduce the confidence of investors.

Another important example is the global oil market, where oil companies face uncertainty about how fast and far the transition will proceed. This uncertainty affects their confidence in the demand and price for their products in 2035 or 2040. As a result, oil companies are increasingly delaying or abandoning projects that could have been relatively low-cost sources of oil supply in the distant future. Since these projects might take 10 years to develop and then need to produce oil for 10 to 20 years after that to recover costs and turn a profit, the risk that oil demand and prices will fall within that time frame is too great to justify investment. Instead, commercial oil companies are increasingly turning their attention to oil fields that can build on existing infrastructure, can be developed quickly when prices spike, and can produce their oil relatively quickly, avoiding possible downturns. They turn to these investments even though this oil could be more expensive than the longer-term projects they shelve. Hydraulic fracturing (also called fracking) projects are a classic example of oil developments that fit this pattern. Since fracking is both more expensive before the impact of uncertainty and likely to have higher emissions than the alternatives, a world where investors see the transition is inevitable but find it delayed, could experience both higher prices and higher emissions.

Recent geopolitical events demonstrate the potential consequences

The response of energy markets to the Covid-19 pandemic shows how uncertainty surrounding the climate transition could be magnifying risks and volatility. Figure 1 shows the oil supply curve for 2030 the firm WTW has developed to forecast oil prices, oil production asset valuation, and climate transition risk for oil and gas companies. These supply curves, which are built based on a forecast of the price each of several thousand oil fields would require to produce oil in 2030, are updated in January of each year. Simultaneously, WTW forecasts both market expectations for oil demand and how that demand would vary in a given year as a function of price expectations for that year (price elasticity).

Figure 1. Evolution of forecast 2030 oil supply and demand curves in response to the Covid-19 pandemic



Sources: IEA, Rystad, WTW modeling (reproduced with permission)

WTW analysis finds that between 2020 and 2021, oil companies delayed or abandoned several projects that would have been available to produce in 2030. Simultaneously, costs for some oil fields increased (while others decreased). Concerns about declining demand due to both the aftermath of the pandemic and the climate transition are likely to have contributed strongly to many of these decisions. By 2022, market expectations for the oil supply that could potentially be available in 2030 had decreased, causing the supply curve to shift upward and to the left in the figure. In other words, for expected levels of oil demand in 2030, oil prices were expected to be higher.

At the same time, market expectations for oil demand also fell, but not by nearly as much. That is, the demand curve shifted down and to the left. The net result was that WTW models predicted significantly higher oil prices in 2030. Further, since oil demand now crossed a steeper part of the supply curve, relatively small changes in demand could lead to much larger changes in prices, implying much more volatility in oil prices. In Figure 1, a 1 million barrel a day change in demand would have five times the impact on prices in the 2022 model as it would have had in the 2021 model.

By 2023, partly in response to the Russian invasion of Ukraine and the consequences for global oil markets, forecast oil supply partially recovered and expected demand fell further. The result was forecast 2030 prices similar to those from 2021, but project cancellations and replacement with higher cost fields led to continued expectations of higher volatility if demand did not fall further than current expectations. The volatility of prices is driven by a delay in demand reduction that lags declines in available production—potentially driven by delayed adoption of alternatives.

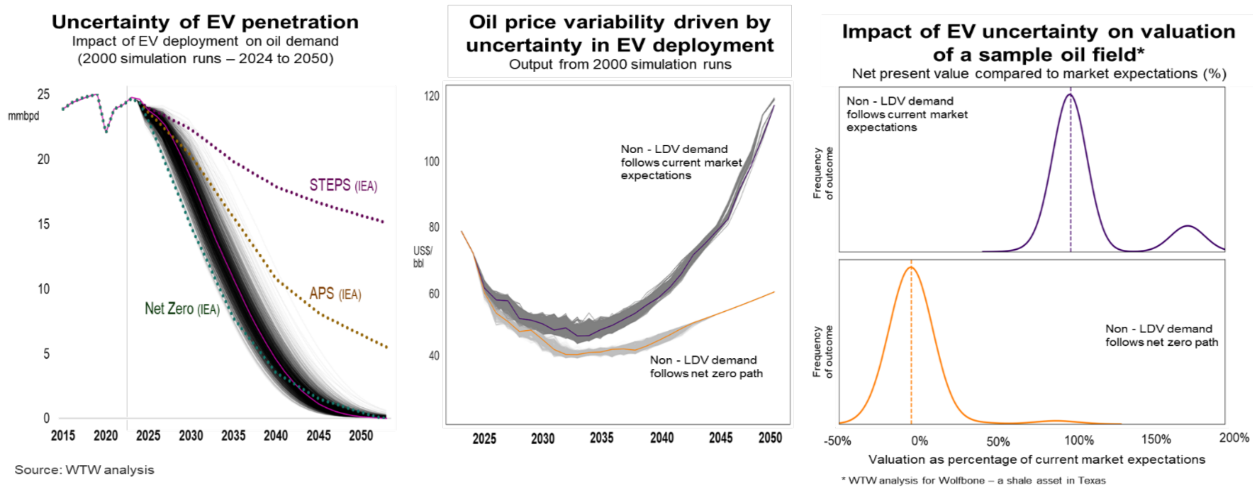
If demand does fall further, the models suggest a different story. The gray-shaded area represents the range of oil demand for 2030 that is consistent with climate transition forecasts that meet UN climate goals. Since production to meet that lower level of demand is already well established, a further 10% decline in global oil demand would potentially lead to much lower energy prices and significantly lower energy price volatility. Of course, these benefits to the overall economy could be accompanied by stranded asset concerns in the oil industry if the transition is not managed properly.

Uncertainty and risk look set to grow in the medium term, but the timing and impact will depend on the speed of the transition

Looking forward, volatility and risk in the oil market due to the transition are set to grow and, potentially, increase oil prices.

Uncertainty around the timing and extent of a switch to EVs provides a current example. The transition to EVs is still in its early stages. Nevertheless, policy uncertainty at a country level notwithstanding, global EV technology and deployment patterns are well established and are already broadly incorporated into valuations of affected companies, like automobile companies. WTW analysis indicates that the current valuation of automobile companies broadly reflects a climate transition consistent with about 1.7°C of warming (but not yet 1.5°C).

Figure 2. The impact of uncertainty of EV deployment on the economics of individual oil fields



*Note: *INET and WTW analysis for Wolfbone—a shale asset in Texas.*
Source: INET and WTW analysis (reproduced with permission)

Despite this acceptance, there remains significant uncertainty around the timing and path of EV deployment and its impact on oil demand. The growth of new technologies such as EVs tends to follow predictable patterns as they mature. Statistical analysis developed by the Institute for New Economic Thinking at the Oxford Martin School, Oxford University (INET Oxford) uses historical growth to forecast potential future development paths for new technologies. INET simulated the range of possible EV deployment paths for the next 30 years, producing a run of 2,000 potential future deployment paths consistent with observed historical EV development. In turn, WTW commodity models translated these deployment levels to assess the impact on global demand for crude oil from the passenger vehicle segment. These simulations imply a degree of uncertainty over oil demand by the segment as demonstrated by the width of the oil demand forecast (Figure 2, left).

Crude oil demand for the passenger vehicle segment represents about one-quarter of total global crude oil demand. The central panel of Figure 2 combines these 2,000 simulation paths for passenger vehicle oil demand with two different scenarios for oil demand in the other three-quarters of the oil market. The higher of the two bands includes scenarios (in darker gray) where the remaining oil demand follows the path currently expected by financial markets and investors. The lower of the two bands (light gray) assumes that all other segments transition in line with a carbon budget consistent with a 1.7°C global temperature rise.

The width of the two bands, representing the outcomes of the 2,000 scenarios, depicts the range of future oil prices where the only uncertainty is EV deployment. Note that where demand for oil outside of the Light duty vehicle segment follows current market expectations, risk (as represented by the width of the line) increases rapidly before peaking sometime around 2035. If all sources of oil demand transition faster, risk (the width) is much smaller and peaks earlier, perhaps by 2030.

Finally, the right panel of Figure 2 demonstrates how this uncertainty injects uncertainty into the valuation of individual oil fields and development opportunities. The uncertainty faced by potential oil developers could have a large impact, as this uncertainty could change investment decisions by oil companies. WTW analysis suggests the uncertainty around oil prices should change many investment decisions by oil companies. Oil companies will choose to develop higher-cost, but more flexible and thus less risky, fields rather than some lower-cost options. By 2030, these changes are enough to increase expected global oil prices by around 15%.

Furthermore, higher energy price volatility will create financial risks across all industries and consumers affected by energy prices, spreading the increased volatility across the entire economy. This modeling currently covers just one-quarter of oil demand in an oil segment where the transition path is reasonably well established. Early indications from extending this analysis across the remaining three-quarters of oil demand suggest that the total impact could be significantly higher. Further analysis on the impact of technology, policy, and geopolitical risk on oil prices, price volatility, and macroeconomic impacts is expected to be published by INET Oxford in fall 2025.

For most, a faster transition will be less risky and therefore less costly, but in all cases MoFs can expect to manage greater levels of volatility and uncertainty while the transition proceeds. The analysis in both Figures 1 and 2 shows that a faster transition should reduce both energy prices and energy price volatility, benefitting oil consumers and oil importing countries. A faster transition could accelerate and increase overcapacity and a decline in resource value for fossil fuel exporters. However, these impacts could be partly offset by certainty that would allow more confident action to avoid further stranded assets and enable early progress on transition planning. In any case, even within the fastest and most predictable transition plans, MoFs will need to manage shocks and uncertainties along with the response of investors.

Tools to evaluate and manage various shocks, delays, bottlenecks, and uncertainty associated with disorderly transitions need further development

MoFs have many models at their disposal. These include sectoral models for key transition sectors such as oil and gas, power, renewable energy, chemicals, transportation, manufacturing, housing, finance, and agriculture. They also include macroeconomic models and scenario modeling capability, as well as consumer behavior models and agent-based modeling to unpack the response of individual actors to policy decisions.

However, these models fall short in providing the information necessary to evaluate and manage disorder. Early attempts to evaluate the impact, such as the disorderly scenarios offered by the Network for Greening the Financial System (NGFS) capture the potential impact of disorder on economic growth and interest rates, but they fail to address the sector-level impacts and the differentiation between sectors and geographies needed by MoFs to manage and reduce the cost of disorderly transitions. They also fail to address the fundamental nature of disorderly scenarios: how outcomes could be driven by a set of shocks across several sectors and geographies that are drawn from a larger set of potential shocks. It is impossible to predict which shocks will actually occur, so MoFs need to identify the largest potential shocks in advance and prepare for these.

New economic modeling tools are required to meet this challenge:

- Sectoral models need to be integrated within the macroeconomic models. This integration should include feedback between macroeconomic models and sector models to address the impact of changing interest and growth rates on sector outcomes.

- Analysis needs to identify the range of potential disorder, shocks, and uncertainties—such as the EV shock cited above—and to create sectoral scenario models that reflect these shocks for incorporation into the combined macro/sector models.
- Labor markets and skill mismatches need to be incorporated into the models, including the response of labor skills to climate transition shocks and uncertainty and their time lags.
- Since investor behavior plays a key role, models need to incorporate a deeper view of financial market and investor behavior in response to policy and uncertainty, including the impact of volatility on investment decisions by different investor groups such as institutional investors, individuals, corporate investors, and state investors.
- Above all, the models need to be scenario-led and probabilistic. That is, these models need to identify the range of potential shocks and uncertainties, assess their impact, and identify their probability of occurring.
- The models need to be able to incorporate and evaluate potential active policy mechanisms to moderate the shocks and uncertainties, including the feedback loops of the policies across the economy.

Avoiding the biggest impacts of disorderly transitions requires attention from MoFs

For MoFs, the key points are the following:

- There are four risks from climate change that MoFs need to manage jointly. **Physical** risks; the risk of overcapacity and **stranded assets** as old carbon-intensive industries decline; the risk of potential **shortages** driven by delays to establishing alternatives; and the impact of a **disorderly transition** driven by economic and political shocks, investor uncertainty, or mismanagement of the transition.
- Economic analysis and modeling—including scenario analysis, sectoral models, and macroeconomic models—supports the management of all four risks.
- Multiple tax and policy mechanisms are available to manage these risks.
- Of the four risks, disorderly transition risk is the least understood, and possibly the most dangerous:
    - Fear of disorder can drive investor and policy decisions that significantly increase costs and reduce economic growth, even if the disorder-related shocks never materialize.
    - Similarly, uncertainty can drive investment and policy decisions that lead directly to disorderly transitions.
- Active management of the transition at a national and global level can create significant economic value globally, by increasing confidence, lowering the cost of investment, and avoiding volatility that reduces economic growth.
- Clear and transparent plans and targets, an accelerated transition, and robust, credible, and viable mechanisms—whether technological, economic, political, or resource driven—are needed to manage transition relevant shocks.
- There are significant gaps in the analytical tools and policy mechanisms required to manage disorderly transitions.

During the transition there are options to manage risks and reduce the impact of uncertainty

In either a rapid or a slow transition, there will continue to be uncertainty and volatility. For instance, unexpected delays in the arrival of alternative energy sources, possibly caused by unforeseen supply bottlenecks, could be one of many events that lead to the mismatch between phasing out and phasing in.

While better analytical tools are needed to help MoFs address transition risks, there are many steps that Ministries can take today to reduce these risks:

- The first step should be to identify the sectors, technologies, and regions where a mismatch would have major economic impacts that could propagate through the economy and are highly susceptible to mismatches. These sectors deserve special attention and could require policy and market mechanisms designed to help managing the risks of overcapacity or undercapacity. This analysis could also clarify the need to reduce some critical potential bottlenecks, such as planning bottlenecks.
- For all sectors, setting credible targets and sticking to them creates the policy certainty that reduces one major source of uncertainty and volatility.
- For critical sectors, mechanisms such as release valves, stockpiling of resources or creating options to manage supply and demand over shorter time horizons could be critical for avoiding risks that propagate through the system.
- In some sectors, policy might go even further, encouraging fixed-price or fixed-volume contracts between suppliers and consumers during parts of the transition, to create certainty that encourages the investment needed within the transition. Such contracts could simultaneously discourage investment in potentially stranded assets by increasing the risk to producers investing in assets not supported by contracts.

These types of arrangements will be needed for several years to cover the years of highest volatility and uncertainty for the transition. With these arrangements in place, possibly the biggest source of cost of the climate transition—uncertainty around timing and path—could be tamed, enabling the economic benefits of a well-managed climate transition to flow across the economy.

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References

Climate Policy Initiative (2014) *Moving to a Low-Carbon Economy: The Financial Impact of a Low-Carbon Transition*. http://climatepolicyinitiative. org/publication/moving-to-a-low-carbon-economy

Energy Transition Commission (2020) *Making Mission Possible: Delivering a Net-Zero Economy.* https://www.energy-transitions.org/wp-content/uploads/2020/09/Making-Mission-Possible-Full-Report.pdf

Guillemette, Y., and J. Château (2023) *Long-Term Scenarios: Incorporating the Energy Transition*. OECD Economic Policy Paper 33., OECD Publishing, Paris. https://doi.org/10.1787/153ab87c-en

IPCC (2023) *Climate Change 2023: Synthesis Report. Contribution of Working Groups I, II and III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change* (Core Writing Team, Lee, H. and Romero, J. (eds.). IPCC, Geneva. https://www.doi.org/10.59327/IPCC/AR6-9789291691647

Nelson, D. et al. (forthcoming, fall 2025) *Evaluating European Energy Infrastructure Investment within the Context of a Climate Transition,* Institute for New Economic Thinking at the Oxford Martin School, University of Oxford.

Way, R., M. C. Ives, P. Mealy, and J. Doyne Farmer (2022) Empirically Grounded Technology Forecasts and the Energy Transition. *Joule* 6(9), 2057–2082.

WTW (2022) *Energy Market Review 2022—Facing Up to Uncertainty: Managing the Transition Amidst Geopolitical Turbulence.* https://www.wtwco.com/en-gb/insights/2022/04/energy-market-review-2022