Fossil Fuels, Global Energy, and International Policy: Qualitative and Quantitative Scenario Forecasting Towards 2050

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Overview

The future development of global energy and fossil fuel markets is subject to numerous uncertainties, which is why researchers make use of forecasting to predict possible pathways (see Krey, 2014, for an overview of methods and examples). Qualitative forecasting, on the one hand, allows for the inclusion of a wide range of possibilities and factors but fails to estimate the system-wide consequences and to produce reliable numbers. Quantitative forecasting, on the other hand, delivers consistent and precise numerical results, but it is inherently bound by the assumptions and rules of the underlying model.

This paper aims to bridge between both worlds and give independent insight into four distinct, novel scenarios of future developments. Our scenarios (base case 'Business-as-usual', worst case 'Survival of the Fittest', best case 'Green Democracy', and surprise scenario 'ClimateTech') were established as storylines in a strategic foresight exercise and then implemented in the multi-fuel multi-sector numerical model MULTIMOD. They provide valuable insights for understanding if and how emerging trends of today may be 'weak signals' of forthcoming threats and opportunities in the future.

The abundance of relevant influences makes it inconceivable for forecasters to focus on all developments equally. Hence, we – in contrast to previous work – focus on changes in the global order, the behavioural perception of climate objectives for policy-makers, and resulting technological pathways. The work reveals that a successful global renewable energy transition is strongly tied to the development of international relations and the global state of security as well as the integration of energy transition with wider economic objectives, such as poverty alleviation, infrastructure modernisation, and private investment.

Methods

First, we developed qualitative scenarios using strategic foresight. Multiple scenario generation was conducted in three fundamental steps: (a) identifying key drivers, (b) generating mutually exclusive scenarios, and (c) defining indicators of each pathway. The first two steps were carried out in an expert workshop with practitioners, analysts, and academics. Led by a specialist scenario-workshop facilitator, participants constructed initial scenario themes. Storylines for all four scenarios were elaborated via additional desk-research, and indicators were defined by generating several objectives and observable hypotheses for each alternative scenario.

For the quantitative part, DIW-maintained MULTIMOD is used, which is a multi-fuel multi-sector model of the global energy system with a particular emphasis on the inclusion of imperfect competition, endogenous investments, and endogenous fuel substitution via computationally-calibrated end-use costs (see e.g. Huppman & Egging, 2014; Langer et al., 2016; Oke et al., 2016). Based on the storylines, critical input parameters for MULTIMOD (e.g. reference demand, parameters for future technologies, transport possibilities) were quantified and fed into the model with base year 2015. Prices, quantities, and investments are obtained from the numerical model in 10-year steps (2015, 2025, 2035, 2045, 2055).

Results

The four narratives do not attempt to predict the state of the global energy system by the year 2050, but they rather give bounds to the range of plausible alternative futures by defining certain trajectories, downside risks, new trends, and 'unknown unknowns' that could significantly affect markets and policy in the years to come. The study furthermore highlights how storylines can help simplify the complex network of interactions and dynamics that make up the global energy system and can, hence, contribute to successfully navigating our economies towards a decarbonised future.

Sets of indicators for each scenario help identify different easy-to-overserve situations that provide a signal that the future develops into the direction of either of the scenarios. Results of the numerical modelling quantify key variables along the trajectories of each scenario, particularly prices, supply, investment, and demand. Comparison of the different trajectories shows the importance of certain drivers and trends.

Conclusions

Despite the prominence of the scenarios by institutions such as IEA, the lack of robustness of forecasts to changes in either data or modelling approach makes new scenario research anything but superfluous. A comparison of well-established scenarios shows that while global electricity demand projections are similar across different studies, pathways for fossil fuels show significant divergence over time.

Global energy transition is particularly sensitive to three main forces, namely: i) the state of international politics which itself is to a large extend contingent on security matters; ii) the integration of economic and energy-related objectives and incentives; and, iii), the balancing between climate change mitigation and adaptation responses. International relations and the state of security are strongly tied to the renewable energy transition in the long-run, while energy transition needs to be integrated with wider economic objectives, such as poverty alleviation, infrastructure modernisation, or private investment. Moreover, it is crucial to develop an inclusive approach to policy-making that combines both mitigation and adaptation options.

The scenarios make clear that is necessary to look beyond the economics of energy markets for a comprehensive understanding of climate policy. In turn, several factors can be influential – and can therefore be tackled by policy-makers. While the complexity of drivers of climate policy and emissions may be discouraging, the variety of tuning parameters for policy-makers to convince their partners of ambitious climate policy should actually be viewed as an advantage. The realm of tuning parameters goes from technology and innovation support over (regional) geopolitics to trade and, of course, energy policy.

References

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