# Scenarios for a Future EU Energy System Until and Beyond 2050 - Charting Energy Visions towards 2060

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## Motivation and central research question

The global energy transition requires a massive re-thinking of the ways we generate, consume, and transform energy. To achieve the set climate targets of the European Union of 100% emission reductions in 2045-2050 [1], heavy electrification, combined with a significant expansion of variable renewable energy sources (vRES) is required. However, the current unstable geopolitical landscape, both globally, but also with nationalistic trends emerging within Europe itself, poses several additional challenges to the already gargantuan task of the needed rapid decarbonization.

## Methodology

To chart these uncertainties towards 2050 and beyond, the "European Energy Vision 2060" or EU-EnVis-2060 scenarios have been created. The scenario generation process included several workshops between experts from academia, industry and policy stakeholders, as well as need-owners from the CETP project "Man0EUvRE". The result of this process were four distinct qualitative storylines, mapping the major driving forces and key uncertainties facing the European energy transition (see Figure 1).

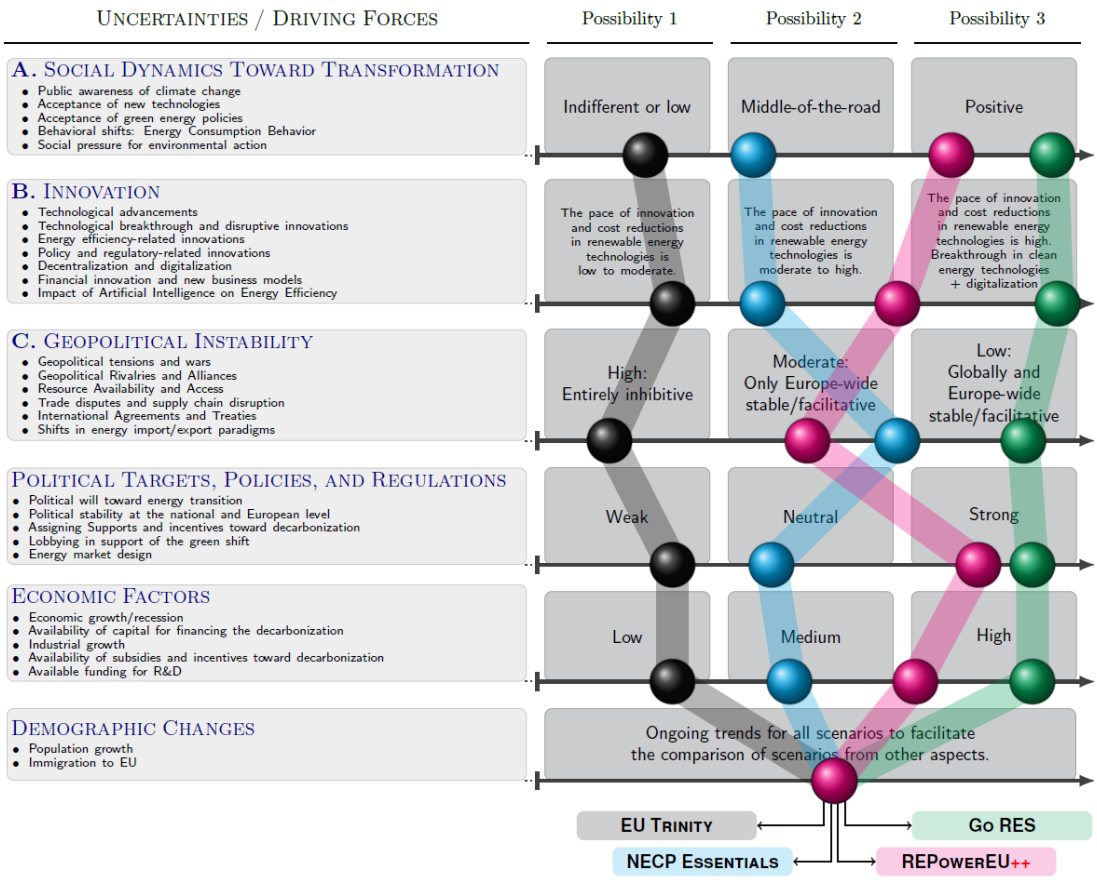


Figure 1: The main uncertainties & driving forces of the EU-EnVis-2060 scenarios

These qualitative storylines were then parametrized and translated into usable information for the use in energy system models. For this analysis, the Global Energy System Model (GENeSYS-MOD) [1] will be used to quantify the Pan-European pathways that result from the four developed scenarios. GENeSYS-MOD is a sector-coupled, open-source energy system model that includes the sectors

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electricity, buildings, industry, and transport, and performs a linear cost optimization of the energy system towards the future – in this case 2060 [3]. Main model results include investment trajectories, capacity expansion plans, the energy dispatches of the different energy carriers, as well as the flexibility and transmission requirements (see Figure 2).

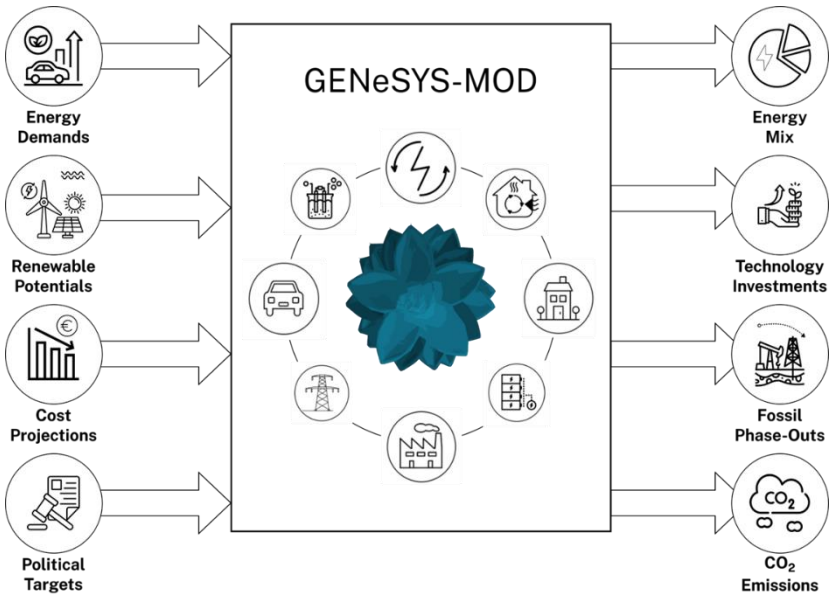


Figure 2: Inputs and outputs of the Global Energy System Model (GENeSYS-MOD)

## Results and Conclusions

The expected results will show possible developments of the European energy system towards 2060 and possible solutions to achieve set climate targets while navigating the societal, geopolitical, and technological challenges that we face, including the uncertainty that exists around them. The GENeSYS-MOD outputs will display the necessary deployment and ramp-up of renewable energy sources and showcase no-regret options across the different storylines. Within the Man0EUvRE project, the Pan-European energy system results will then be passed on to regional and sectoral models in an iterative fashion – incorporating the findings from these models into the broader energy system model. The main goal of the project is to give detailed feedback to the National Energy and Climate Plans (NECPs) of the European member states to improve the planning for a sustainable, secure and robust energy system of the future.

## Literature

[1] European Commission. The European green deal. Communication from the commission to the European parliament, the European Council, the Council, the European economic and social committee and the committee of the regions COM (2019) 640. Belgium: European Commission. Brussels; 2019a. https://ec.europa.eu/info/sites/info/files/european-green-dealcommunication_en.pdf

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[3] The Global Energy System Model – GENeSYS-MOD: GitHub (2024). https://github.com/genesys-mod

## Speaker biography

Mr. Nikita Moskalenko is a Research Associate and PhD candidate that has been working at the chair of Infrastructure Policy at Technische Universität Berlin in the field of energy system modeling since February 2022. Applying the Global Energy System Model (GENeSYS-MOD) he works on modeling the low-carbon transition and their resulting socio and techno-economic effects. He is part of various projects like the CETP project MAN0EUVRE, a project focusing on the improvement of energy system modelling and providing results on emission reductions in line with the Fit-for-55 targets, and the Horizon Europe project iDesignRES which aims to provide modular open-source toolboxes allowing to plan and optimise the uptake and enhancement of low and zero emission energy sources and infrastructure, while also teaching courses in optimization with python and energy system modeling. In his studies as industrial engineer he was working on modeling the decarbonization and associated effects on employment in South Africa and Colombia for his bachelor's thesis. For his master's thesis he was writing on quantifying the role of renewable hydrogen in the future energy system by using GENeSYS-MOD in different analyses.