# Energy Transition: Modelling and Simulating Large Scale Multi-Carrier Energy Networks

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The Netherlands aims to have an energy supply that does not contribute to climate change in 2050. To achieve this goal, we have to significantly reduce the usage of fossil fuel. This can be achieved by using different energy sources such as renewable energy, interaction with neighbouring countries and using our energy network more efficiently by allowing interaction with different energy carriers. The latter leads to multi-carrier energy networks. The interaction happens at coupling units such as electrolysers and combined heat and power plants (CHP). Careless implementation can lead to an unreliable network. This can lead to higher capital expenditure (CAPEX) and operating expenditures (OPEX). To create a reliable network, one needs a model of an energy network that can show the effects of coupling units. Moreover, these models need to be fast and accurate, because many different scenarios have to be simulated.

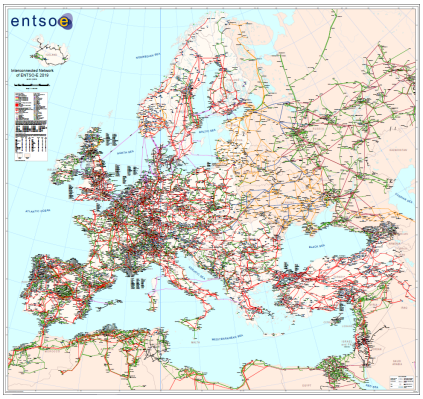


Figure 1: European electricity network.

One of the key components is determining the energy flows of a multi-carrier network, which is also known as a load flow analysis. In Markensteijn's PhD research [1], it has been demonstrated that a steady-state load flow analysis can be done for multi-carrier energy networks. However, convergence problems occur for networks with more than 100 degrees of freedom, whilst for practical purposes energy networks of interest can vary between $10^6 - 10^9$ degrees of freedom. Hence, solvability and scalability are challenges pertaining to this problem.

The aim of this project is to develop fast and robust solvers for steady-state load flow analysis of large multi-carrier energy networks. Several topics are available within this project to tackle the aforementioned challenges:

- Investigate problem formulation to achieve faster computation times.
- Investigate solvers and preconditioners.
- Investigate regularisation techniques for ill-conditioned and ill-posed scenarios.

## Contact

If you are interested in this project or if you have questions feel free to contact the following persons:

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## References

[1] A. S. Markensteijn. *Mathematical models for simulation and optimization of multi-carrier energy systems.* PhD thesis, Technische Universiteit Delft, 2021.