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Renewable Energy Systems

cross-border versus cross-sector interconnectivity in renewable energy systems

BY JAKOB ZINCK THELLUFSEN[1], HENRIK LUND[1]
[1] Aalborg University, Aalborg, Denmark

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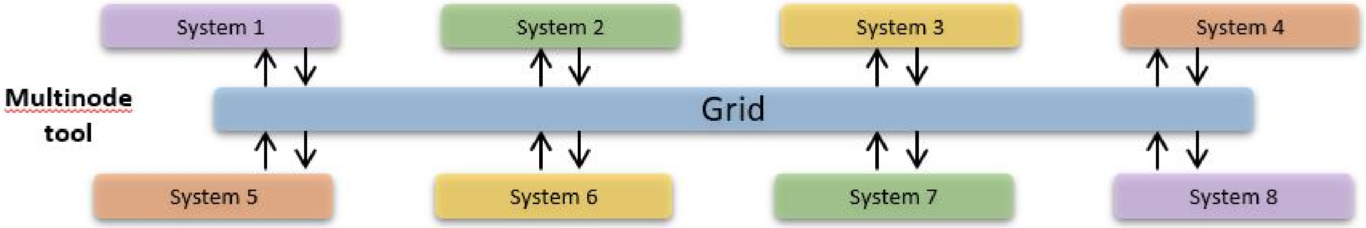
Introduction

The **fluctuation** in production of energy from renewable energy sources (wind and solar) plays a significant and important role in an energy system based on renewable energy sources. The challenge is to match demand with the fluctuating production. Two possible solutions to this issue include transmission of energy between the different energy systems, as well as integrating the energy systems.

This study evaluates the benefits of both solutions individually. However, more importantly, the study evaluates whether and to which extent the two types of interconnectivity can work together to increase flexibility in energy systems with high amounts of fluctuating **renewable energy**. The study has been carried out in two interconnecting European energy systems representing Southern (Italian model from the Heat Roadmap Europe) and Northern (Danish CEESA model).

. Transmission:
Interconnection between energy systems and integration is interconnection within an energy system. Together these can be viewed as a two-dimensional approach to interconnection.

. Integrated Energy System:
A type of smart energy system, which combines and coordinates electricity, thermal, and gas grids in order to optimize the benefits of each sector as well as of the overall system.



A Multinode tool was used and is a simple method to balance the potential import and export of energy based on the principle that a system can not import more electricity than needed, nor can it import more electricity than available. Therefore, the sum of import and export between systems will always equal zero. Multinode is an add-on to EnergyPLAN

Analysis

The analysis consisted of two scenarios for cross-boarder interconnectivity and cross-sector interconnectivity. In addition, in the second scenario, the impact of using transmission cables is also tested. Thus, it is possible to evaluate how the combination of cross-sector and cross-border interconnectivity might influence each other.

.Cross-boarder interconnectivity

The use of transmission cables to achieve an interconnection of systems. The increase in the transmission capacity between the Northern and Southern systems was analysed regarding different capacity of transmission cables, 3, 6, and 9 GW.

If both systems use a mix of wind and solar, the fuel use is reduced by 2% at 3 GW transmission, while for both 6 GW and 9 GW transmission, the decrease is 3%. Moreover, a better utilisation of **renewable energy** is achieved with an increase by 10% at 3 GW, and 12% for both 6 GW and 9 GW transmission capacity.

.Cross-sector interconnectivity

Firstly, it is necessary to change the conventional system to a system with district heating. Secondly, heat pumps needs to be integrated into the district heating sector. Thirdly, electric vehicles need to integrated.

If both systems use a mix of wind and solar, the integration of district heating and thermal storage reduces fuel consumption by 3%. Following the introduction of heat pumps, the fuel consumptions drops by 11%. Moreover, if electrical vehicles are included, the fuel efficiency increases by 20%. Furthermore, the utilisation of **renewable energy** is only increased with the two last steps by 18% and 29%, respectively, compared to the reference.

.Two-dimensional interconnectivity

Including the final step of cross-sector interconnectivity (electric vehicles inclusion) the variable **renewable energy** utilisation is 79% with no transmission between the Northern and Southern systems. The introduction of cross-border interconnectivity increases the utilisation to 81%.

Discussion

Cross-sector interconnectivity seems to perform better than transmission from one system to another from a technical point of view. However, the two solutions are not mutually exclusive, since the cable connection improves the system compared to not having connections.

When the scenarios are compared and the two-dimensional interconnectivity is included, the results show that the greatest benefit is achieved from cross-sector interconnectivity, since the added benefit of a cable is small. Therefore, integration should be preferred compared to transmission cables, even though both solutions lead to more efficient energy systems.

Contact

Jakob Zinck Thellufsen (jakobzt@plan.aau.dk), Assistance Professor, Department of Planning and Development at AAU, Aalborg University, Denmark

Henrik Lund (lund@plan.aau.dk), Professor, Department of Planning and Development at AAU, Aalborg University, Denmark

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