

## **Electricity system expansion planning of the Rhenish Mining Area considering environmental impacts by using multi-criteria-optimization**

In the context of climate change and the increasing demand for sustainable solutions in the energy sector, it is of particular interest to consider environmental impacts in energy system analyses. The consideration of CO<sub>2</sub>-emissions is quite common, whereas other environmental impacts are often neglected. However, many other impacts are highly relevant, too, especially given that for renewable energies, the environmental impacts shift towards other impact categories, e.g. the consumption of certain metals. Impacts also shift from the use phase to the production phase.<sup>1</sup> This requires a multi-objective optimisation of energy systems, considering not only techno-economic, but also environmental and/ or societal aspects.

Using the energy system model Backbone<sup>2</sup>, the German electricity system is analysed with special consideration of the Rhenish Mining Area (RMA). This area is of particular interest since lignite-fired power plants are highly concentrated there, which will be shut down until 2038 which leads to a new structural change in the region. The current state is compared with scenarios after the end of the coal phase-out. This study examines to what extent and under what conditions the replacement of lignite-fired power plants takes place within the RMA. In addition to costs, CO<sub>2</sub>-emissions and the consumption of certain resources are included in the optimisation, not only as boundary conditions but as objective functions. Through this multi-criteria optimisation, insights can be gained into the interrelationships of the various target variables and their effects on the optimal solutions. The augmented epsilon-constraint method AUGMECON<sup>3</sup> is used to determine pareto-optimal solutions.

### **Keywords (1-3 possible):**

Energy Policy and Planning;  
Electrical Markets;  
Multi-Objective Programming

Multi-Objective Decision Making;  
Capacity Planning;  
Decision Support Systems;  
Environmental Management

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<sup>1</sup> Paper Tietze → Textfeldeingabe, deshalb keine Quellen im Abstract

<sup>2</sup> Backbone-Paper

<sup>3</sup> AUGMECON-Paper