9th Smart Energy Systems Conference, 12-13 September 2023, Copenhagen

Transformation of the heat and gas infrastructure for a cost-optimised climate-neutral European energy system

Jens Schmugge[1,*], Hedda Gardian[1], and Hans Christian Gils[1]

[1]German Aerospace Center (DLR), Institute of Networked Energy Systems, Curiestr. 4, 70563 Stuttgart, Germany

[*]presenting author: jens.schmugge@dlr.de

Abstract

The need to advance towards zero-emission energy systems goes along with the need to build sector-integrated energy systems. We therefore present a geographically, temporally and technologically highly resolved linear optimisation model of the European energy system to investigate promising pathways to a cost-effective decarbonised future.

Our model is built using the energy system optimisation framework REMix [1, 2] and consists of 70 nodes representing regions in Europe, more than 100 different types of energy sources and storage options. We consider electrification of heating and transport as well as the production and import of hydrogen from several regions as major options to link sectors. The objective is to minimise system costs while meeting the hourly demand of all considered energy carriers at all nodes through expansion and usage of energy conversion, storage and transport options. The analysis particularly evaluates the future gas pipeline infrastructure.

Our results indicate that the electrification of heat supply caters for most demand of that sector in a cost-optimal decarbonised future. Significant cost reductions can be achieved by using the flexibility that heat and hydrogen storage can provide to the power system through sector integration. With the buildup of electrolysis capacities throughout Europe combined with some overseas imports, a hydrogen transmission network provides flexibility to the system and leads to a significant decline of overall system costs compared to the sole use of the electrical grid.

Keywords: sector integration, power-to-heat, power-to-gas, gas infrastructure, decarbonisation, cost-optimised pathway

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