Probabilistic Assessment of Heat Electrification Impacts on Integrated Gas and Electricity Networks

Key Contributions

Development of an integrated gas and electricity network model to investigate the impacts of heat electrification on gas and electricity networks considering their interdependence.

The correlated uncertainties of electricity and gas demand are modelled using copula method, while the wind generation uncertainty is modelled using kernel density estimation.

The applicability of proposed model is shown through a case study in the Great Britain's electricity and gas networks.

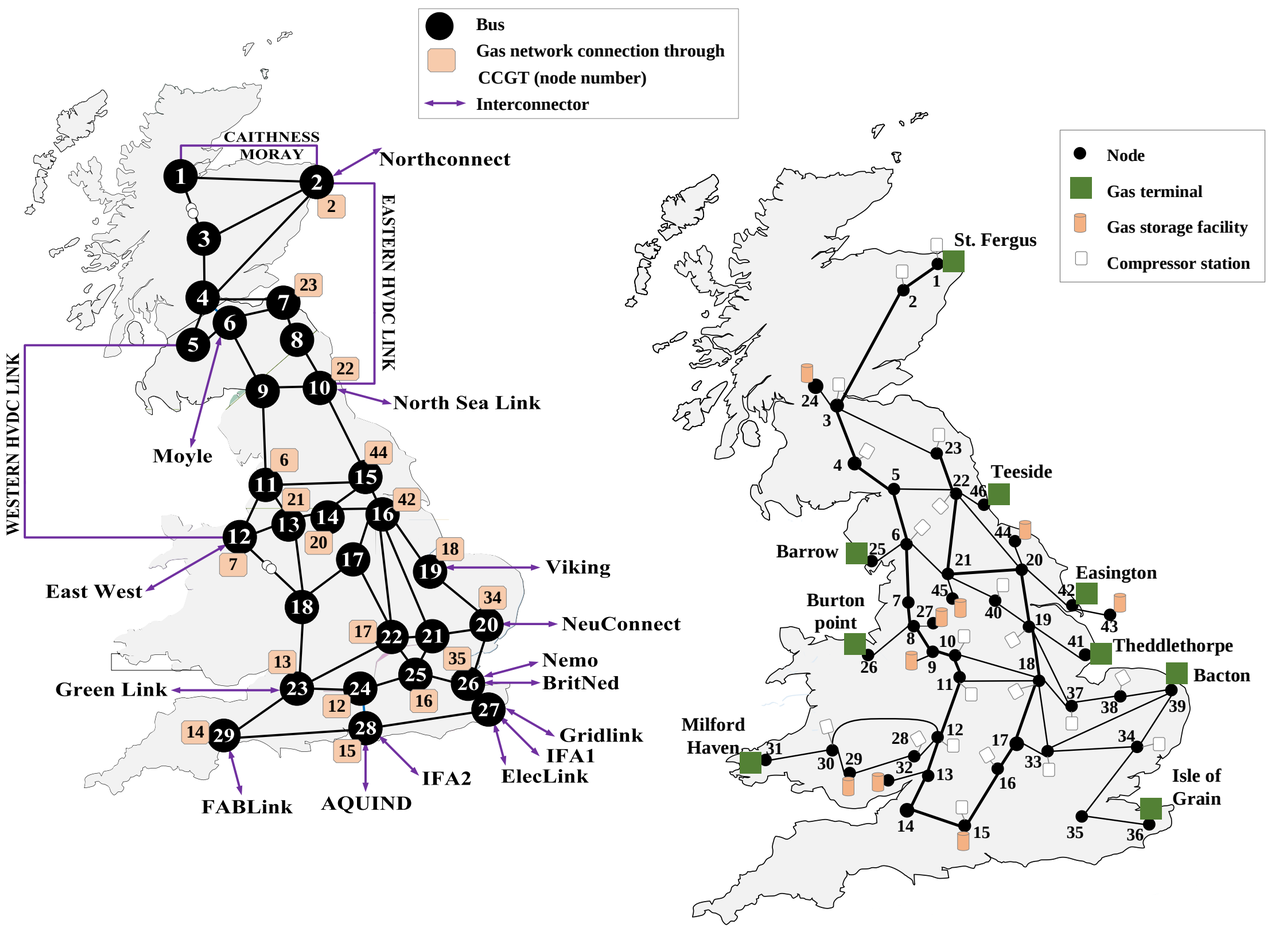
Methodology

Uncertainty modelling of input variables
Kernel density estimation: wind generation;
Correlation modelling using copula: electricity demand and gas demand

Optimal power and natural gas flow problem
Non-sequential Monte Carlo
Minimise operational costs subject to gas and electricity network constraints

Output quantification
(considering heat electrification)
Gas consumed by CCGT plants; Overload probability of each power line and gas pipeline

Great Britain's Electricity and Gas Networks

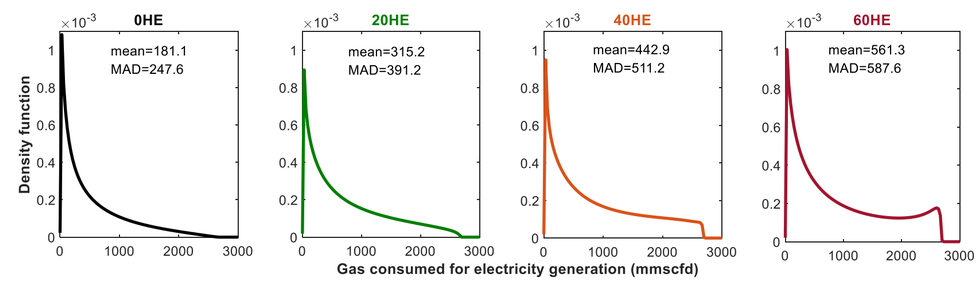


Test Cases

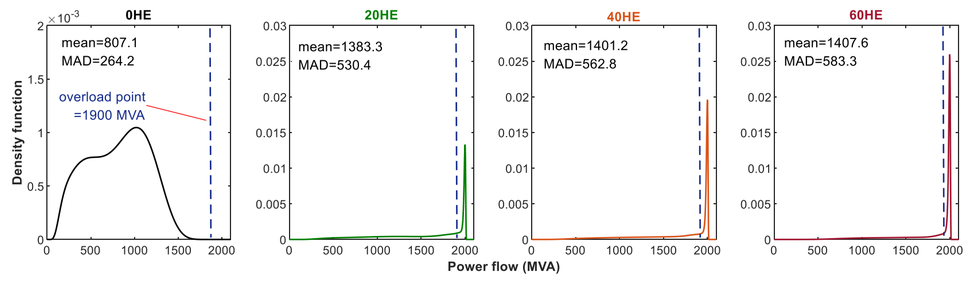
Test case	0HE	20HE	40HE	60HE
% of heat load shifted from gas network to electricity network	0%	20%	40%	60%

Results

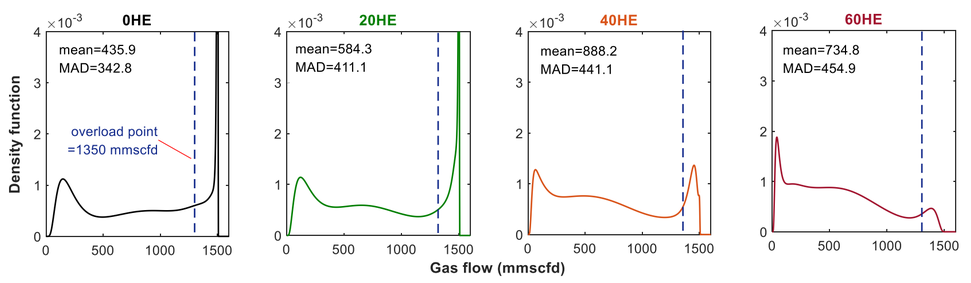
Kernel density estimates of gas consumed for electricity generation



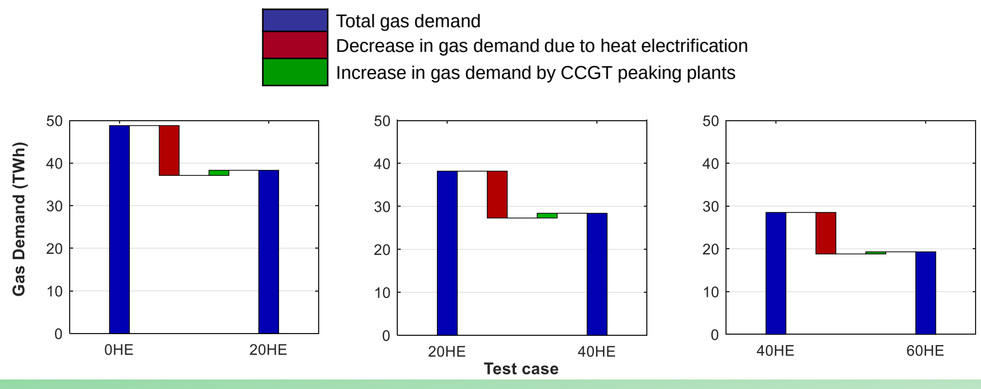
Kernel density estimates of power flow in representative line #110



Kernel density estimates of gas flow in representative pipeline #22



Change in total gas demand in successive levels of heat electrification



Conclusions

Gas consumed for electricity generation increased and became volatile since the gas-fired power plants provided the peaking capacity to compensate for increased heat demand.

Total gas demand decreased because the increased gas consumption of electricity generation was insignificant compared to the gas demand reduction from heat electrification.

Overload probability of power transmission lines increased as the electricity demand increased due to the shift of heat loads to the electricity network.

Overload probability of gas pipelines decreased as the gas demand decreased due to the shift of heat loads from the gas network to electricity network.

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