Electricity, gas, heat integration via residential hybrid heating technologies

Steve Heinen (steve.heinen@ucd.ie), Mark O’Malley (mark.omalley@ucd.ie)
UCD School of Electrical, Electronic and Communications Engineering

INTRODUCTION

- Space and water heating demand represent roughly 80% in Europe and 60% in the United States of final energy use in residential buildings.
- Residential heat electrification is promoted to reduce fossil fuel usage and increase use of efficient heat pumps, while power sector is decarbonised.

HYBRID HEATING TECHNOLOGY

- Hybrid heaters combine different heating appliances and can switch between those appliances during operation
- Advantageous from building perspective
  - Lower upfront cost compared to HP
  - No efficiency penalty at lower ambient temperatures compared to air-source HP

Objective:
Quantify system-wide planning and operational costs of deploying hybrid heating technologies in the residential sector

METHODOLOGY

A least-cost linear investment model

- Optimises power and residential heat sector, including thermal storage, jointly
- Internally determines capital investment and operational expenditure for both sectors
- For hybrid heaters, model optimises dispatch between the gas-fuelled appliance (B) and the electricity-fuelled appliance (HP or R) based on an also optimised hourly marginal electricity price
- Full hourly representation of supply and demand, in chronological order

TEST SYSTEM

- Irish all-island system, Target year 2030
- Wind capacity 6000 MW and other generation capacities from TSO capacity statement 2014-2023
- Share of households with new heating technology for all scenarios is 40%

RESULTS:

CONCLUSIONS

- Integrating gas, electricity and residential heating sectors through hybrid heating technologies equipped with smart controls could provide overall energy system planning and operational benefits, but results differ based on characteristics of underlying hybrid heating technologies
  - HP-B: minimises total system cost, reduces electric peaks and generation capacity, and compared to HPs reduces consumer investments
  - B-R: Wind curtailment reduction, gas fuel savings
  - HP-R: no considerable system impacts
- Hybrid heaters enable power system to tap into storage capability of gas and heat network, even in absence of district heating networks

FUTURE ANALYSIS

- Capture planning impact of annual weather variability ('normal', 1-in-20 year, 1-in-50 year) on investment cost, operations and security of supply
- Capture planning impact of consumer preferences (e.g. self-sufficient, ICT-savvy, conservative) on energy system

RELATED PUBLICATIONS

ACKNOWLEDGEMENT

Steve Heinen is supported by the CITIES project, Denmark (Project ref: 1205-00027B/001) and the Fonds National de la Recherche, Luxembourg (Project ref: 6020454). This work was conducted in the Electricity Research Centre, University College Dublin, Ireland, which is supported by the Electricity Research Centre’s Industry Affiliates Programme (http://erc.ucd.ie/industry/).