Imperial College London

Centre for Process Systems Engineering

Greening Britain's Gas

Biomethane to heat buildings

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Can we switch from natural gas to a green substitute?

Which technologies to use where?

How much carbon reduction at what cost?

1 Project Overview

Assess *techno-economic potential* to decarbonise heating by injecting biomethane to the gas network.

Mathematically *model the supply chain*: production, collection, processing and distribution.

Optimise scenarios for Great Britain as a whole, trading-off costs and environmental benefits to *demonstrate the ideal system*.

2 Problem

85% of UK homes are heated by gas boilers
2015 [1]

12% total UK emissions are from residential gas boilers
2015 temperature corrected [2]

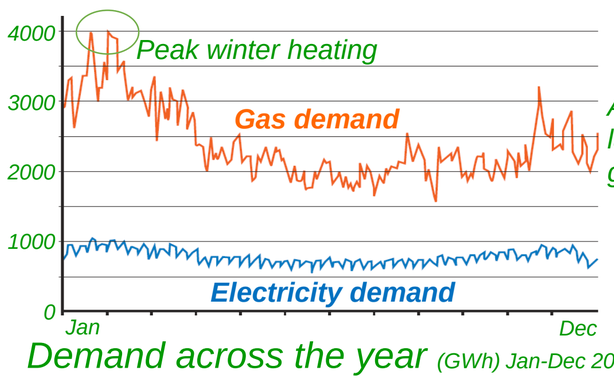
80% Emissions reduction needed from buildings
2015-2050 [3]

There has been a lack of progress to implement…

Insulation

District heating

Heat pumps



Demand across the year (GWh) Jan-Dec 2015 [4]

An opportunity: large, flexible gas grid

Can some of us keep our gas boilers?

3 Modelling framework

Supply chain model

Mixed integer linear program built in AIMMS®.

Feedstocks

Wet waste

Grassy crops

Dry waste

Wood

Biomethane production

Anaerobic digestion

BioSNG production

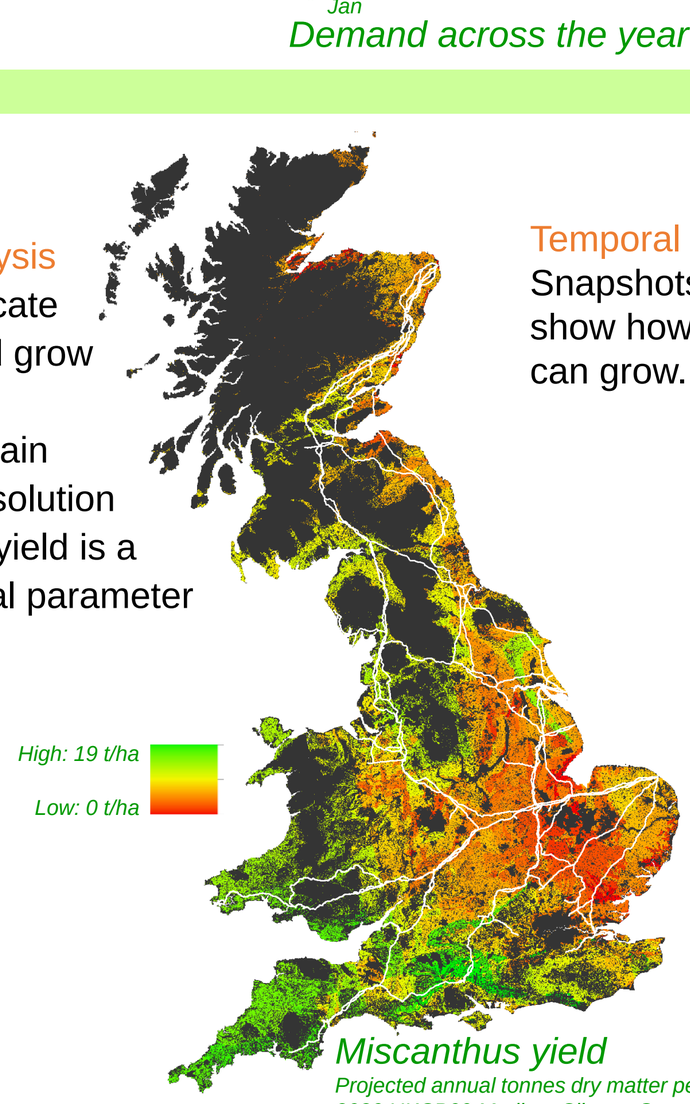
Gasification & Methanation

Gas Distribution

Spatial analysis

Where to locate facilities and grow crops?

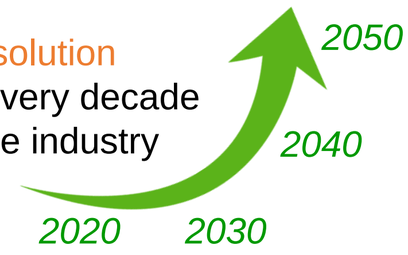
- Great Britain
- 50km^2 resolution
- Biomass yield is a key spatial parameter *see right*.



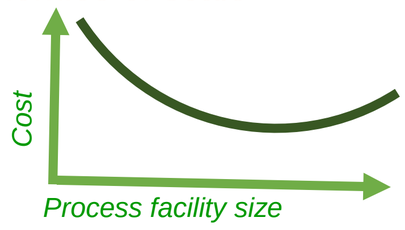
Miscanthus yield
Projected annual tonnes dry matter per hectare. 2030 UKCP09 Medium Climate Scenario [5], with exclusion criteria (grey) [6] & gas transmission network (white) [7]

Temporal resolution

Snapshots every decade show how the industry can grow.

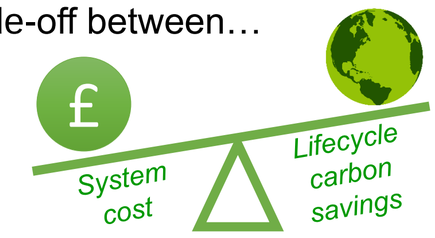


Economies of scale



Multi-objective optimisation

trade-off between…



4 Future work

Model additional feedstocks, processes & distribution modes…

Grass

Separation

Road tanker

Electric grid

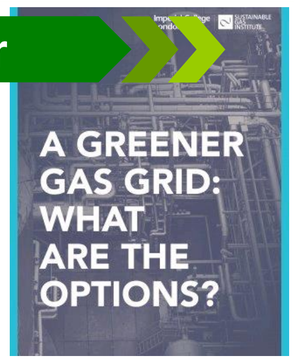
Scenarios

- Sustainable focus, growth focus, business as usual
- Resource availability cases: competition for feedstocks
- Policy impact cases

5 Upcoming paper

Sustainable Gas Institute White Paper

Register for the launch event: 19th July, 5pm Imperial College.



6 Take home message

Low carbon gas could be the optimal solution for heating some British homes.
Green, affordable and low impact for consumers.

Contact

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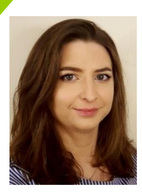

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References

[1] Ofgem, Insights on households with non-gas heating 2015
[2] BEIS, Energy consumption in the UK, 2016
[3] CCC, Sectoral scenarios for the Fifth Carbon Budget (Central Scenario), 2015
[4] National Grid, Future of gas: Unlocking network capability, 2017
[5] Hastings et. al., Technical potential of GB ligno-cellulosic biomass, GCB-Bioenergy, 2013
[6] Sunnenberg et. al., Availability land for perennial energy crops GB, GCB-Bioenergy, 2013
[7] National Grid, Transmission Network Gas Pipe Shape File, n.d.