4th International Conference on Smart Energy Systems and 4th Generation District Heating
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Agent-based modelling for the thermal energy transition of natural gas dependent neighborhoods

4DH
4th Generation District Heating
Technologies and Systems

AALBORG UNIVERSITY
DENMARK

TU Delft

4th International Conference
on Smart Energy Systems and
4th Generation District Heating
2018 #SES4DH2018

Agent-based modelling for the thermal energy transition of natural gas dependent neighborhoods

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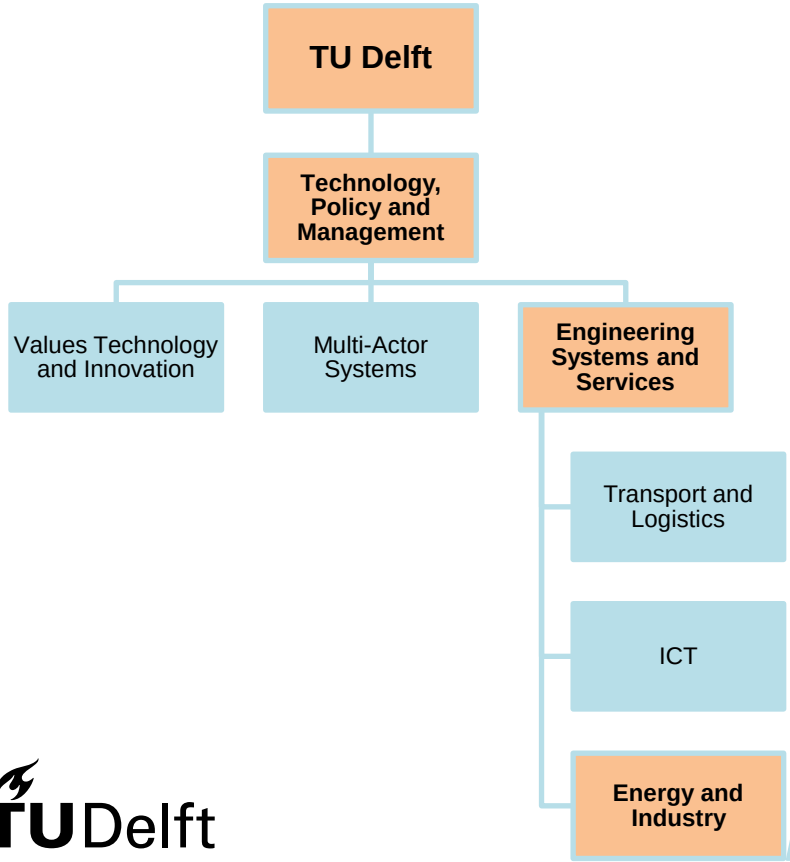
Supervisors – TU Delft

Programme: Smart Energy Systems in the Built Environment (SES-BE)
Project E: Modelling Lab for smart grids, smart policies and smart entrepreneurship

Team members



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Helle Hvid Hansen

Gijsbert Korevaar

Graciela Nava

Energy transition in the European Union

Targeted reductions in greenhouse gas emissions

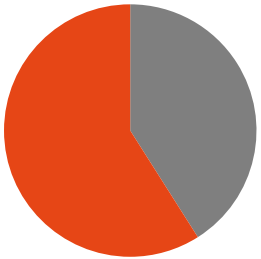
2050
Down to 80%
of 1990 levels

2040
Down to 60%
of 1990 levels

2030
Down to 40%
of 1990 levels

Heating and Cooling sector

50% of energy consumption



59% of gas consumption

Buildings have old boilers and low renovation rates.

Renewables are not widely used in the sector.

Heat from industries is being wasted.

European Commission – Fact Sheet (2016). Towards a smart, efficient and sustainable heating and cooling sector.

Smart Energy Systems in the Built Environment (SES-BE)

NWO
Netherlands Organisation for Scientific Research

Smart Energy Management and Services in Buildings and Grids

Academic partners

TU Delft

CWI

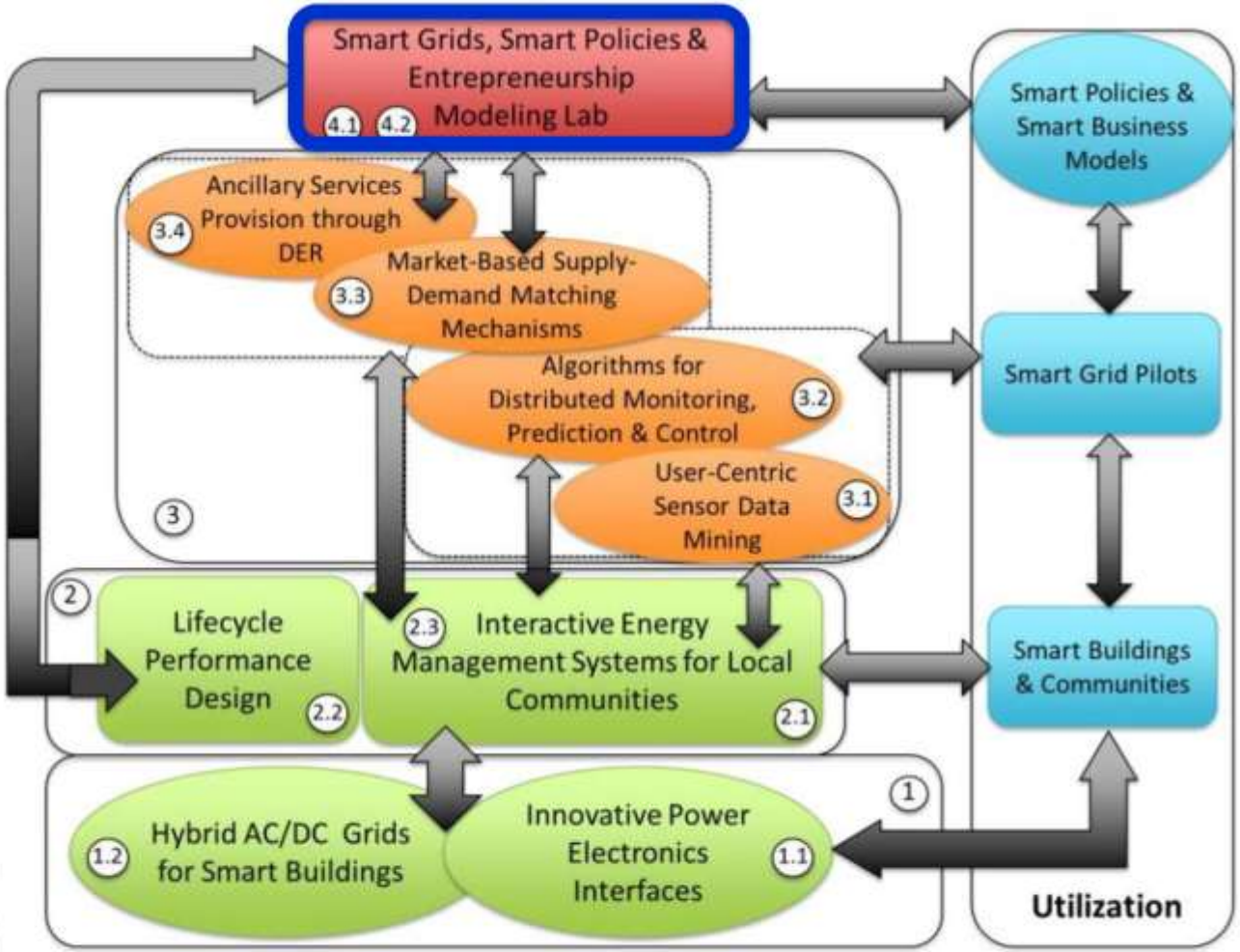
TU/e

Industrial partners

Royal HaskoningDHV
Enhancing Society Together

alliander

TU Delft



SES-BE

Smart Energy Management and Services in Buildings and Grids

Project E: smart grids, smart policies and entrepreneurship modelling lab

TU Delft

Research approach and methods

Socio-technical perspective

Theory of complex adaptive systems

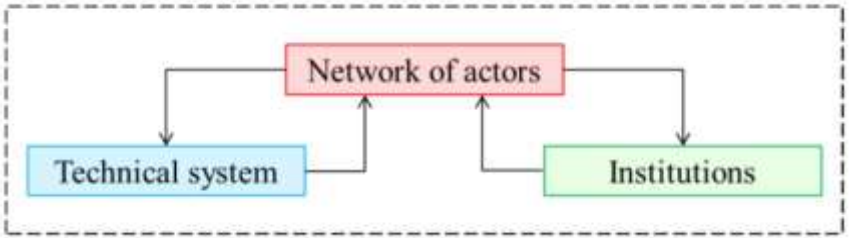
Agent-based modelling

Research approach and methods

Socio-technical perspective

- Physical and social networks
- Interaction under rules (institutions)

De Bruijn & Herder (2009)



Moncada et al. (2017)

Research approach and methods

Theory of complex adaptive systems

- Systems' emergent behavior
- Learning and adaptation

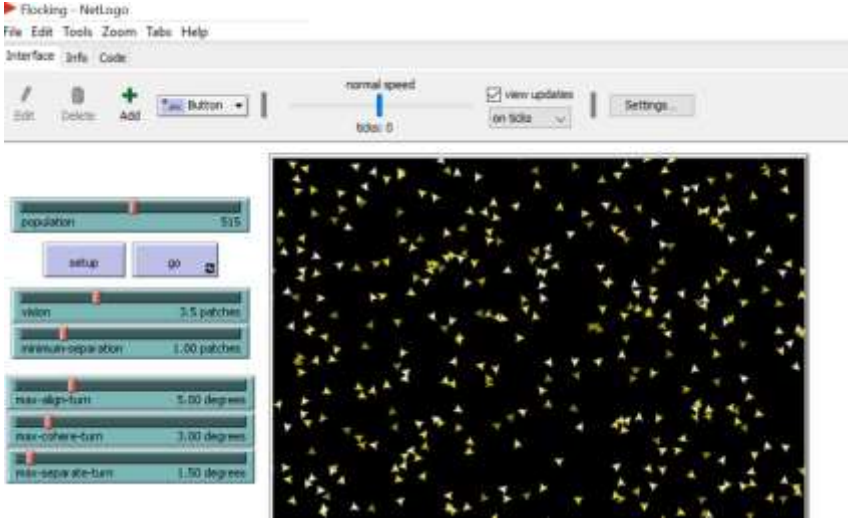
Macal & North (2005), Nikolic & Kasmire (2013)

Research approach and methods

- Autonomous agents
- Bounded rationality

Jennings (1998), Macal and North (2005)

Agent-based modelling



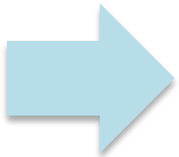
Recent work

ABMUS 2018

The 3rd Workshop on Agent-based modelling of urban systems

Stockholm, Sweden. July 15, 2018.

Nava Guerrero et al. (2018) Workshop presentation.
http://modelling-urban-systems.com/abmus2018



Research question

How can a Dutch neighborhood transition from natural gas-based to natural gas-free heat supply over the coming years while meeting the neighborhood's heat demand?

Modelling questions

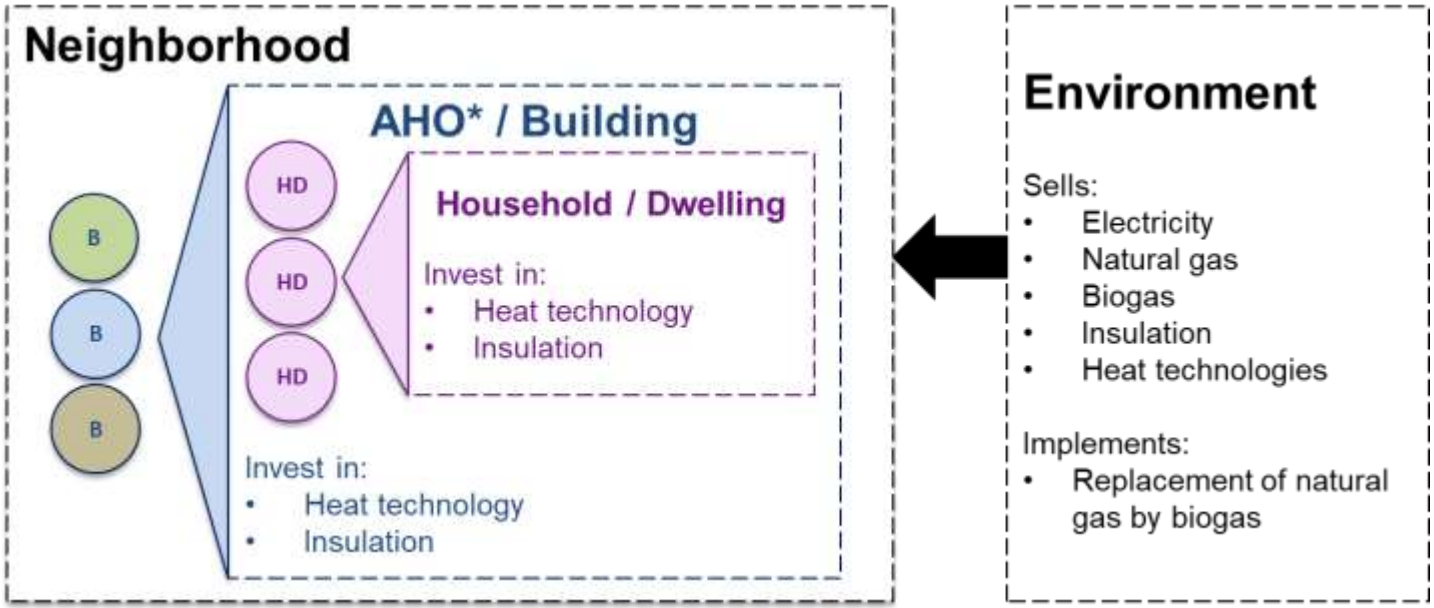
1. Which **combinations of household's characteristics** lead to low natural gas consumption and low expenses at the end of the simulation?

2. What are **promising combinations of technologies and insulation levels** with which low natural gas consumption and low expenses were achieved?

3. How would the **cost of heat supply** be affected by promising combinations of technologies and insulation levels?

Nava Guerrero et al. (2018) Workshop presentation.
http://modelling-urban-systems.com/abmus2018

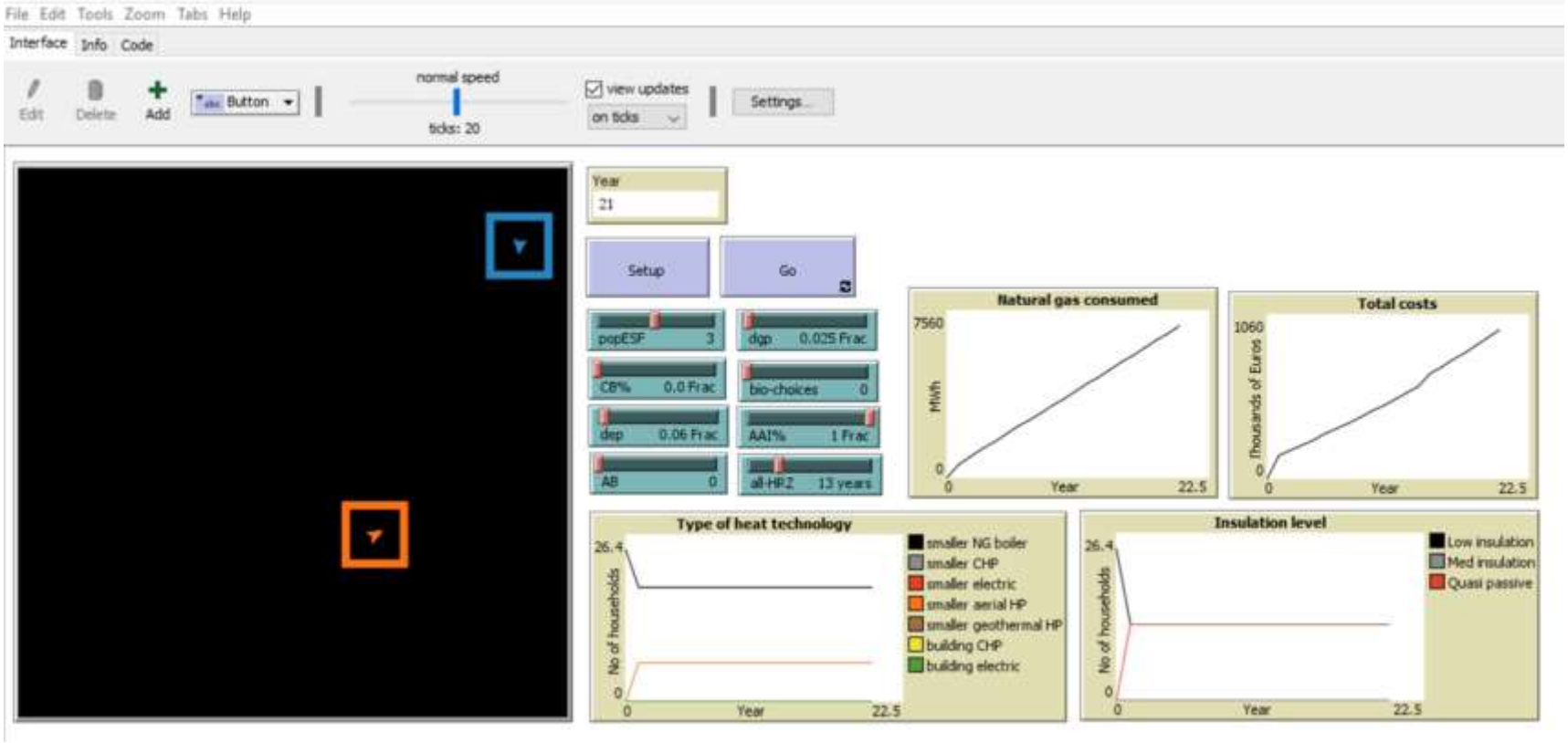
System conceptualization



**AHO: association of house owners*

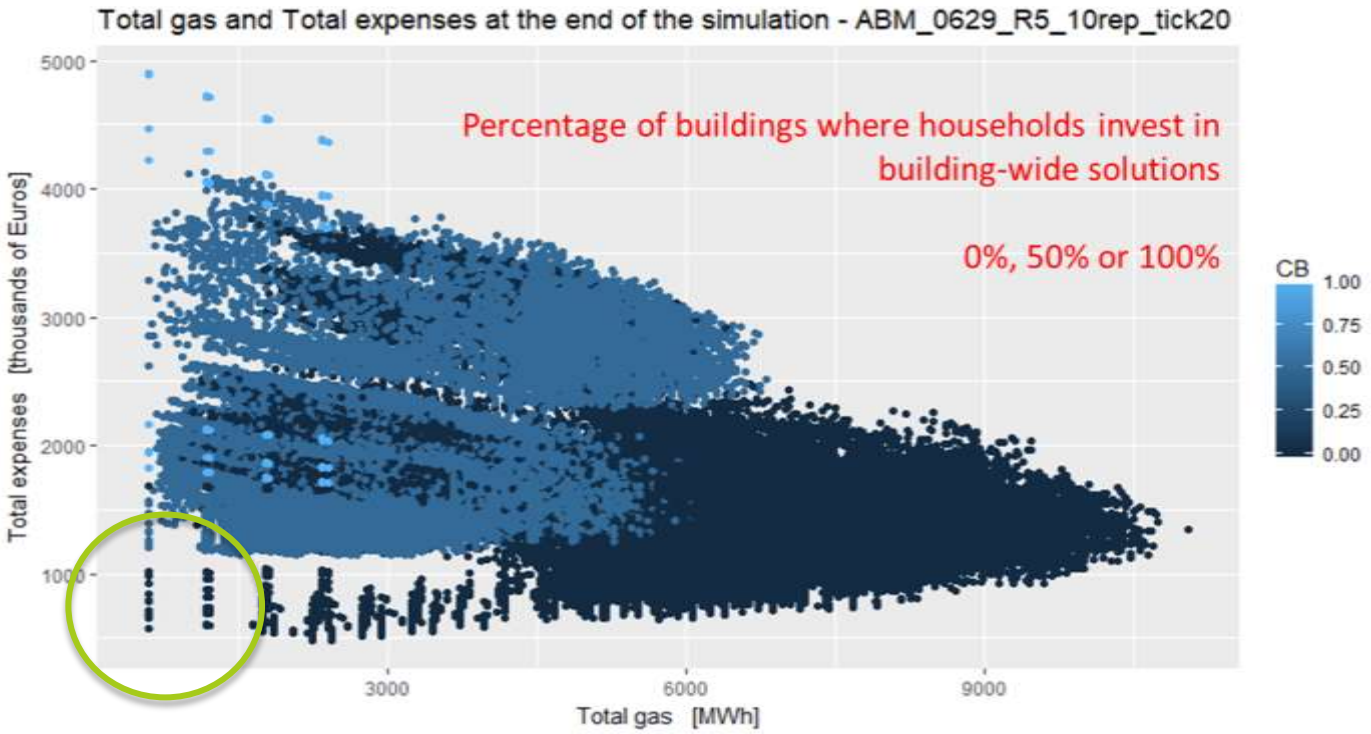
Nava Guerrero et al. (2018) Workshop presentation.
http://modelling-urban-systems.com/abmus2018

Agent-based model



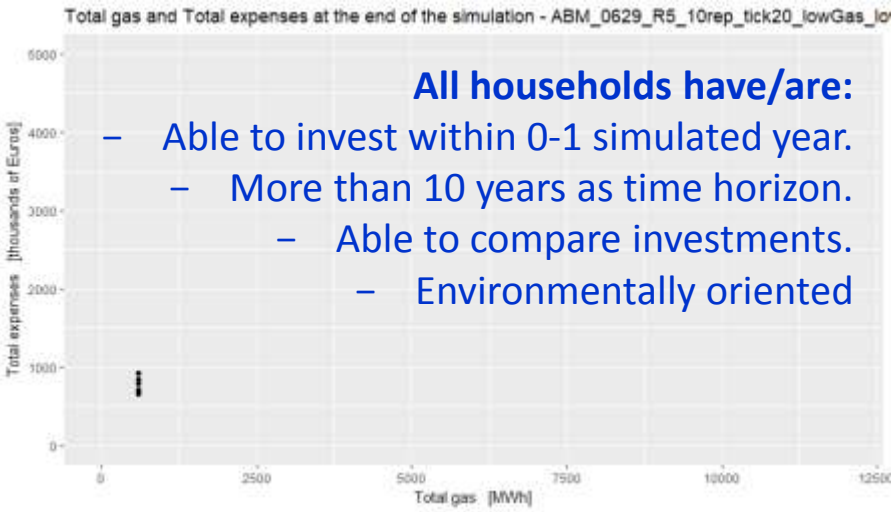
Nava Guerrero et al. (2018) Workshop presentation.
http://modelling-urban-systems.com/abmus2018

KPIs after 20 simulated years



Nava Guerrero et al. (2018) Workshop presentation.
http://modelling-urban-systems.com/abmus2018

Results when households invest individually



All households have/are:

- Able to invest within 0-1 simulated year.
- More than 10 years as time horizon.
- Able to compare investments.
- Environmentally oriented

Heat technologies and insulation

- Immediately:
  - Replaced boilers with aerial heat pumps.
  - Highly insulated dwellings.
- 15 years later:
  - If time horizon > 15 years, no change.
  - Else, replaced aerial heat pumps with radiators.

Cost of heat supply

- Likely similar to that of keeping boilers.

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Nava Guerrero et al. (2018) Workshop presentation.
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Outlook

- Exploring long term production contracts.
- Applying the perspective of socio-technical systems to modelling and simulation.
- Research question:
  - *Under which contractual conditions could a district heating network with a single supplier transition towards a lower greenhouse gas emissions system?*

Keep in touch

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