USER INCENTIVES FOR LOW-ENERGY RENOVATIONS IN DISTRICT HEATING SYSTEMS OF DIFFERENT SCALES

By Gorm Bruun Andresen, Rasmus Pedersen from Department of Engineering, Aarhus University Aarhus, Denmark
Adam Bruun from AffaldVarme Aarhus, Denmark
Driving questions

• How are the consumer incentives for low energy retrofit affected by:
  – The DH company size?
  – The fixed-variable cost ratio?

50 kWh/m²/yr
DISTRICT HEATING COST MODEL

Investments and O&M costs
Variable fuel costs
Pipe network costs
Heat loss
Heat production cost

• Fixed cost for the heat transmission network and production units are 302 million dkk/yr. The fixed cost are shared according to the total heat supplied to each area.

• Variable costs are calculated hour by hour. On average the cost is 249 dkk/MWh.

http://transmissionsnet.varmeplanaarhusapps.dk/
Distribution network cost ($DNC_i$)

- Database of 65,000+ individual pipes
  - Length ($L_i$)
  - Diameter ($d_i$)
  - Location
- Database of 100,000+ buildings (BBR)
  - Building foot-print ($a_{ii}$)
  - Land area ($A_i$)

Cost model

$$DNC_i = \text{annuity} \cdot (C_1 + C_2 \cdot d_i) \cdot L_i$$

Heat sales and Heat loss

- Database of 55,000+ individual consumer installations
  - 3 years of annual heat consumption ($q_i$).

- Heat delivered to each of the 50+ districts
  - Hourly heat load ($Q_i$).

$$\text{Heat loss}_i = \frac{Q_i - q_i}{Q_i}$$
Cost per unit sold **for each district**

- **High cost district** (1000 dkk/MWh)
- **Low cost district** (400 dkk/MWh)
The districts of Aarhus are representative for DH in Denmark.
Consumer cost = \( f \times \frac{\text{system cost}}{\text{number of consumers}} \) + \( (1 - f) \times \frac{\text{system cost}}{\text{total heat sales}} \times \text{consumer heat purchase} \)
Example of consumer cost in different areas

![Graph showing price for standard house vs. share of fixed cost for high cost and low cost districts.]

- **Real fixed-variable split**
- **Aggregated system**
- **High cost districts**
- **Low cost districts**

G.B. Andresen, September – 2017
gba@eng.au.dk
CONSUMER INCENTIVES

What is in it for me?

G.B. Andresen, September – 2017
gba@eng.au.dk
About 95% of consumers use more than 50 kWh/m²/yr
Consumer cost distribution

For 35,696 consumers, we have highly detailed consumption and building data.

You cannot save more than your heat bill!
Consumer benefit of aggregation

Supports individual heat districts

Supports aggregated heat areas

Most consumers would benefit from localized cost models.
Both localized and aggregated cost models provide similar incentives for low energy retrofit.
Conclusion

In Aarhus:

• The cost of heat varies from 400 to 1000 dkk/MWh.
  – Aggregation can ensure that socio-economical DH also becomes attractive for all consumers.

• Most consumers would benefit from a localized cost model.

• An aggregated cost model leads to slightly higher incentives for low energy retrofit.

• In absolute numbers the incentives are low, about 25 dkk/MWh/m².