Identification of Thermal Performance using Smart Meter data

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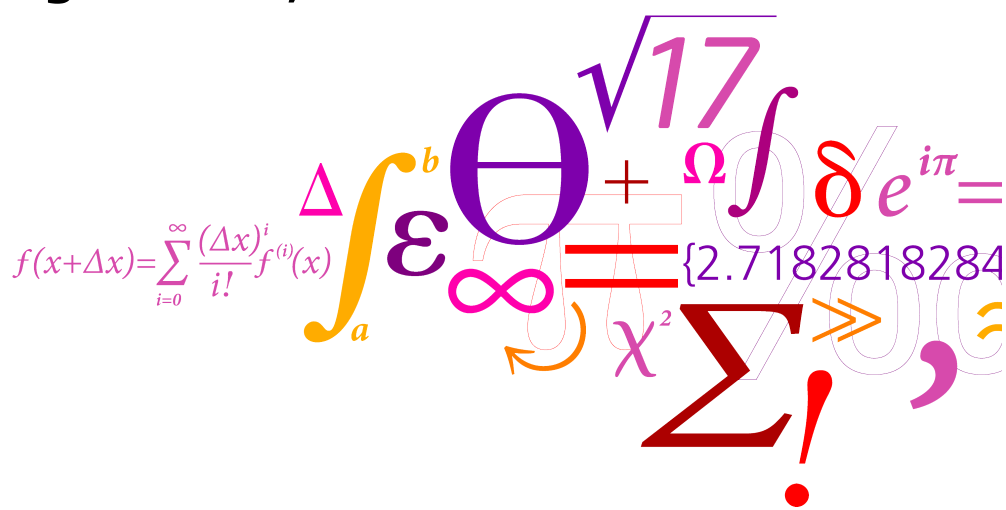
Peder Bacher, Henrik Aalborg Nielsen, Henrik Madsen



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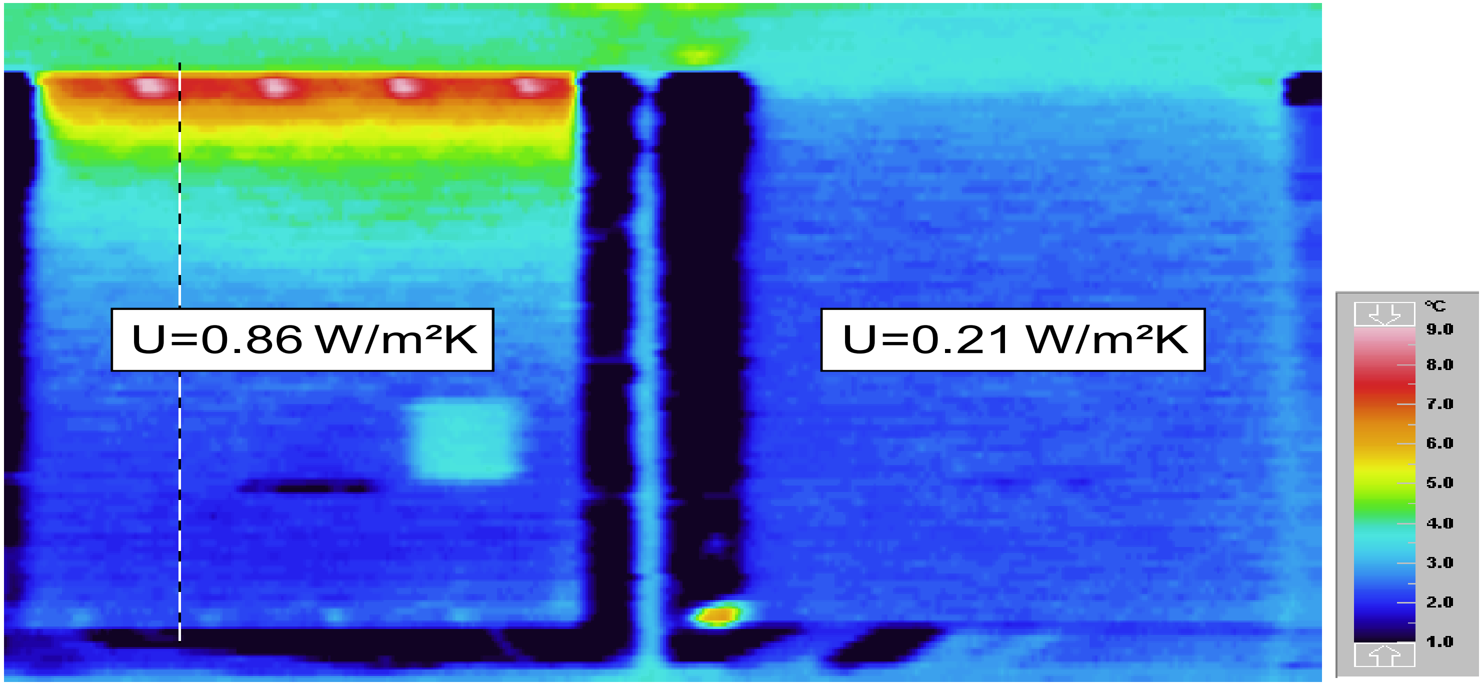
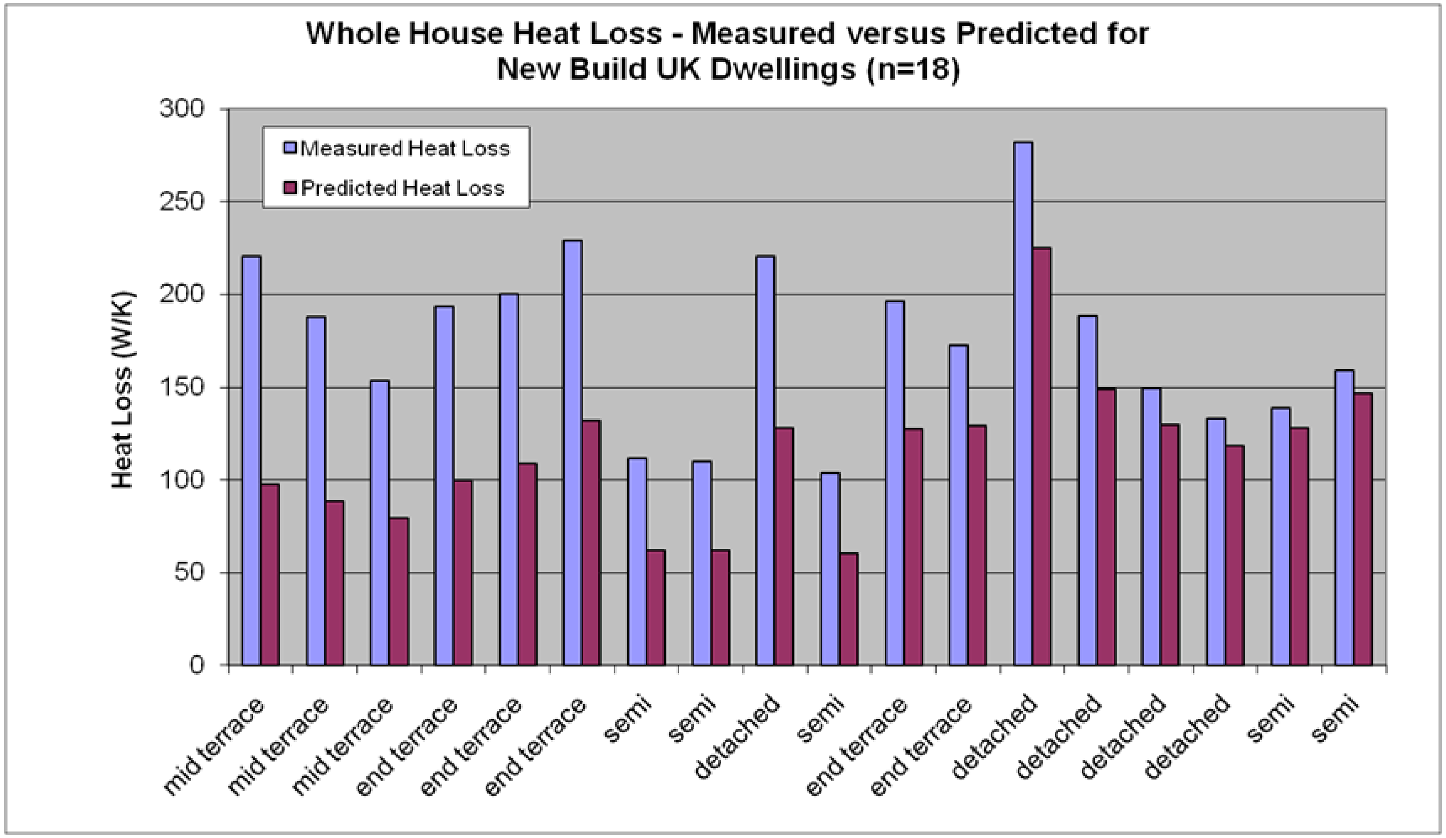
Example



Consequence of good or bad workmanship (theoretical value is U=0.16W/m2K)

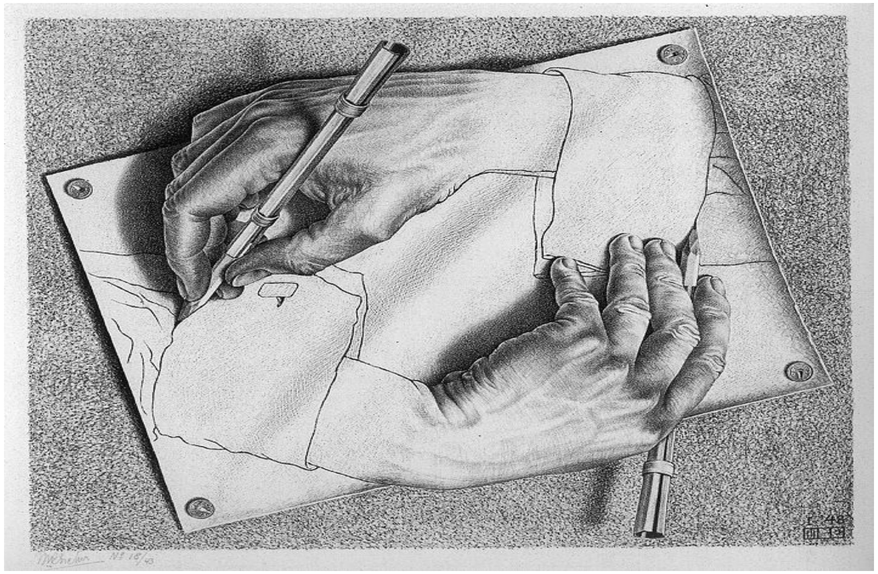
Examples (2)



Measured versus predicted energy consumption for different dwellings

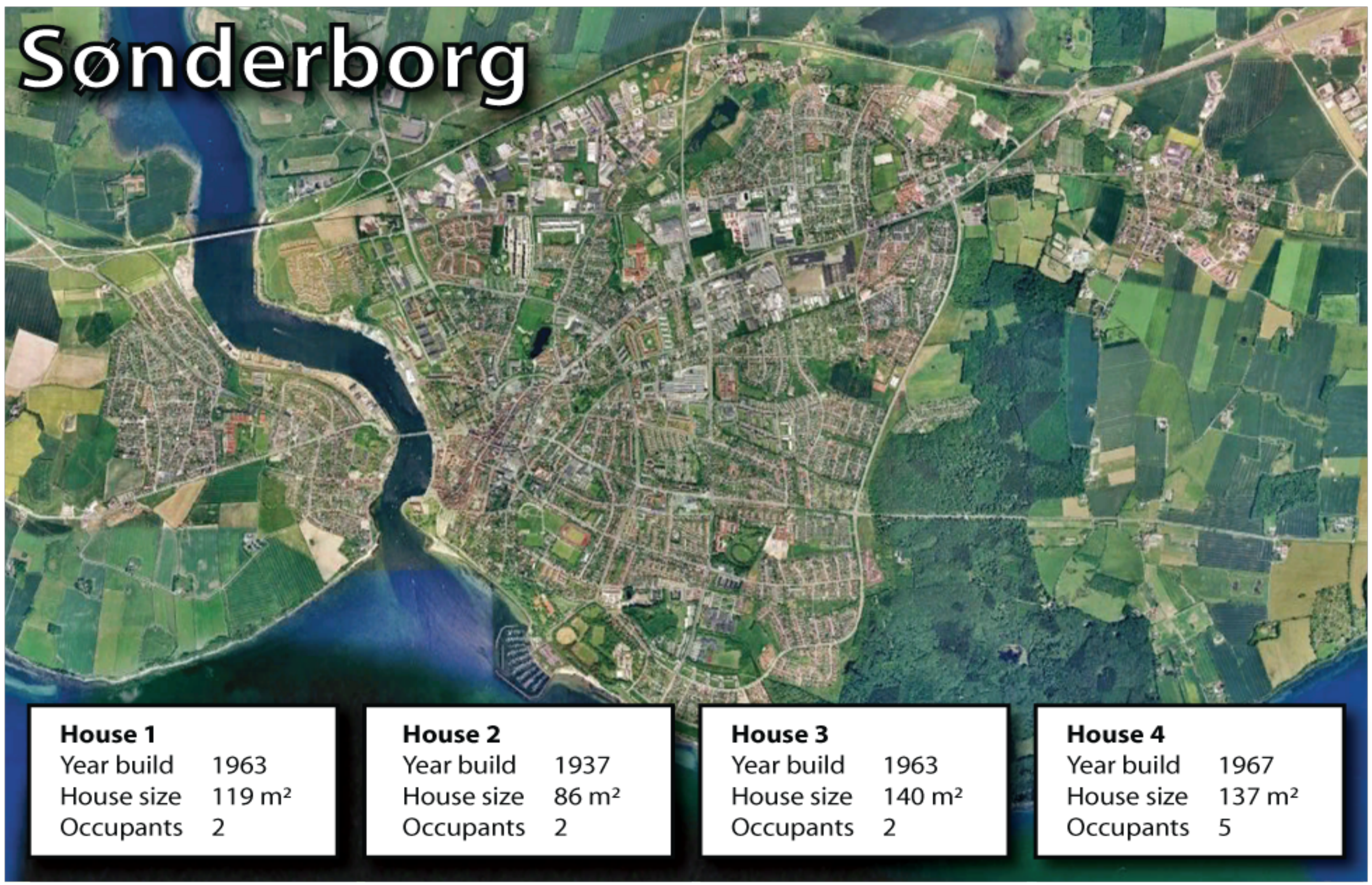
Energy Labelling of Buildings

- Today building experts make judgements of the energy performance of buildings based on drawings and prior knowledge.
- This leads to 'Energy labelling' of the building
- However, it is noticed that two independent experts can predict very different consumptions for the same house.



Data

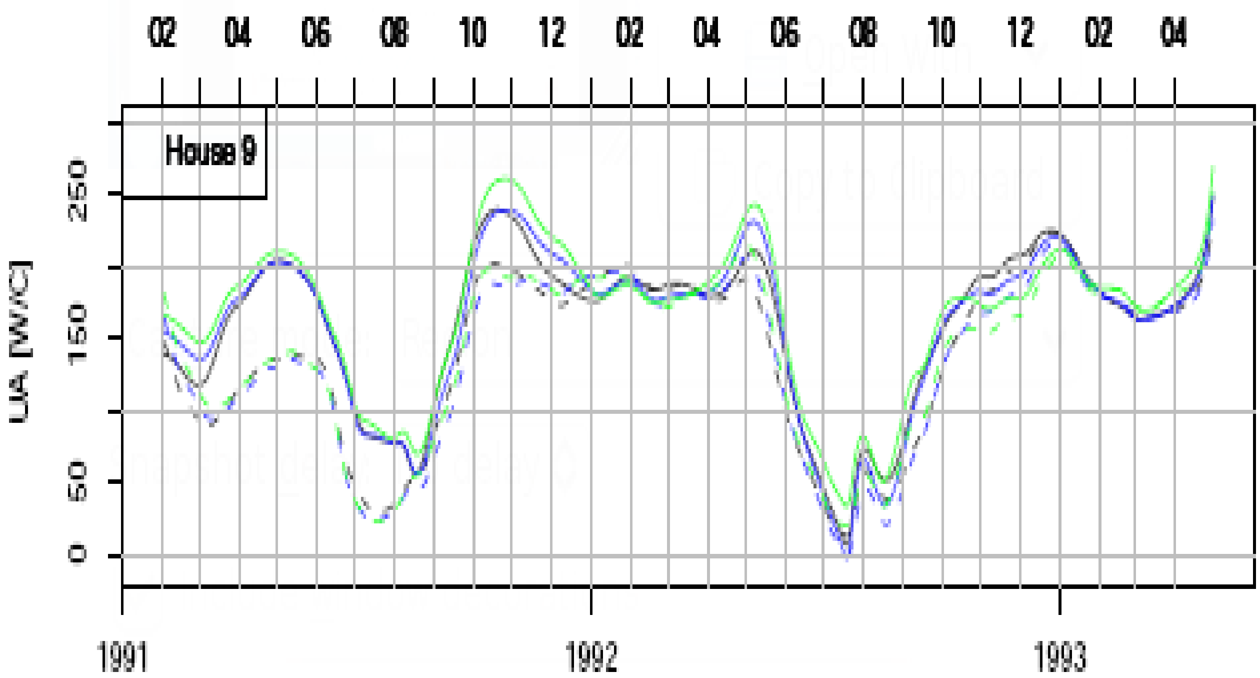
- Daily averages from a number of houses



Characterization using Smart Meter Data

- Separation of usage and building effect on heat load
- Energy labelling
- Estimation of UA and gA values
- Wind induced ventilation (directional)
- Indoor temperature and other non-weather dependent losses are estimated

Find the heating season



Simple estimation of UA-values

- Consider the following model (t=day No.) estimated by kernel-smoothing:

$$Q_t = Q_0(t) + c_0(t)(T_{i,t} - T_{a,t}) + c_1(t)(T_{i,t-1} - T_{a,t-1}) \qquad (1)$$

- The estimated UA-value is

$$\hat{UA}(t) = \hat{c}_o(t) + \hat{c}_1(t) \qquad (2)$$

- With more involved (but similar models) also gA and wA values can be stimated

Results

	UA	σ_{UA}	gA^{max}	wA_E^{max}	wA_S^{max}	wA_W^{max}	T_i	σ_{T_i}
	W/°C		W	W/°C	W/°C	W/°C	°C	
4218598	211.8	10.4	597.0	11.0	3.3	8.9	23.6	1.1
4381449	228.2	12.6	1012.3	29.8	42.8	39.7	19.4	1.0
4711160	155.4	6.3	518.8	14.5	4.4	9.1	22.5	0.9
4836681	155.3	8.1	591.0	39.5	28.0	21.4	23.5	1.1
4836722	236.0	17.7	1578.3	4.3	3.3	18.9	23.5	1.6
4986050	159.6	10.7	715.7	10.2	7.5	7.2	20.8	1.4
5069878	144.8	10.4	87.6	3.7	1.6	17.3	21.8	1.5
5069913	207.8	9.0	962.5	3.7	8.6	10.6	22.6	0.9
5107720	189.4	15.4	657.7	41.4	29.4	16.5	21.0	1.6
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Based on measurements from the heating season **2009/2010** your typical indoor temperature during the heating season has been estimated to **24** ^oC. If this is not correct you can change it here $\boxed{24}$ ^oC.

If your house has been left empty in longer periods with a partly reduced heat supply you have the possibility of specifying the periods in this $\boxed{\text{calendar}}$.

According to BBR the area of your house is **155** m^2 and from **1971**.

Based on BBR information it is assumed that **you do not use any supplementary heat supply**. If this is not correct you can specify the type and frequency of use here:

- Wood burning stove used $\boxed{0}$ times per week in cold periods.
- Solar heating $\boxed{\text{y/n}}$, approximate size of solar panel $\boxed{0} \times \boxed{0}$ meters.

Based on the indoor temperature **24** ^oC, the use of a wood burning stove **0** times per week, and **no** solar heating installed, the response of your house to climate is estimated as:

- The response to outdoor temperature is estimated to **200** $W/^oC$ **which given the size and age of your house is expectable**[a].
- On a windy day the above value is estimated to increase with **60** $W/^oC$ **when the wind blows from easterly directions. This response to wind is relatively high and indicates a problem related to the air sealing on the eastern side of the house.**
- On a sunny day during the heating season the house is estimated to receive **800** W as an average over 24 hours. **This value is quite expectable.**

[a]Many kind of different recommendations can be given here.

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Perspectives for using Smart Meters

- Reliable Energy Signature.
- Energy Labelling
- There will be outliers
- Statistical techniques for outlier detection and uncertainties
- Proposals for Energy Savings:
  - Replace the windows?
  - Put more insulation on the roof?
  - Is the house too untight?
  - ......

Conclusions

- Smart Meters (or frequent readings) can give:
  - Objective and reliable energy signatures / labelling of buildings
  - Advanced knowledge about potentials for energy savings
  - Naturally, there will be outliers, but can be detect them and dealt with
- All methods need large scale testing before final conclusions

Further perspectives for using data from Smart Meters

- Advices for improving user energy behaviour
- Time Constants (eg for night set-back)
- Optimized Control
- Integration of Solar and Wind Power using DSM