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”You cannot optimise what you do not meassure”

Smart Energy Systems and 4th Generation District Heating
September 2016

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Kamstrup A/S

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Beijing AQI: Beijing Real-time Air Quality Index (AQI).

373 **Hazardous**

Updated on Monday 1:00

Temp: **2°C** (0 ° – 11°)

Last 2 days	Current	Min	Max
PM2.5 AQI	373	93	433
PM10 AQI	173	10	225
O3 AQI	11	11	18
NO2 AQI	49	7	57
SO2 AQI	76	11	98
Temp	2	-3	6
Dew	-5	-11	-2
Pressure	1029	1029	1032
Humidity	60	46	75

EPA Air Quality Index	Levels of Health Concern
0 - 50	Good
51 - 100	Moderate
101 - 150	Unhealthy for Sensitive Groups
151 - 200	Unhealthy
201 - 300	Very Unhealthy
301 - 500	Hazardous

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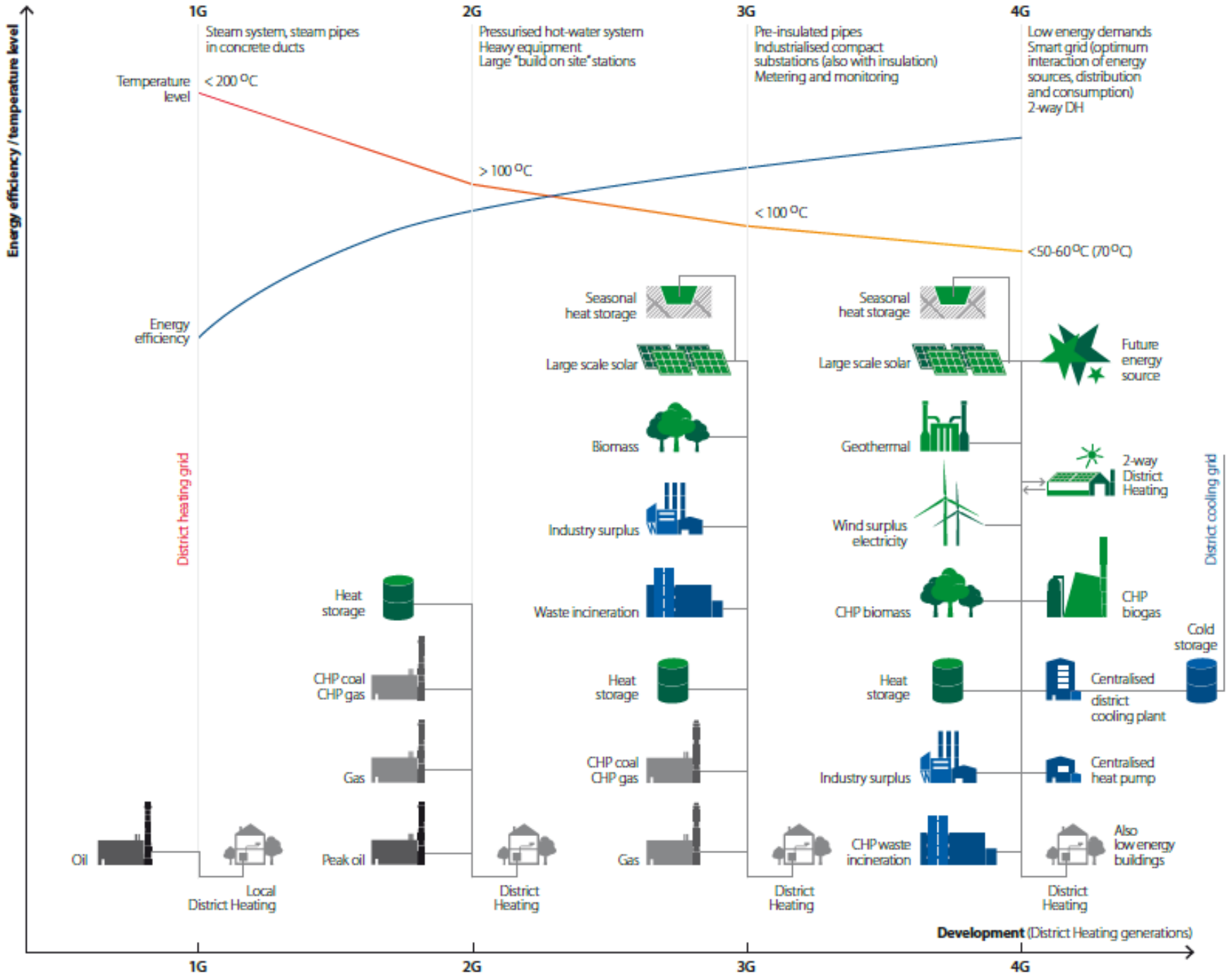
But also challenges to overcome

- Increasing the share of renewables and waste heat from industry
- Improving the link between electricity systems and district heating systems – the integrated energy system
- Reducing peak demands and losses in the distribution network – run closer to the limits
- Boosting the energy efficiency of buildings
- Easing information access for consumers – allowing them to better understand the consequences of their energy behaviour


Energy efficiency / temperature level
1G
Steam system, steam pipes in concrete ducts
2G
Pressurised hot-water system
Heavy equipment
Large "build on site" stations
3G
Pre-insulated pipes
Industrialised compact substations (also with insulation)
Metering and monitoring
4G
Low energy demands
Smart grid (optimum interaction of energy sources, distribution and consumption)
2-way DH
Temperature level
< 200 °C
> 100 °C
< 100 °C
<50-60 °C (70 °C)
Energy efficiency
District heating grid
District cooling grid
Seasonal heat storage
Large scale solar
Biomass
Industry surplus
Waste incineration
Heat storage
CHP coal CHP gas
Gas
Peak oil
Oil
Local District Heating
District Heating
Seasonal heat storage
Large scale solar
Geothermal
Wind surplus electricity
CHP biomass
Heat storage
CHP coal CHP gas
Gas
District Heating
Future energy source
2-way District Heating
CHP biogas
Cold storage
Centralised district cooling plant
Centralised heat pump
Industry surplus
CHP waste incineration
Also low energy buildings
District Heating
Development (District Heating generations)
1G
2G
3G
4G

Frequent data from smart meters creates proven value

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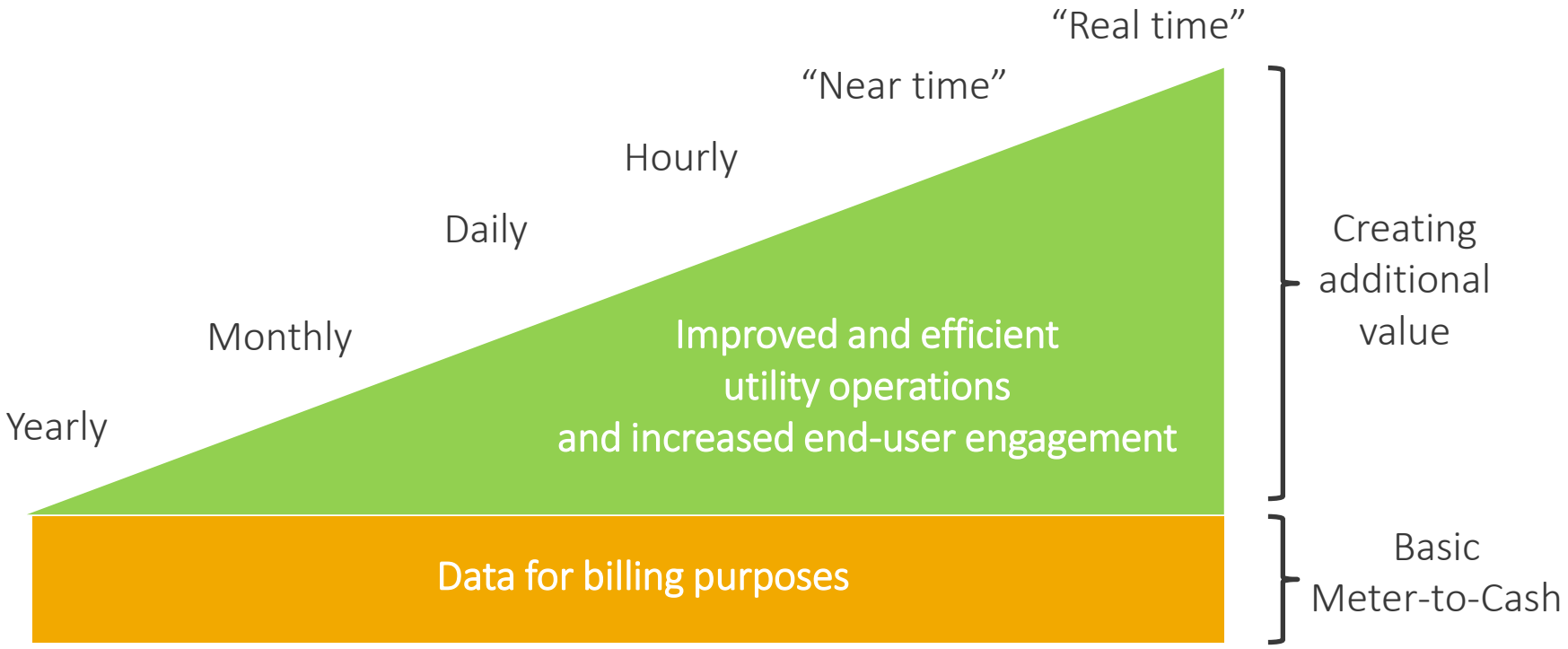
You cannot optimise what you do not meassure!



The world’s leading supplier of intelligent energy and water metering solutions

Examples from Danish District Heating

”Turning data into knowledge and actions”

Example 1

”Optimising building performance and end-user behaviour”

A Copenhagen example

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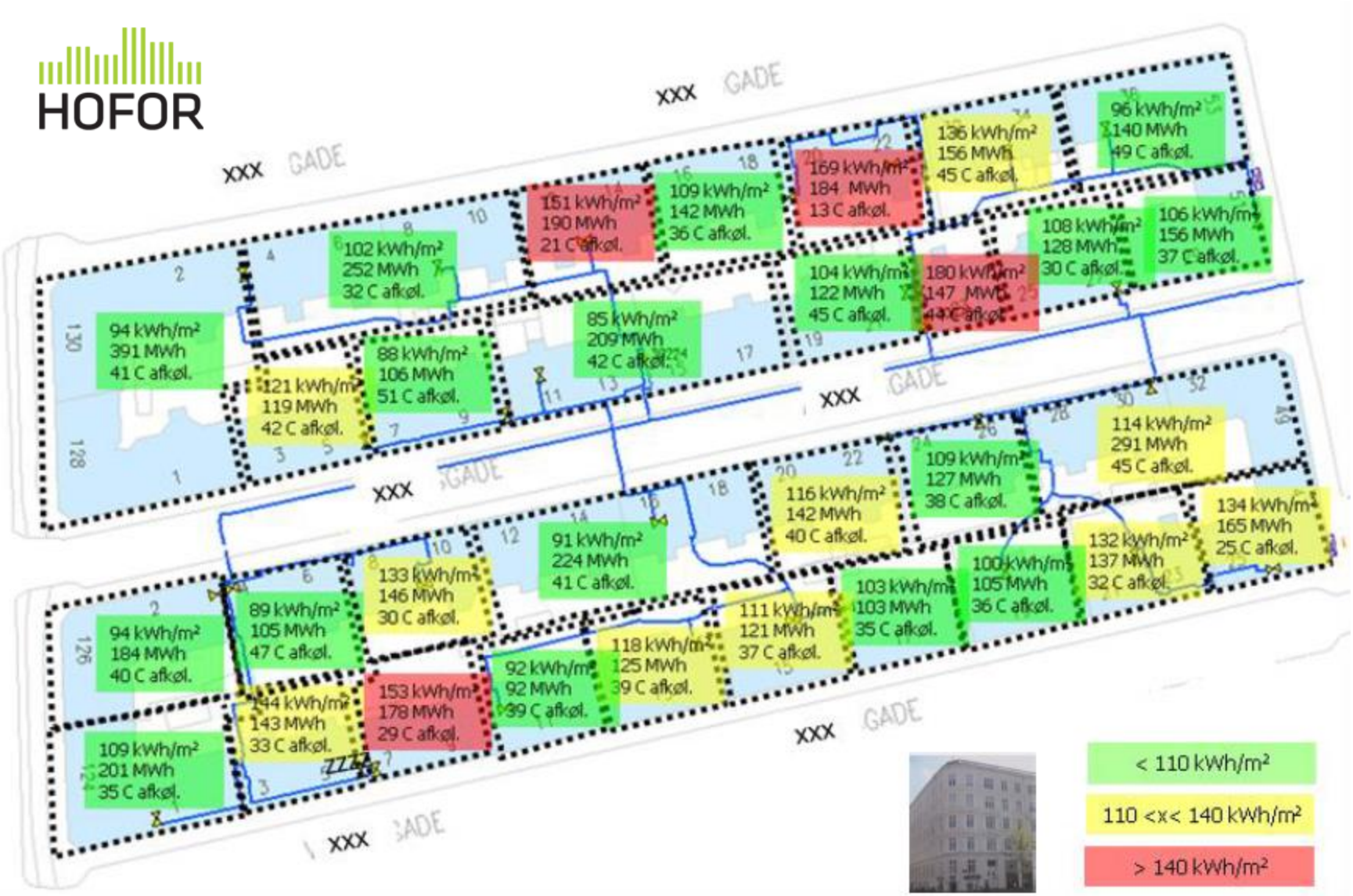

A Copenhagen example

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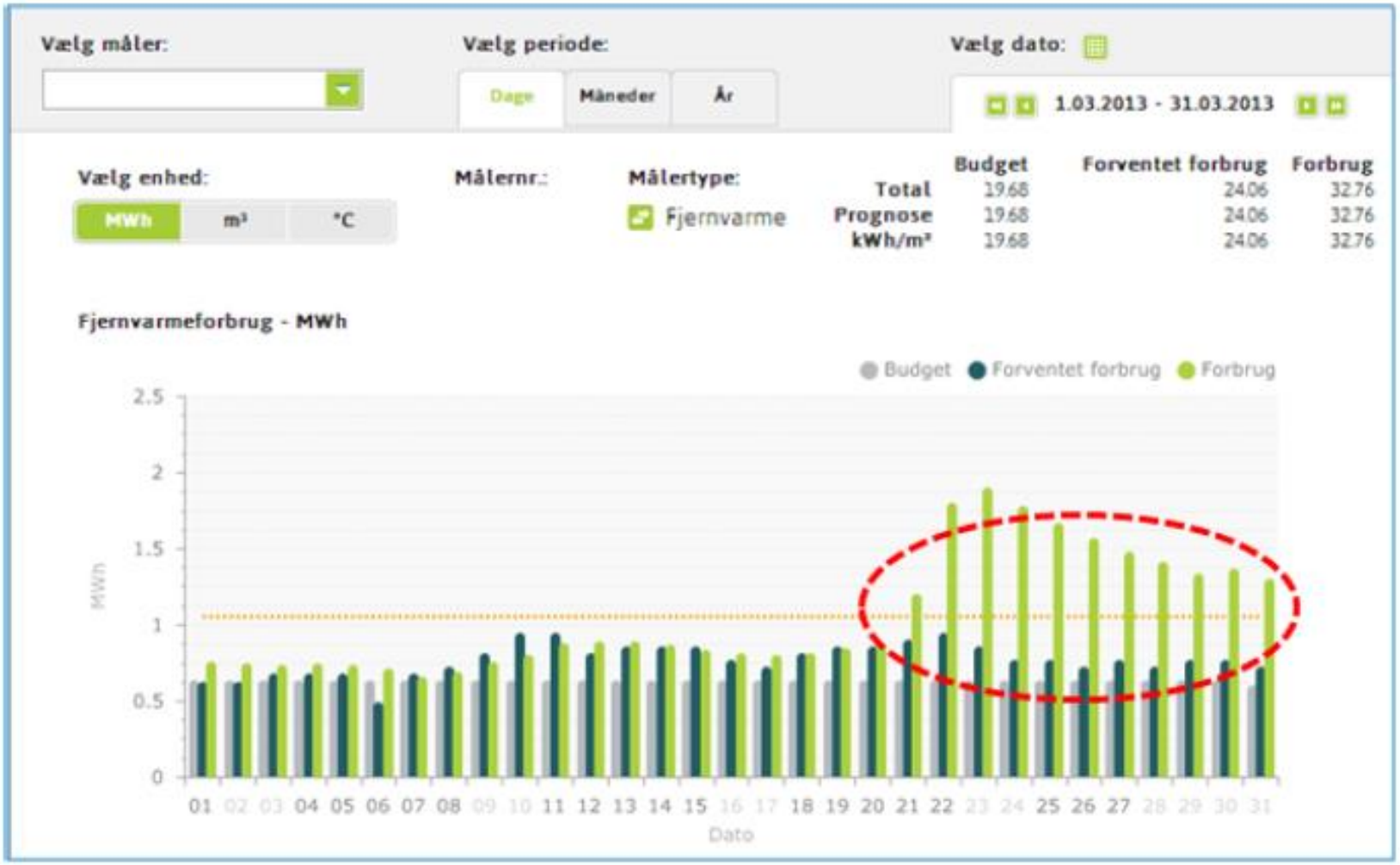

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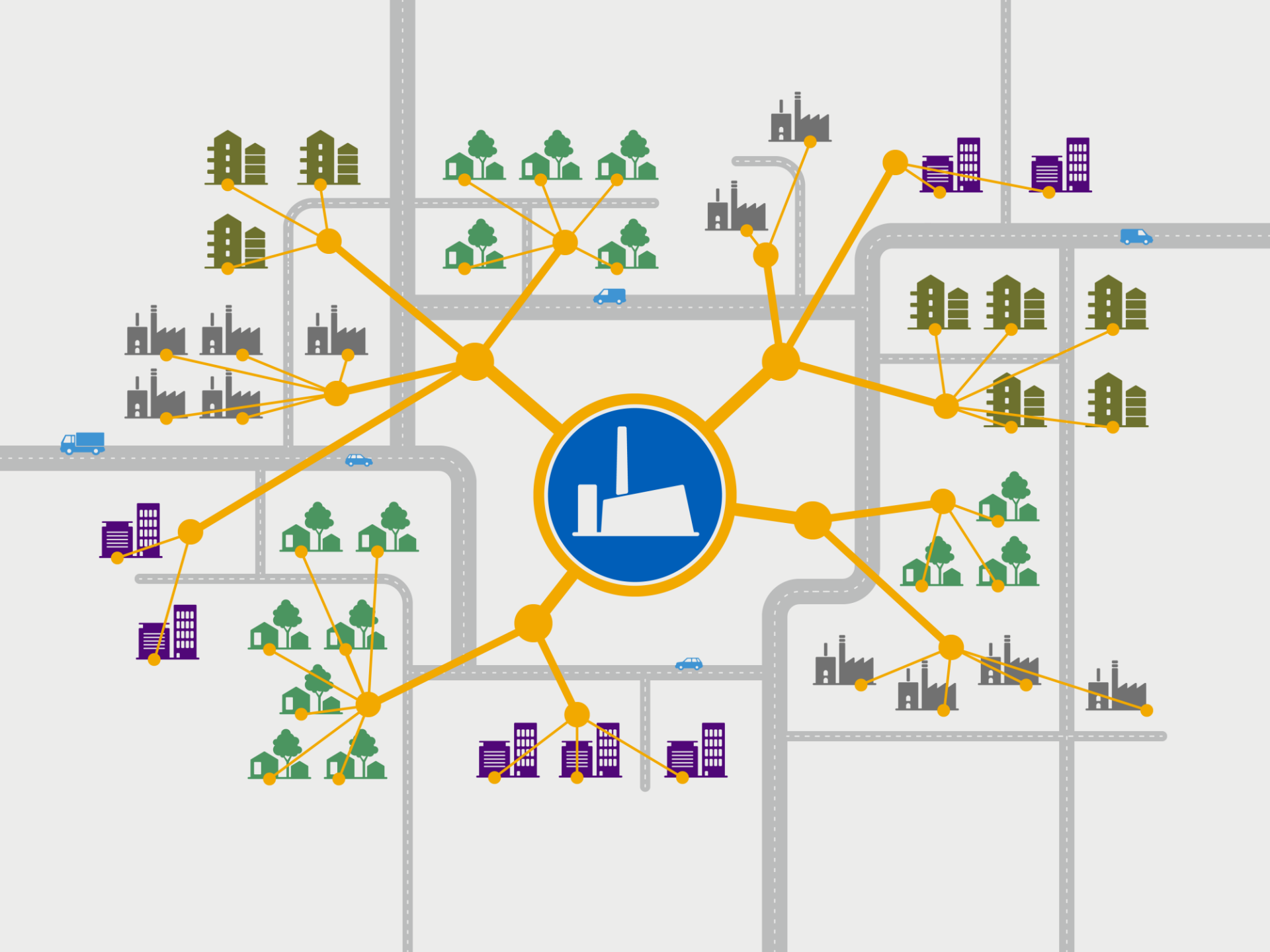
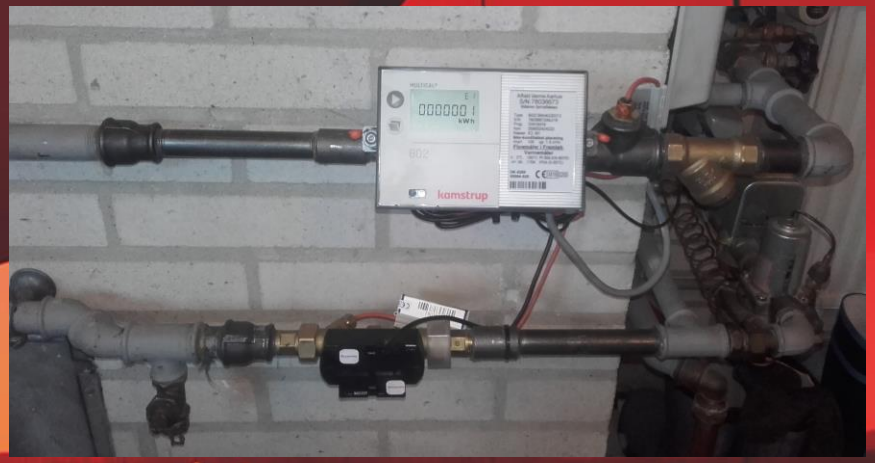
Example 2

”Identifying losses in the distribution network”



CITY OF AARHUS

AffaldVarme Aarhus
Denmark



"Daily water loss reduced by 100m^3"

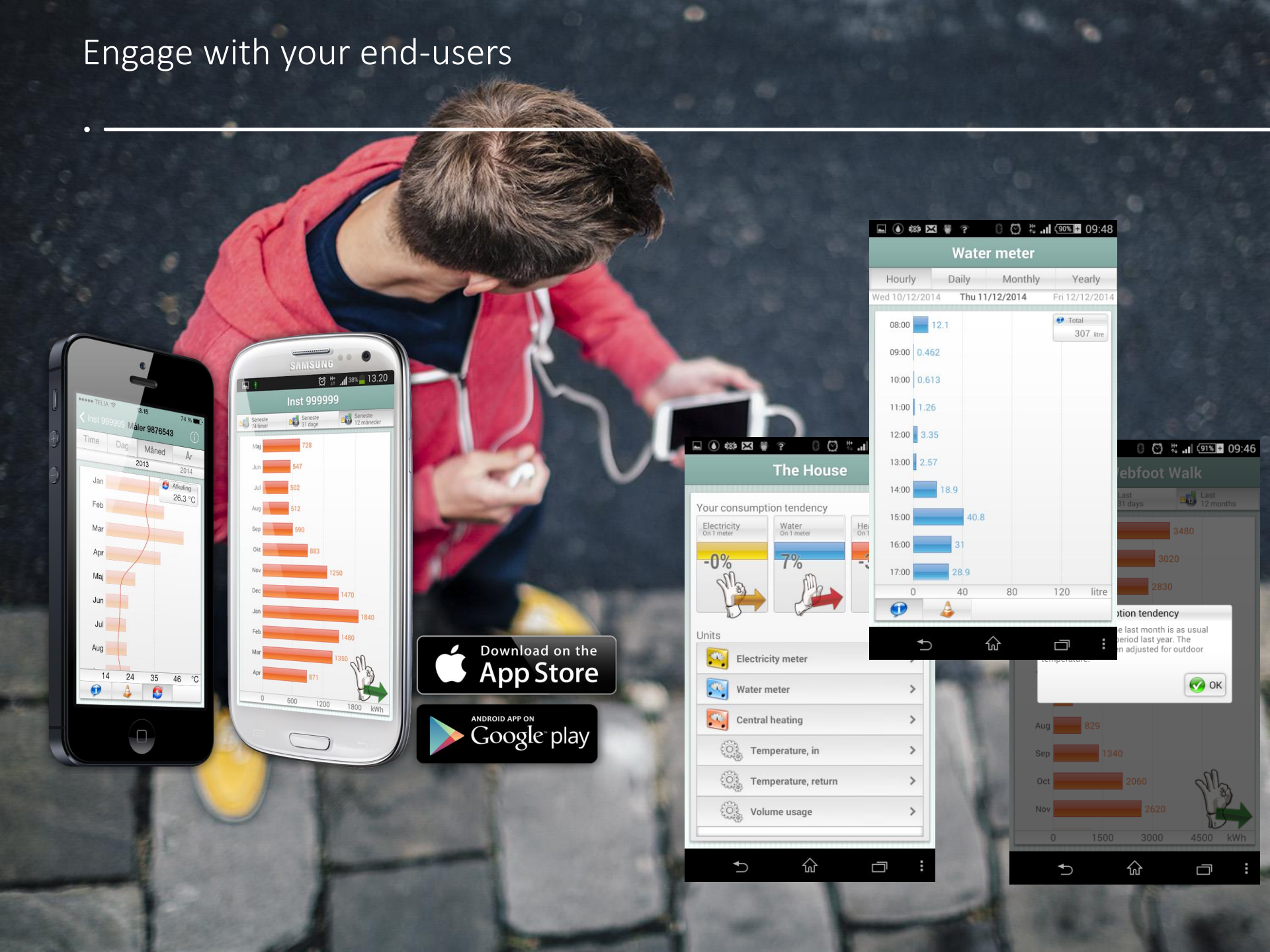
"Better interaction with end-users"

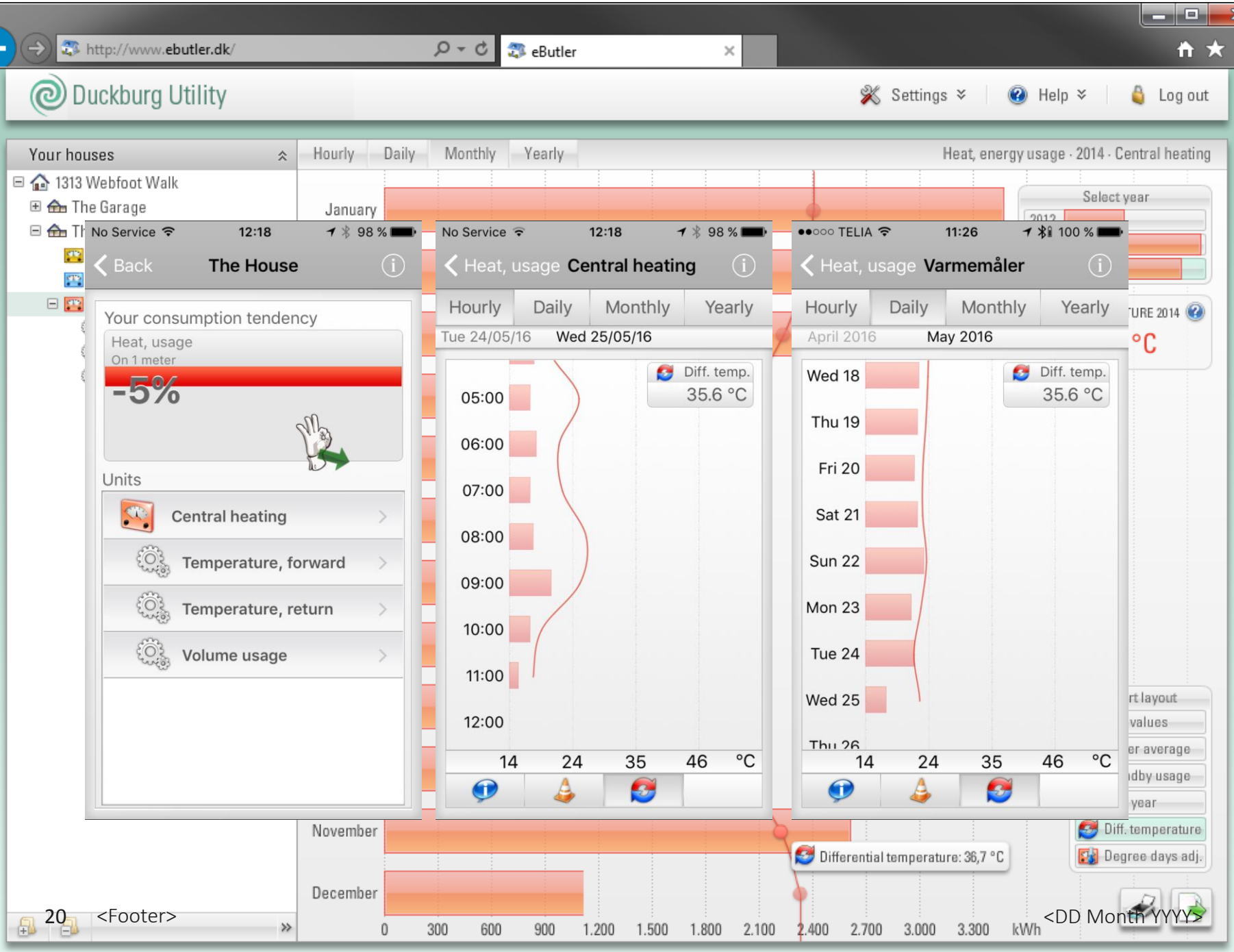
"Strong focus on utilizing data in the daily operation"

Example 3

”Better customer service
and new energy services”

Engage with your end-users




http://www.ebutler.dk/
eButler
Duckburg Utility
Settings
Help
Log out
Your houses
1313 Webfoot Walk
The Garage
Hourly
Daily
Monthly
Yearly
Heat, energy usage · 2014 · Central heating
January
Select year
2012
No Service 12:18 98 %
Back
The House
Your consumption tendency
Heat, usage
On 1 meter
-5%
Units
Central heating
Temperature, forward
Temperature, return
Volume usage
Heat, usage Central heating
Tue 24/05/16
Wed 25/05/16
Diff. temp.
35.6 °C
05:00
06:00
07:00
08:00
09:00
10:00
11:00
12:00
14 24 35 46 °C
●●○○○ TELIA 11:26 100 %
Heat, usage Varmemåler
April 2016
May 2016
Wed 18
Thu 19
Fri 20
Sat 21
Sun 22
Mon 23
Tue 24
Wed 25
Thu 26
November
December
Differential temperature: 36,7 °C
Diff. temperature
Degree days adj.
0 300 600 900 1.200 1.500 1.800 2.100 2.400 2.700 3.000 3.300 kWh

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Graphical overview of consumption

Set up own text message or email notifications

Analyze and identify errors

Benchmark with other consumers

Example 4

”Energy performance of buildings”

A buildings energy performance

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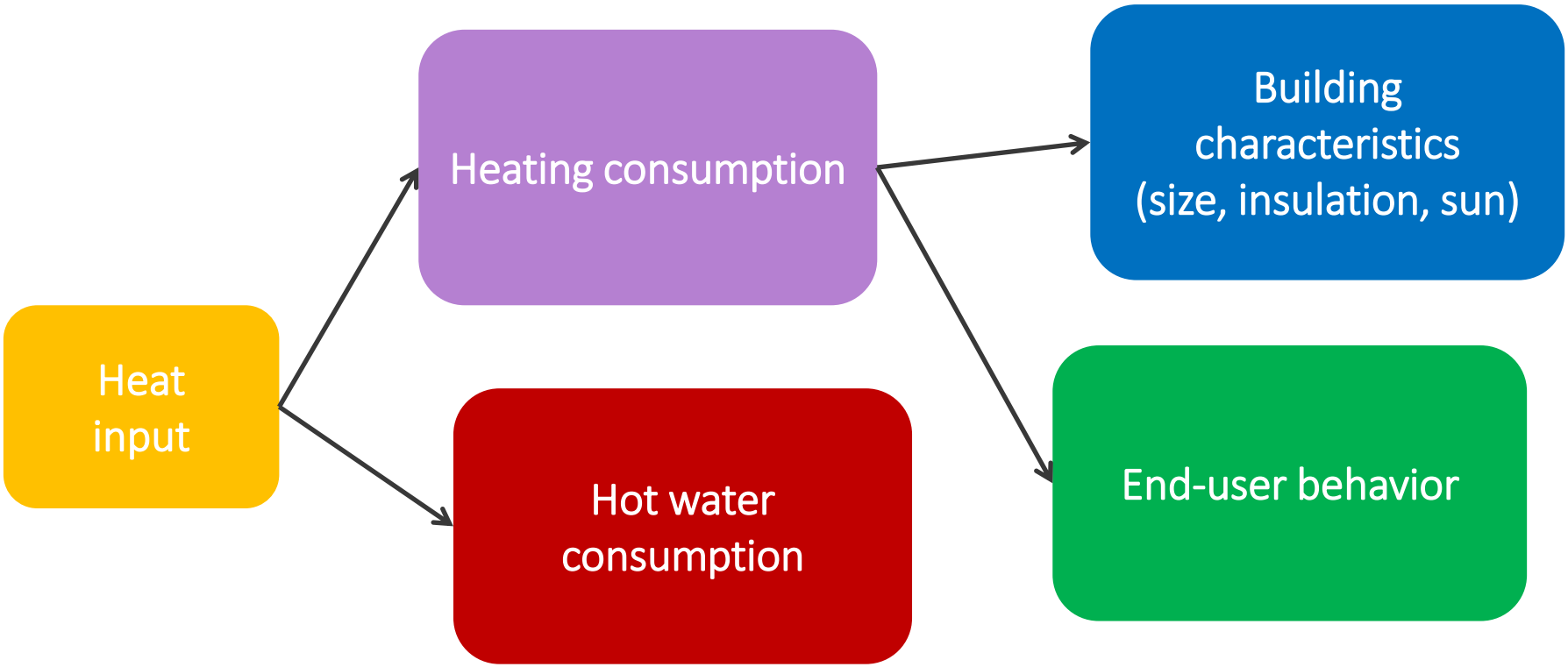
"categorize the heat consumption to focus on a buildings performance"



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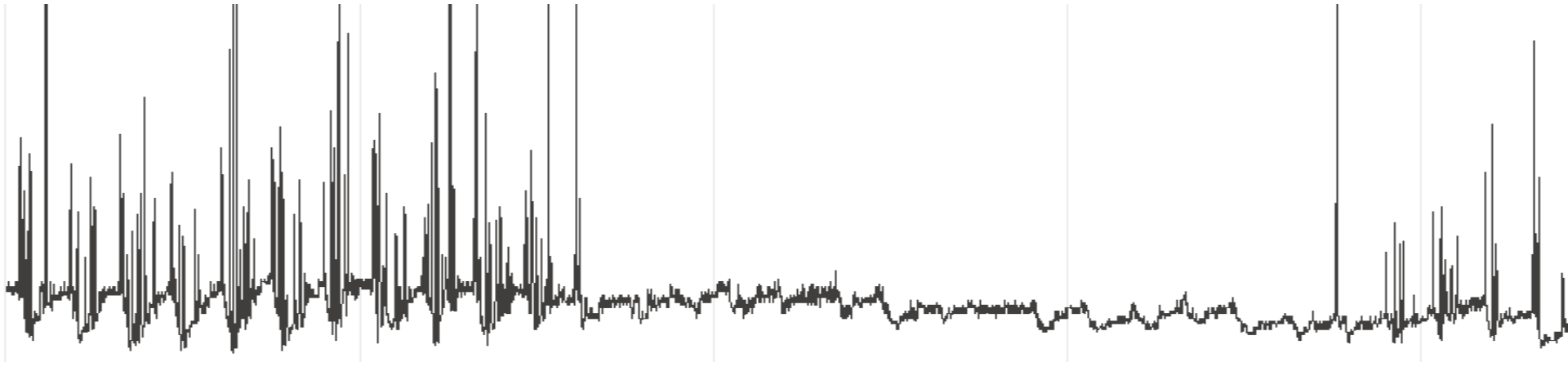
Meter data from Kamstrup heat meters…



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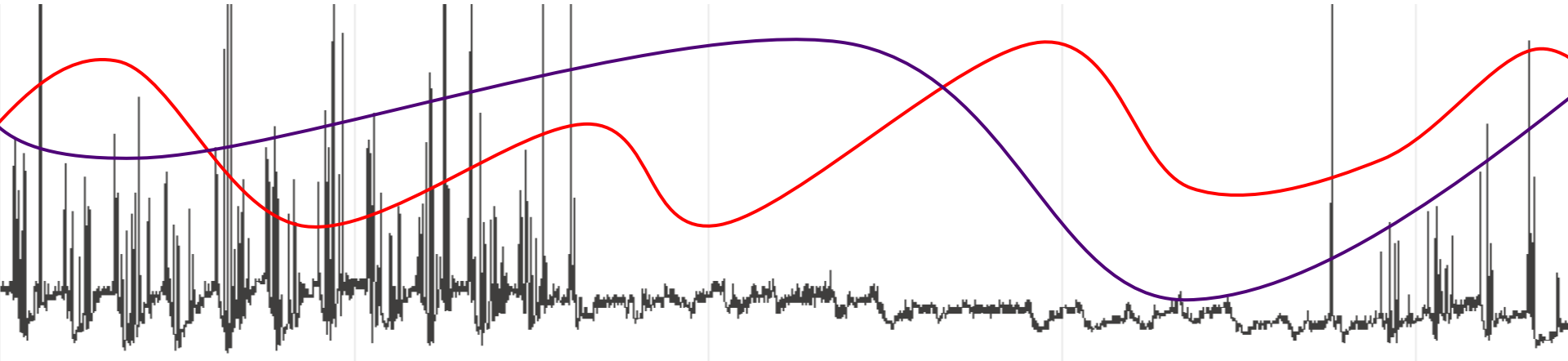
…combined with weather data from the Danish Metrological Institute…



Energy balance for a building

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$$\text{IN}: Q_{\text{heating}} + Q_{\text{electricity}} + Q_{\text{humans}} + Q_{\text{sun}} + Q_{\text{secondary-heating}}$$

$$\text{OUT}: Q_{\text{thermal-conduction}} + Q_{\text{convection}} + Q_{\text{hot-water}}$$

$$Q_{\text{heating}} = -(Q_{\text{electricity}} + Q_{\text{humans}} + Q_{\text{sun}} + Q_{\text{secondary-heating}}) + Q_{\text{thermal-conduction}} + Q_{\text{convection}} + Q_{\text{hot-water}}$$

$$Q_{\text{heating}} = Q_{\text{thermal-conduction}} + Q_{\text{convection}} - Q_{\text{sun}} + \text{constant}$$

Calculating the thermal conductance

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$$Q_i = b_0 - b_1 \cdot T_{ai} - b_2 \cdot T_{a(i-1)} - gA \cdot R_i + (T_i - T_{ai}) \cdot b_c \cdot wA_i$$

Input variables

Q_i : Heat consumption

T_{ai} : Temperatur

R_i : Radiation from the sun

wA_i : Avg. wind amplitude

Output parameters

b_0 : Everything constant

$b_1 + b_2 = UA$: Thermal conductance

gA : Sun dependency

b_c : Wind dependency

T_i : Fictional indoor temperature

Yearly consumption for a single family house

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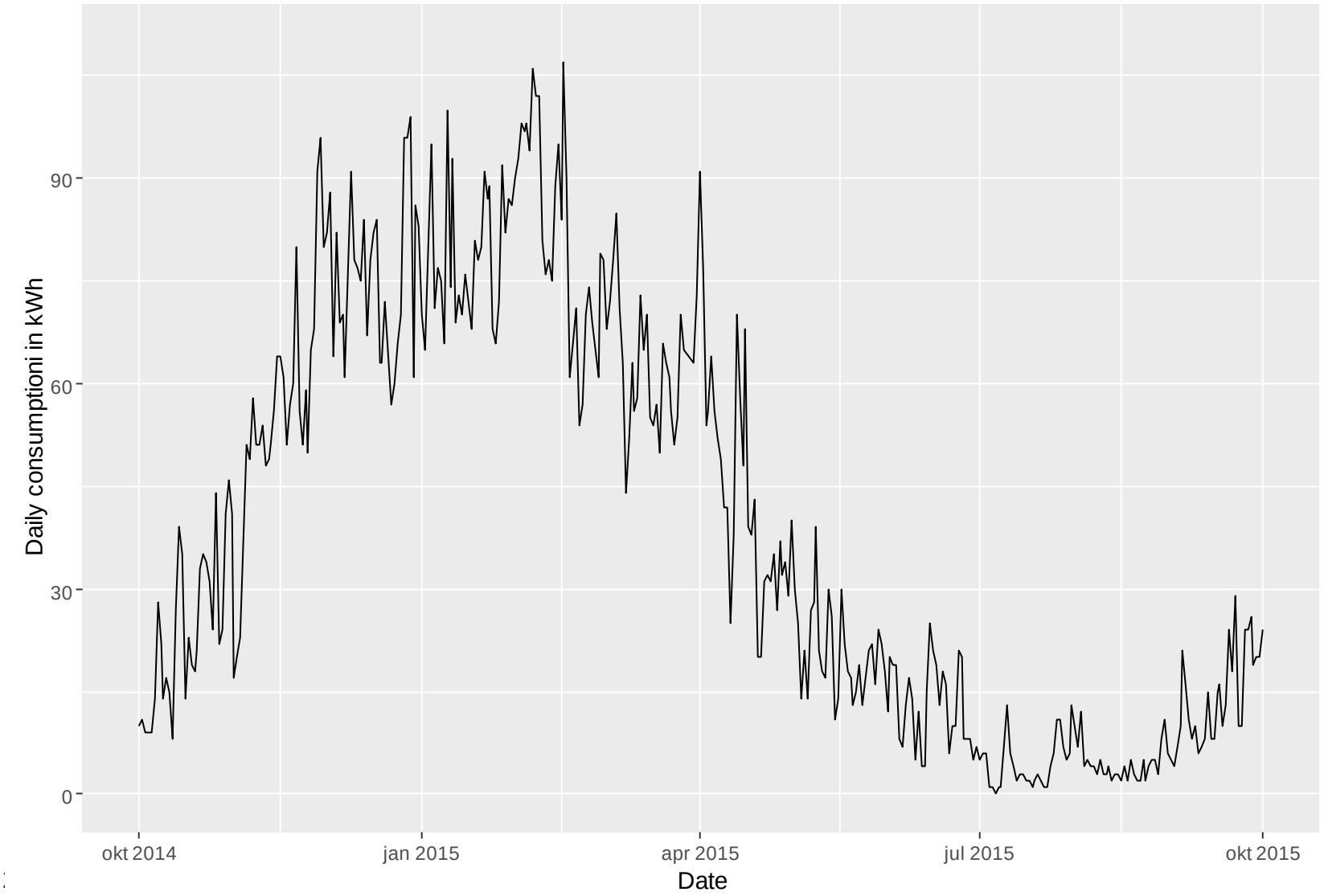
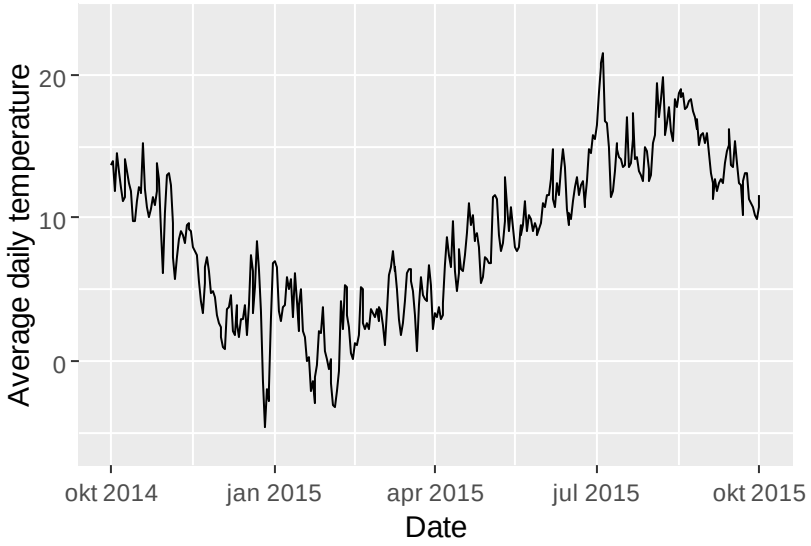
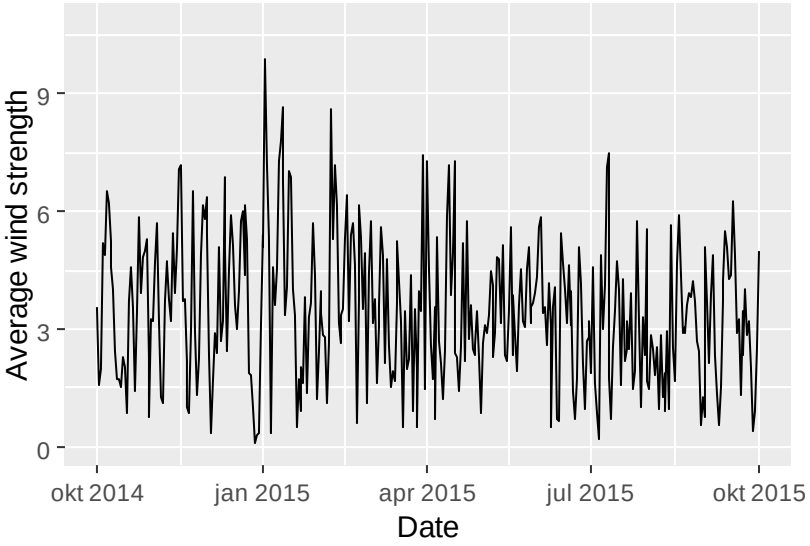
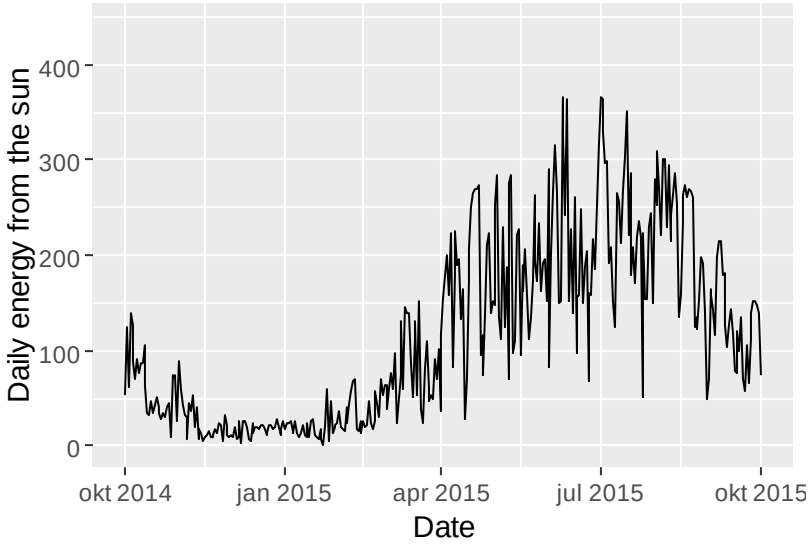
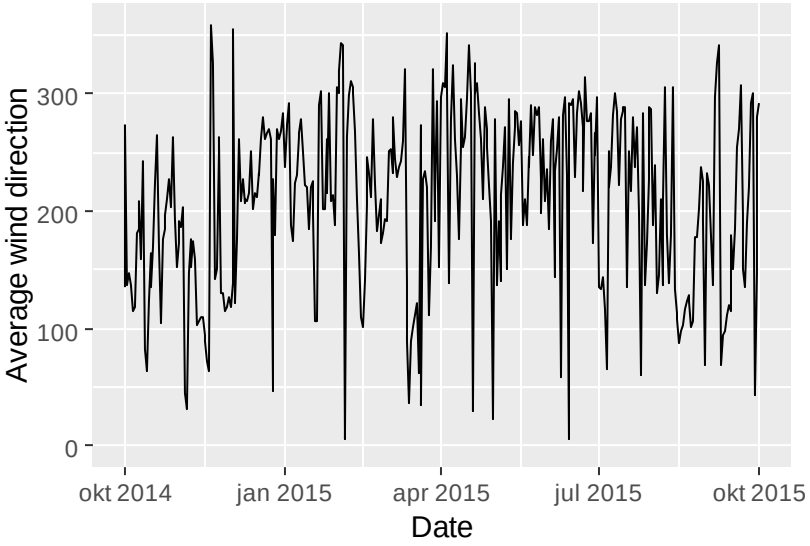


Weather input









Thermal conduction study – without building codes

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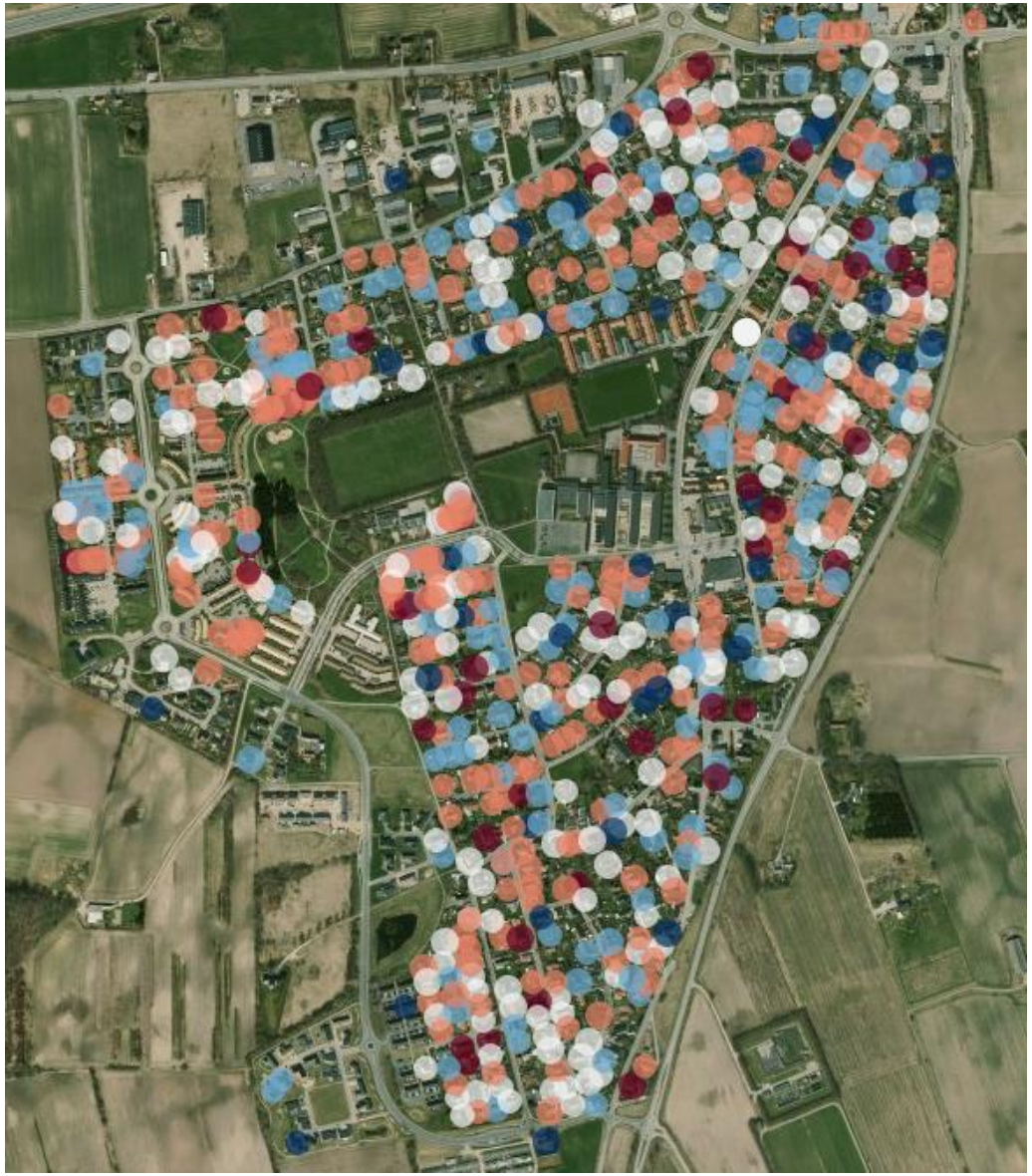
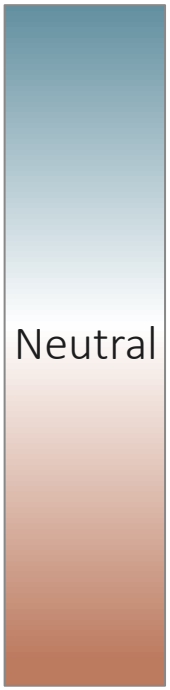
Good

Bad

Thermal conduction study – compared with similar



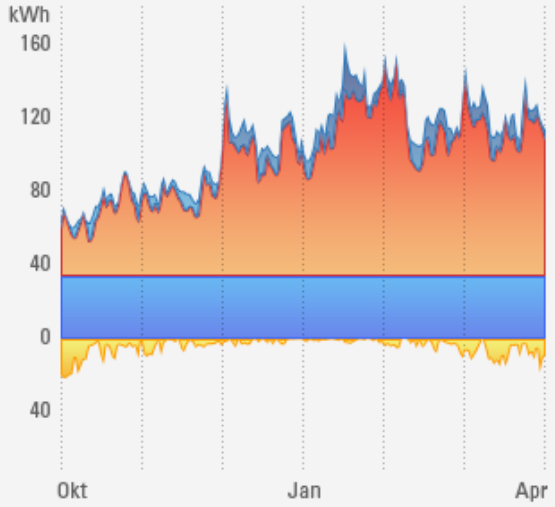
Good – compared to similar



Bad – compared to similar

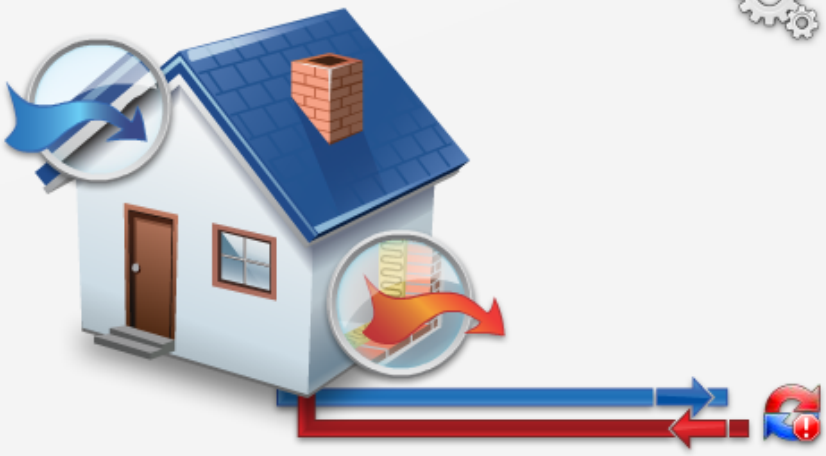
Fyrringssæson 2015 / 2016

Varmeforbrug pr. dag



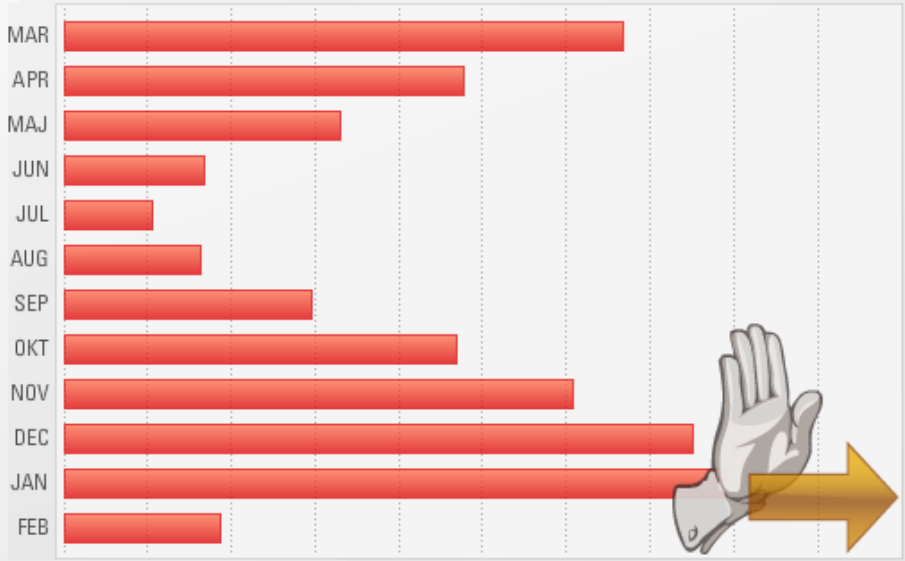
Ejendommens varmeprofil

Peg på ikonerne for yderligere informationer.



Varme, forbrug (kWh)

De seneste 12 måneder

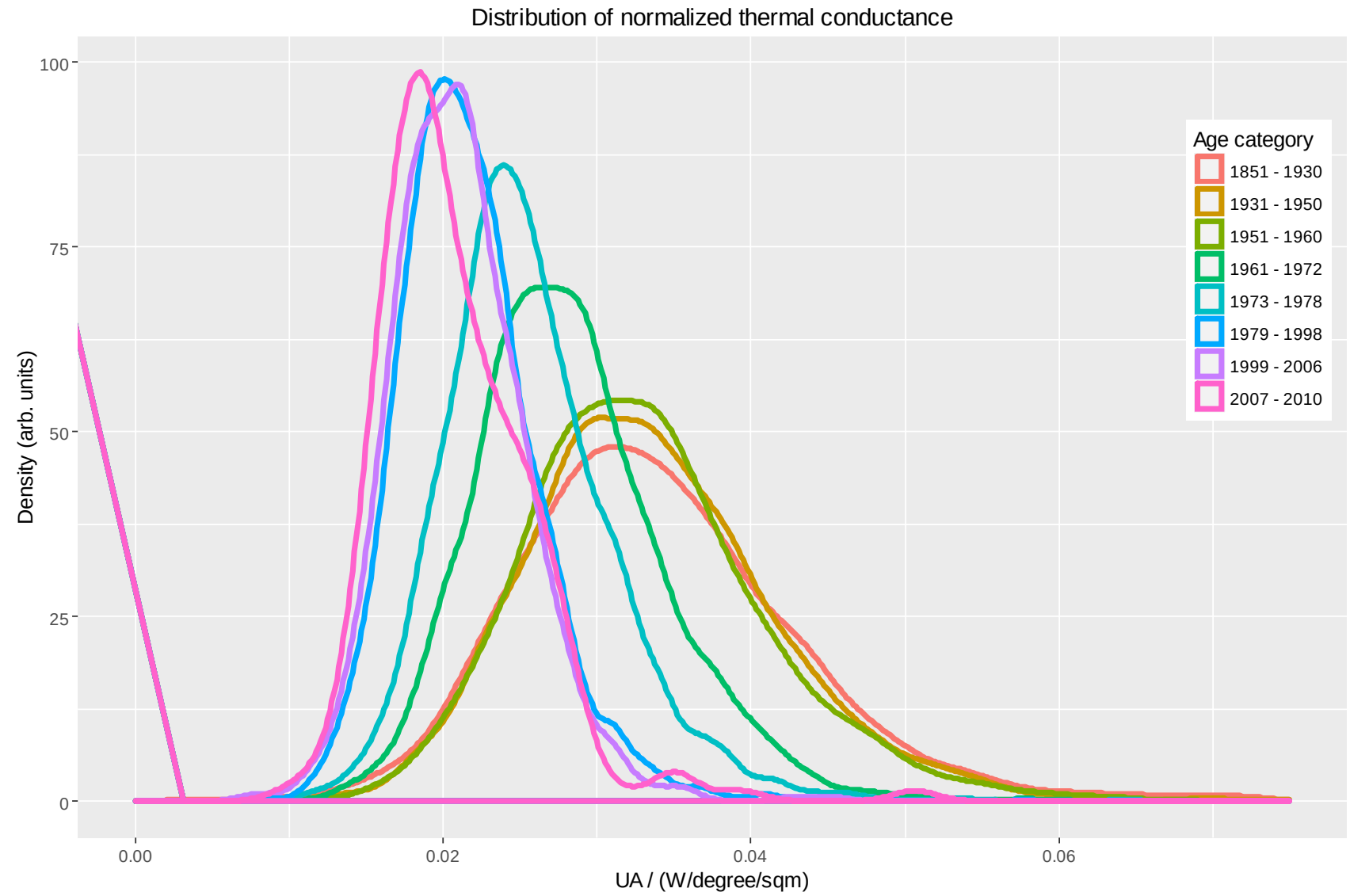


Mærkningsordninger

Seneste 12 måneder

Følgende mærkningsordning(er) er beregnet på baggrund af ejendomsoplysningerne og forbruget for Inst 3246987.

Grouping buildings for comparisons



Summing up…

- Great opportunities for low temperature district heating – in both new and existing systems
- Also a lot of challenges to make district heating green, energy efficient and economically attractive
- At Kamstrup, we believe that data plays a key role in the digital future of district heating

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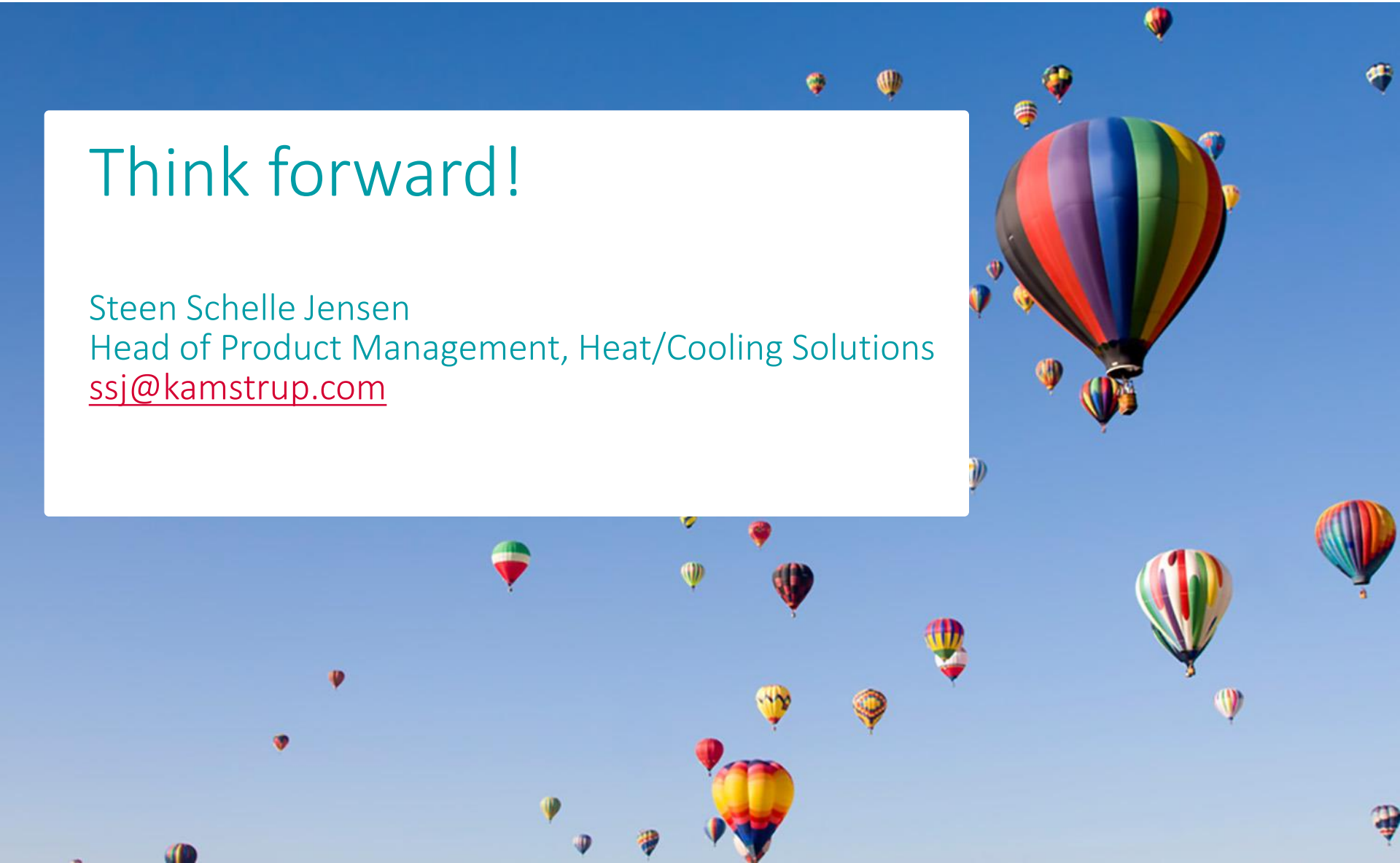

Think forward!

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