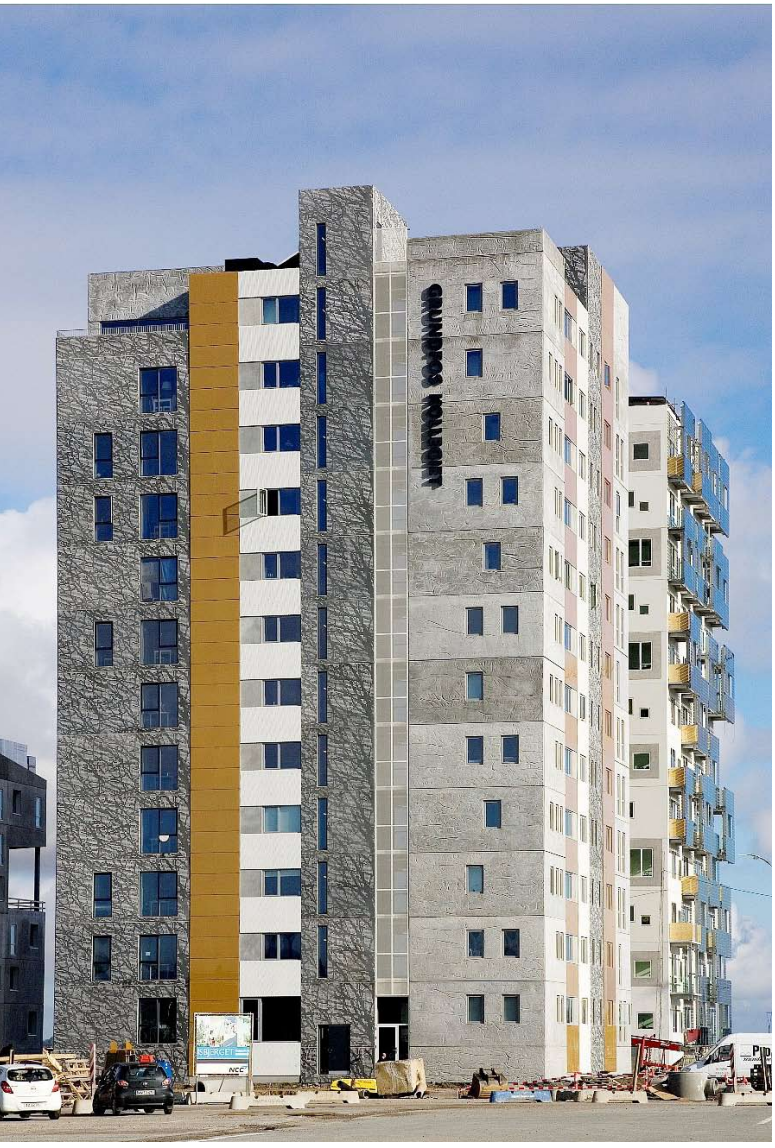
Grundfos dormitory – a living laboratory



Grundfos dormitory – Student hall of residence in Aarhus a living laboratory:
- 12 floors
- 159 apartments - 7 different designs
- Basement: pump systems & laundry
- Roof: Ventilation & Solar panels

A new dormitory in the Danish city of Aarhus is not just the residence of more than 200 students it is also a living laboratory. More than 1,800 sensors throughout the building allow Grundfos and partners to test new energy-saving technologies in a real environment – and gain valuable knowhow on how to minimise the water and energy consumption in the 12-storey building.

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Over the next years, Grundfos and other external partners will continue to test different solutions in an effort to further optimise operations in the building. The access to valid data in the building is a unique chance to learn more about consumption patterns and test alternative solutions and thereby becoming able to develop new solutions to support even more sustainable building in the future.

Green building

The Grundfos dormitory already has a green profile. It has been built according to the Danish standard of low-energy, class 1 (2015) that provides very low consumption of primary energy – more precisely 52.5 kWh/a per m^2 including heating, cooling, ventilation and domestic hot water.

Reality vs. Theory

A key motivation behind the project is the paradigm of understanding between theory and reality. Years of data collection, simulations and extensive test facilities have offered valuable information, but not the precise and unpredictable environment that a living laboratory does. Today, most systems are modelled based on how things are supposed to work in theory. The truth is; most component and system builders do not have valid, detailed data that document how systems perform in real life, and why.

To serve the purpose as a learning environment, the dormitory has been equipped with state-of-the-art pumping systems for heating, ventilation and wastewater, and in addition sensors throughout the building to monitor "everything".

1,800 Sensors installed for monitoring

To acquire the necessary level of information from the building, it has been fitted with close to 1,800 sensor points. In addition to sensors on all main energy and water meters, each apartment has 12 sensor points that measure:

- Indoor climate - temperature, CO_2 level and relative humidity
- Electricity consumption
- Flow and temperature in the cold domestic water and flow
- Flow, pressure and Delta T on the hot water.
- Flow and Delta T on the heating system.

Partners make it possible

To ensure that the Dormitory is Smart Grid ready and actually reap the full potential of the living lab Grundfos has teamed up with Aarhus University and the technical Alexandra Institute. These specific studies and experiments are a part of the strategic research council project EcoSense and the ForskEl project VPP4SGR both anchored at Aarhus University.[1]

1 http://www.alexandra.dk/dk/projekter/sider/ecosense.aspx
https://www.forskel.dk/Pages/default.aspx

The cooperation offers thorough analyses of relevant data in the right context and in-depth behaviour studies, on the large group of residents.

Data analysis

To succeed in developing high-tech solutions that use less energy and provide flexibility for future intelligent electricity and water systems in buildings, it is essential first to understand how residents use the building and enable them to interact with the control system.

With the advanced sensor setup it is possible to measure changes in any parameters down to 250 milliseconds. The analysis of the data is expected to reveal differences in consumptions based on where in the building the apartment is located, dependent on weather conditions, time of day, time of week, general load of the building, etc.

Sensors reveal consumption patterns

The massive time-series of sensor data from 159 apartments allow for detailed investigation of how various control strategies for the mechanical systems impact the consumption or waste of water and energy, e.g.:

Domestic Hot Water recirculation

What are the true costs and benefits of recirculating hot water? By varying the control strategy across different well-known approaches and monitoring the results, data will reveal exactly how much energy is spent on hot water recirculation and how much water is saved. It will even be possible to analyse the time spent on waiting for hot water at all instances of hot water use. Combined with occupant surveys, the perceived impact on comfort and convenience may be included as well.

Pressure Boosting

A state of the art intelligent boosting system ensures that the needed water pressure is available at all time at the minimal energy consumption. But how close are we in fact to the optimal boosting strategy? By mapping the static pressure levels and actual water consumption across all apartments in the building it is possible to determine the true water delivery efficiency at system level and assess potential areas for optimisation.

Space Heating

By analysing the detailed dynamics of the radiators, the loads and the building itself, it is possible to determine and implement the optimal strategy for controlling the heating system. Combined with historic

and predictive weather data from the on-site weather station and meteorological internet sources, it is possible to assess and compensate for the true passive performance of the building. Data will also allow a solid investigation of the thermal effect of the hot water recirculation system on the space heating load.

These are merely examples – the abundance of data enables a wide range of research that aims to dramatically improve our understanding of the complex nature of buildings.

Resident behaviour

Gaining an understanding of WHY the residents do what they do is crucial, in the effort to change this behaviour into a more sustainable behaviour. The assumption is that two demographically similar tenants might exhibit very different usage patterns. The key to bringing down the consumption is to understand this difference and learn from it.

Right now a baseline study including technical data from all the different sensors and meters is being carried out. This is followed by a more qualitative baseline, where the important values and norms of the residents will identify what is important for the residents in their daily lives.

Un-hiding consumption

One of the challenges with energy consumption today is that it's "hidden". Energy is something we all consume more or less subconsciously, even though many of us would like to do 'the right thing' as responsible world citizens. However, the innovative sensors allow each resident to follow the development of his or her own consumption measured against the average consumption for the entire building.

It is assumed that un-hiding the energy consumption and the potential gains will create a cognitive relation between daily practice and energy consumption and eventually influence the behaviour. ■

Links for websites:

http://www.alexandra.dk/dk/projekter/sider/ecosense.aspx

https://www.forskel.dk/Pages/default.aspx