What can we learn from case study buildings?

Associate professor Natasa Nord
Department of Energy and Process Engineering
Norwegian University of Science and Technology

Case study buildings

- Office building in Trondheim
- Heated area: 16 200m^2
- Energy aim is 85 kWh/m^{2}a

- Office building in Stavanger
- Heated area: 19 623 m^2
- Energy aim is 127 kWh/m^{2}a

Measuring energy use for hydronic systems

- Measurement of energy use of hydronic systems (water-based) can be challenging

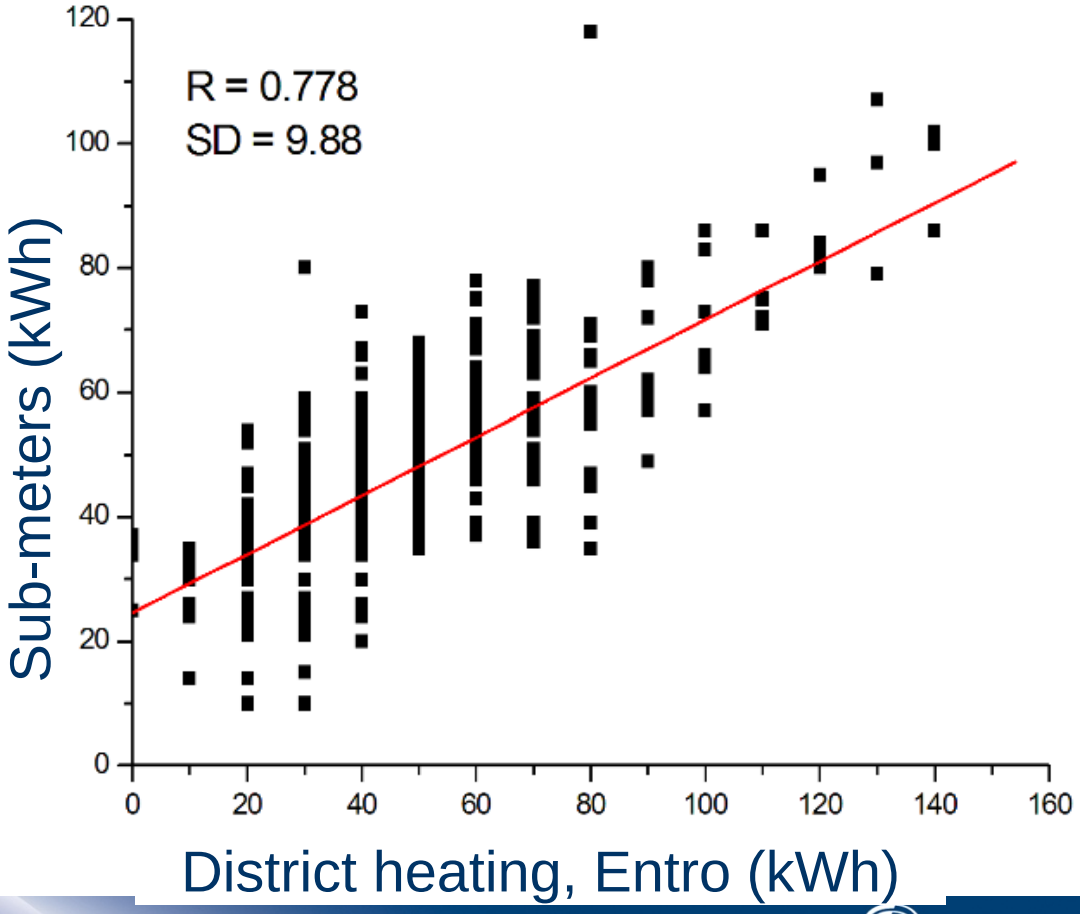
- Measurement of heating energy

$$Q = \int_0^t \dot{m} \cdot \left(h_{p,tur} - h_{p,ret}\right) dt$$

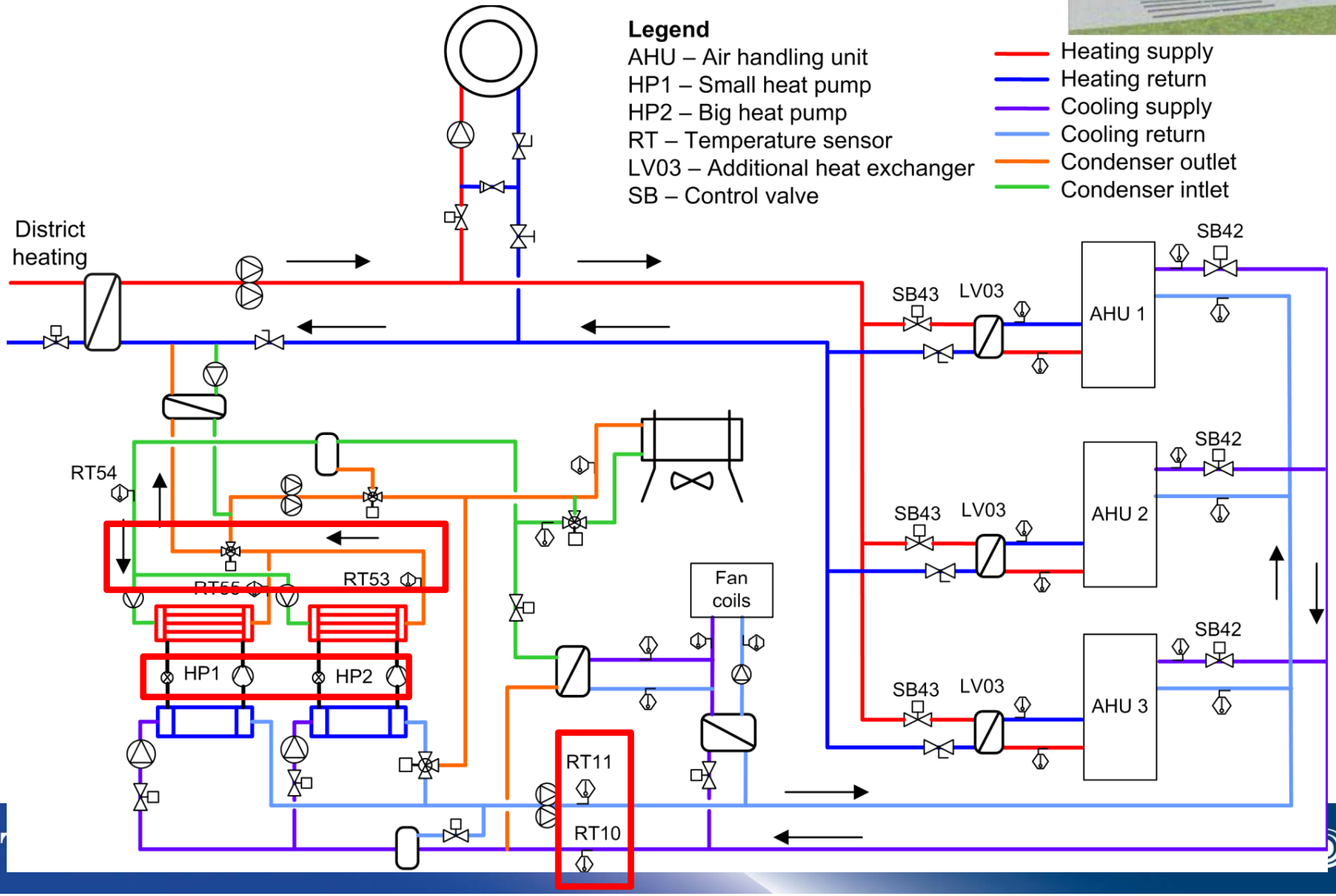
or

$$Q = \int_0^t \dot{V} \cdot \left(T_{p,tur} - T_{p,ret}\right) \cdot k dt$$

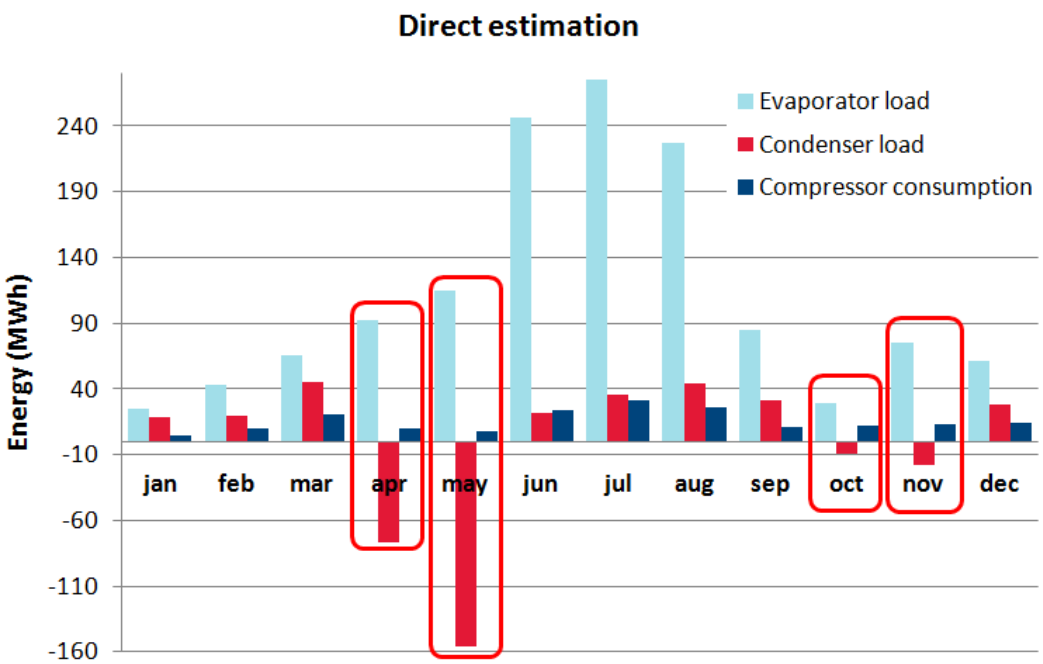
$Q_{FV} = Q_{320.002} + Q_{320.003} + Q_{320.004} + Q_{36} - Q_{CD35.02}$

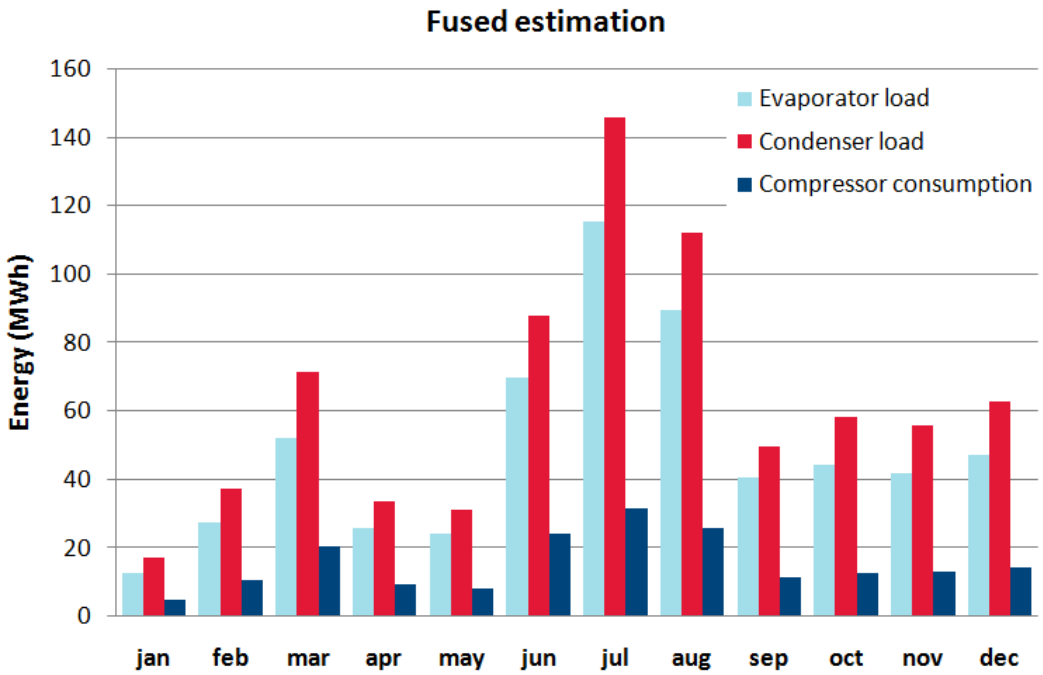


Performance estimation of complex system



Performance estimation of complex system

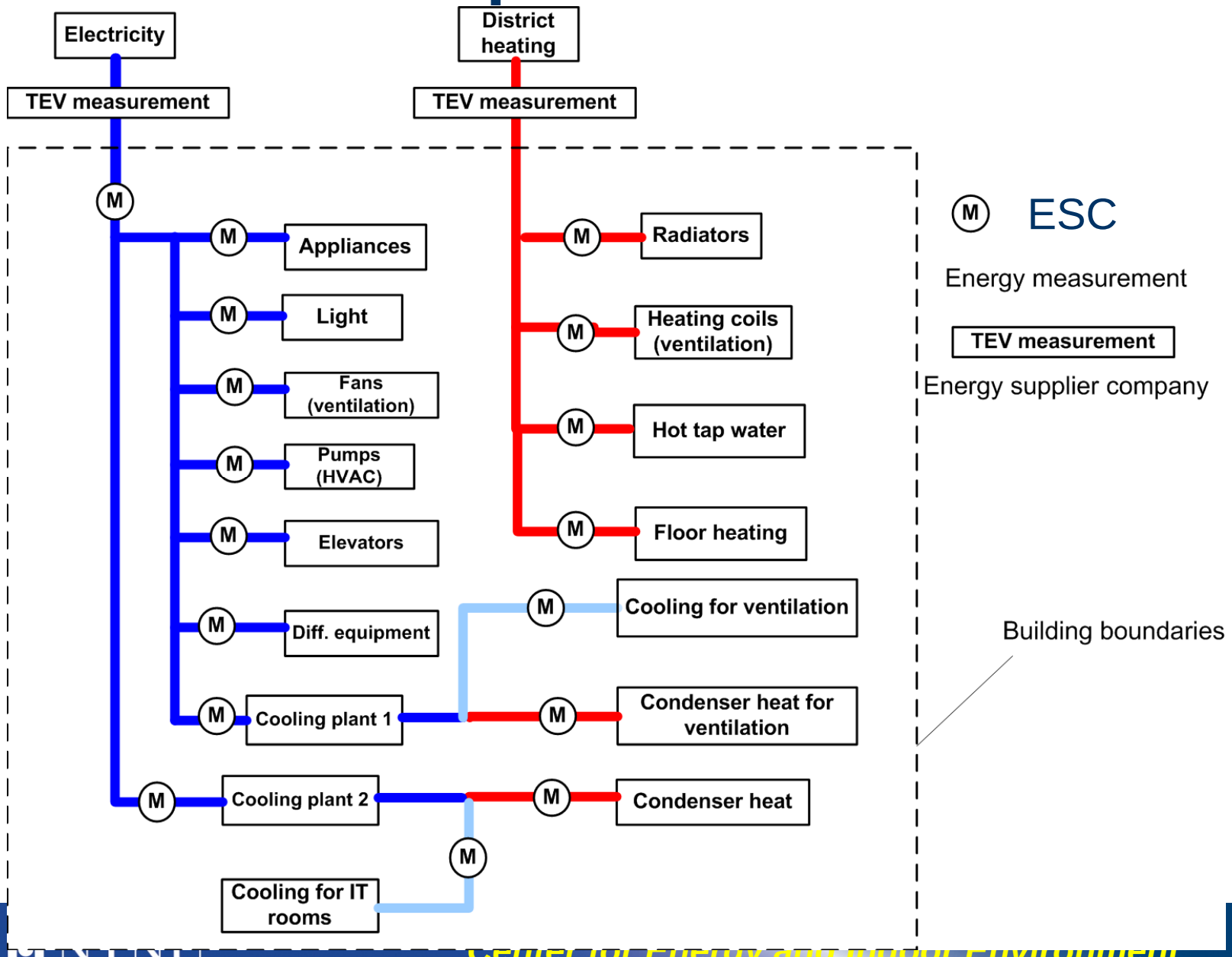




- Sensors on the evaporator seems to include free-cooling
- Temperature difference on the condenser were very low

- Fused estimation fits better to thermodynamic theory
- Fused estimation was used for further assessment

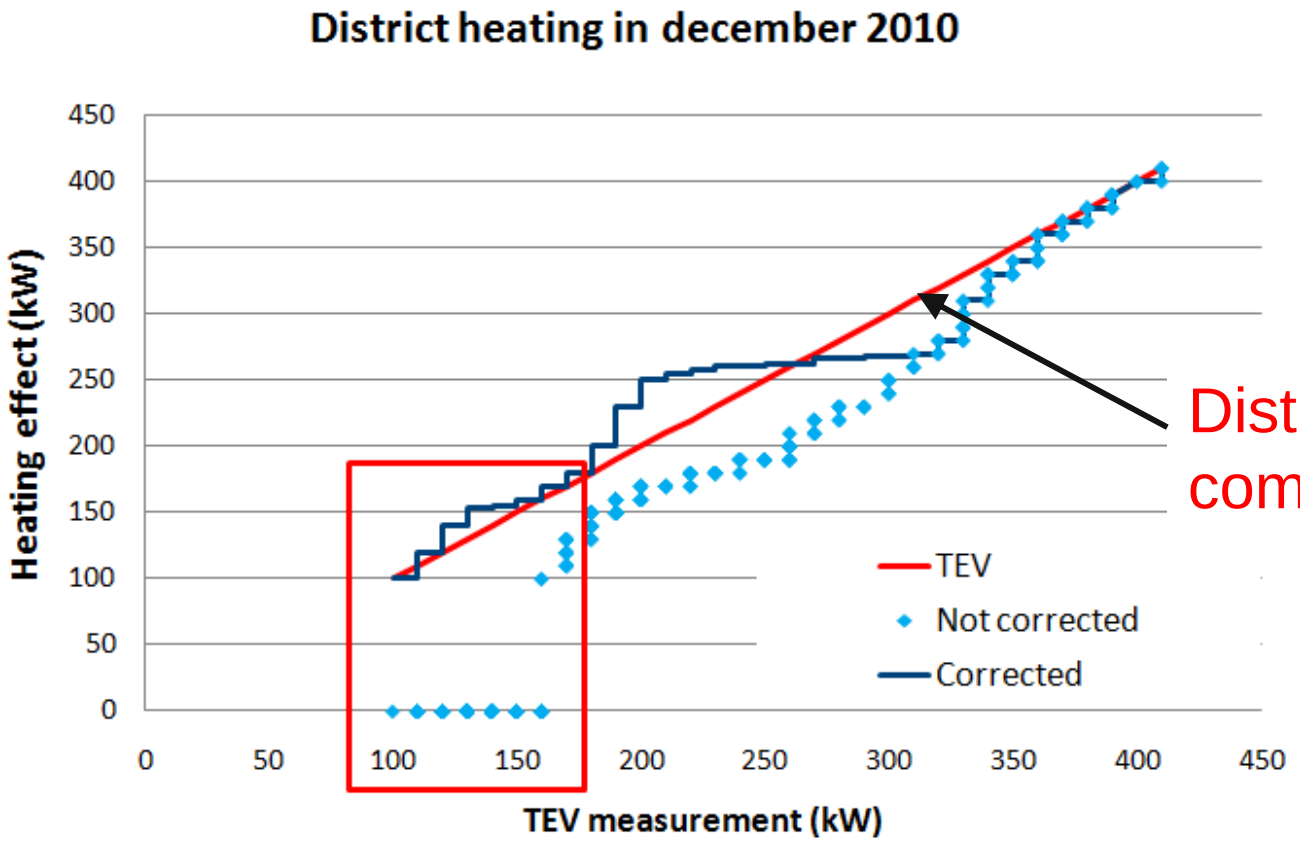
Energy measurement with different platforms



- 74 energy measurers
- 66 measurers for electricity
- 8 measurers for heating and cooling
- Two measurers from energy supplier
- Trondheim Energy District heating – TEV
- Energy Savings Company Entro - ESC

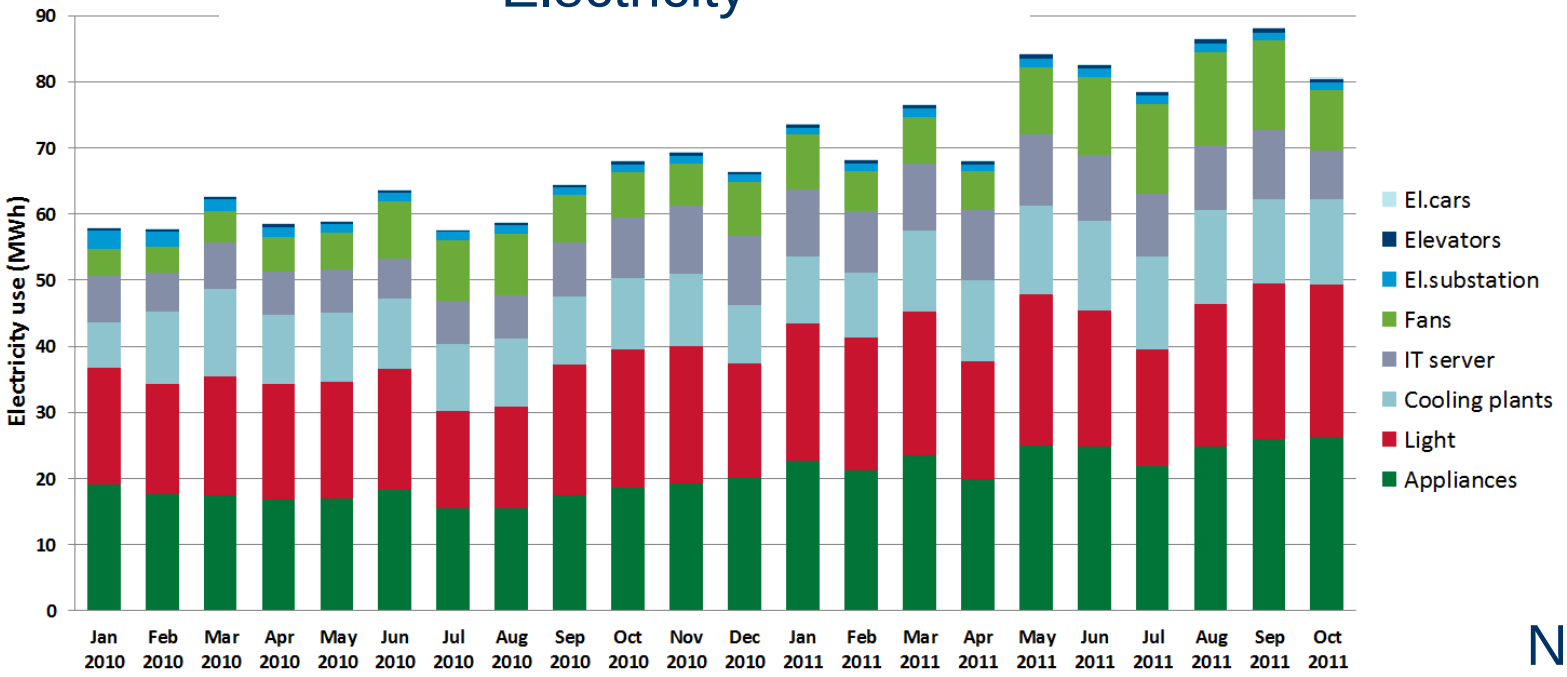
Energy measurement with different platforms

Some of measurement data were lost in data transmission at Energy Savings Company

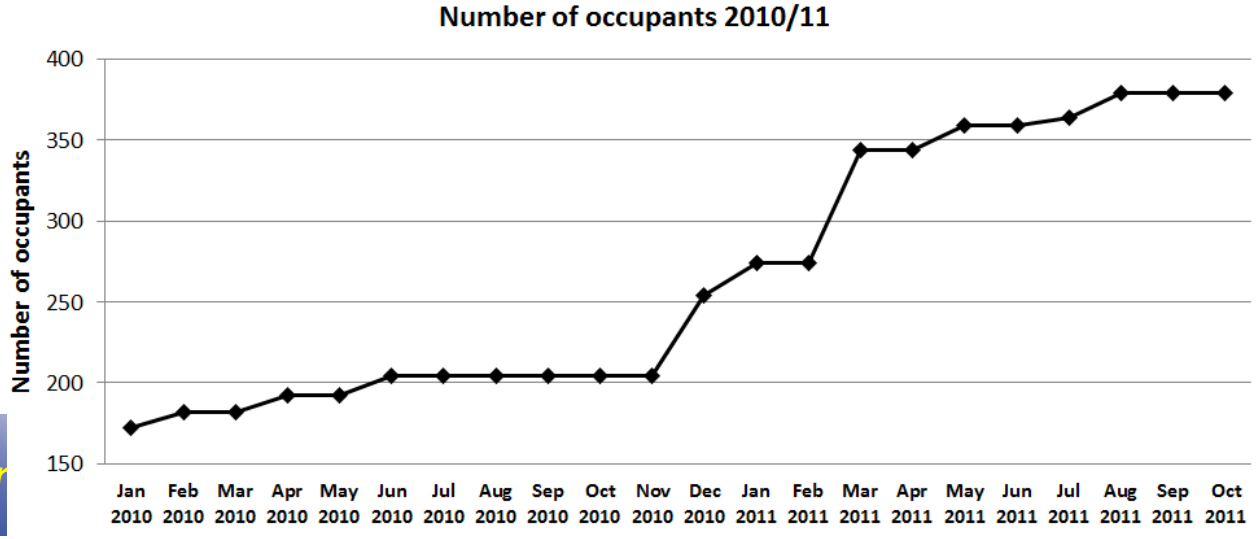


Occupant influence on total energy use

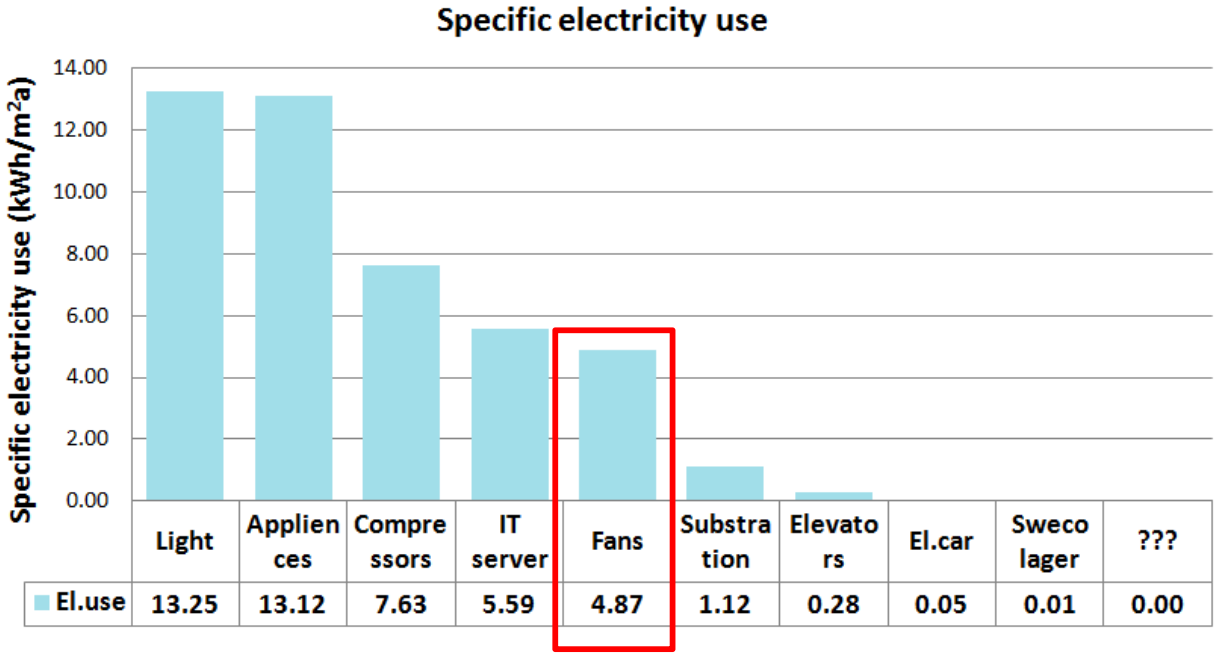
Electricity

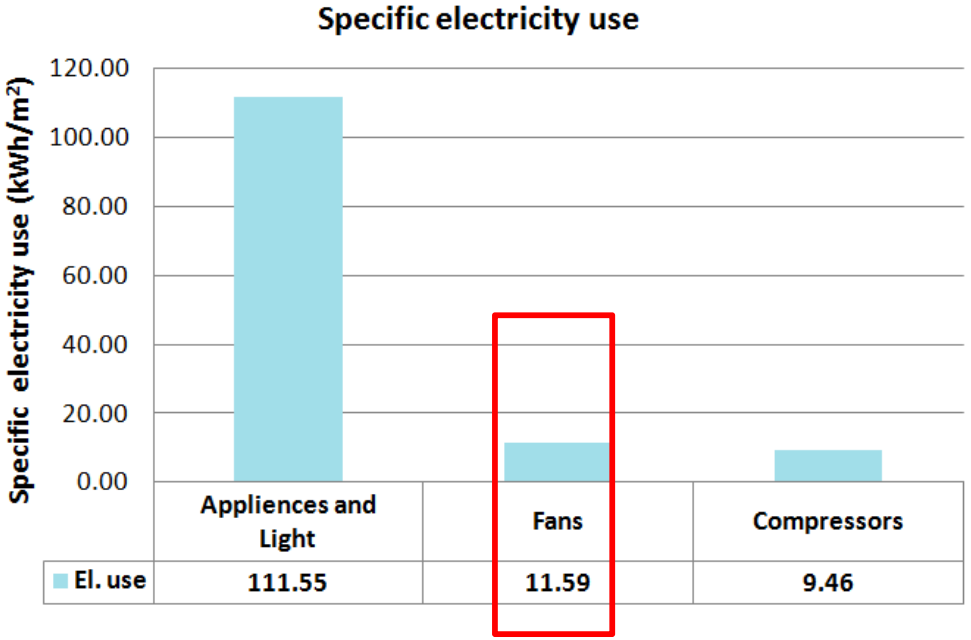


Number of occupants



Specific electricity use for fans





- Office building in Trondheim
- Specific electricity use for fans per occupant was about 375 kWh

- Office building in Stavanger
- Specific electricity use for fans per occupant was about 189 kWh

What can we learn from case study buildings?

- **Detailed documentation** is necessary to understand all energy use in building
- The **building ownership** defines ***motivation factor*** for good energy monitoring
- **Monitoring platform** defines quality and possibility for energy measurement
- **Reliable measurements** are necessary to better estimate and increase awareness of the building energy use

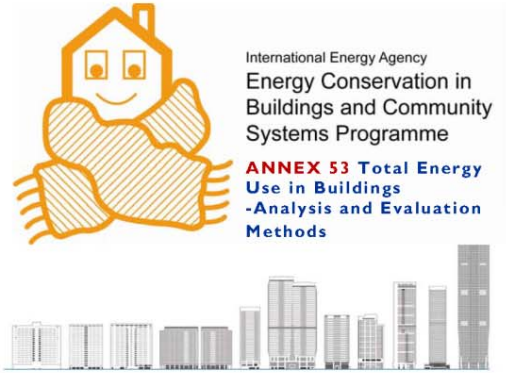
The ultimate outcome of Annex 53 is better understanding and strengthening the knowledge for robust prediction of total energy usage in buildings, thus enabling the assessment of energy-saving measures, policies and techniques. For that this annex pursues to study how the occupant behaviors influence building energy consumption on this base, and hence to bring the occupants behaviors into the building energy field so as to conduct the building energy works (research, practice, policy, etc) more closed with the real world.

The deliverables of Subtask B is:

- Demonstration of case studies of energy use by end use in buildings
- Demonstration of measurement and data acquisition technologies for long term monitoring (On-line Database)

STB CASE CONTRIBUTOR

AUSTRIA	Vienna University of Technology
BELGIUM	University of Liège
CHINA	Tsinghua University
	Swire Properties Ltd.
FRANCE	Insa de Lyon
ITALY	Politecnico di Torino
JAPAN	Tohoku University
	Chubu Electric Power Co., Inc.,
NORWAY	Norwegian University of Science and Technology



Case Information

WEATHER

In Norway, CDD is not an actual parameter. HDD is 4856 of year 2010. HDD was calculated for the base indoor temperature of 17°C.

BUILDING

The case is an office building in Professor Brochs gate 2. Height of the building is 21 m (the front block) and 14 m (the back block). The Gross Floor Area and conditioned building both are 16,200 m^2

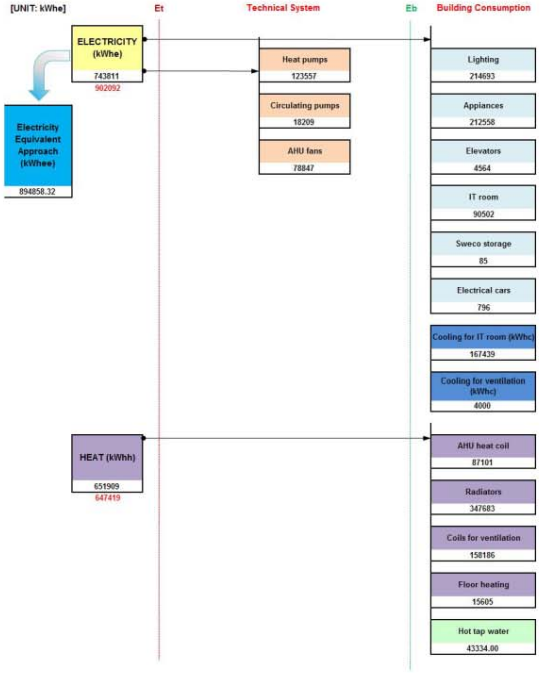
ACKNOWLEDGMENT

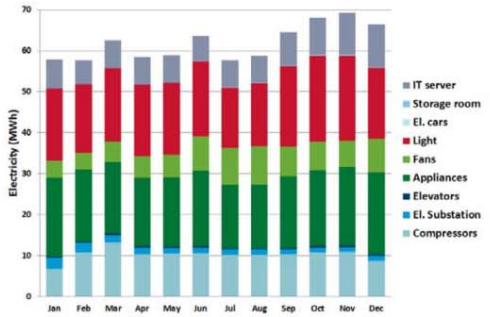
All the information and data is provided by Energy and Process Engineering of Norwegian University of Science and Technology.

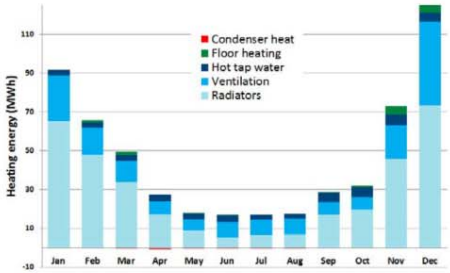
Subtask B- Case Study

Large-scaled office building in NORWAY

Energy Consumption

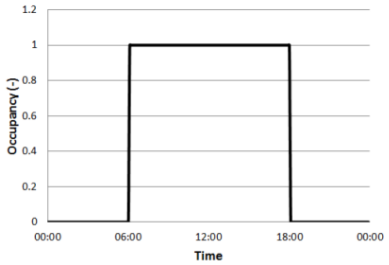


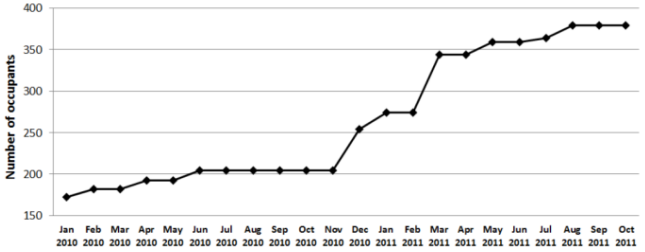




Occupant Behavior

The presence schedule for the office building in Trondheim is given in the following figure. This office building is rented to different companies, usually companies have working time between 8 a.m. until 4 p.m. But some companies could extend working time until 5 or 6 p.m. In general, it can be assumed that working hours is about 2000 hours for light and ventilation in the building. Light in the corridors and common area is working longer. Working hours of the IT server room is 8760 hours.





Thanks for your attention!

Natasa Nord

natasa.nord@ntnu.no