CITIES
Centre for IT Intelligent Energy Systems

Energy in buildings

Control for optimal efficiency

Hakon Børsting, Senior Manager Grundfos Holding A/S

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Grundfos - Building Services

Installations in and around buildings:

- Air-conditioning
- Hot water recirculation
- Heating
- Wastewater
- Pressure boosting
- Fire protection
- District energy
- Drainage

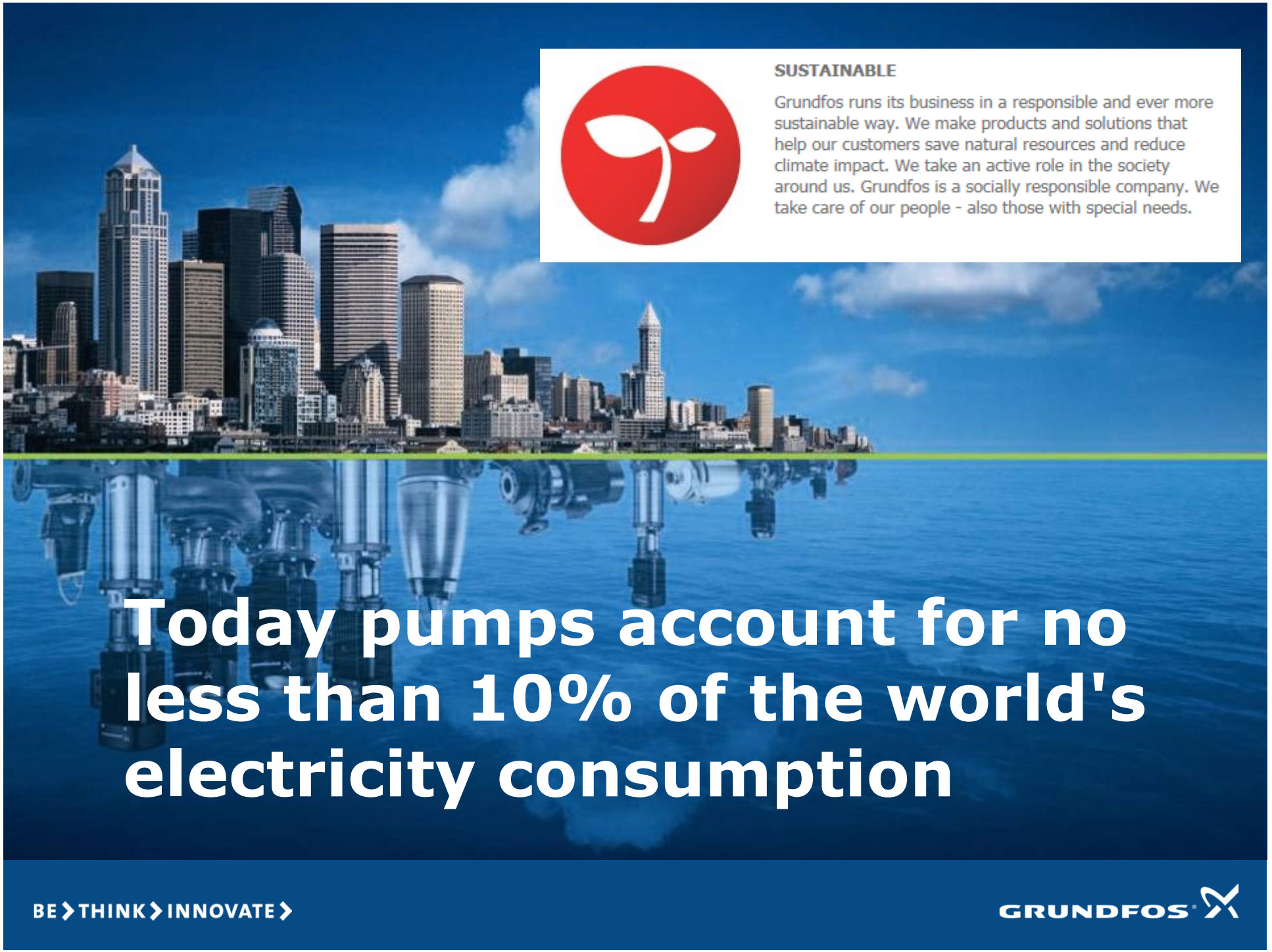
33% of all energy in EU is used for transport

26% of all energy in EU is used by industry

41% of all energy in EU is used by buildings

⅔ of energy consumption in buildings is used for heating and cooling

80% of energy consumption is used in small buildings < 1000 m²


SUSTAINABLE
Grundfos runs its business in a responsible and ever more sustainable way. We make products and solutions that help our customers save natural resources and reduce climate impact. We take an active role in the society around us. Grundfos is a socially responsible company. We take care of our people - also those with special needs.
Today pumps account for no less than 10% of the world's electricity consumption
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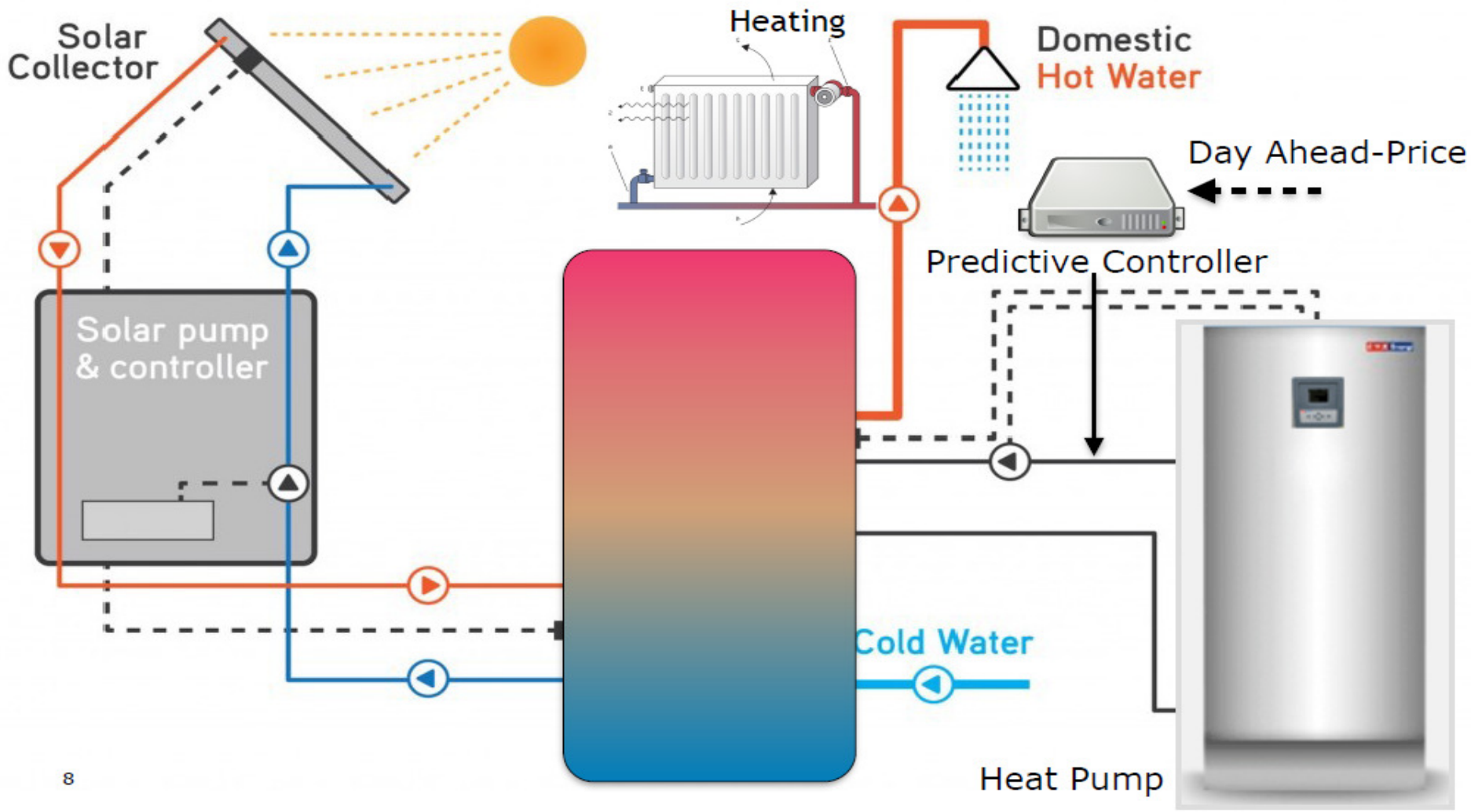
Two application studies

- Model Predictive Control of Heat pump and Solar Thermal supply
- Control of Return Temperature in Gas Boilers

Model Predictive Control of Heat pump and Solar Thermal supply



SunampCube

This exciting new product responds to the needs of large community and commercial scale heat storage. It helps deal with grid constraints and ensures continuous generation. This can have a huge impact on project payback.

SunampCube can also be used to harvest and reuse waste heat.

Trial development in progress.

Ideal for agricultural and industrial use

Save £££'s and replace LPG, Oil, Gas Heating

Transportable compact heat storage

Stores vast quantities of energy as heat

Size of a standard pallet

	SunampPV	SunampStack	SunampCube
Compatibility	PV with combi boiler	Heat pump, Biomass	Wind, Hydroelectric, Large PV, Waste heat source
Projected Savings	Up to £200 per year*	Up to £5,000 per year*	By Application
Capacity (kWh)	5.7	Up to 60†	Up to 250
Replaces Water Tank (L)	150	Up to 2000	5000
Mobile	✗	✗	Optional
Central Heating	✗	✓	✓
Hot Water	✓	✓	Optional
Temperature Output (°C)	Up to 65	System dependent	Up to 80

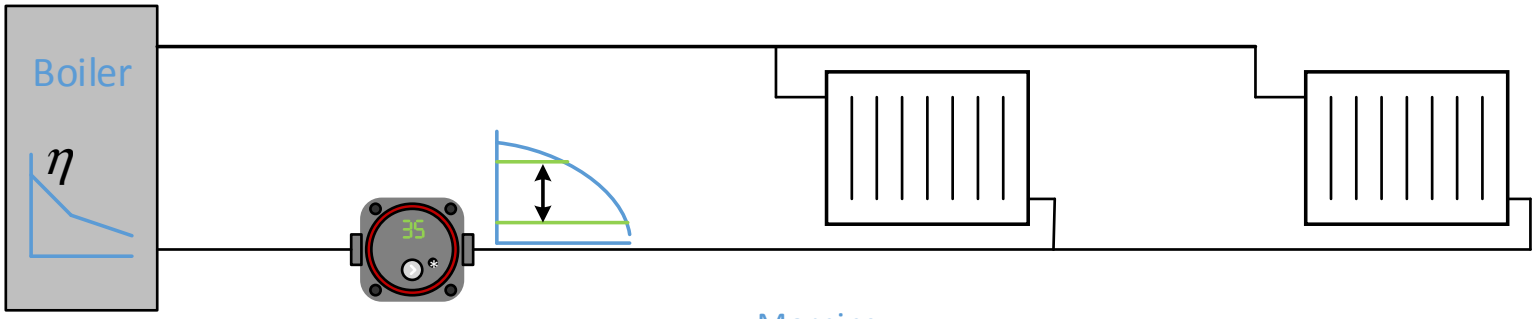
*Including Government Incentives (Feed-in tariff/ renewable heat incentive)

†System dependent

Two application studies

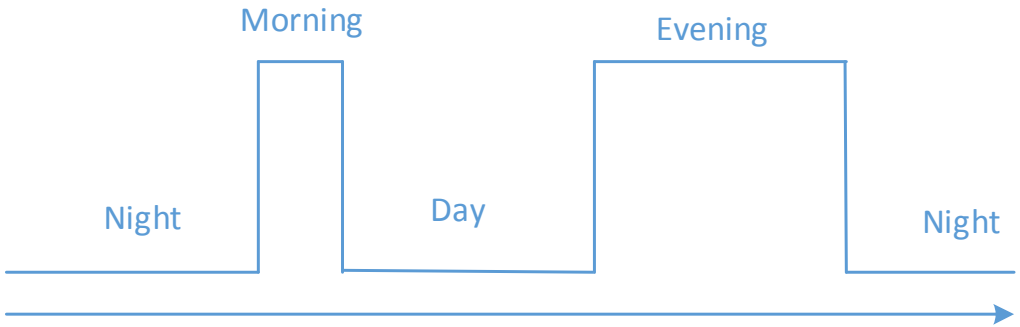
- Model Predictive Control of Heat pump and Solar Thermal supply
- Control of Return Temperature in Gas Boilers

Control of Return Temperature in Gas Boilers



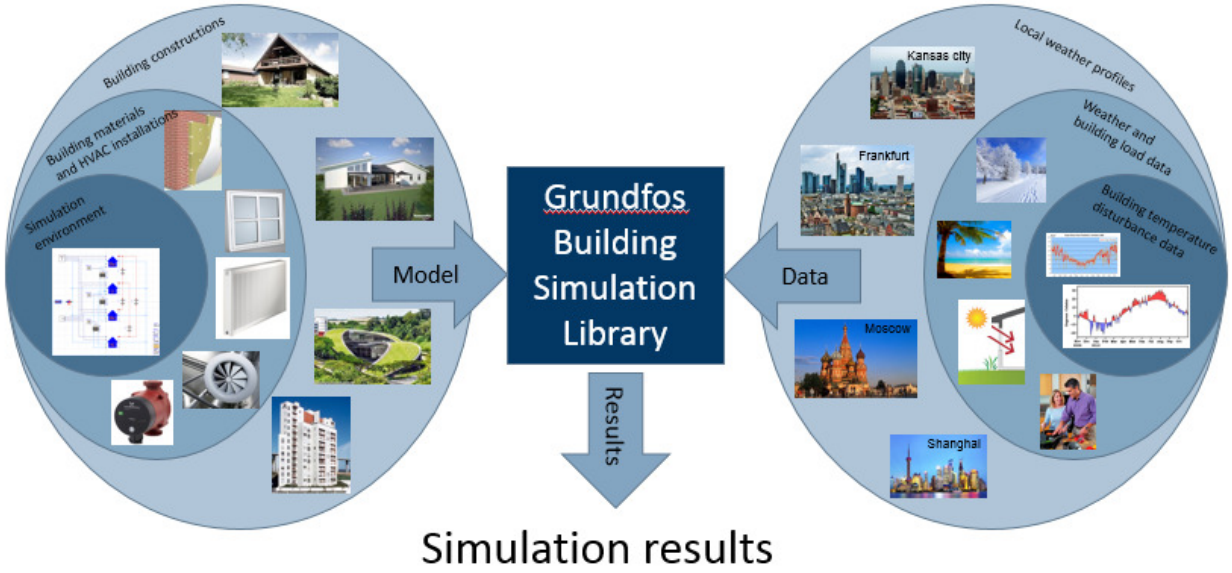
Savings from:

- Reduced room temperature
- Reduced return temperature



Grundfos Building Simulation Library

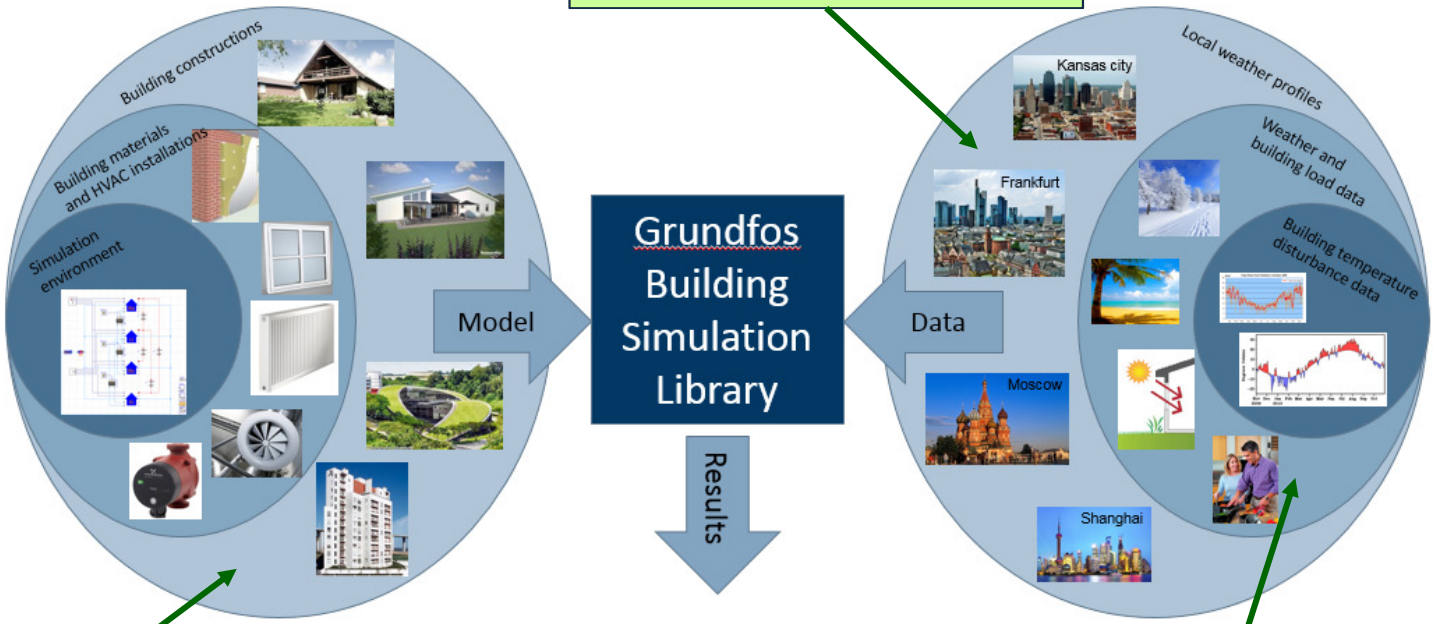
Simulation Driven development



Simulation results

Control of Return Temperature in Gas Boilers

Copenhagen area

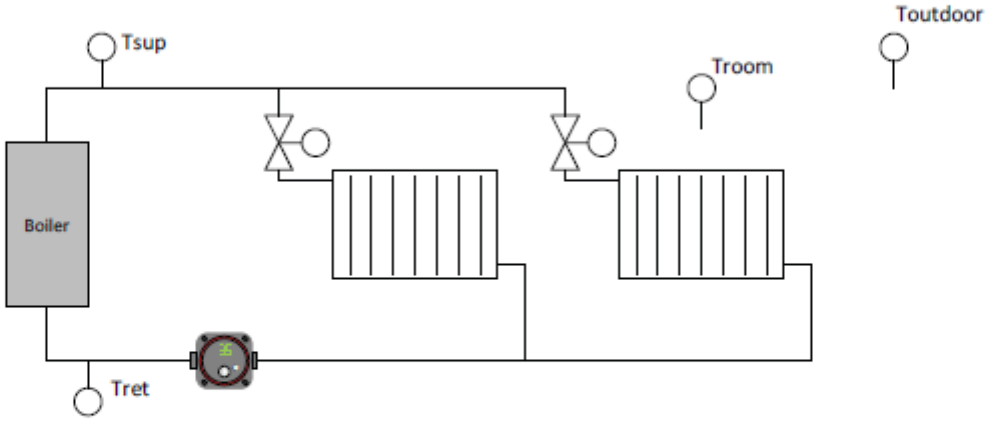


Archetype Building 1970-1980

- Meteorological average year
- Free heat disturbance (week sequence)

Control of Return Temperature in Gas Boilers

System Definition

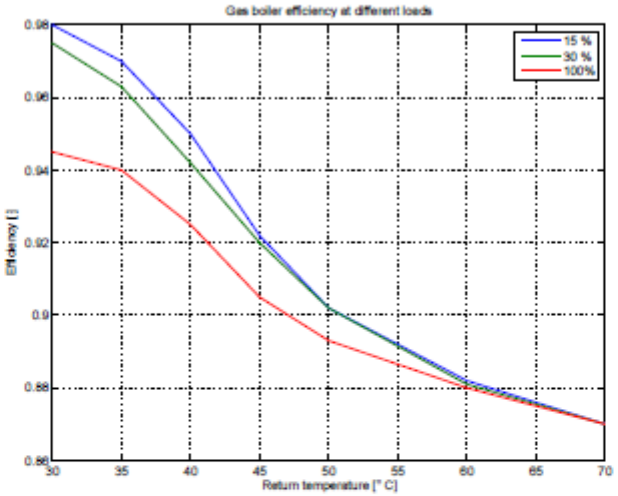


Energy savings from:

1. Reduction of room temperature
2. Improved supply efficiency, $\eta = f(P_L, T_{ret})$

Control of Return Temperature in Gas Boilers

Boiler/supply Model

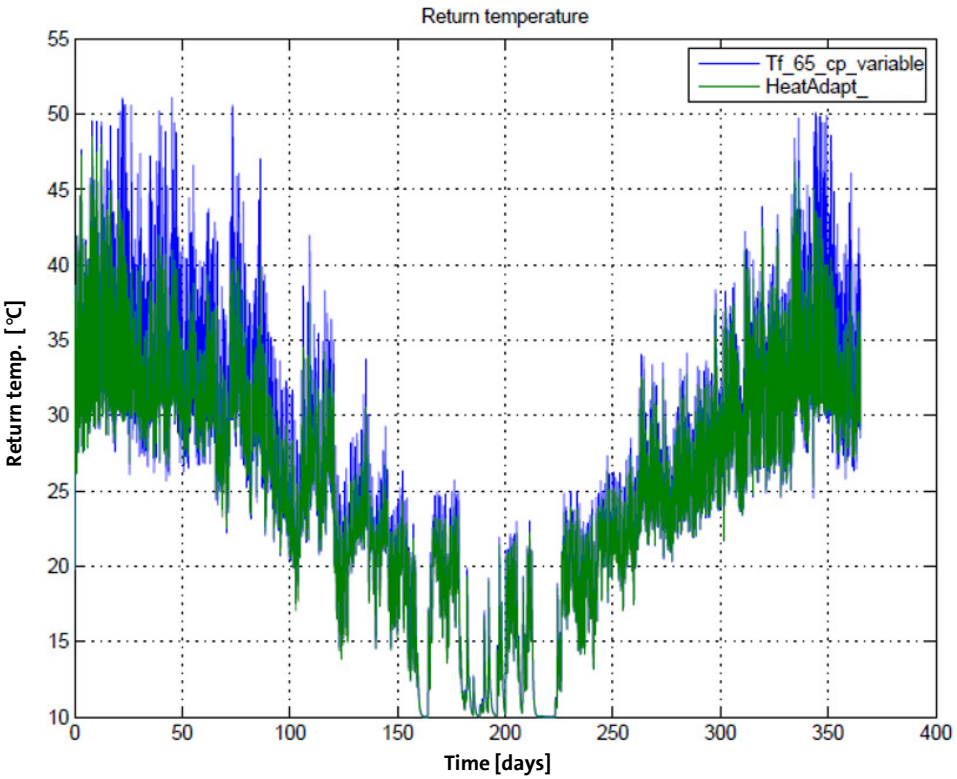


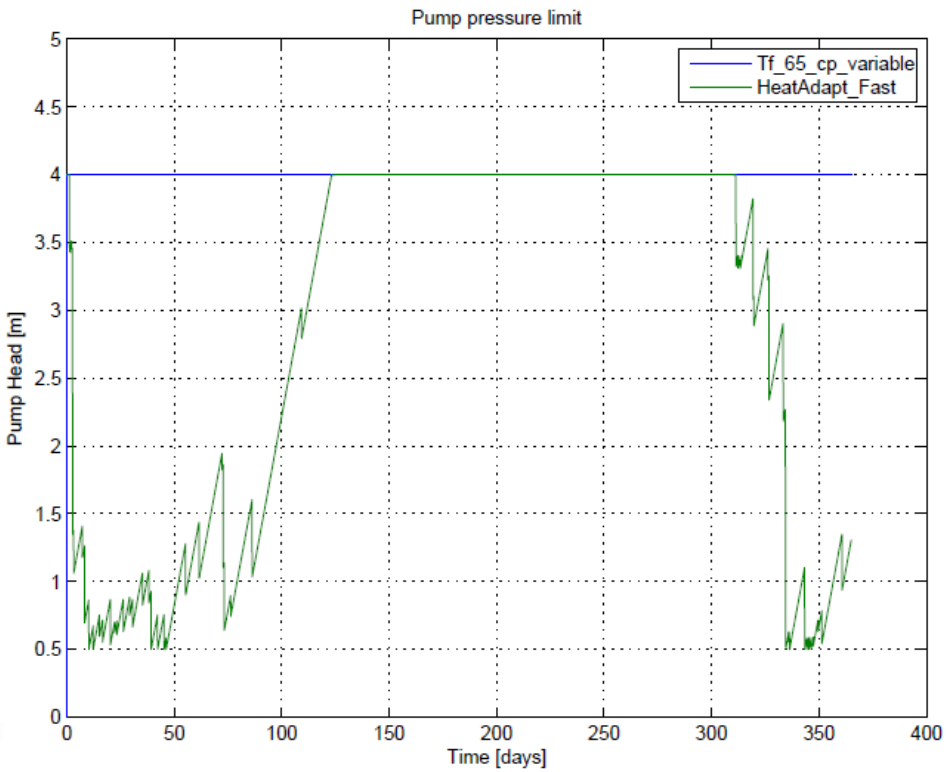
$$\eta_S = \theta_1 T_{ret} + \theta_2 T_{ret}^2 + \theta_3 R_L + \theta_4 R_L T_{ret} + \theta_5$$

Example

On part load 15 %, a 10 °C reduction in T_{ret} implies a 5 % reduction in η_S.

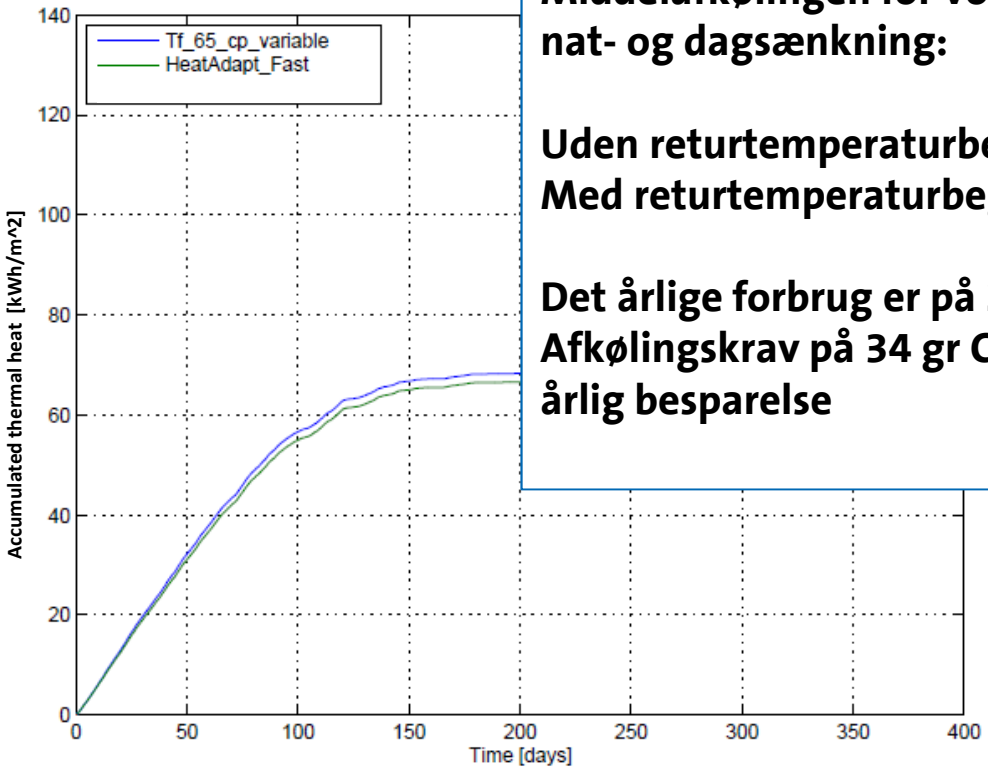
Control of Return Temperature in Gas Boilers





Control of Return Temperature in Gas Boilers

Savings



District Heating considerations

Middelafkølingen for vores specifikke hus med nat- og dagsænkning:

Uden returtemperaturbegrænsning: 39.3 gr. C
Med returtemperaturbegrænsning: 39.8 gr C

Det årlige forbrug er på 29 MWh.
Afkølingskrav på 34 gr C -> Mindre end 100 DKK årlig besparelse

Conclusions

- **Annual savings less than 1% (actual case)**
- **Return temperature control have a tendency to reduce indoor temperature**

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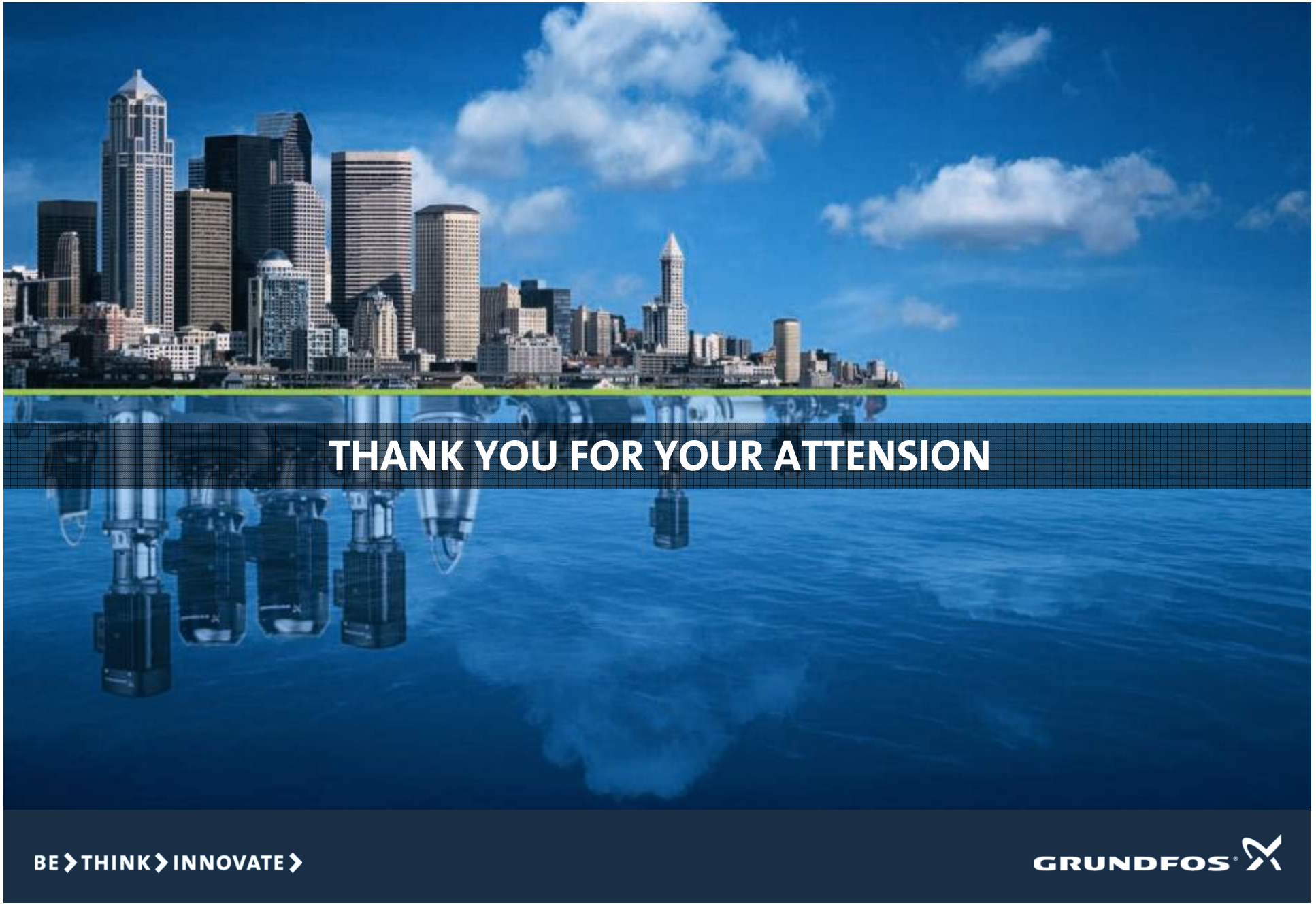

THANK YOU FOR YOUR ATTENSION

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