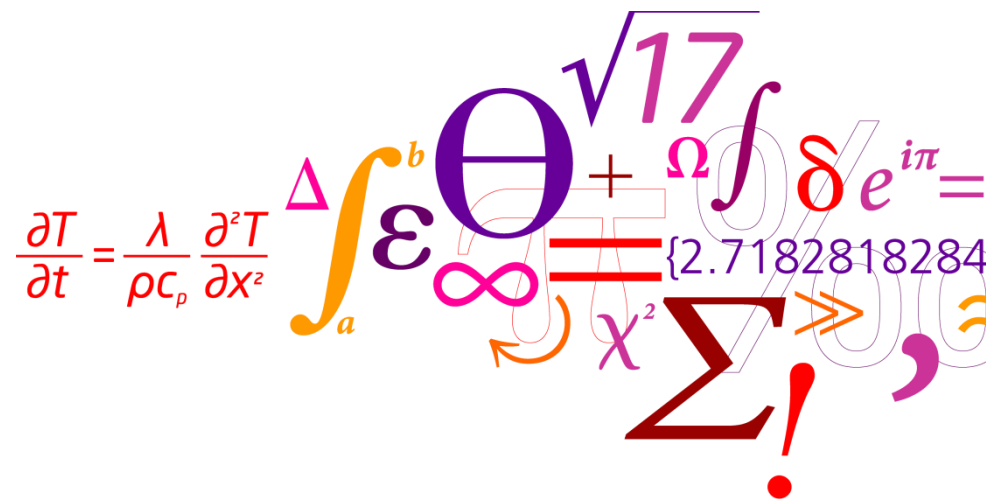


Supply of domestic hot water at comfort temperatures without Legionella

- Case study on electric tracing vs. circulation system of multi-storey buildings

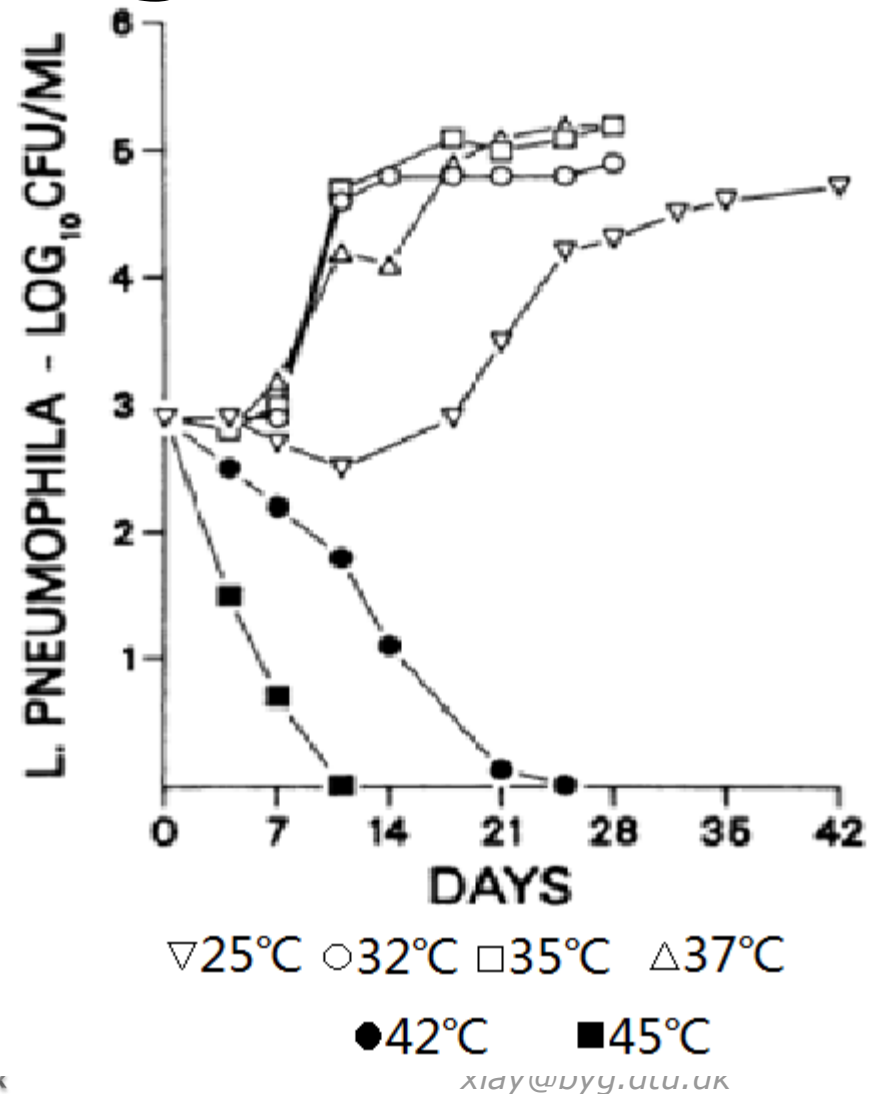
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Background of Legionella

- Incubated at 35°C
- Multiplied from 25-37°C
 - Average doubling time at 37°C is 28.8 hours
- Inhibited at 42°C and 45°C



Temperature regulations today

- For small system* without circulation no temperature requirements
 - *a volume <3L in pipe between heater outlet and draw off point
 - W551
- For large volume systems, a minimum temperature of 55°C is required unless tapping
 - DS/CEN/TR 16355

Potential solutions for large buildings

1. For exist building:

- Keep high DHW temperature at 55°C
- Sterilization methods (thermal treatment, chemical treatment, UV treatment, Micro filtration

.....

2. For renovated and new buildings

- Flat station
- El-tracing

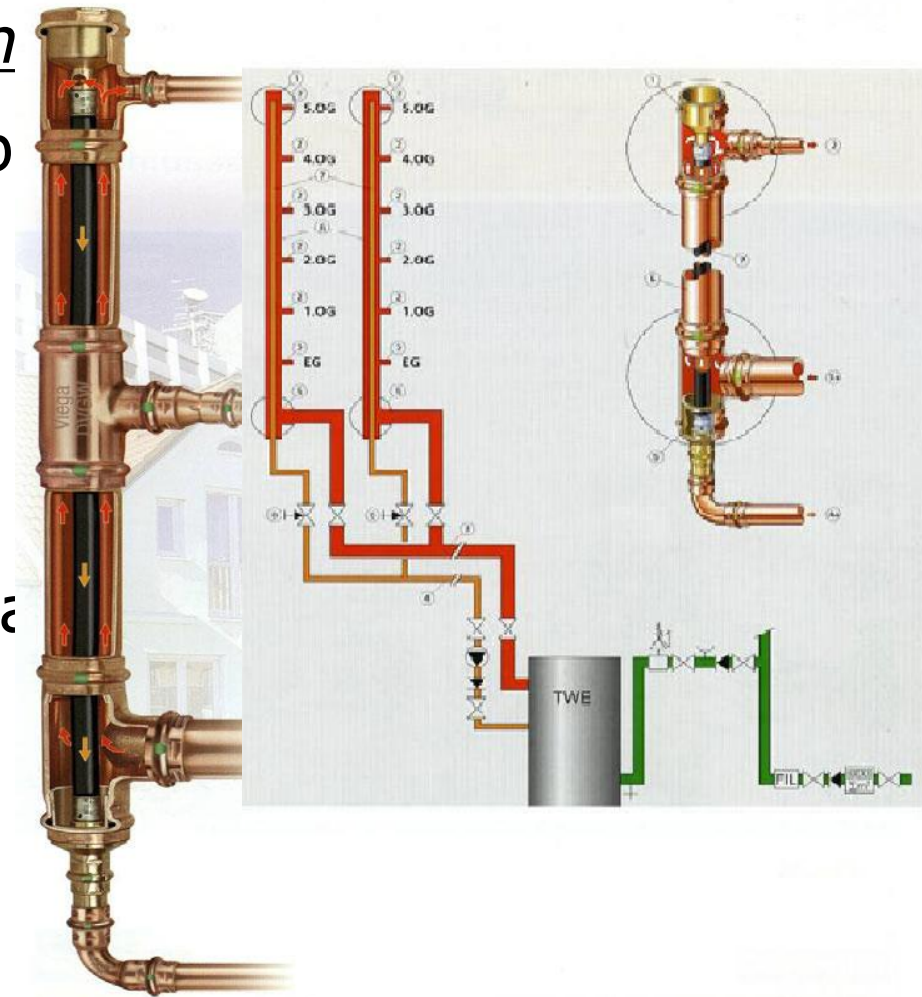
Comparison between system with circulation and EI-tracing

1. Pipe-in-pipe circulation

- Internal-circulation pipe
- External- DHW supply

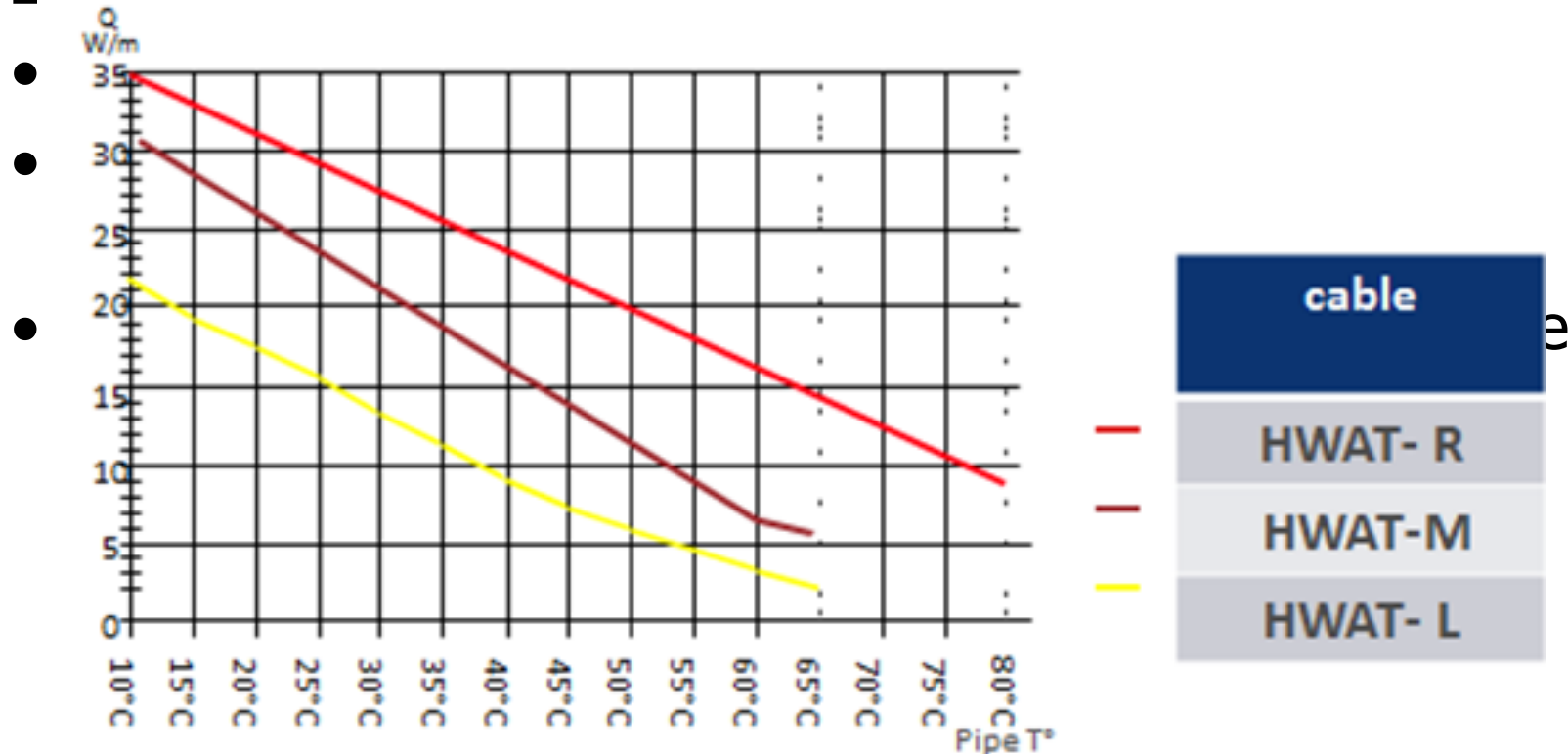
Advantages:

- Easier installation (one pipe)
- Requires less space than conventional circulation system
- Less heat loss



Comparison between system with circulation and EI-tracing

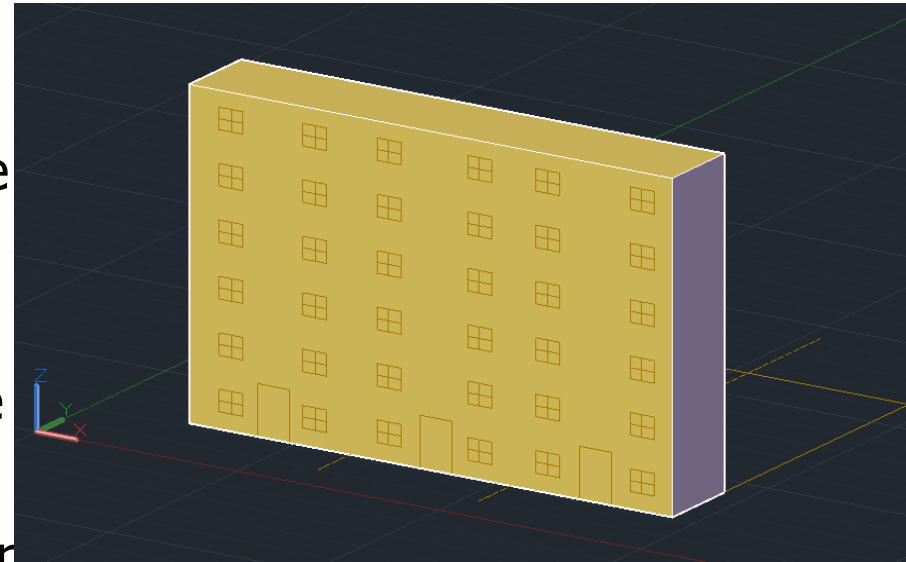
2. Electric tracing



Note: pipe material needs to be considered

Case study for a 6-storey building

- Building/system information
 - 2 apartments/floor/staircase
 - 6 floors each staircase
 - 3 staircases
 - Horizontal pipe length in the basement: 20m
 - Distribution pipe length/floor :36m
- Designed temperatures
 - 55°C in the pipe without tapping
 - 45°C during peak load
 - 60°C at the tank outlet
 - 10°C for basement and ground floor, 20°C for 1st~5th



Pipe-in-pipe circulation

- Dimension for the system

	Basement 1	Basement 2	Ground floor	1st floor	2nd floor	3rd floor	4th floor	5th floor
Inside pipe diameter (m)	0.012	0.014	0.012	0.012	0.014	0.014	0.014	0.014
Outside pipe diameter (m)	0.042	0.054	0.042	0.042	0.042	0.042	0.042	0.035
Heat loss coefficient Φ [W/m]	11.172	11.173	11.172	11.172	11.172	11.172	11.172	9.970

– Pipe insulation is according to DS452

- Heat loss

Annually

Total heat loss for pipes	22718	kWh/year
Heat loss for hot water tank	1787	kWh/year
Total heat loss for building	24505	kWh/year
Heat loss per apartment	681	kWh/year

Electric tracing

- Dimension for the system

	B 1	B2	Ground floor	1st floor	2nd floor	3rd floor	4th floor	5th floor
Pipe diameter (m)	0.028	0.035	0.028	0.028	0.022	0.022	0.022	0.018
Heat loss coefficient Φ [W/m]	8.366	9.544	8.366	10.221	8.824	8.824	8.824	7.867

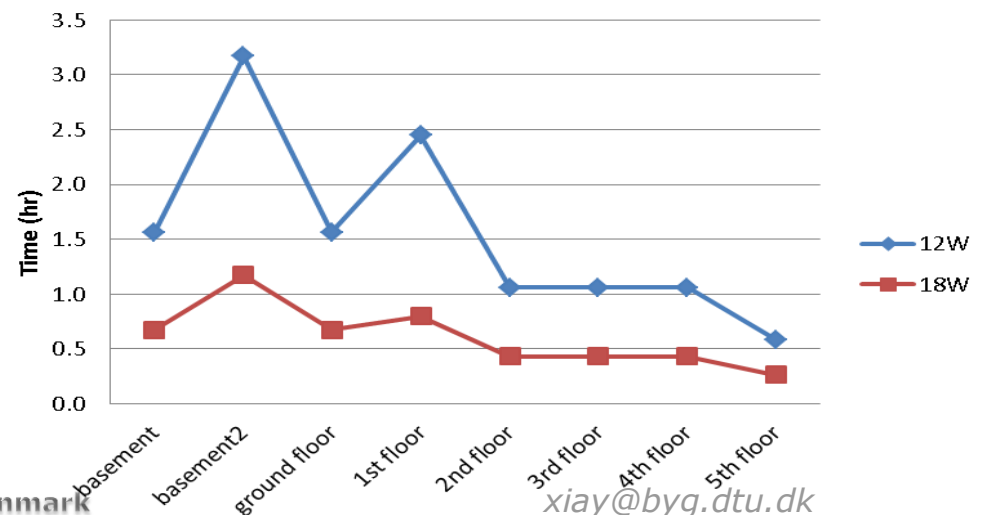
– Pipe insulation is according to DS452

- Power of the cable

– 6W, 12W, 18W are analyzed for heating up DHW from 45°C to 55°C

– 6W is unable to fulfill the heat demand

– 12 W is selected



Electric tracing-different control methods

Assuming 0 am. to 6 am. no tapping happened, the power of el-tracing can be regulated by on/off switch.

1. Full-power-always control

- El-tracing run with full power all the time

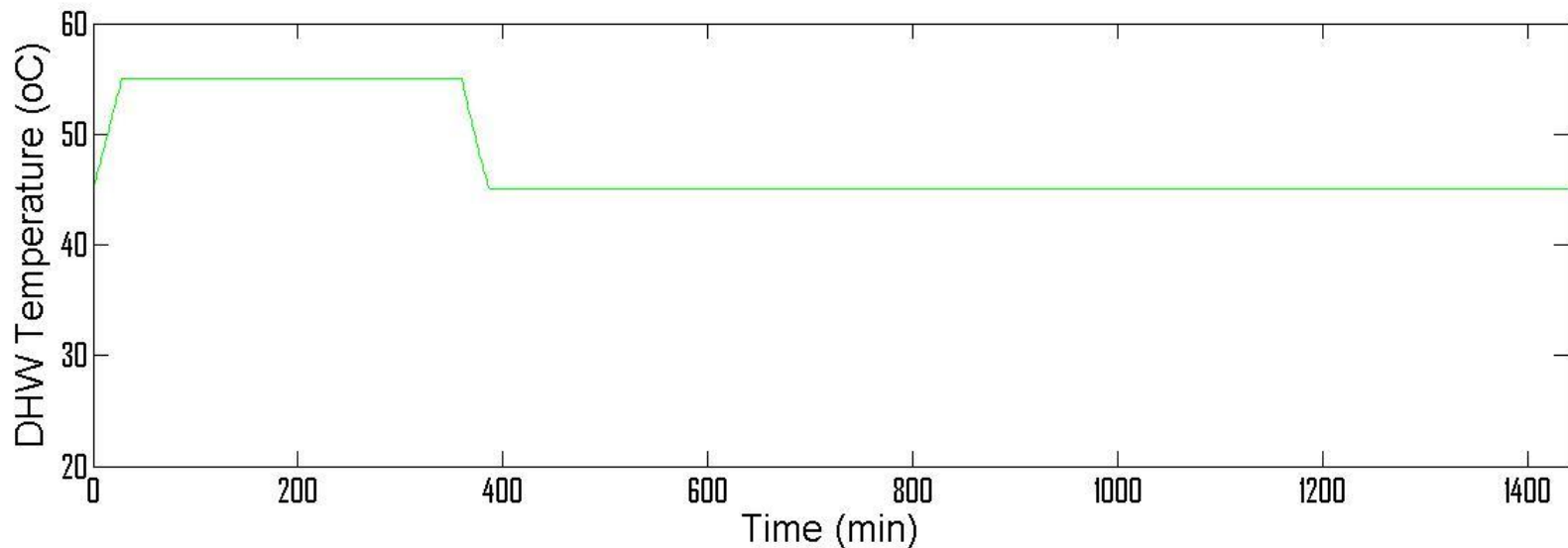
(assuming hot water flowing all the time with high flow rate)

- The electricity consumption could be much larger than real case
- The worst situation

Electric tracing-different control methods

2. continuous tapping control

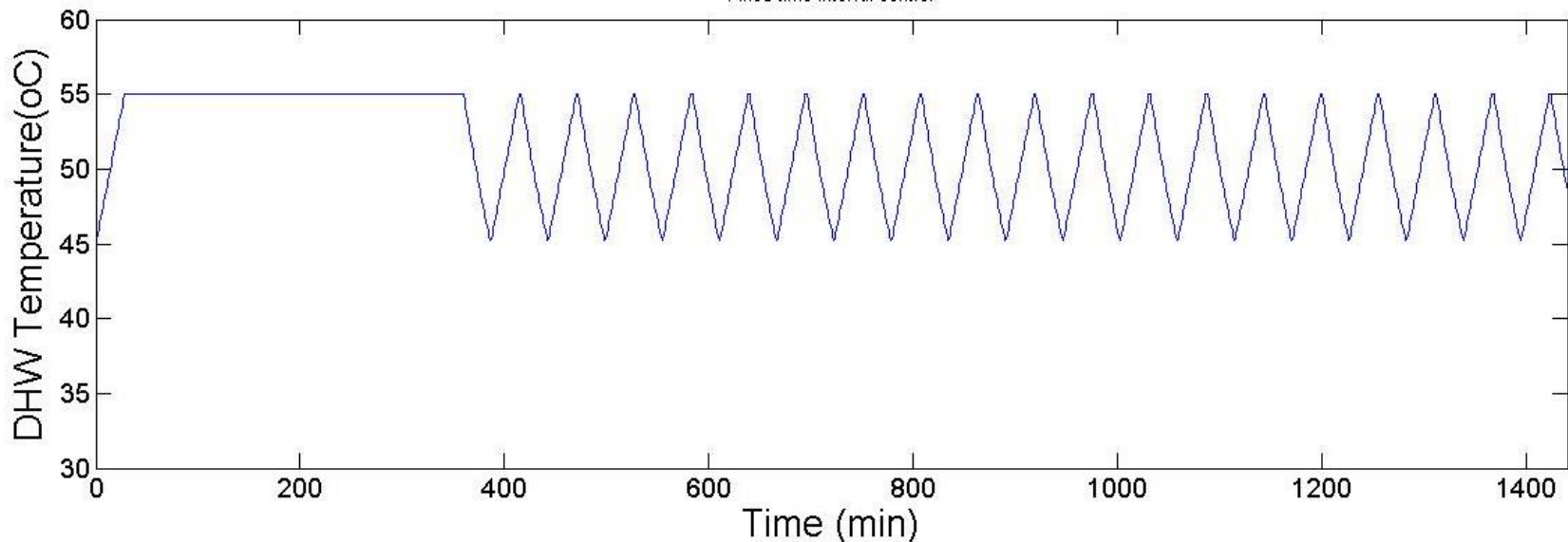
- From 0.am to 6.am, the DHW was first heated up to 55 °C and then kept at this level until the first tapping.
- During the heat-up period, the el-tracing is operated with full power, afterwards, the average power is adjusted to only cover the heat loss (maintain hot water at 55°C)
- After 6.am the el-tracing is switched off.



Electric tracing-different control methods

3. fixed-time-interval control

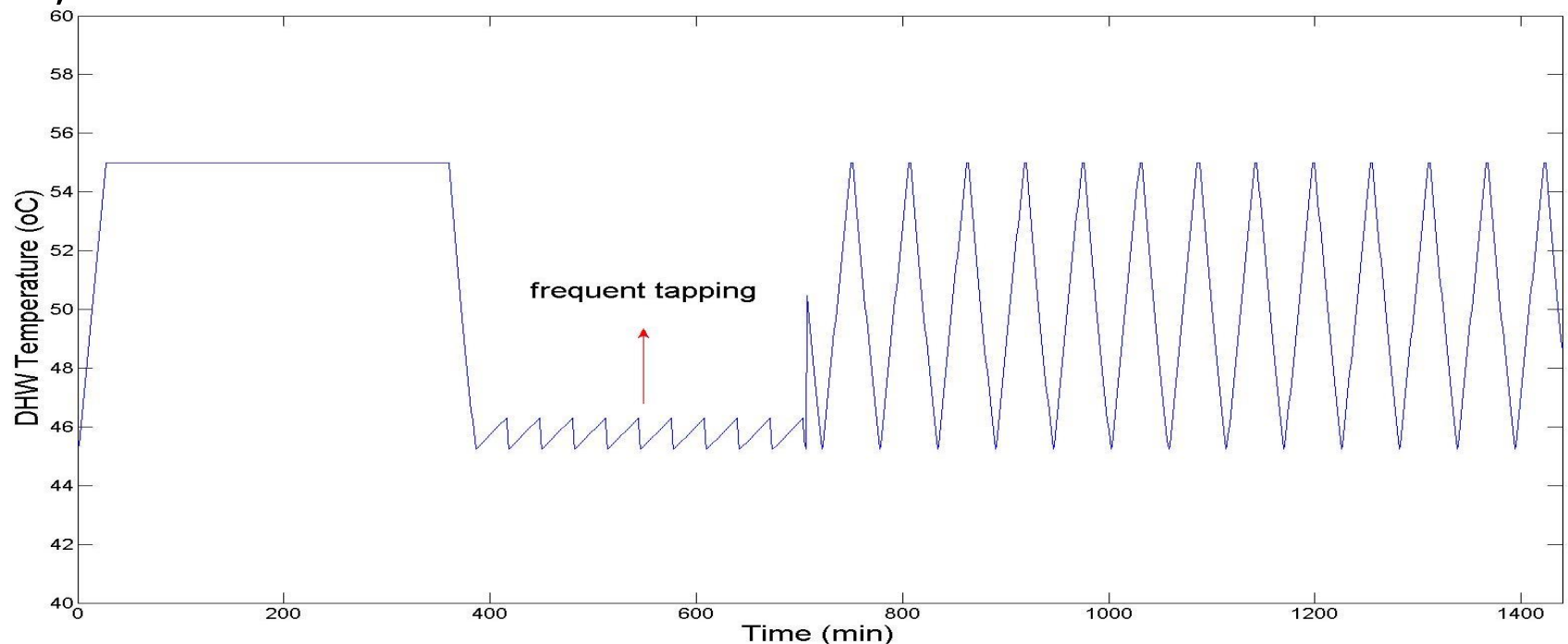
- From 0.am to 6.am, same control as continuous-tapping
- After 6.am heat up water by fixed time interval
- Switch on the el-tracing as soon as the water temperature reaches 45°C



Electric tracing-different control methods

4. Smart control

- From 0.am to 6.am, same control as continuous-tapping
- After 6.am heat up water with full power
- Switch off the el-tracing if there's tapping
- If there's no frequent tapping, switch off when DHW get 55 °C, and restart when 45°C



Electric tracing-different control methods

Annual results for different control methods

Entire building	Ideal situation	Smart control	Fixed control	Full power always
Energy used for heating	1424	<	<	kWh/year
Energy used for heat loss (55)	3391	<	<	kWh/year
Sum of energy use for entire building	4815	<	<	24808 kWh/year
Energy use for heat loss per each apartment	94	<	<	kWh/year
Energy use for each apartment	135	<	<	689 kWh/year

Heat loss for pipe-in-pipe circulation: 681 kWh/year

Benefit of EI-tracing

- **Give possibility to the DH system to supply with low temperature at 55°C**
- **Protect safe supply without risk of legionella**
- **Save the expense of circulation loop**
- **Reduce the pipe dimension of DHW supply**
- **Compare to the conventional system, EI-tracing can save up to 85% (94/681) heat loss if controlled properly**
- **User pattern has strong effects on the control method**
- **.....**

THANK YOU!

