4th Generation District Heating – Third Annual Conference, Aalborg

Low temperature and summer operation

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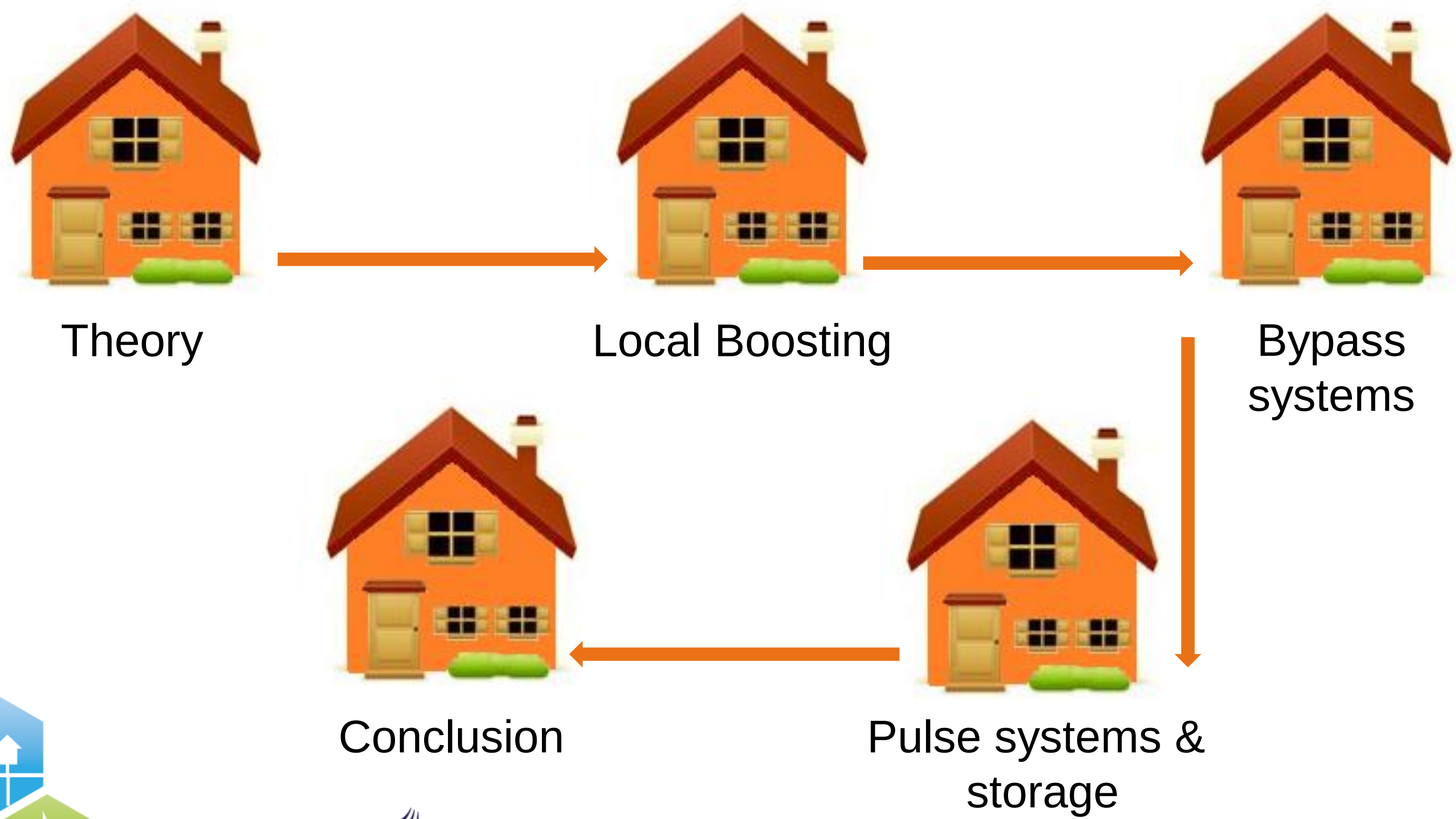
Outline



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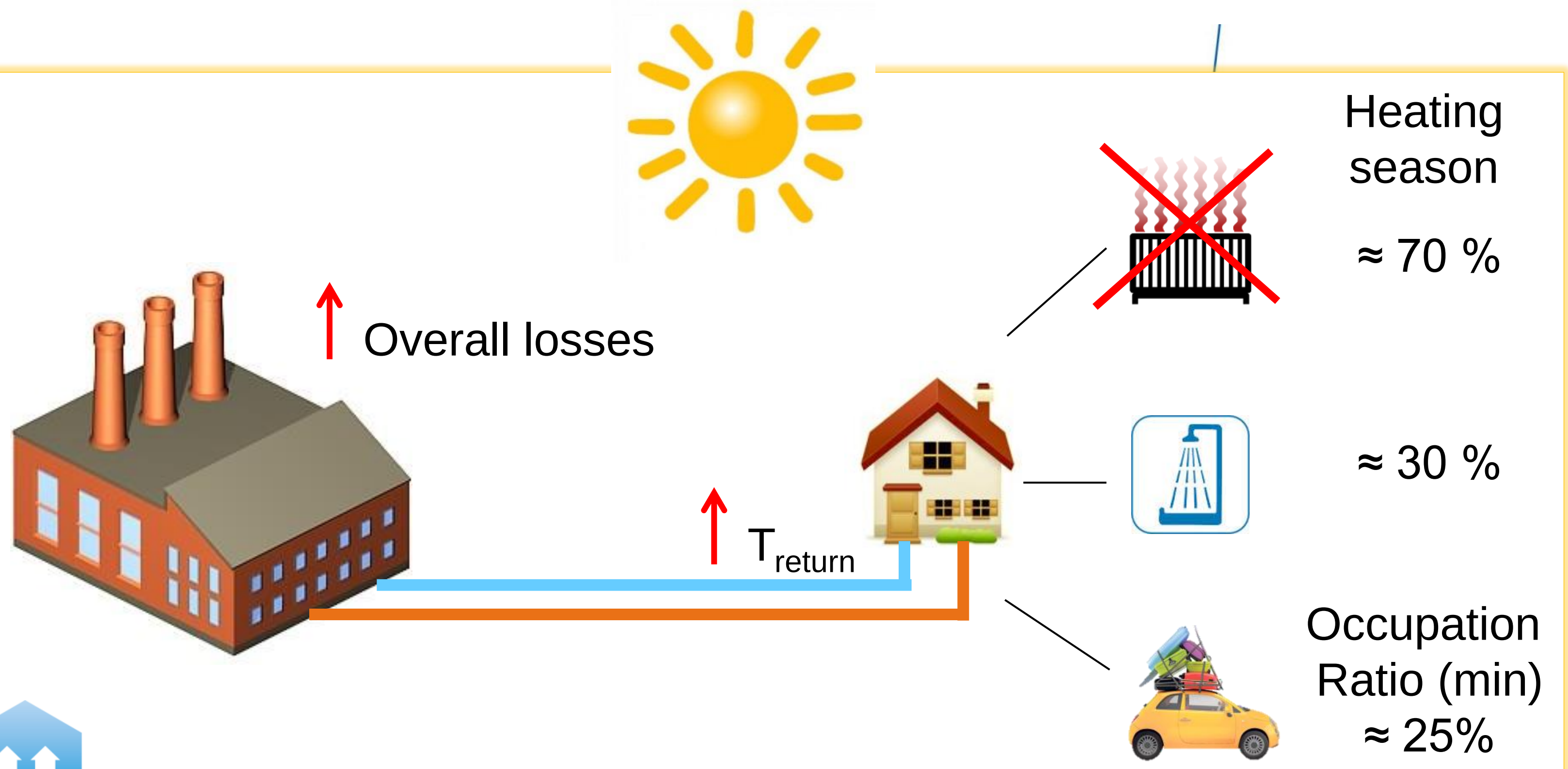
Summer operation I – The challenge



Sources: Dalla Rosa & Christensen, 2011; Tol & Svendsen, 2012

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Summer operation II – an example

<u>Case study from literature:</u>

- ≈ 150 low energy houses (2 occupants)
- Low temperature network
- Danish conditions

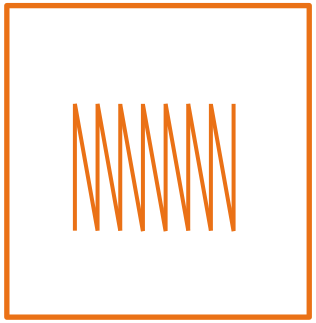
	October - April	May - September
Heat demand	423.7 MWh (84 %)	78.6 MWh (16 %)
Average heat losses	13 %	30 %
Heat losses	53.2 MWh	24.7 MWh

Source: Dalla Rosa & Christensen, 2011

The measures - overview

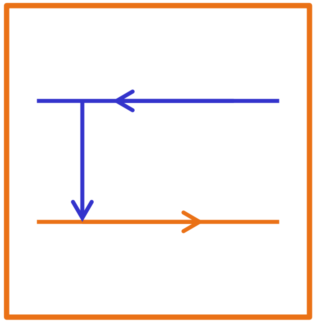
=> Securing instant and stable heat supply by:

1)



Local boosting

2)

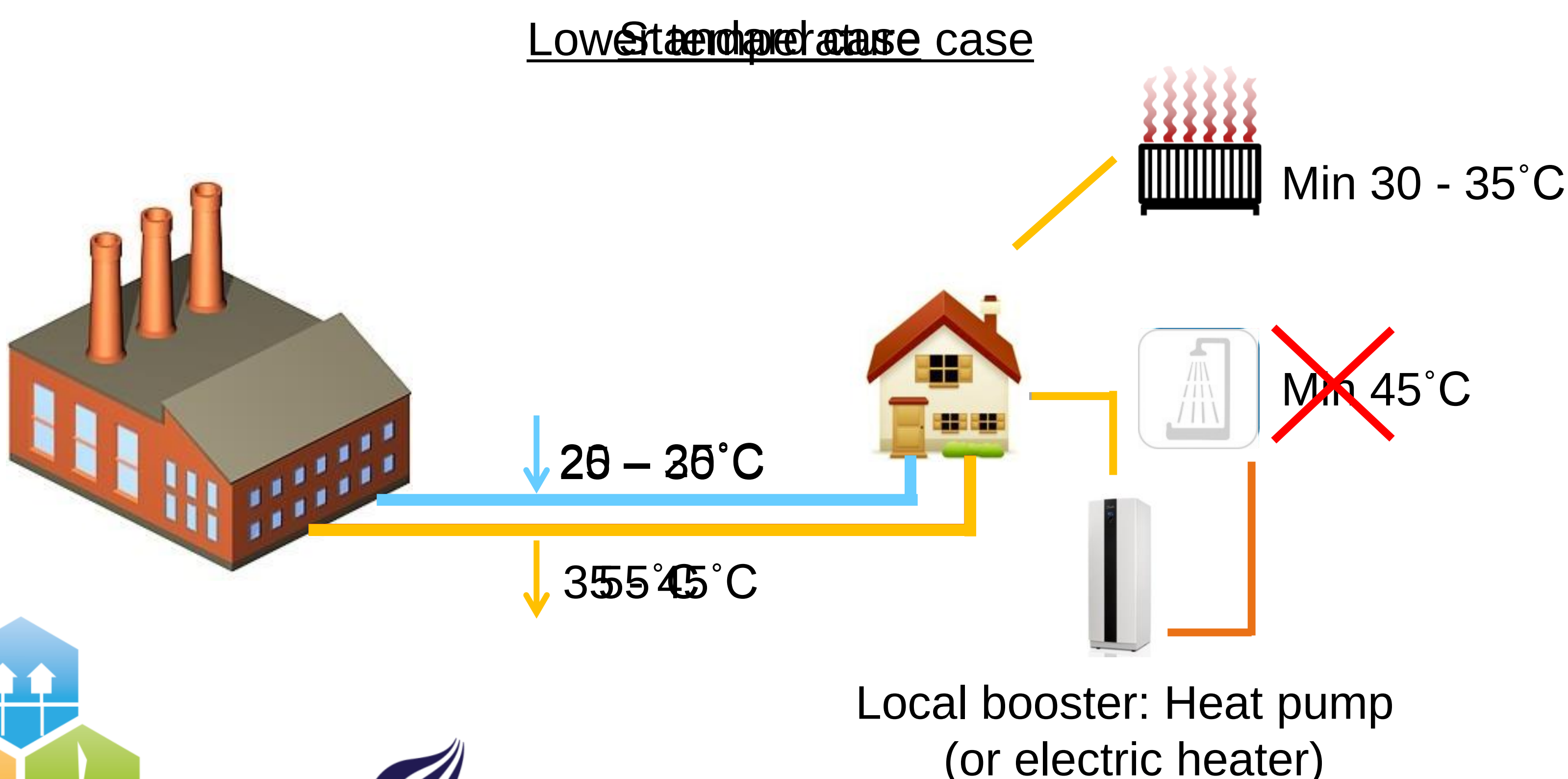


Bypass systems

3)

Pulse systems
& storage

Local Boosting – Theory I



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Local Boosting – Theory II

Components:

a) Heat pump + storage

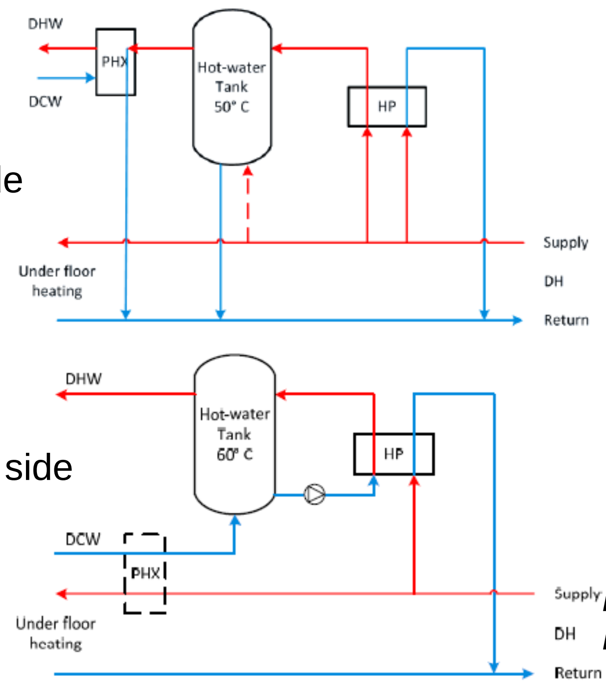
or

b) Electric heater

Integration:

a) Primary side (45-50˚C)

b) Secondary side (55-60˚C)



Sources:

1) New plants for distribution of hot water (35°-45°C)
2) Return water from DH system
3) Waste heat from industrial processes
4) Geothermal heating
5) Solar heating
6) Etc.

DCW=Domestic cold water
PHX=Plate heat exchanger

Source: Markussen et al., 2013

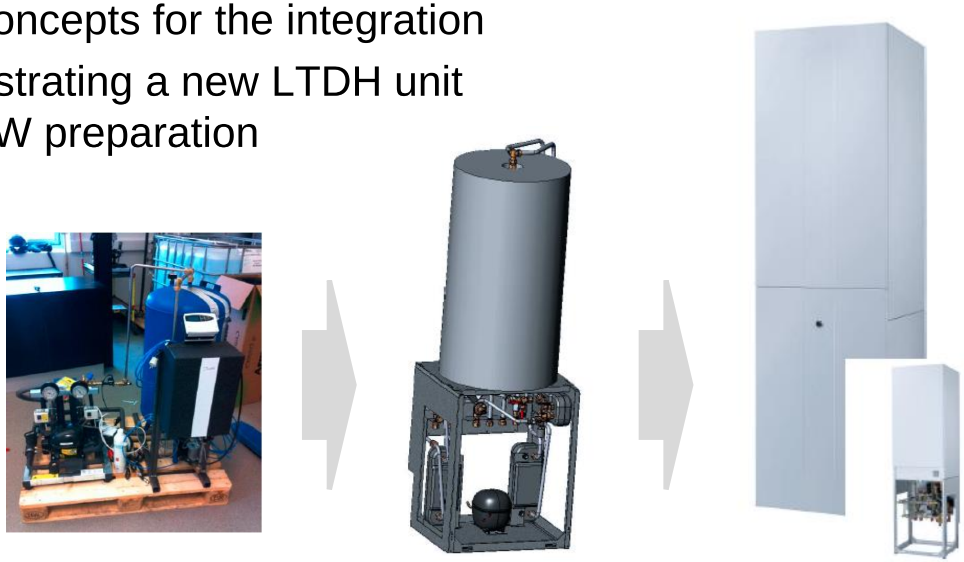
Local Boosting - Status

EUDP research project *"Heat Pumps for Domestic Hot Water Preparation in Connection with Low Temperature District Heating"*:

- focussed on individual single-family houses (output 500 – 1000W_{th})
- investigated various system concepts for the integration
- aim of developing and demonstrating a new LTDH unit with an intregrated HP for DHW preparation
- succesfully concluded in 2013

New EUDP project launched:

- Ongoing from 2014 to 2016
- Focus on integration of electric heater



laboratory setup   product draft   final product

Source: Zvingilaite et al., 2013

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Local Boosting – Experiences I

General results EUDP Project:

- Demonstration project successfully implemented in Birkerød north of Copenhagen (operational 1 year from spring 2013)
- Best configuration directly connected system with HWT on the primary side => no legionella problems and high exergetic efficiency
- Improved conversion efficiency at CHP plants due to the lowered return temperature less relevant => System integration with selected heating source more important
- Combined DH and electric water heater is a competing technology from cost perspective, Heat pump is more cost-effective with higher hot water consumption and low DH prices
- Future reduction of investment costs of the micro-booster HP system desirable

Source: Markussen et. al. 2013; Zvingilaite et al., 2013

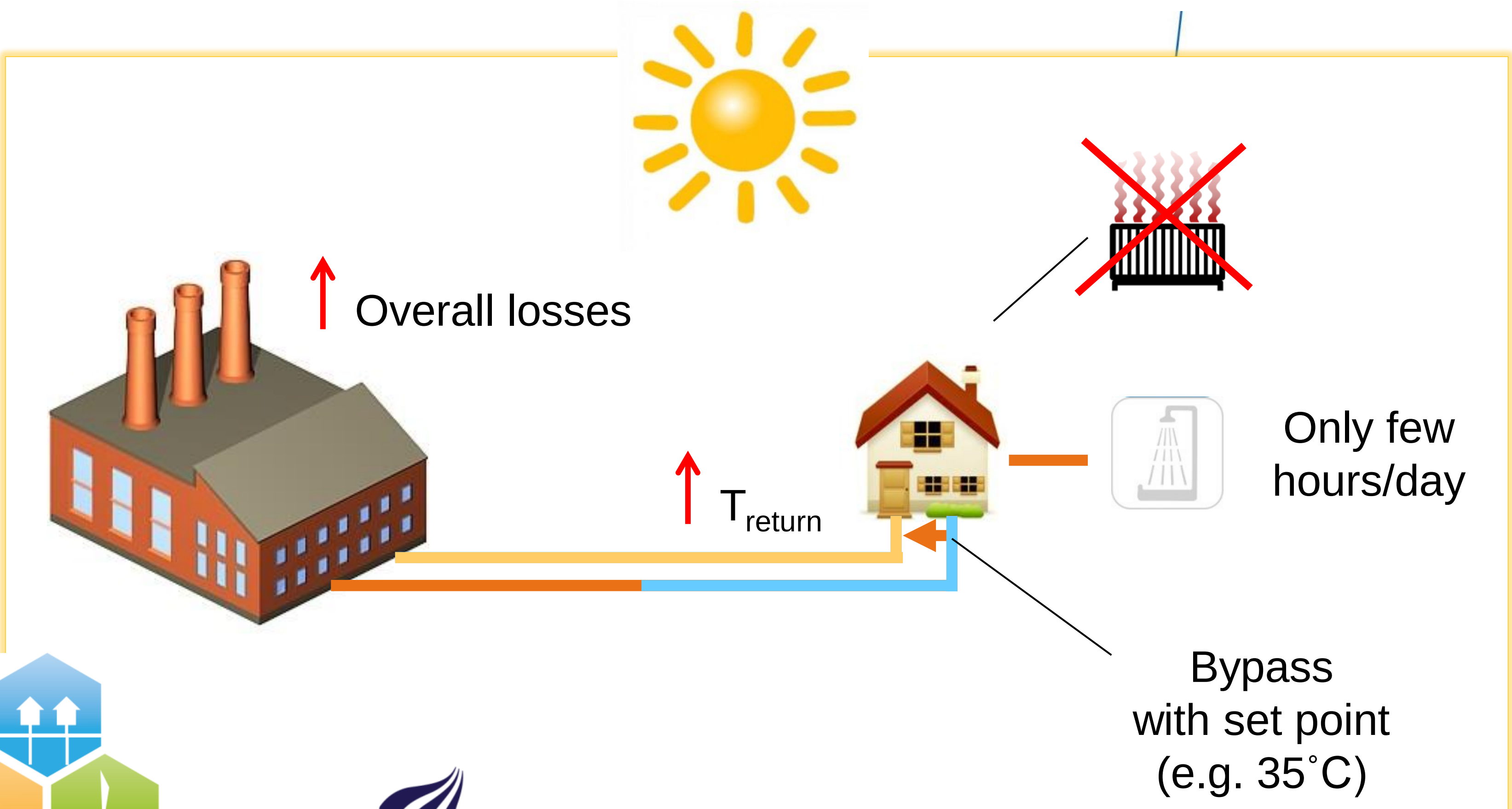
Local Boosting – Experiences II

Performance results of EUDP project:

- 7% increase of overall electricity use
- COP of HP between 4.5 and 4.8

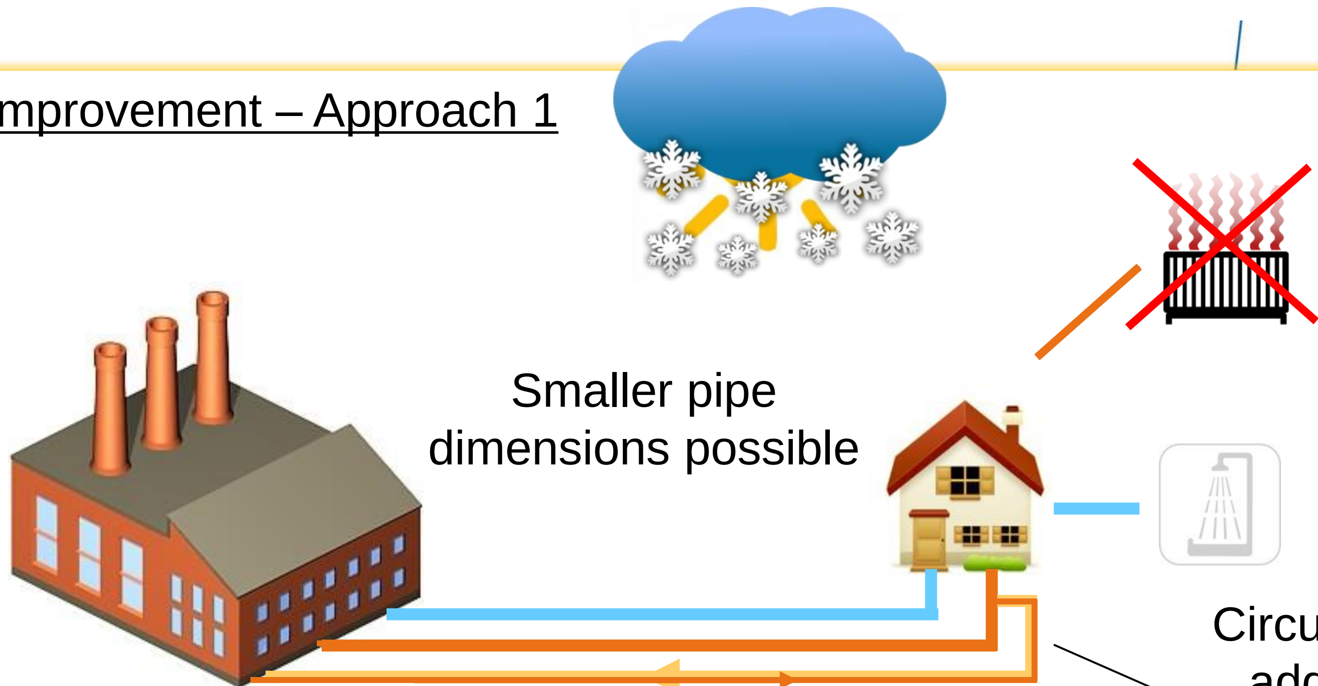
Source: Markussen et al., 2013

Bypass - Theory I



Bypass - Theory II

Improvement – Approach 1



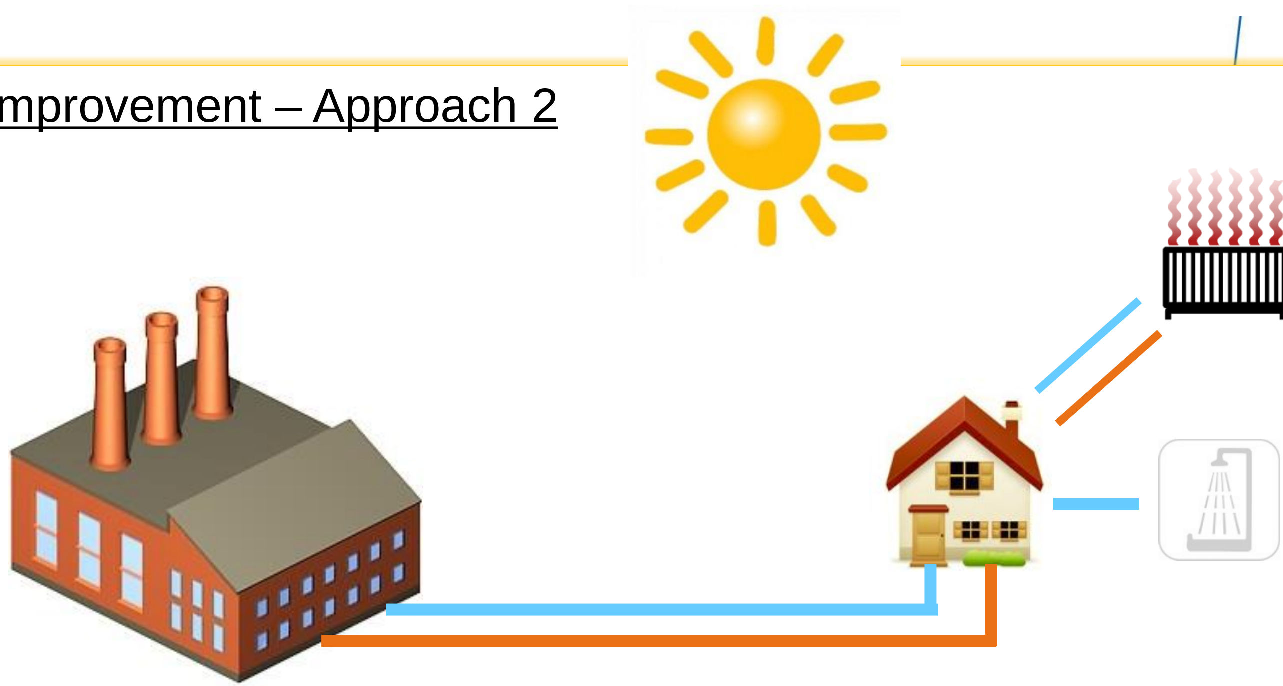
Circulation in additional pipeline

Possible adaption: usage as 2nd supply pipe in winter

Source: Li et al., 2010

Bypass – Theory III

Improvement – Approach 2



Circulation in bathroom floor heating

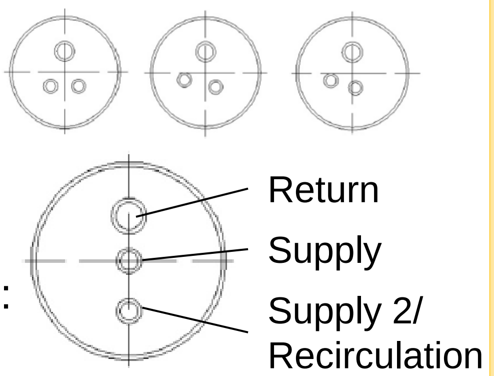
In Scandinavian regions demand also in summer

Source: Brand et al., 2014

Bypass - Status

Approach 1:

- Triple pipe proposed and analysed by (Bøhm & Kristjansson, 2005)
- First prototypes applied in demonstration projects (Bøhm & Frederiksen, 2004), (IEA-DHC Annex VIII, 2008:8DHC – 08-03)
- Optimal design investigated by (Dalla Rosa et al., 2011):
- No commercial products available yet



Approach 2:

- Detailed concept design and model investigation by (Brand et al., 2014)
- Implementation and field studies in preparation

Bypass – Experiences I

Approach 1:

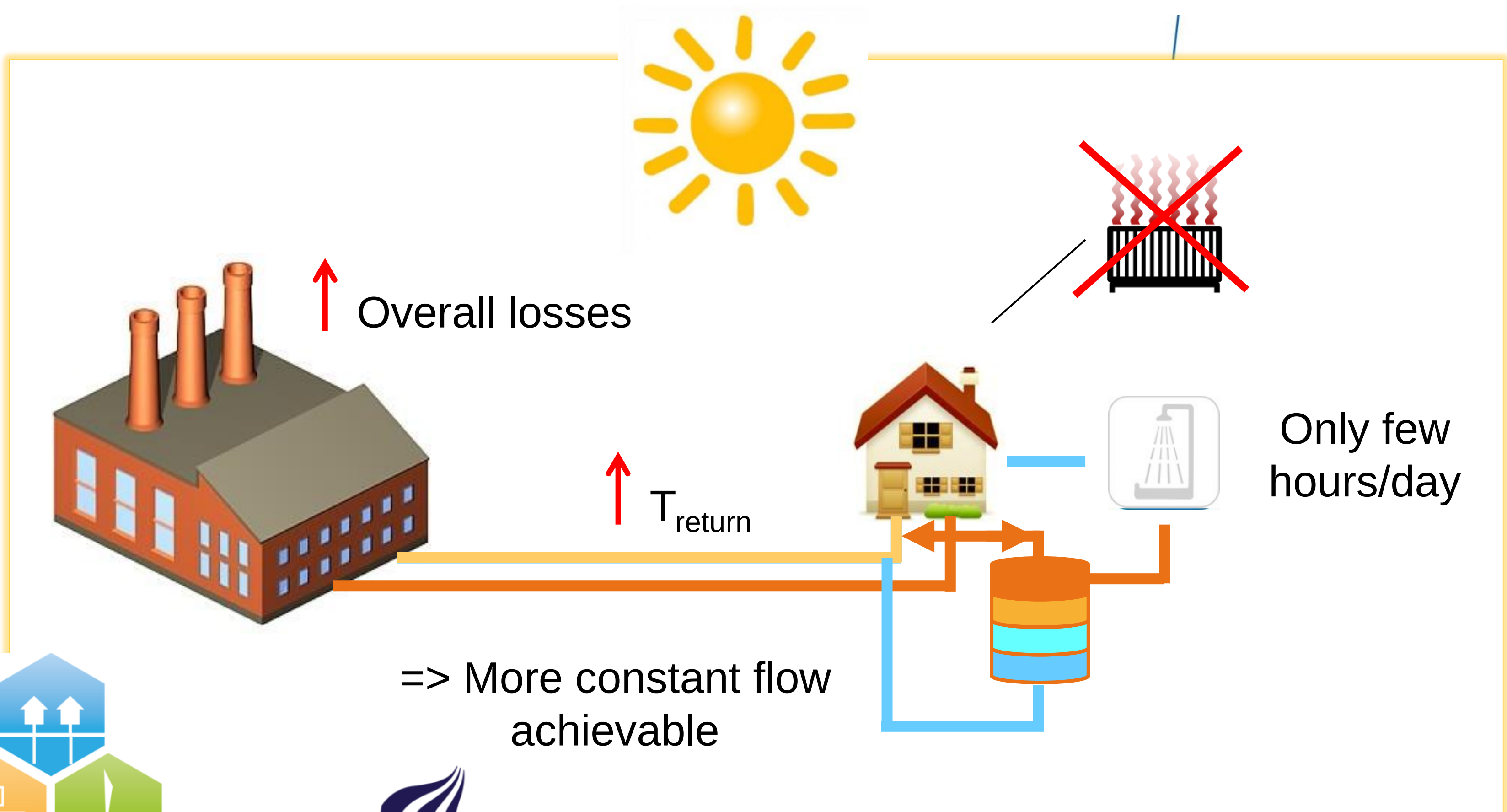
- Modelling of triple service pipes indicated heat loss reduction by 45 % compared to common single pipes and by 24% compared to circular twin pipes. Investment costs reduced by 21% compared to pairs of single pipes, but up to 6% increase compared to twin pipes (Bøhm & Kristjansson, 2005).
- Economical feasibility of the concept compared to twin pipes could not be proven, but might be achievable (Li et al., 2010).
- Modelling comparison with traditional bypass solutions showed a considerable decrease of the return temperature as desired. However, additional heat losses have to be tolerated due to the additional pipe, which was assumed as an extra single pipe (Li et al., 2010).

Bypass – Experiences II

Approach 2:

- Modelling of a case study with promising results (Brand, 2014) :
- Floor temperature increase by approx. 2.2˚C with reduced return temperature from 35˚C in traditional systems to around 24˚C with bathroom circulation
- 13% reduction in heat loss during the non-heating period covering 40% of the SH demand in bathrooms in summer
- Use of the concept is expected to be more beneficial in traditional buildings than in low-energy buildings
- Increased income for utilities by supplying heat that otherwise would be wasted in distribution heat losses
- Cheap solution for end-customers to achieve a higher comfort standard in their houses
- Society benefits from the opportunity to include a larger share of low-grade heat and renewable energy in the heating system

Pulse Systems - Theory



Pulse Systems - Status

Analysis of several studies showed:

- Current research mostly focusses on economic optimization of the integration of heat storage (Verda & Colella, 2011),(Christidis et al., 2012),(Nuytten et al., 2013)
- Optimal storage integration in terms of system heat losses should be investigated
- Increased importance with larger share of fluctuating sources
- Further analysis in the frame of a Phd project planned

Pulse Systems - Experiences

First investigations showed:

- Integration of hot water storages at the building or within the DH increase system flexibilty (Nuytten et al., 2013)
- Storage units often available in houses (Nuytten et al., 2013)
- Analysis of different types of networks showed a slight decrease of heat losses when applying substations having buffer tanks for DHW production (Tol & Svendsen, 2012)
- Further, substations with buffer tanks were found to reduce the pipe dimension of the DH network appreciably and thus, the heat losses from the piping as well (Tol & Svendsen, 2012)

Conclusion

- No ”best” solution available – select the individual best solution from the toolbox
- Combination of several strategies could lead to further improvements, e.g. local booster combined with a bypass system
- Additional equipment
- Trade off necessary between economics and heat losses
- More demonstration projects and real performance data important

Thank you for your attention…

… and hope that you have enjoyed
the great summer

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