
Low temperature networks: Concept, demonstration and guideline

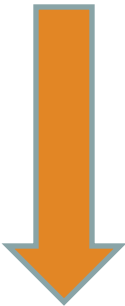
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Background: Development of low-temperature district heating concept, demonstration and guideline

- 3 development and demonstration projects in the period of 2007-2013
- Projects supported by the Danish Energy Agency's Energy Research Program 'EUDP'



- Project consortium:



Fjernvarmens Udviklingscenter
VERKER VIRKSOMHEDER & VIDEN INSTITUTIONER



DTU Civil Engineering
Department of Civil Engineering



TEKNOLOGISK
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- netting solutions



Boligforeningen
Ringgården



Affaldvarme Århus



Høje Taastrup Fjernvarme A.m.b.A.

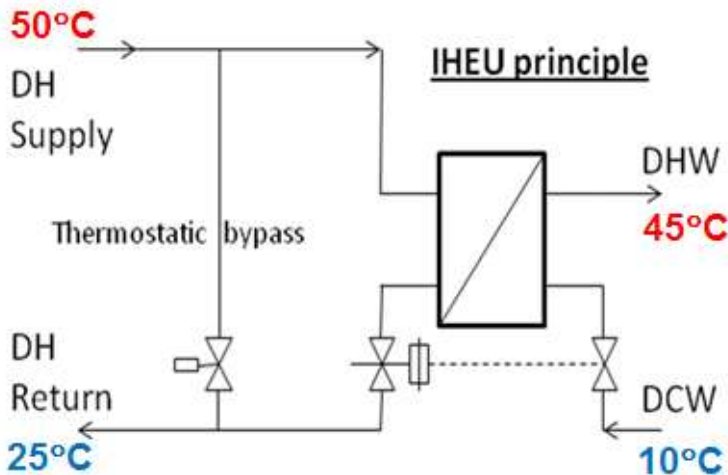
- Guideline

Our definition of low temperature

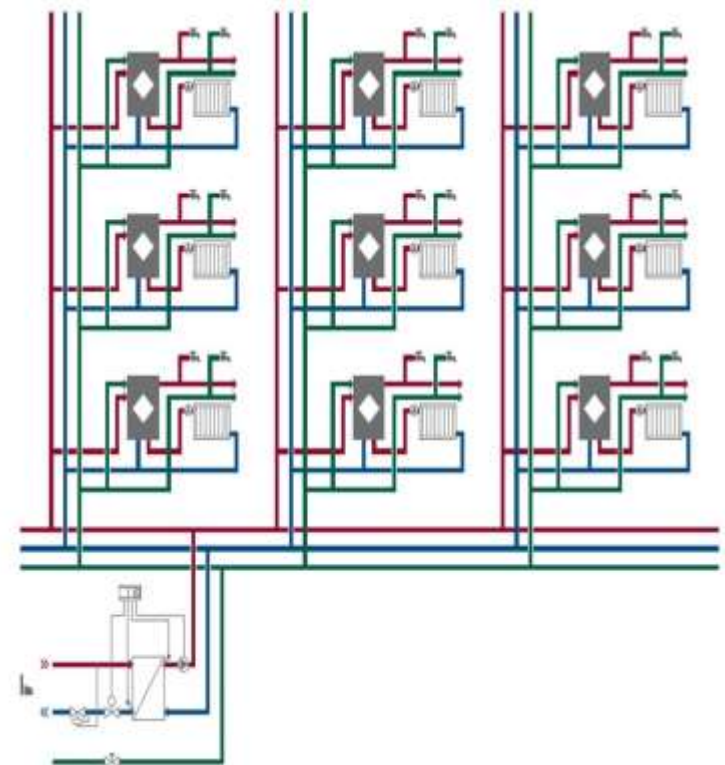
House substation design criteria

- Summer (supply /return) : **50°C/25°C**
- Winter (supply /return): **55°C/25°C**
- Min differential pressure : **0.3 bar**

Single-family houses

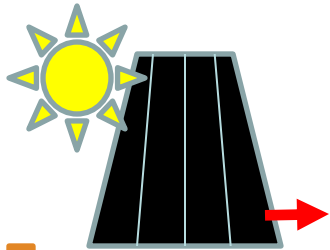


Multi-storey buildings (flat stations)



Why low temperature district heating (LTDH)?

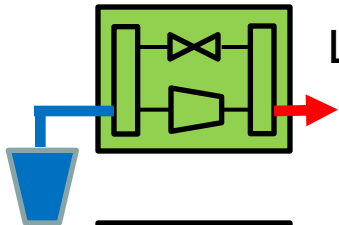
Low temperature renewable heat sources



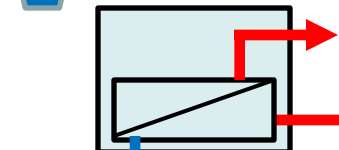
Solar thermal



Surplus heat



Large heat pumps

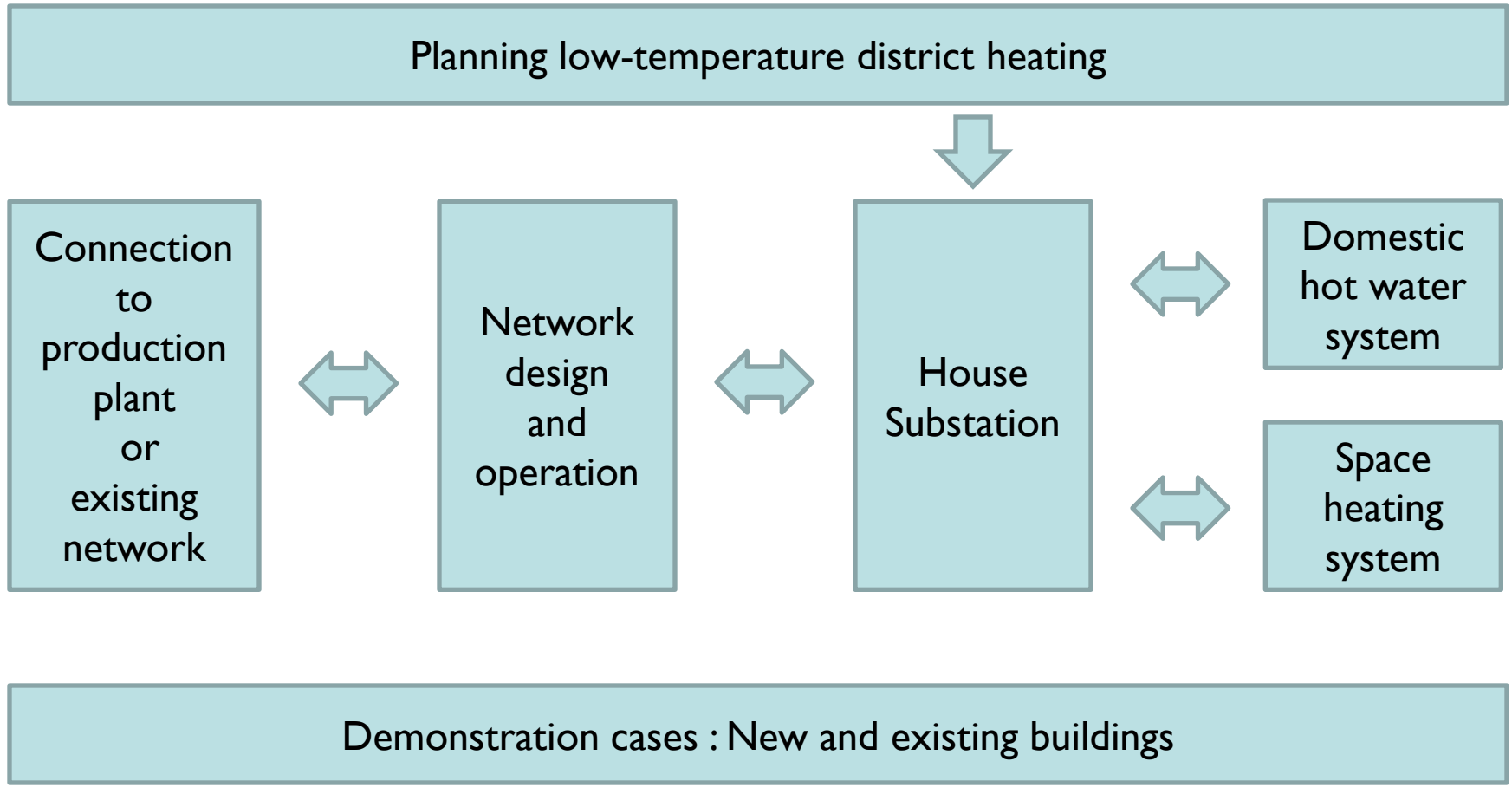


Deep geothermal

Efficient district heating networks for efficient buildings

- Heat demand is decreasing. Energy Performance of Building Directive describes **'nearly zero energy buildings'** from 2020
- **Expanding district heating in Europe** includes going into areas with **lower heat density than before**
- **Stay competitive** with other technologies
- **Long term planning** of reduced supply temperature requires **action now**

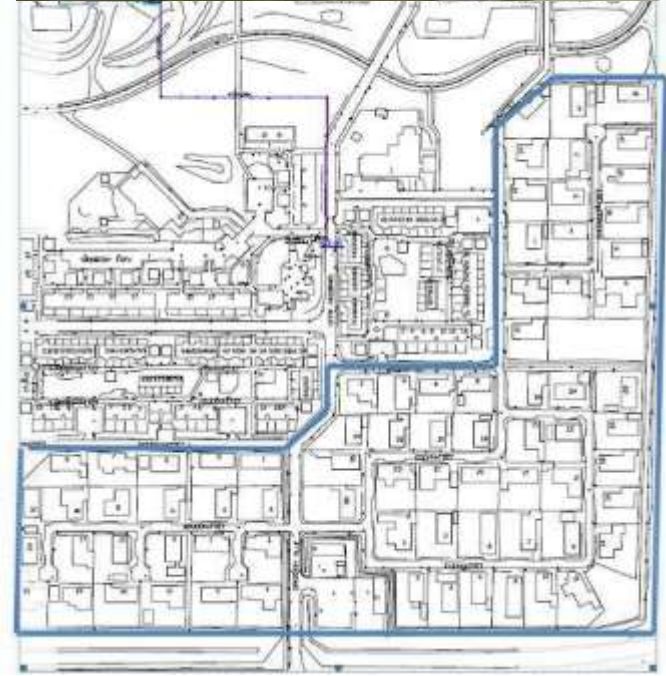
Guideline



Planning LTDH - Sønderby, Høje Taastrup, Denmark

Area with 75 single-family houses from 1997-98:

- Average heated floor area: $\sim 150 \text{ m}^2$
- District heating consumption:
6-20 MWh/year per house
- **Floor heating**
- Existing substations with hot water tank



Old network:

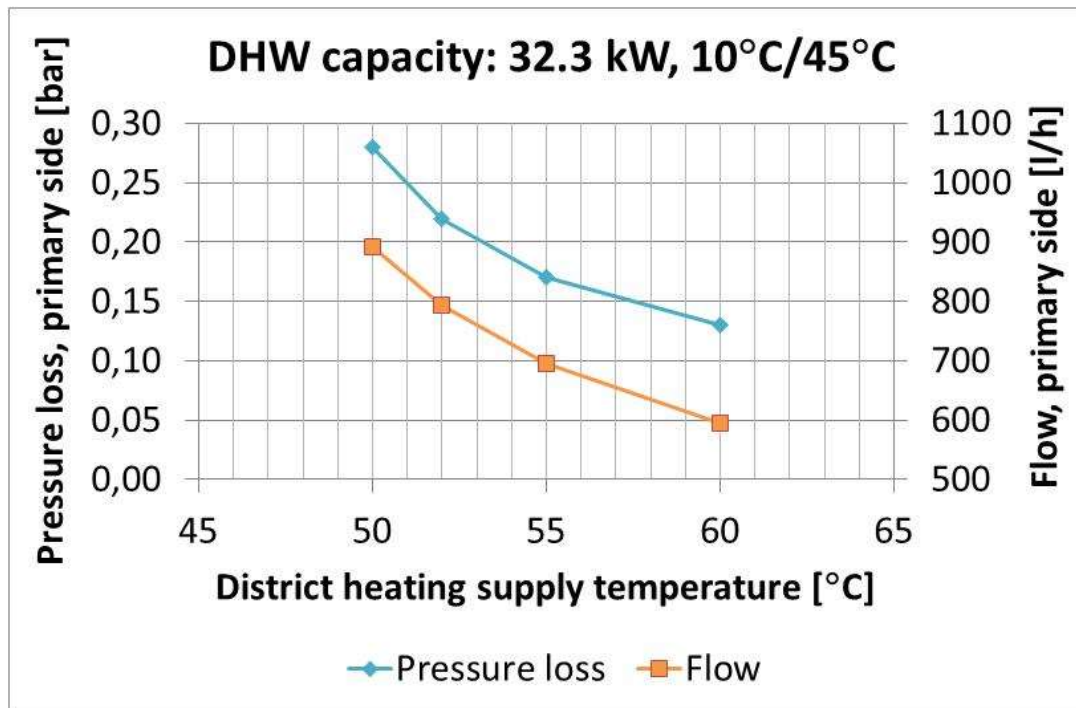
- **Sub-net owned by the house owners**
- **Connected to utility through heat exchanger**
- District heating **supply temperature: 70-75°C**
- **Single street*** and service **pipes**** (Pex)
- **Large network heat loss (43%)**

* $\lambda=0.038 \text{ W/mK}$, without diffusion barrier (measured by DTI)

** $\lambda \sim 0.030\text{-}0.032 \text{ W/mK}$, without λ diffusion barrier (standard technology of that time)

House substation - Sønderby, Høje Taastrup, Denmark

- New instantaneous water heat exchanger design
- In-direct connection for space heating



Network design - Sønderby, Høje Taastrup, Denmark

- Twin pipes, Series 2 or 3
- Highly-efficient PUR insulation, $\lambda = 0.023 \text{ W/(mK)}$
- Cell gas diffusion barrier
- Diffusion-tight flexible carrier pipe (for Alu-Pex)



Pipe type	Pipe dimension (D1-D2/D3) [mm]	Insulation class	Pipe function	Pipe length [tracé m]
Twin alu pex	20-20/125	Serie 3 *	Service pipes	1107
Twin steel DN20	26,9-26,9/140	Serie 2 konti **	Street pipes	501
Twin steel DN32	42,4-42,4/180	Serie 2 konti **	Street pipes	483
Twin steel DN40	48,3-48,3/180	Serie 2 konti **	Street pipes	220
Twin steel DN50	60,3-60,3/225	Serie 2 konti **	Street pipes	112
Twin steel DN65	76,1-76,1/250	Serie 2 konti **	Street pipes	104
Total				2527



**Steel DN50
60-60/225 mm**

* $\lambda=0.022 \text{ W/mK}$, with diffusion barrier

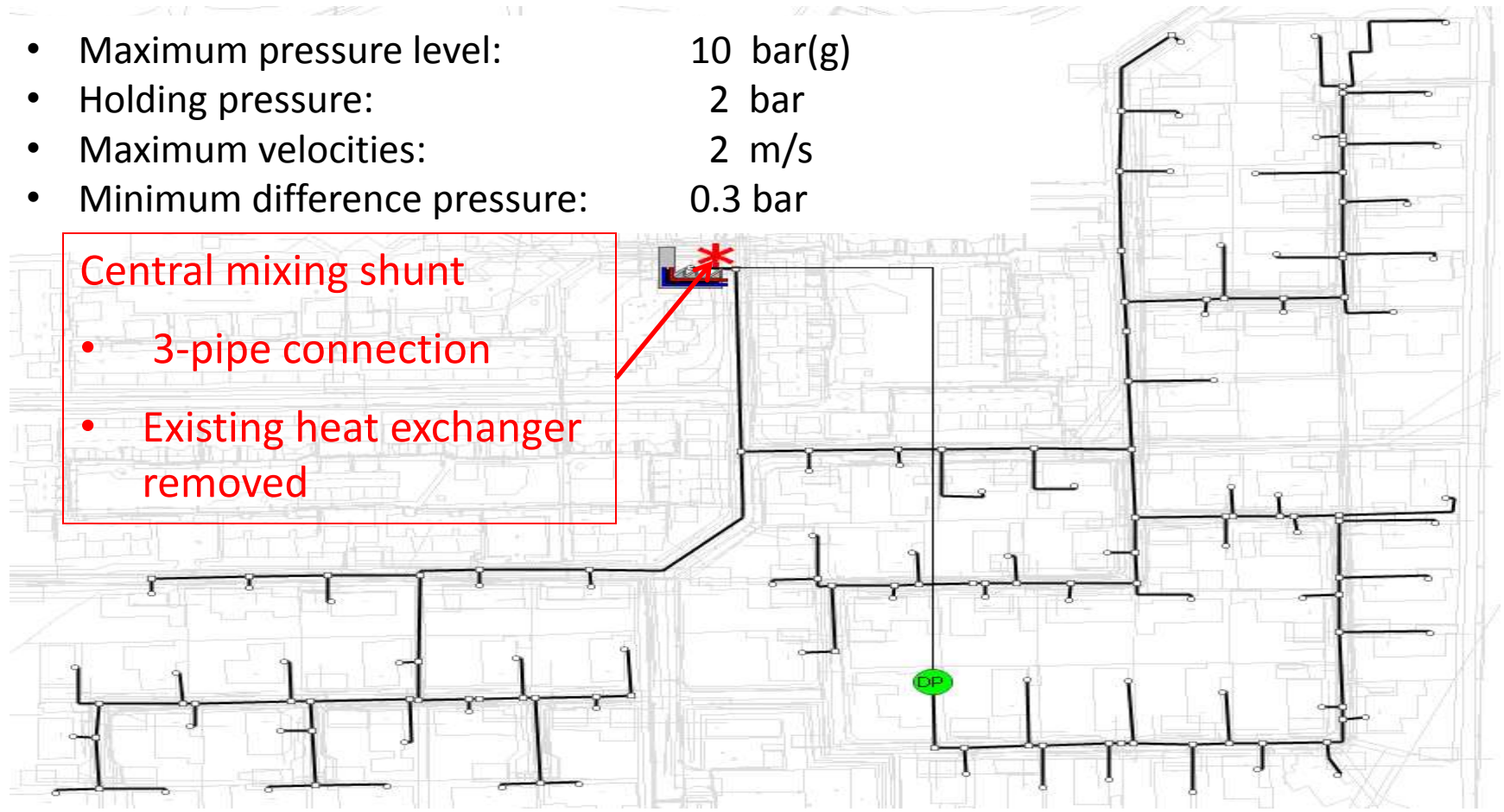
** $\lambda=0.023 \text{ W/mK}$, with diffusion barrier

Network design - Sønderby, Høje Taastrup, Denmark

- Maximum pressure level: 10 bar(g)
- Holding pressure: 2 bar
- Maximum velocities: 2 m/s
- Minimum difference pressure: 0.3 bar

Central mixing shunt

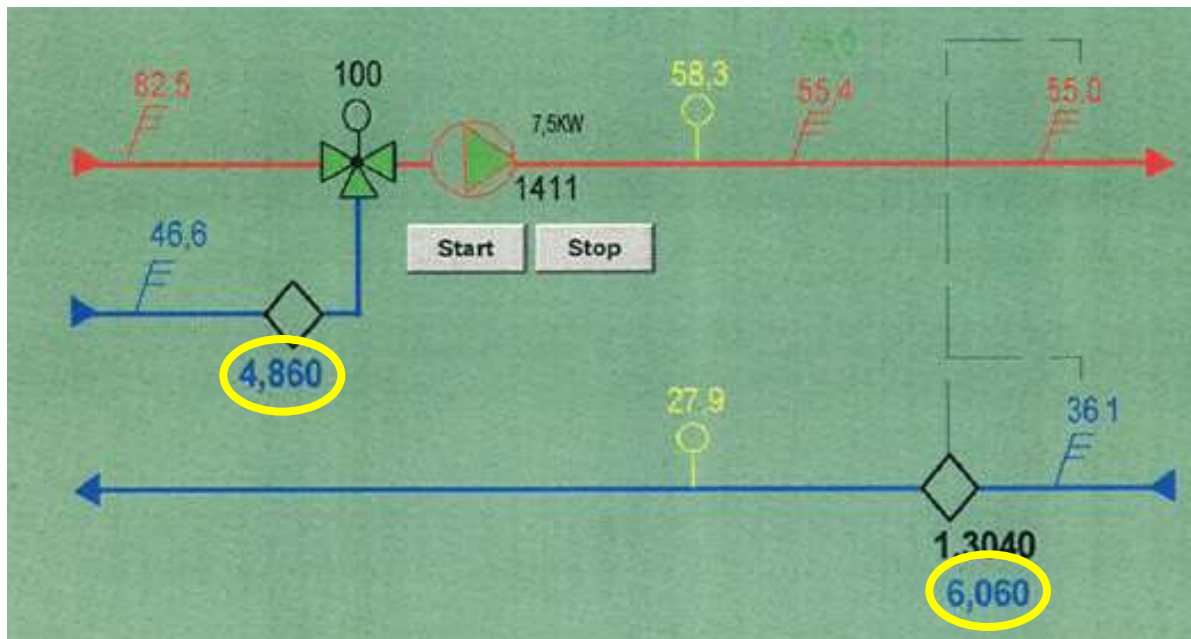
- 3-pipe connection
- Existing heat exchanger removed



Connection - Sønderby, Høje Taastrup, Denmark

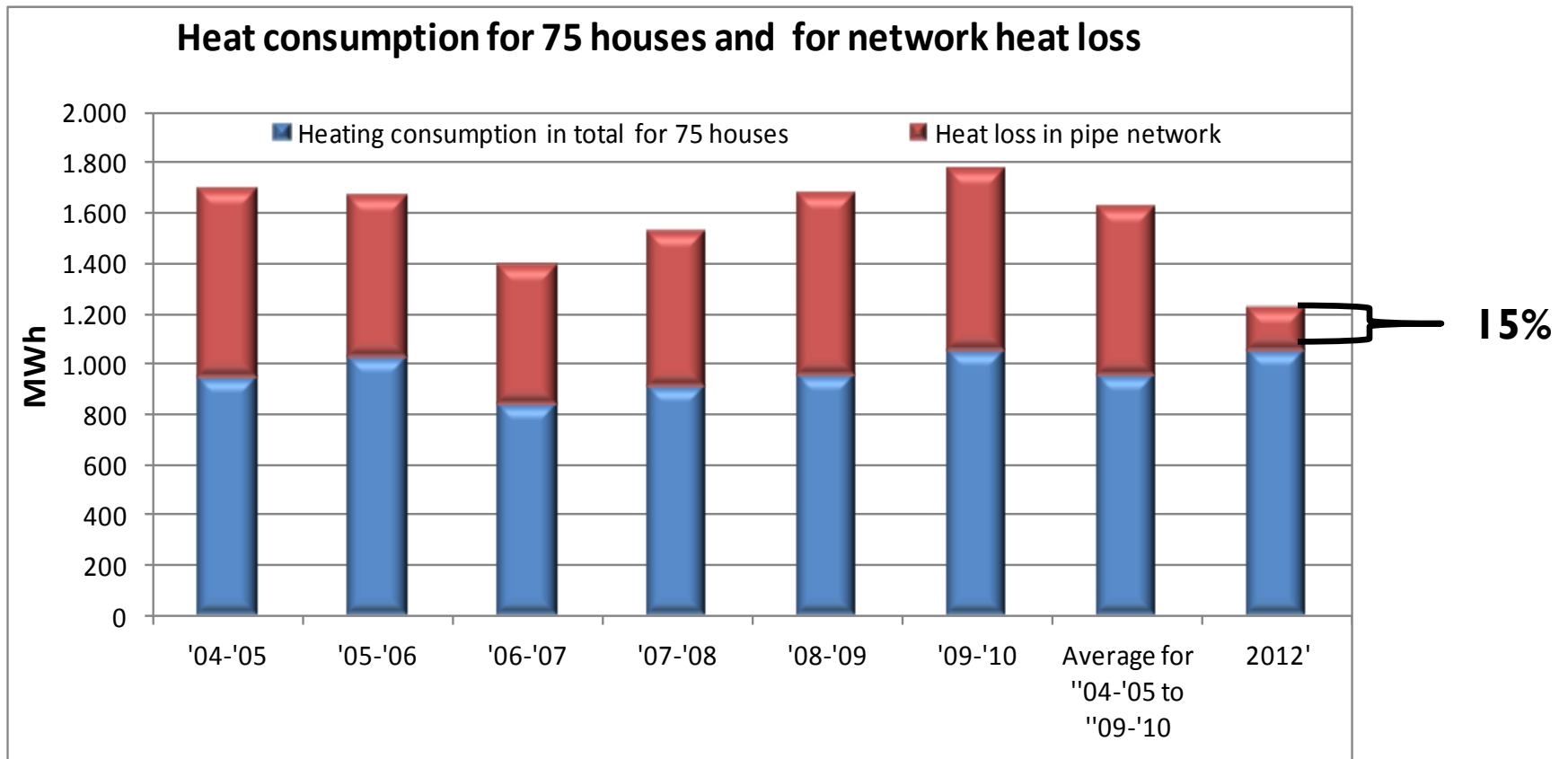
New supply concept: Mixing shunt with a 3-pipe connection!

- Return water from the main DH network is used as low-temperature supply
- "The hot supply" is only used to ensure sufficient temperature
- Advantages for main network: Lower heat loss, increased capacity, plant efficiency (almost without additional investment cost)



80% of supply
from main return
water

Network heat loss - Sønderby, Høje Taastrup, Denmark



Network heat loss more than 4 times higher with old design and operation!

Results & conclusions

Sønderby, Høje Taastrup, Denmark

- **New pipe network**, twin pipes, series 2 & 3, $\lambda = 0.022-0.023$ W/(mK)
- **75 new low temperature house substations** in single-family houses
- **New 3-pipe supply connection** demonstrated: 80% heat supply to the Sønderby network comes from main return water!
- **50-55°C in supply temperature** to the network is sufficient
- **Heat loss in the Sønderby network reduced from 43% to 15% (2012)!**

Concept and Guideline

- Low temperature concept **demonstrated at 3+ sites** – new and existing houses
 - **Draft guideline available** (to be finished by the end of the year)
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Questions

