ENGINEERING TOMORROW

Danfoss

4th Generation District Heating

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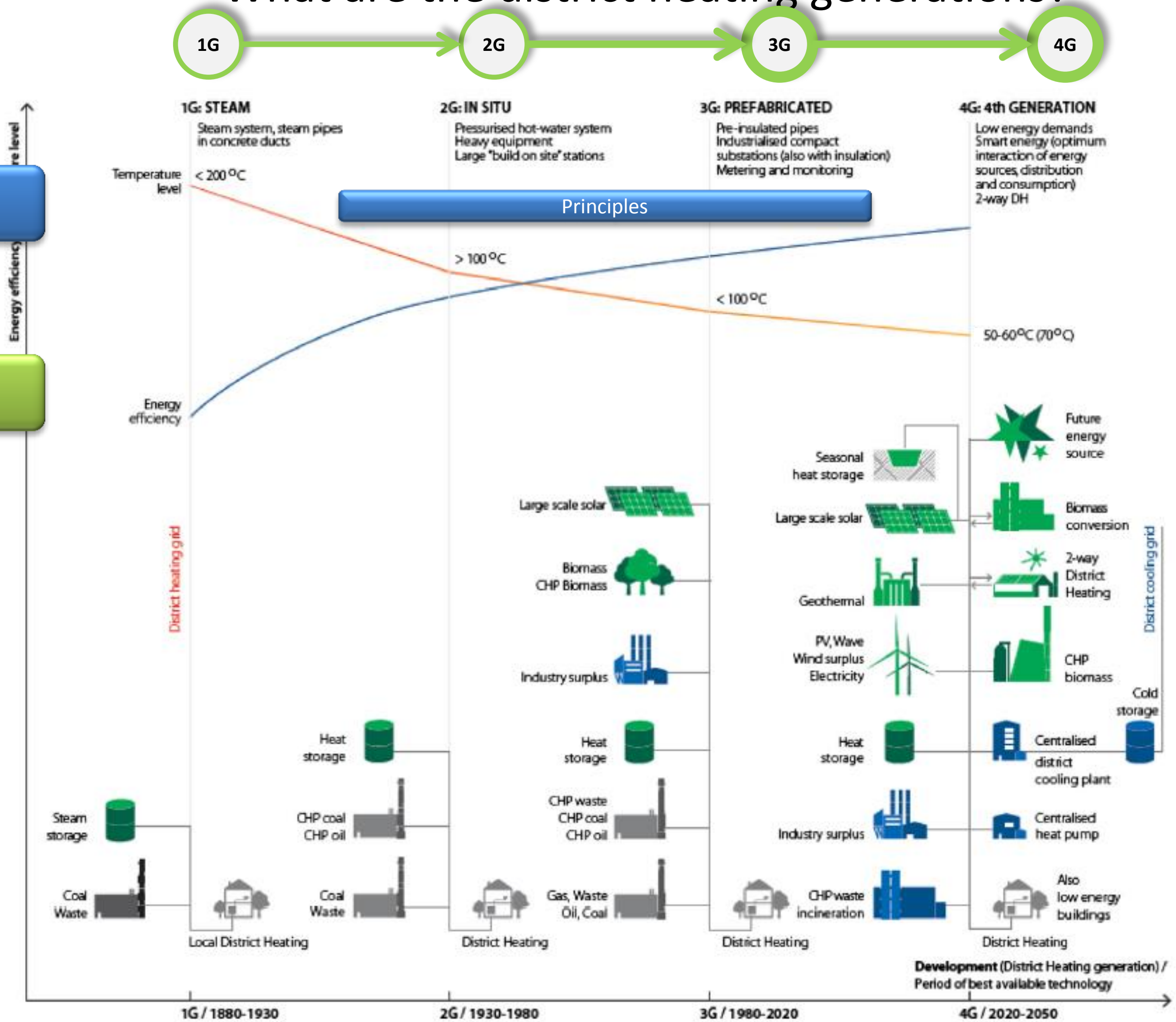
Danfoss Heating Segment

What are the district heating generations?



Temperatures

Efficiency

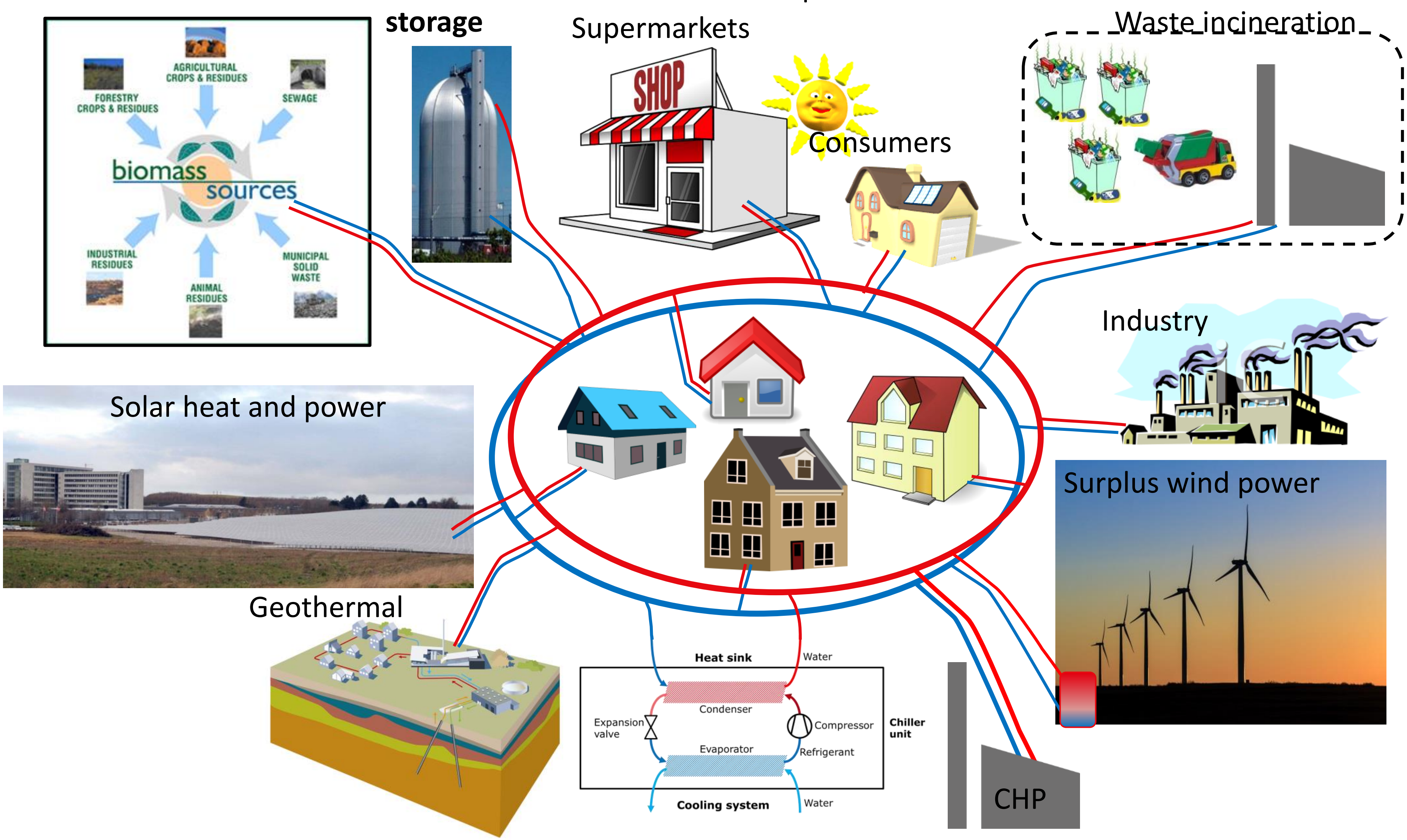
Principles

Same service but lower temperature and higher efficiency

Heat sources

4GDH benefits towards the heat source

- Possibilities of renewable and surplus heat utilization



Other benefits of 4GDH systems to the energy infrastructure

- Increased CHP efficiency
  - Lower supply temperatures increase power generation efficiency
  - Lower return temperatures increase flue gas condensation
- Reduced distribution losses
  - Hea ... emperature
    - T ... ess heat loss is
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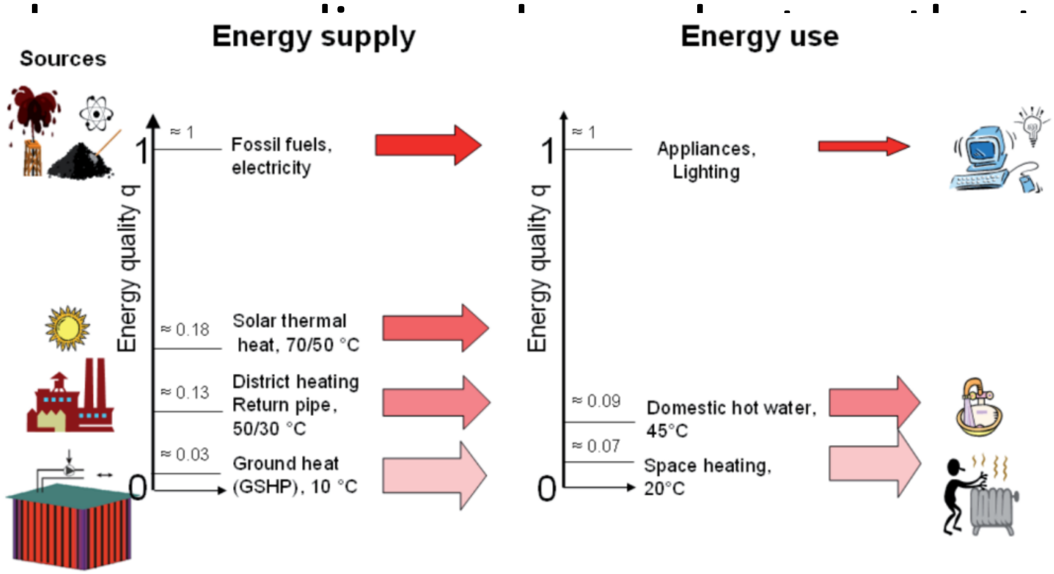
- Better ... and
  demar



What impact has the 4GDH concept on currently applied technologies?

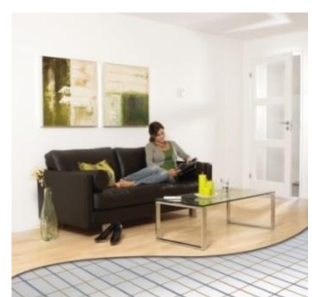
- **Distribution network**
  - Pipe dimensions optimized in relation to heat loss as well as pumping power consumption
  - The low supply temperature opens up for increased application of flexible pre-insulated plastic pi
  - Fast installation
  - Cost efficient

Pictures from Thermaflex pipe manufacturer

Figure 2: Hengelo, NL: 10 houses connected to the heating grid (2 lines) in 1,5 hrs

Figure 3: Alkmaar, NL: 6 houses connected to District Heating in 1,5 hrs

- **Space heating**
  - Heat emitters:
    - *Radiators:* need to be dimensioned for 55°C supply, 25°C return for 20°C indoor air temperature (55/25/20°C)
    - *Floor heating:* No impact as floor heating is generally designed for 45/25/20°C
  - Control equipment:
    - High focus on smart controllers

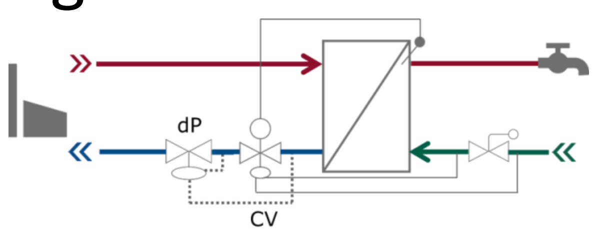


What impact has the 4GDH on currently applied technologies?

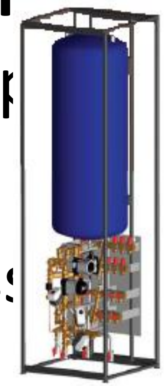
- **Domestic hot water (DHW) preparation**
  - Due to the low supply temperature instantaneous DHW preparation using **high efficiency heat exchangers** and **high quality contr**... ...re required to ensure good coolir ... e supp ... nd stable ... temperatures
  - ... piping volume s ... be less ... n 3 liters to ... nize legionella issues

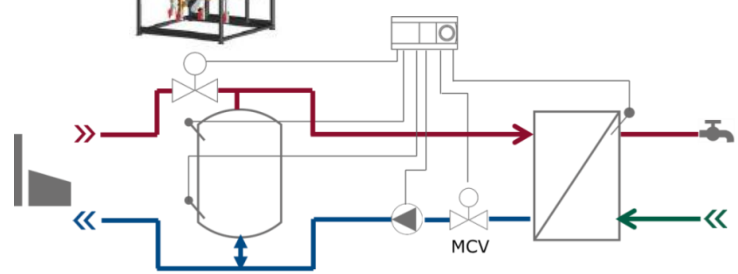
Improved heat exchanger technology

Instantaneous DHW preparation unit



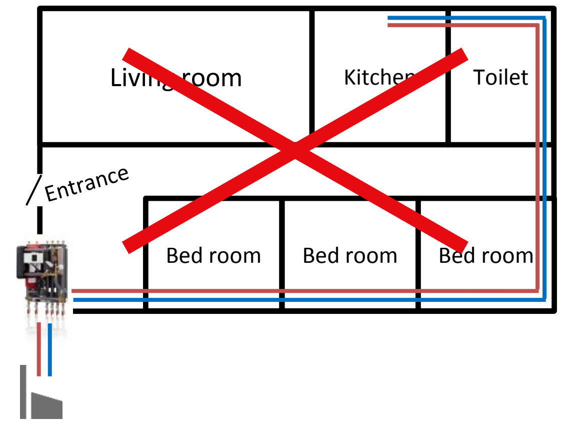
Instantaneous DHW preparation unit with primary side storage

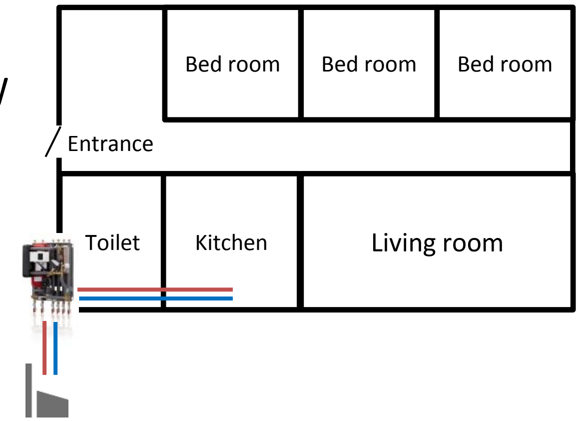


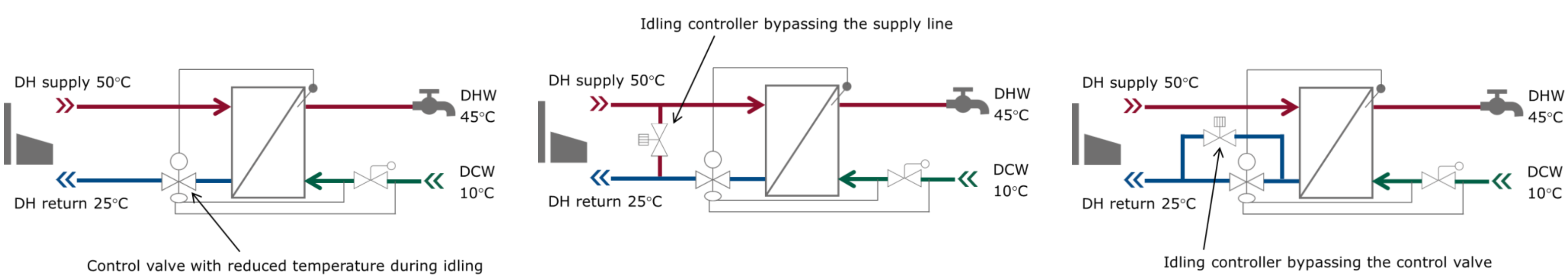


Domestic hot water idling functions

- With the elimination of domestic hot water circulation a new (old) issue emerged:
  - **People are in general impatient**
- To limit the waiting time for domestic hot water some aspects need to be considered:
  - a) Minimize the pipe distances and dimensions from the DHW unit to the taps and
  - b) To keep the supply pipe and/or the domestic hot water heat exchanger warm during non-tapping periods by using by-passes, on the primary side





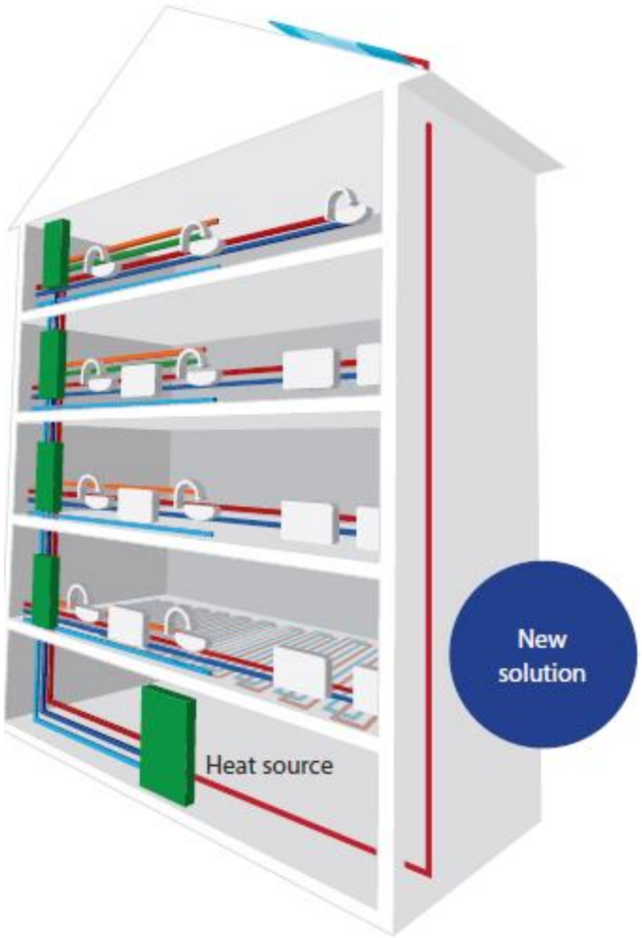


Why does 4GDH fit with future low energy buildings?

- **Low energy buildings:**
  - To maximize energy efficiency low energy buildings are generally designed with low temperature heating installation
    - Floor heating
    - Low temperature radiators
  - **D**omestic **H**ot **W**ater installation is designed to minimize energy consumption
    - Instantaneous DHW preparation
    - Minimum DHW pipe distances
    - No DHW circulation
- Those points fit exactly with 4GDH!

4GDH and multifamily buildings?

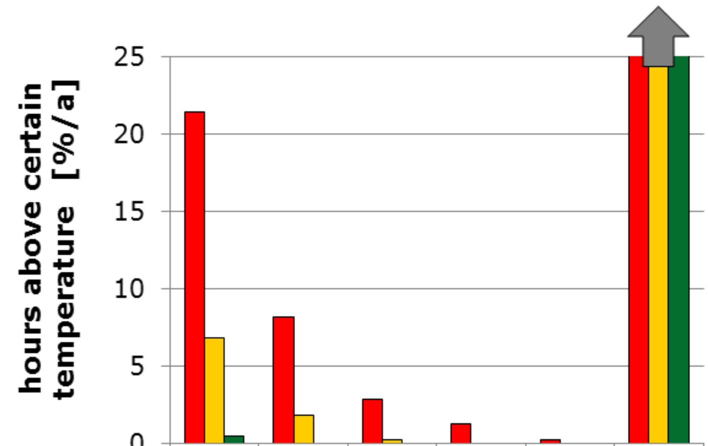
- **Flat stations**
  - Suitable for low-temperature DH
  - Flat station in each flat
  - Overall DHW system volume <3 L
  - Individual control over space heating
  - Simple energy metering
    - ☺ One heat meter for all heat consumption
  - No DHW circulation
    - ☺ Reduced heat loss
  - No vertical risers in flats
    - ☺ Reduced noise
    - ☺ Reduced heat loss



Experience I – Danish single-family houses from 1970
- Simulation results

- The simulations showed:
  - Even for non-renovated buildings 50°C supply temperature is sufficiently high for 79% of the year
  - With moderate renovations, new windows, low-temperature supply can be used for 93% of the time
- This implies that already today low-temperature district heating could be achieved with a temperature boosting during the coldest periods

Duration of T_{supply} over certain temperature



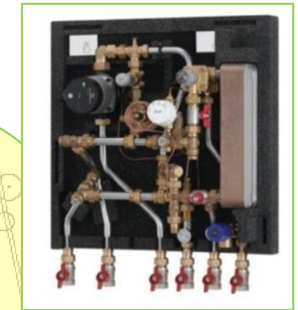
	>50	>55	>60	>65	>70	50
non-renovated 20°C	21,4	8,1	2,9	1,3	0,2	78,6
new windows 20°C	6,8	1,8	0,2	0,0	0,0	93,2
extensive renovation 20°C	0,4	0,0	0,0	0,0	0,0	99,6

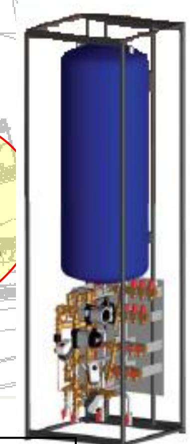
T_{supply} [° C]

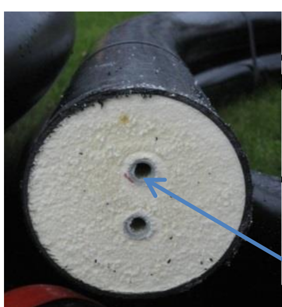
Source: Brand. M, Svendsen. S, *Renewable-based low-temperature district heating for existing buildings in various stages of refurbishment.* Energy, 2013.

Experience II – Low energy houses (2011)
- Lystrup, Denmark

- Project supported by the Danish government
- 40 low-energy single-family houses
- New DH design: Higher DH water speed, higher ure drop
- ng of developed low- p. substations
- Only 14% heat loss from







Inner diameter 14 mm!

Δp_{max} = 8 kPa/m
w_{max} = 2 m/s
$Ød_{min}$ = 14 mm

Low-temperature experience III
- Sønderby, Denmark

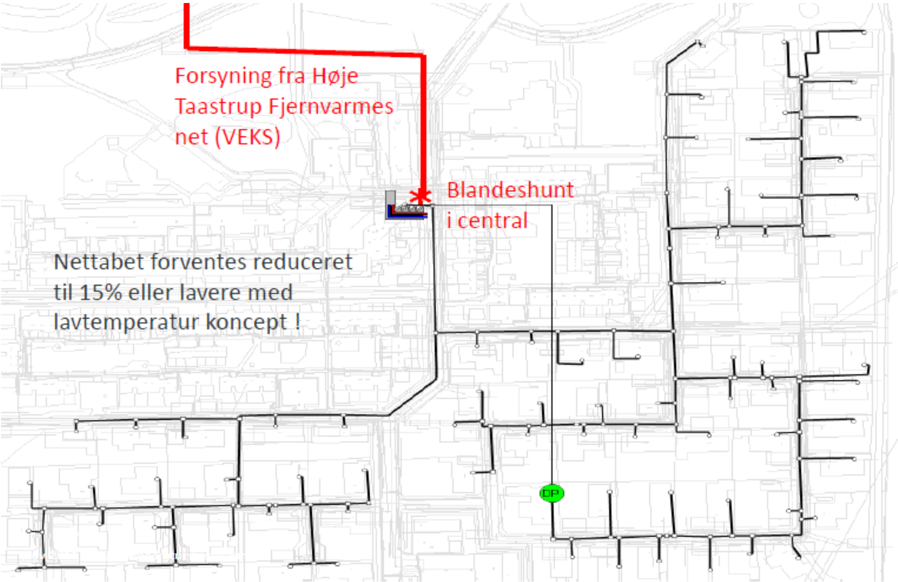
Low-temperature DH for existing buildings

- Project supported by the Danish government
- 75 single-family buildings from 1997
- **Floor heating**

Realization

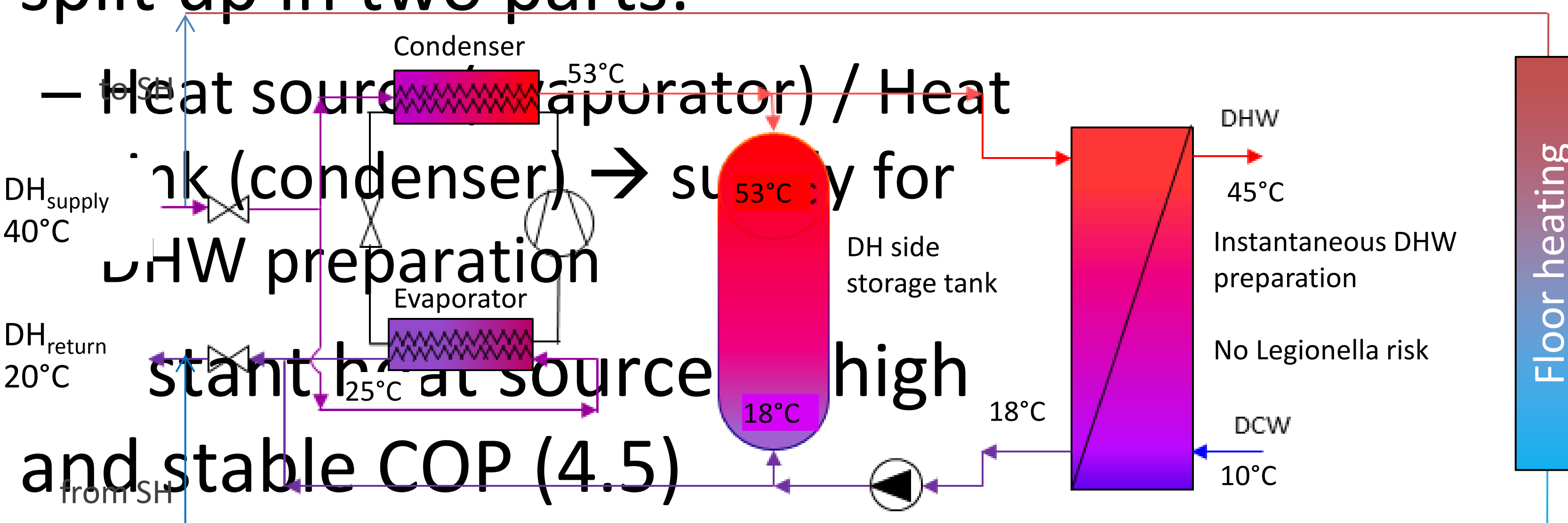
- New low-temperature DH in-house substation
- New DH network
- Heat loss reduced from 40% -> 14%

– 80% of heat demand supplied from main **<u>DH return line</u>**
– Average T_{sup} = 55°C
– No complaints



Experience IV - Heat pump supplied by Ultra-LTDH (2014)
- Copenhagen, Denmark

- DH supply temperature is 40°C
  - Space heating part is not “boosted” => floor heating
- DH supply flow part for DHW is split up in two parts:
  - Heat source (evaporator) / Heat sink (condenser) → supply for DHW preparation
- Constant heat source => high and stable COP (4.5)



Experience V – Electrical heater to boost the DHW (2016)
- Copenhagen, Denmark

- **DH designed for 40/25°C**
  - Electric heater added at the c
    - – DHW instantaneously heated to
    - – Electrical heater boosts the tem up to 60°C by electric heater
  - Expected heat loss reduction
    - \- 17% compared to 50/25°C
    - \- 40-55% compared to 80/40
  - Prototypes installed in 5 hous
    - – First results are promising

Experience VI - Surplus heat from supermarket cooling system
- SuperBrugsen in Høruphav, Denmark

Supermarket

- Area: 1000 m2, built in 2010
- Cooling Capacity: 160 kW
  - Waste heat: 60-100°C

- Partnership model:
  - SuperBrugsen – earns money on the waste heat and increases its green profile
  - Danfoss – DH application and technology provider
  - DH utility – more "green energy"

Thank you for your attention

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