Using Ultra-low temperature district heating for DHW production in single family house

—*Comparisons of 5 different substations*

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Plan of the PhD research

1. Overview possible solutions for supply DHW without Legionella
   - *("Alternative solutions for inhibiting Legionella in domestic hot water systems based on low-temperature district heating" accepted)*
2. Investigate specific technology can be used for realizing LTDH without Legionella risk
   - (Case studies of electric heat tracing system and flat station system)
3. Comparisons and summarizations about available alternatives for supplying DHW without risk of Legionella with LTDH
   - Case study of comparing 5 substations with ULTDH supply,
   - Comparisons and investigations on more general and comprehensive scope
4. Hand in the thesis at the end of January 2016

Aim of the study

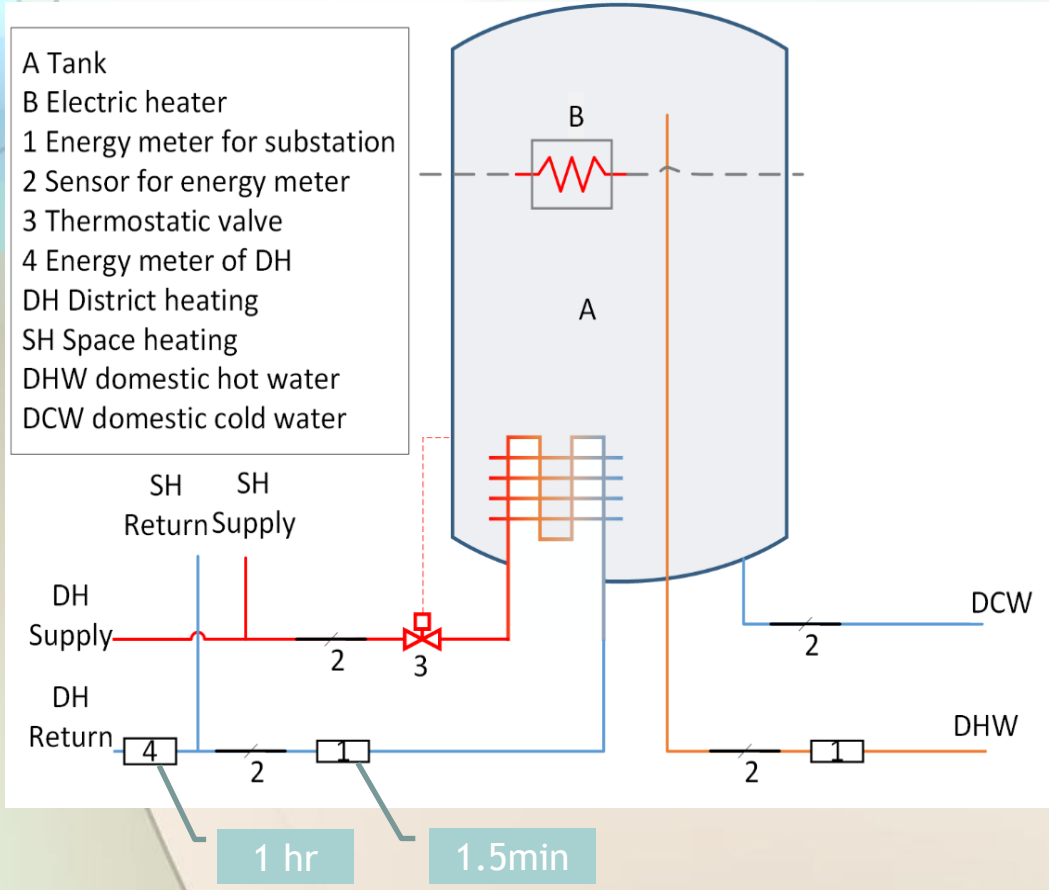
- Viability of using ULTDH for single family houses
- Evaluation for energy/ economy performance of different substations

Background

- Location: Bjerringbro, Denmark
- Heat source: excess industrial heat from local pump company
- Design supply temperature : 46^{o}C
- 21 houses are supplied by ULTDH, and 5 were selected for measurements

Substations

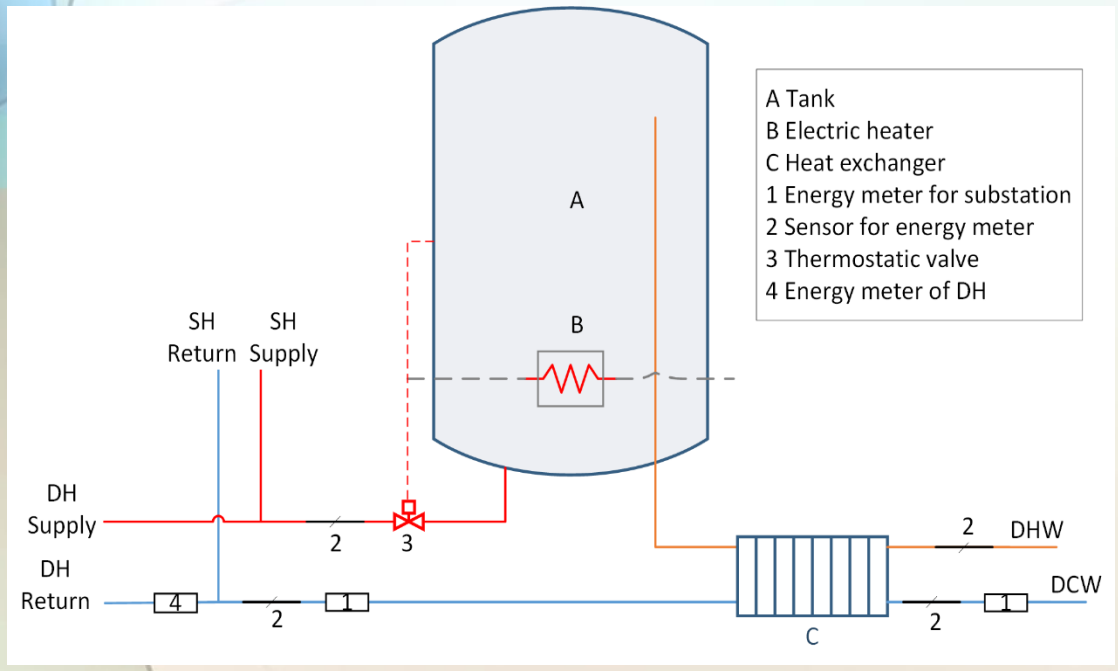
- #1



- DHW stored in the tank
- ULTDH preheat the DHW
- Immersion heater heat up DHW further
- Meters in the substation installed on both sides

Substations

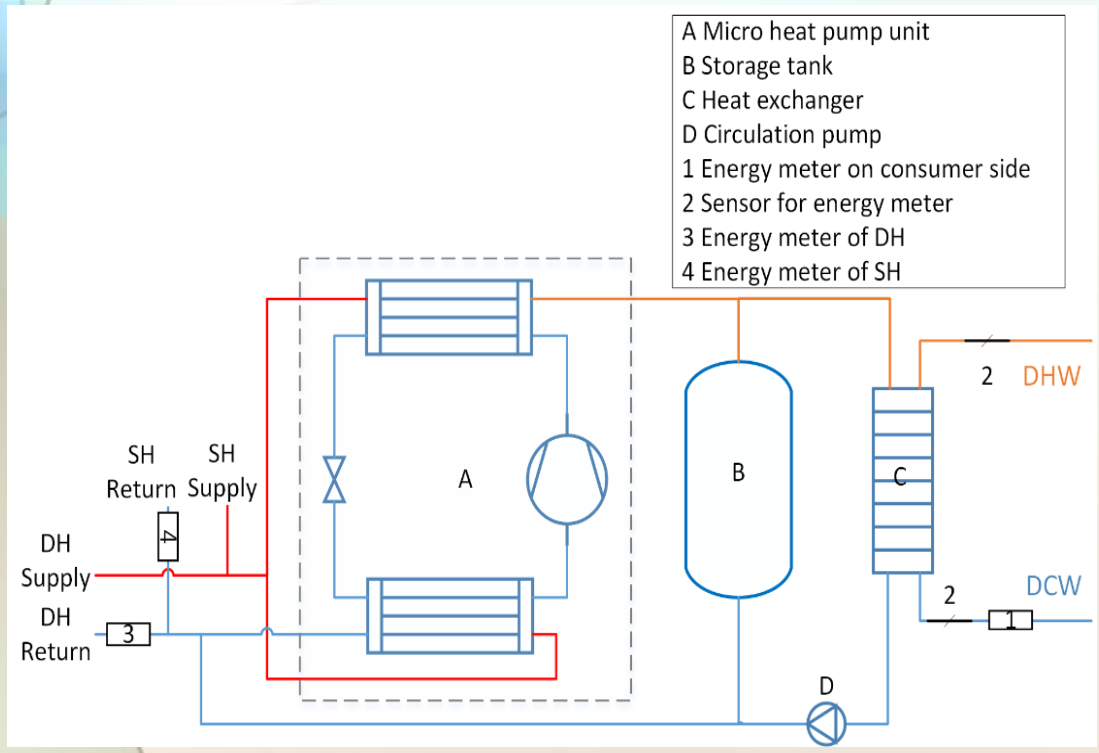
- #2



- DH water stored in the tank
- Immersion heater heat up the DH water
- Meters installed on both sides

Substations

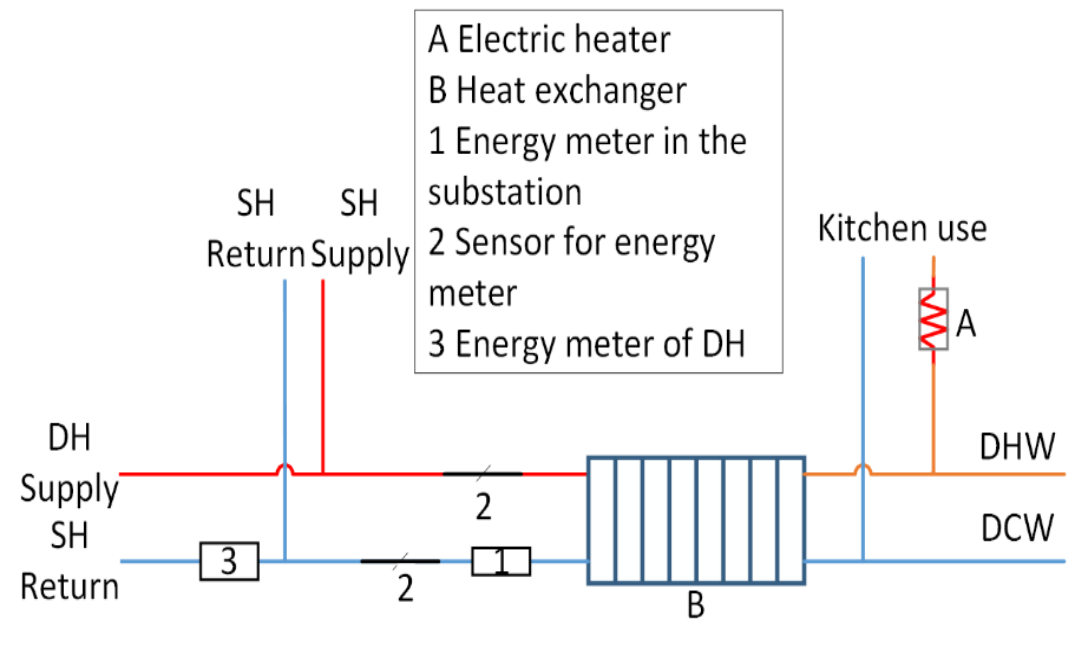
- #3



- Heat pump installed on the production side
- DH water was heat up by the heat pump
- Meters installed on the consumer side

Substations

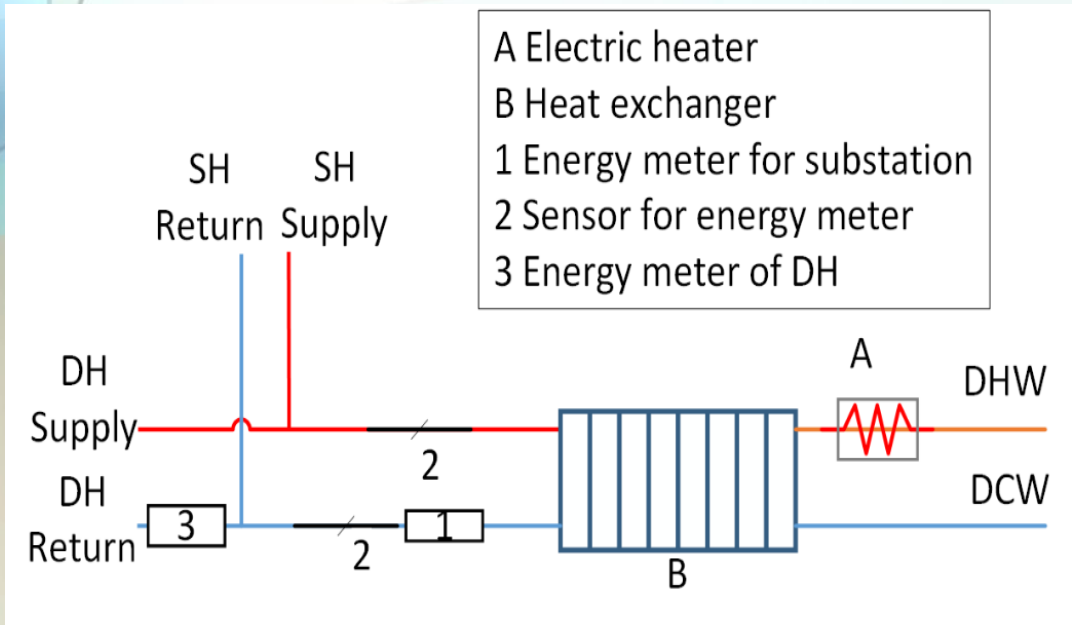
- #4



- Instantaneous DHW production
- In-line heater installed on the consumer side
- In-line heater for only kitchen use
- Meters installed on production side

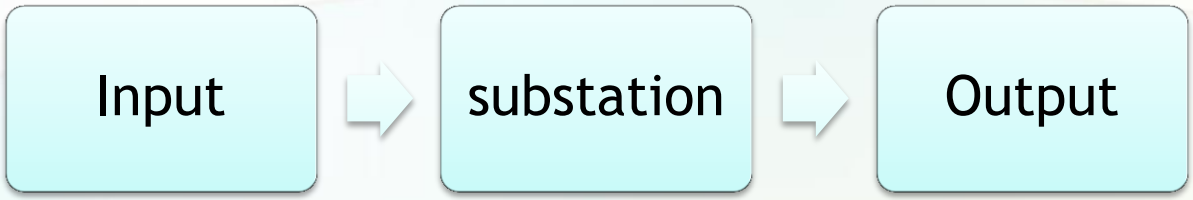
Substations

- #5



- Instantaneous DHW production
- In-line heater installed on the consumer side
- In-line heater for all DHW production
- Meters installed on production side

Integrated energy consumption for DHW production



- Energy input= $Q_{DH} + Q_{el}$
- Energy output= $E_{DHW} + E_{heat\ loss}$
- Relative use of input energy:
  - $C_{dh} = Q_{DH} / E_{DHW}$
  - $C_{el} = Q_{el} / E_{DHW}$

Integrated energy consumption for DHW production

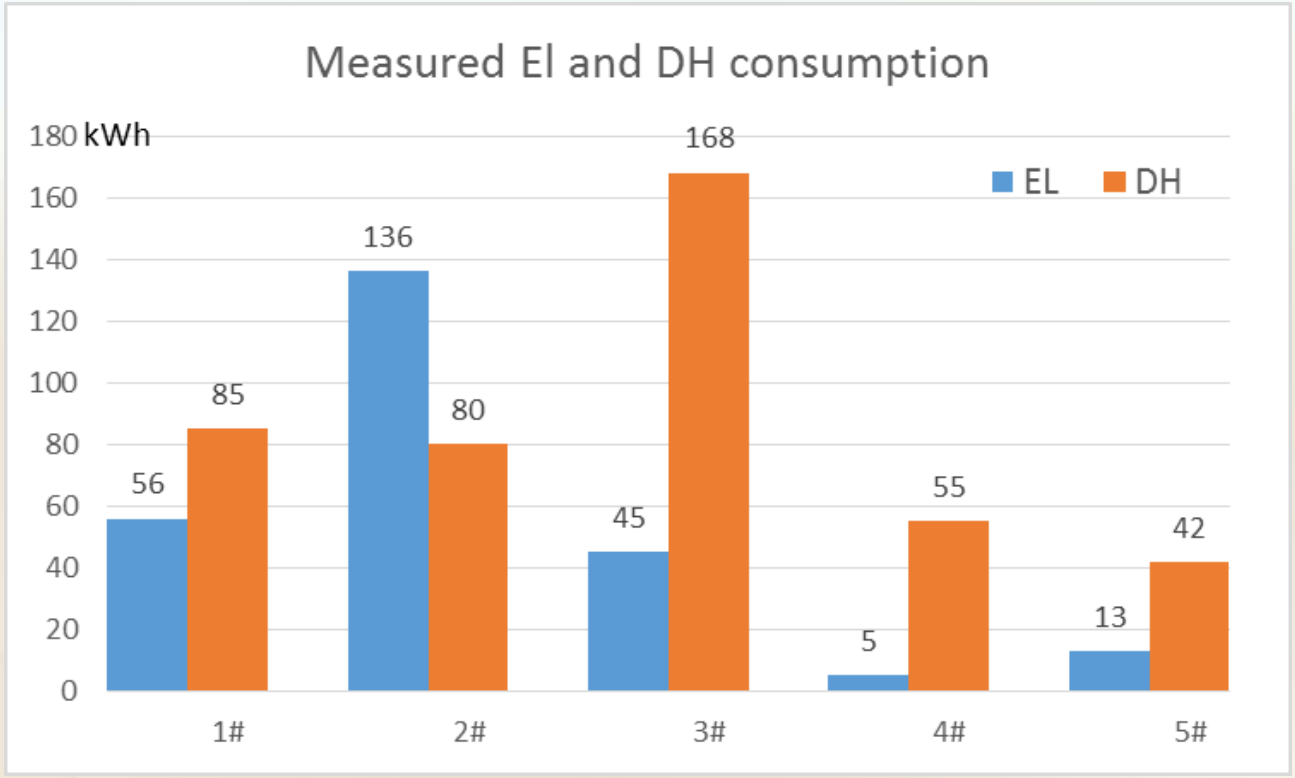
- Parameters and assumptions:
  - E_{DHW} is 2000 kWh/yr (meet the requirement of energy efficient building in 2020)
  - Heat loss rate of the tank:60W, for the heat pump unit:200W (product catalog)
  - Heat loss of the in-line heater was neglected
  - DH supply T 45oC, return T 15 oC, DCW 10 oC
  - Other operation T follows DS 439 and CEN16355

    DHW in the tank 60oC,

    For comfort: 55oC for normal use, no less than 45oC

Results

- 1. Measurements of May



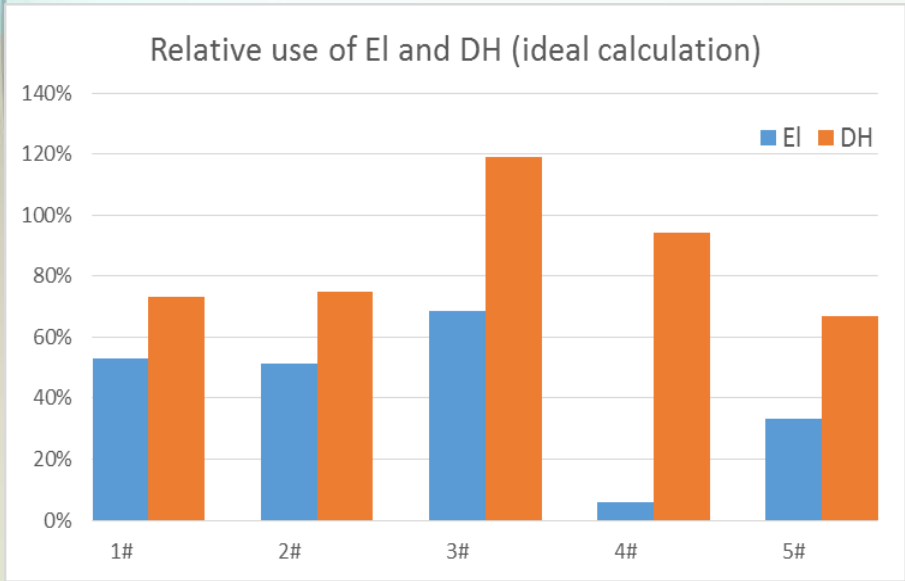
Results

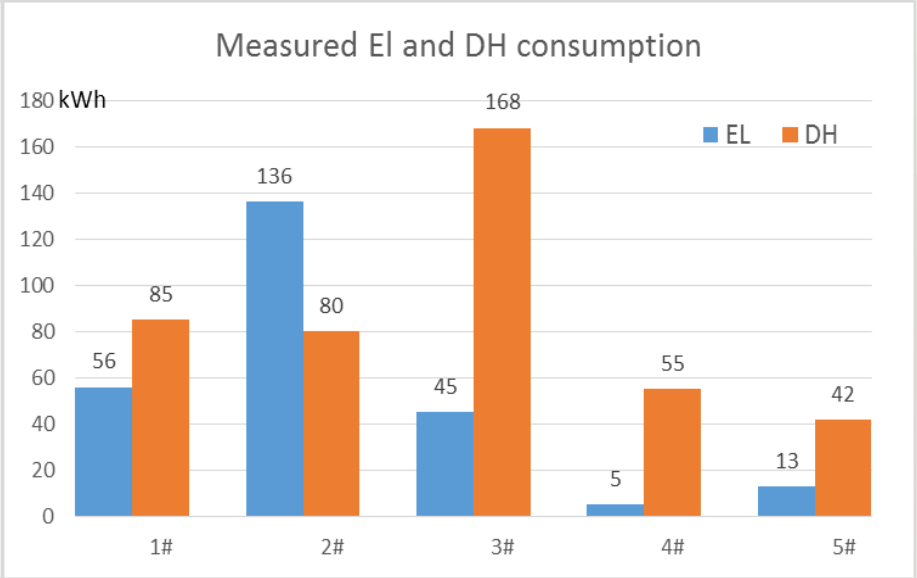
- 2. Ideal case

	E_{hl}/E_{dhw}	Q_{el}/E_{dhw}	Q_{DH}/E_{dwh}	Reference Price	integrated price
#1	26%	53%	73%	0.8	1.6
#2	26%	51%	75%	0.8	1.6
#3	88%	68%	119%	0.8	2.3
#4	0%	6%	94%	0.8	0.9
#5	0%	33%	67%	0.8	1.2

Results

- 3. Comparison





Collaboration with others

- With other PhDs
  - Integrated analysis about the 4DH application in the building sector (SH &DHW) with Dorte wp1.1
  - Full analysis of 4DH including consumer side and network with Rasmus wp2.1 and Dorte
- With industrial partners
  - Viborg DH company
  - Bjerringbro DH company
  - Danfoss

Plan for the abstract of 4DH conference 2016

- The influence of DHW and SH on the consumer side on the overall DH return temperature and possible improve methods