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# SOLAR ENERGY IN LOW TEMPERATURE DISTRICT HEATING: MONITORING AND SIMULATION OF AN INNOVATIVE DISTRICT IN MILAN

**Dall'Ara D.**, Dènariè A., Spirito G., Motta M.

*Department, Politecnico di Milano*

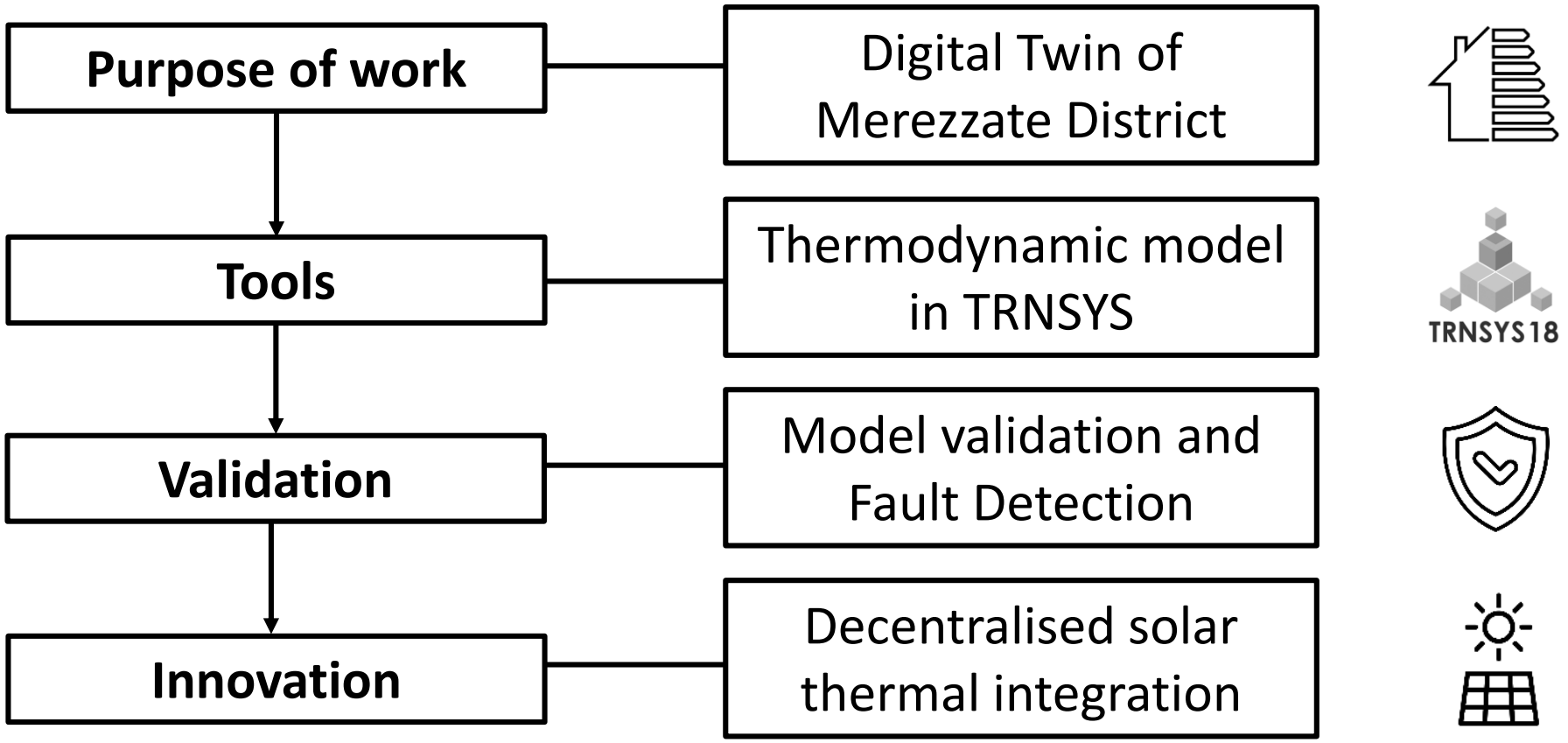
# Goals and Motivation

Development of a **digital twin** for Merezzate District

1) Fault detection:
   - Verifying monitoring data and improving margins

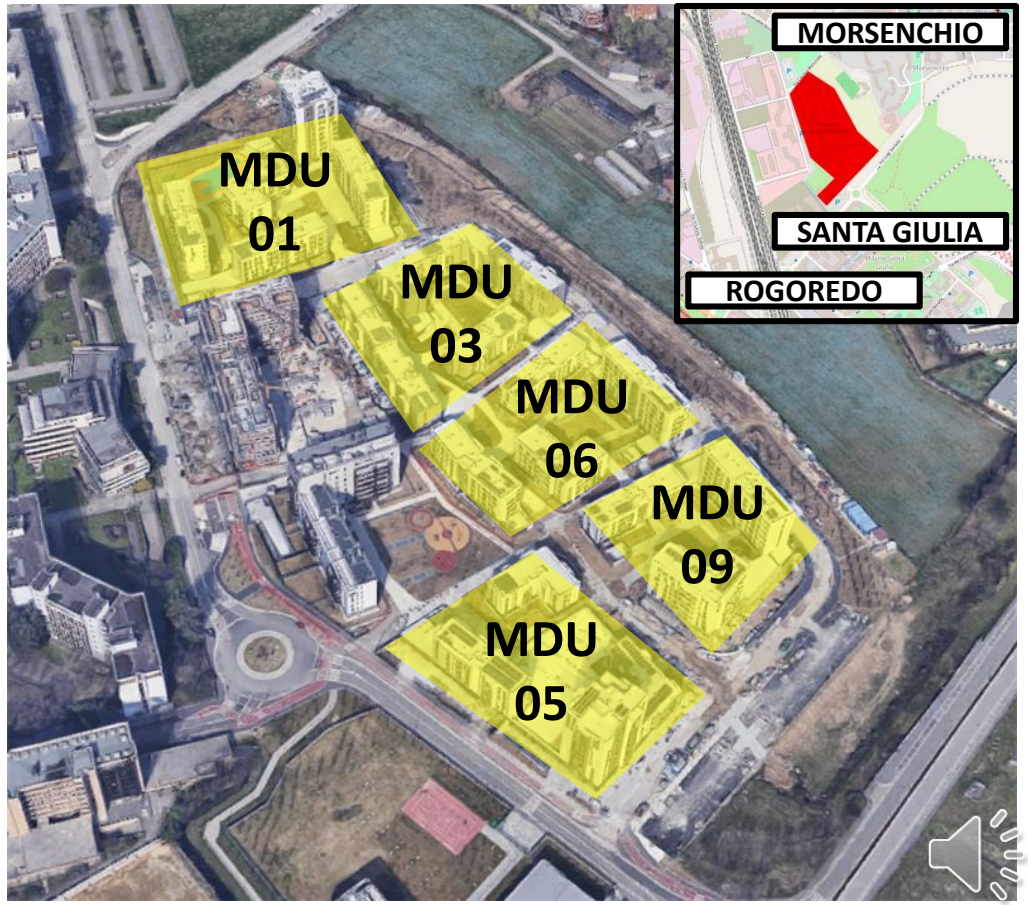
2) Simulating innovative interventions:
   - Converting form HT to LT configuration
   - Evaluation of **decentralised solar system**

# Methodology



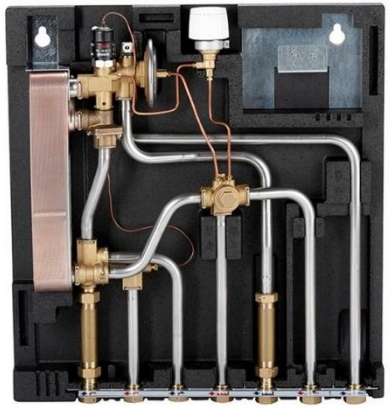
# Merezzate District

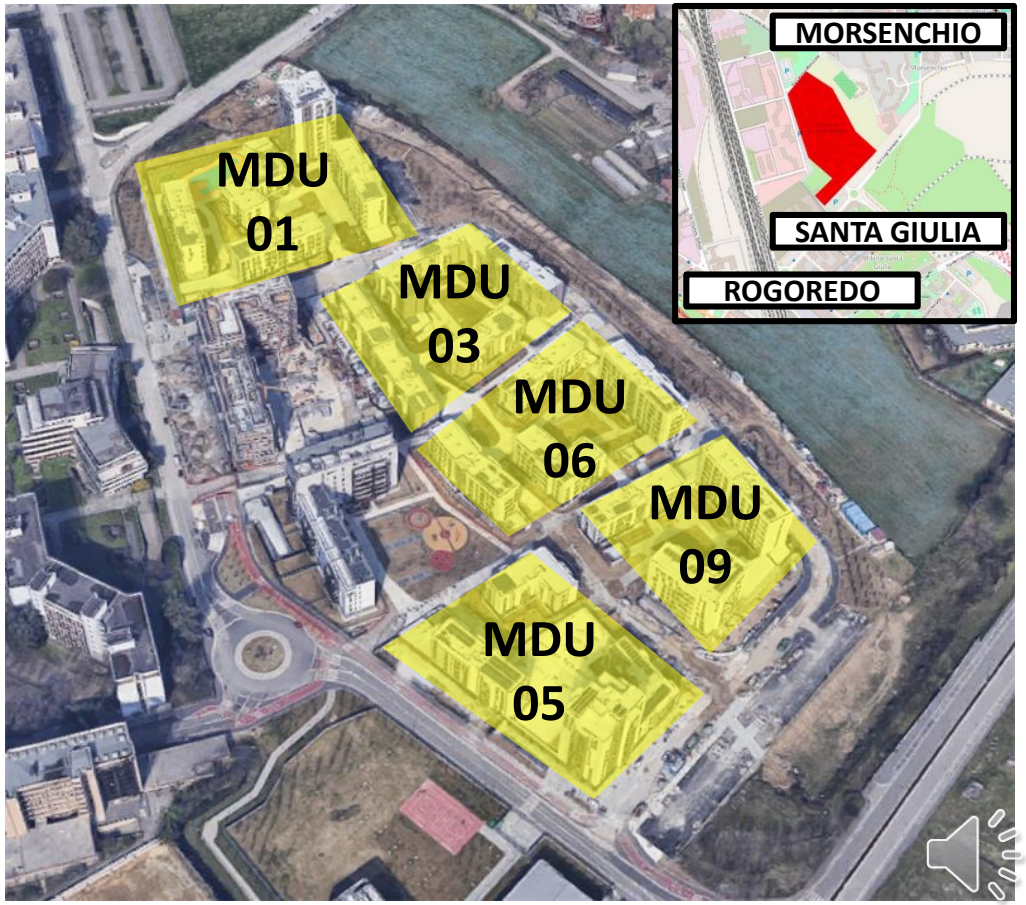
Multi-Dwelling Units (MDU)



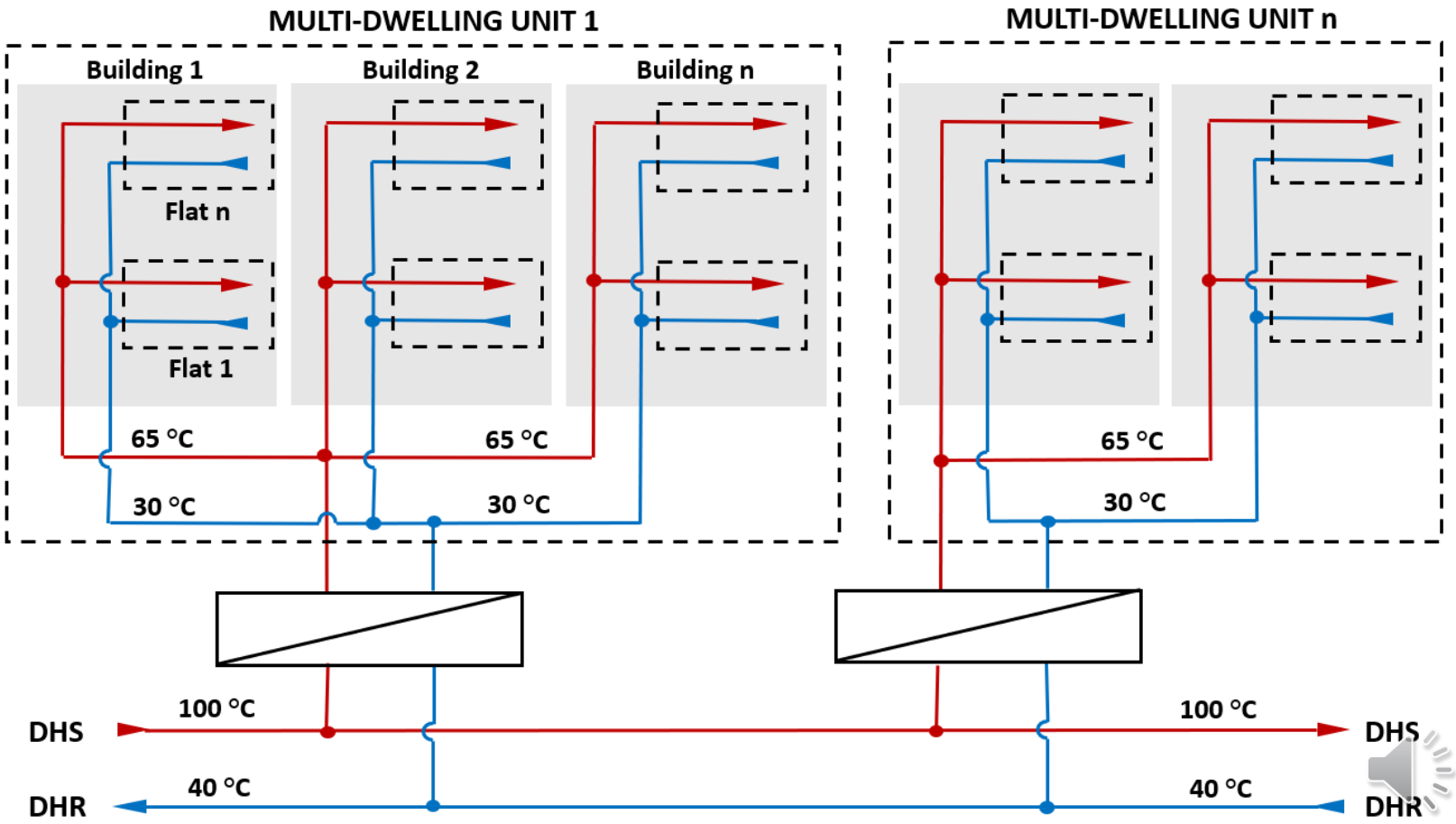
# Merezzate District

- Multi-Dwelling Units (MDU)
- Low Energy Buildings
- Innovative flat stations
  - Space heating without HX
  - DHW without storage tank



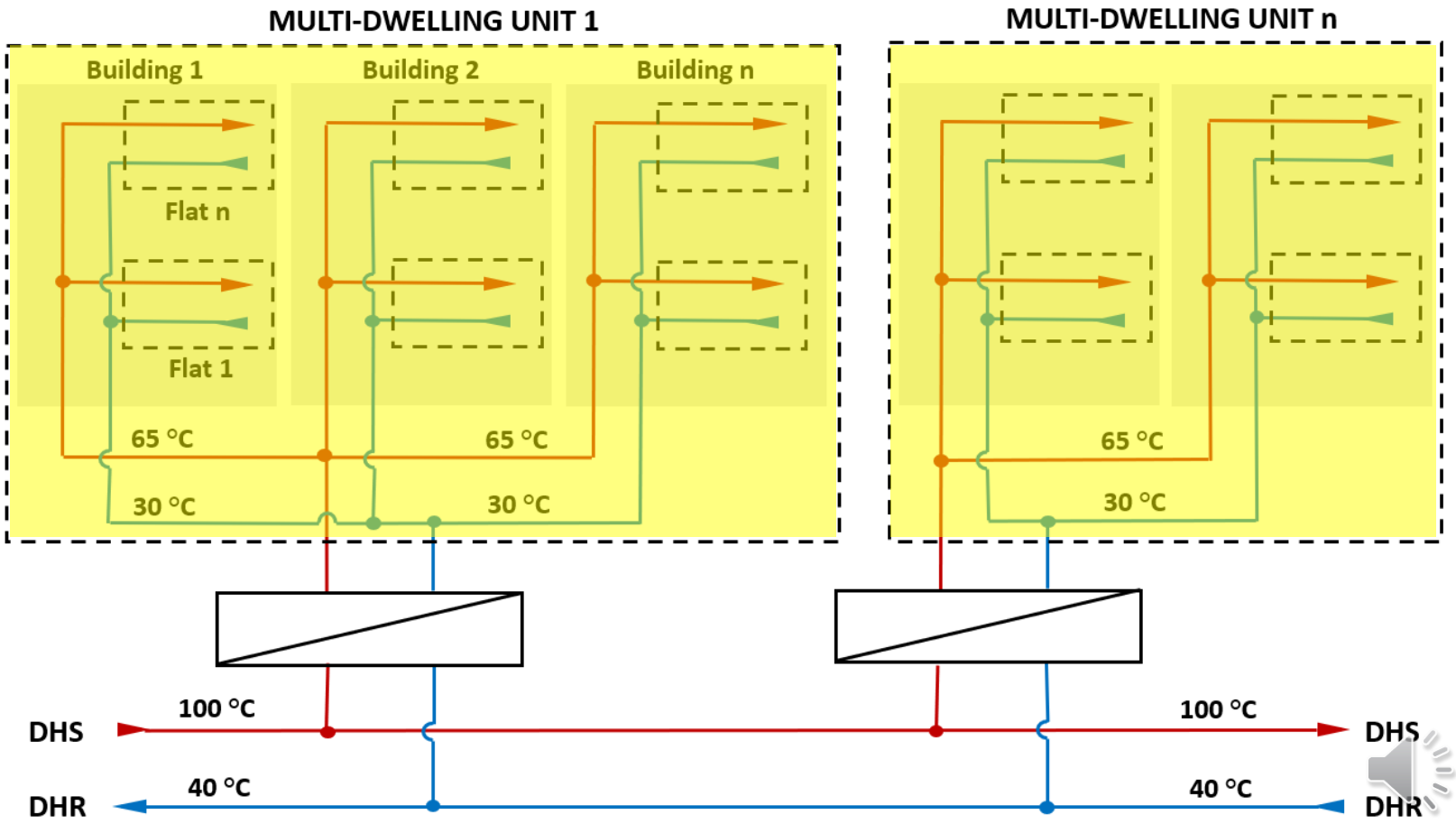


# TRNSYS System Modelling



# TRNSYS System Modelling

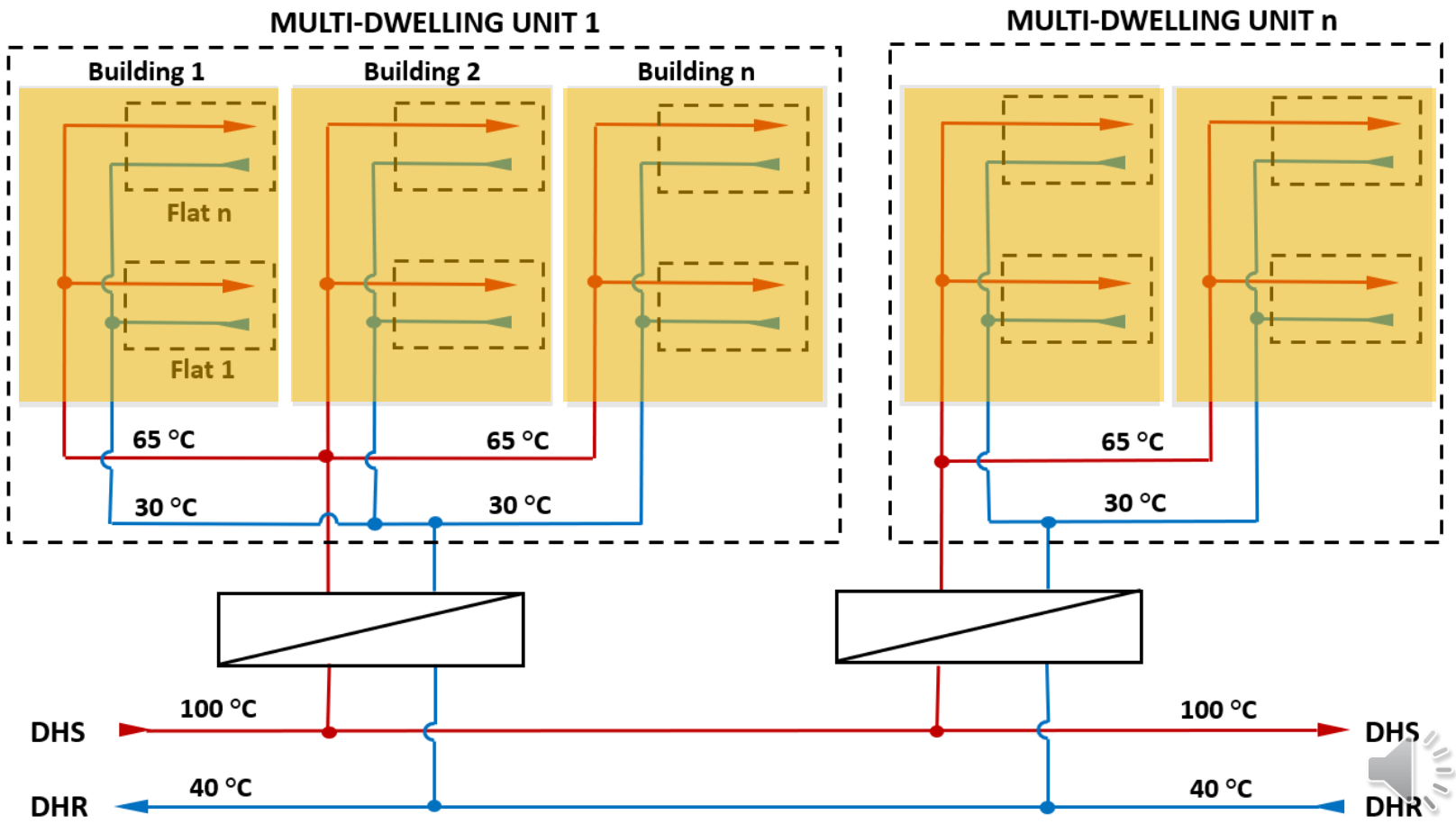
5 Multi-dwelling units



# TRNSYS System Modelling

5 Multi-dwelling units

22 Buildings



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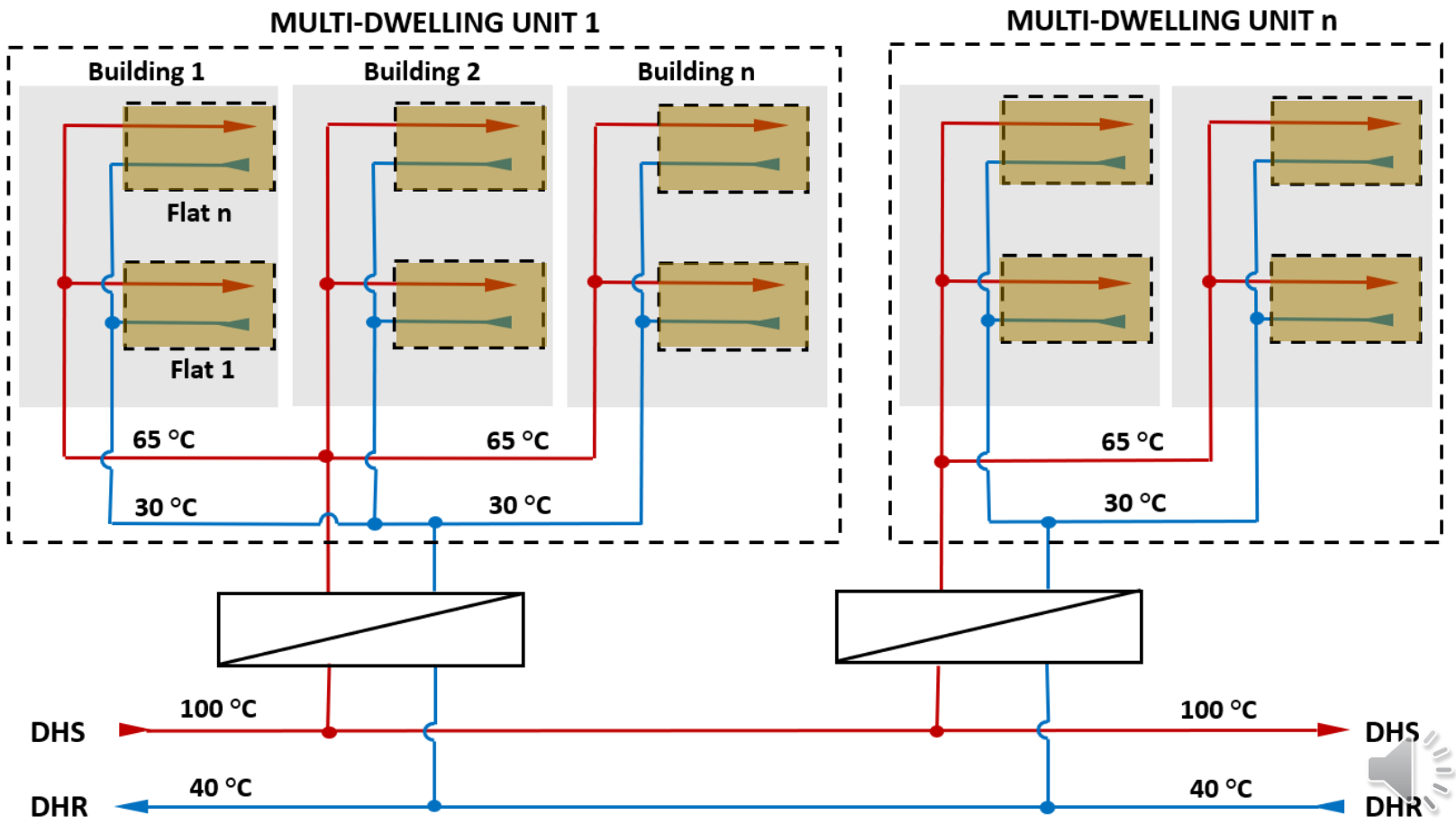
609 Apartments



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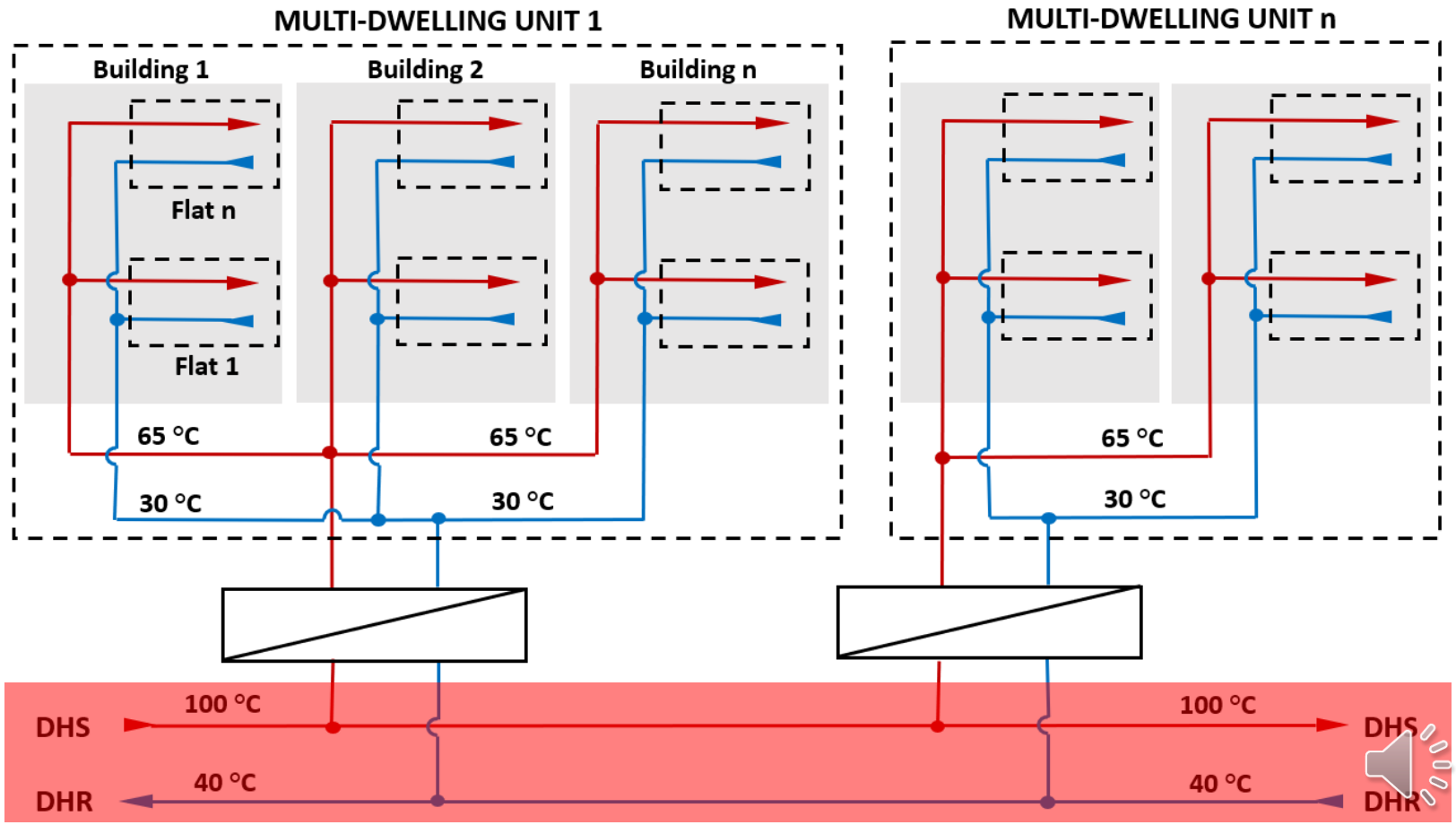
Primary side



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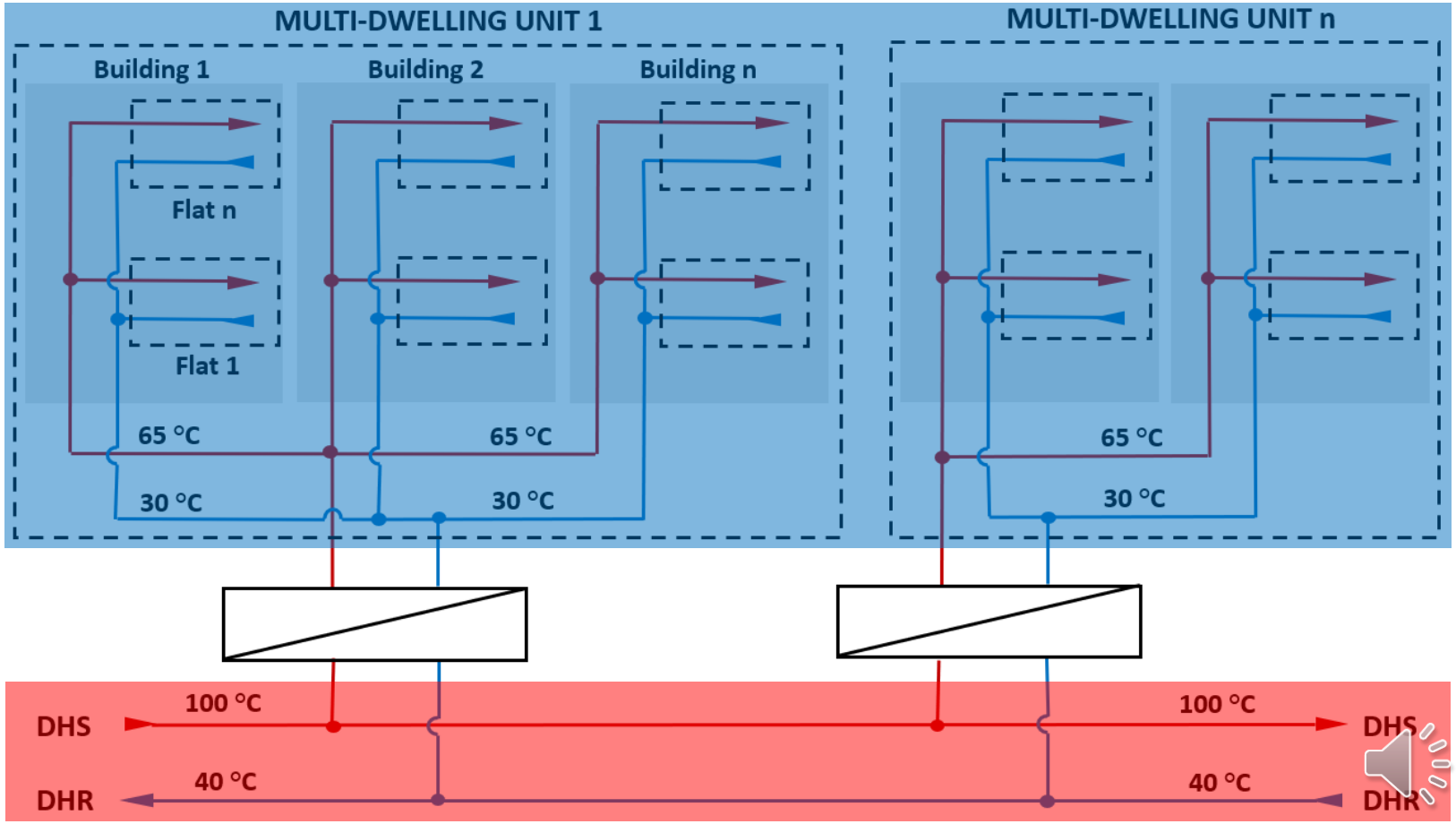
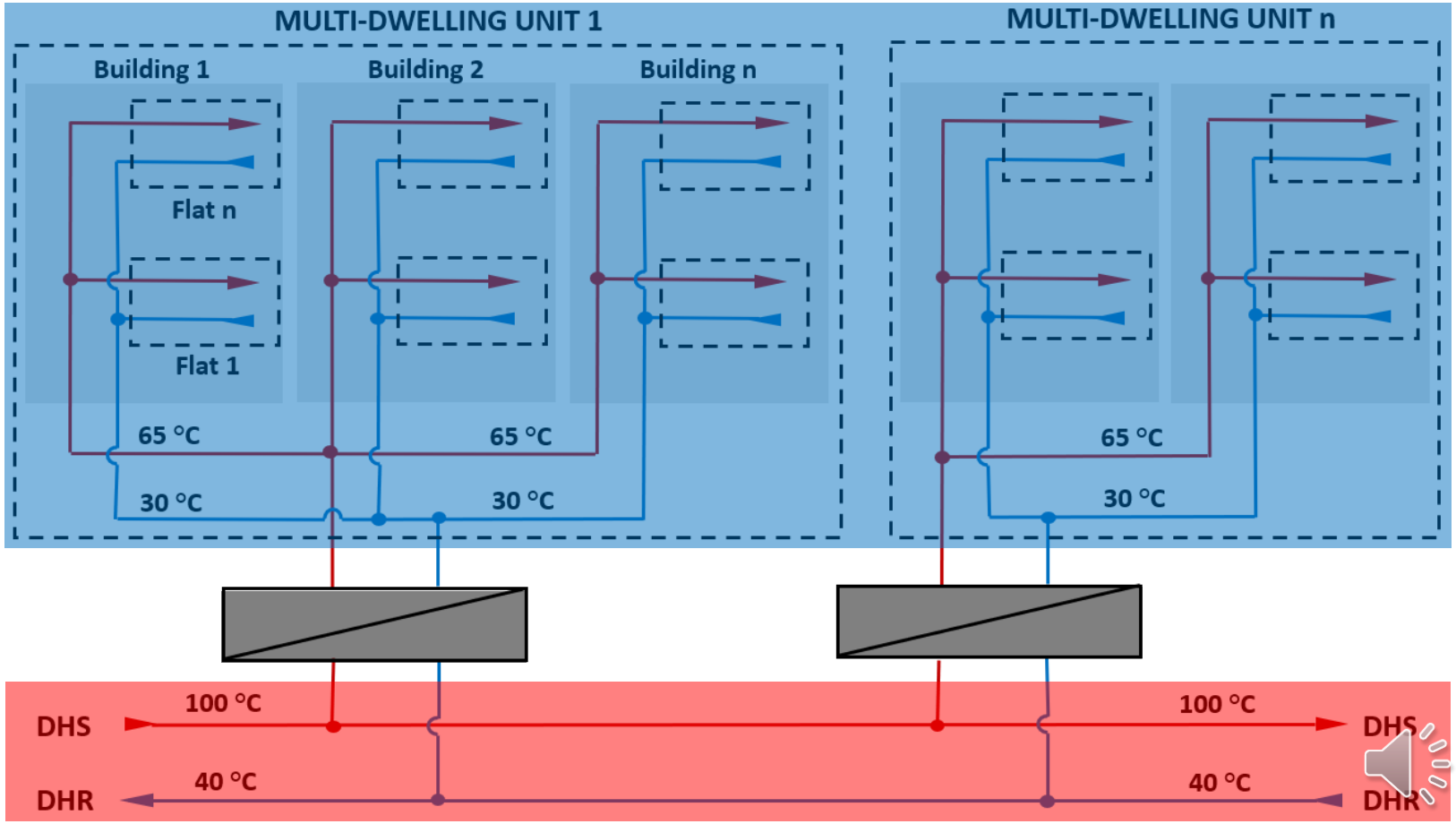
Primary side

Secondary side



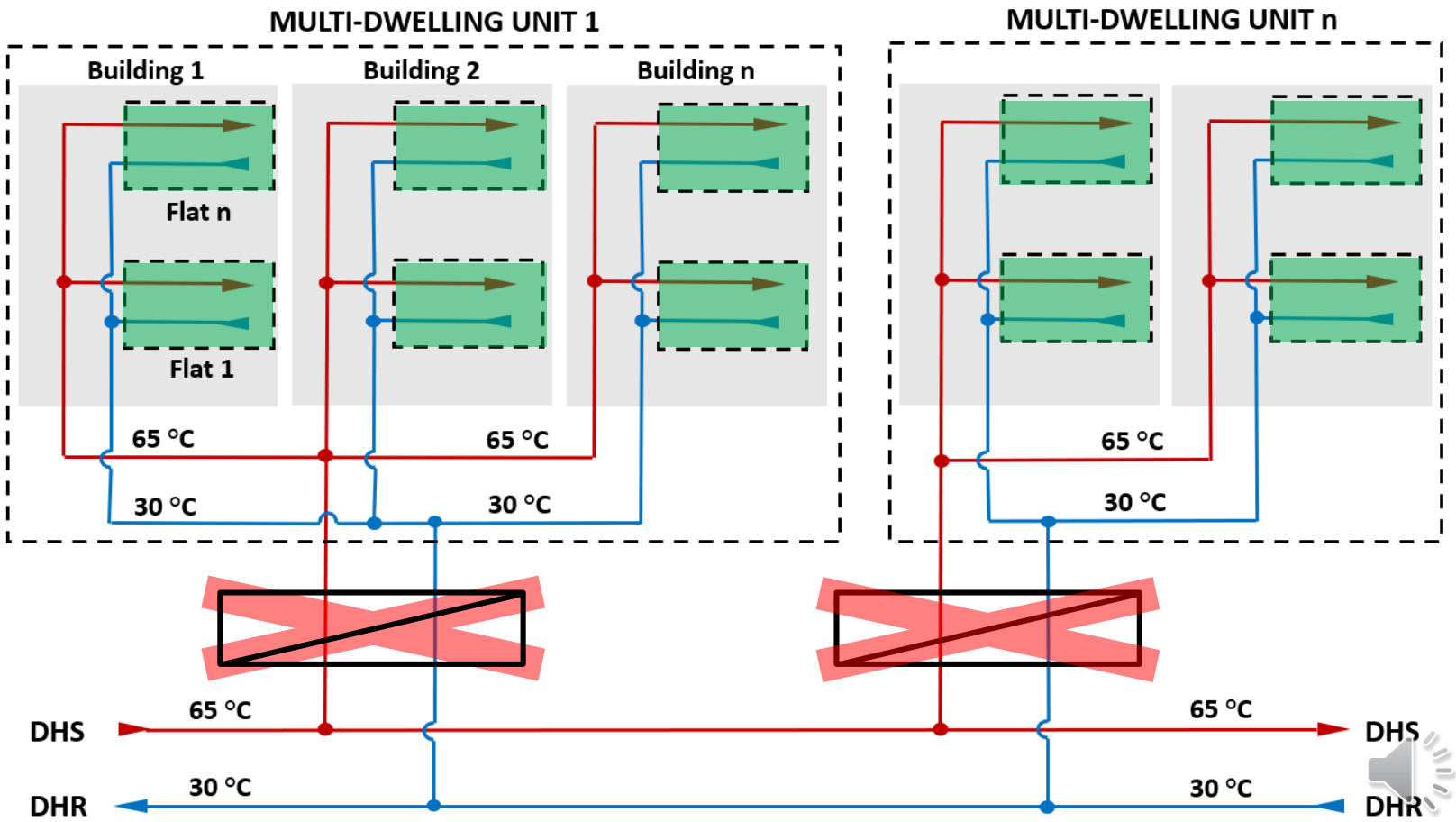
# TRNSYS System Modelling

- 5 Multi-dwelling units
- 22 Buildings
- 609 Apartments
- Primary side
- Secondary side
- Substations



# TRNSYS System Modelling

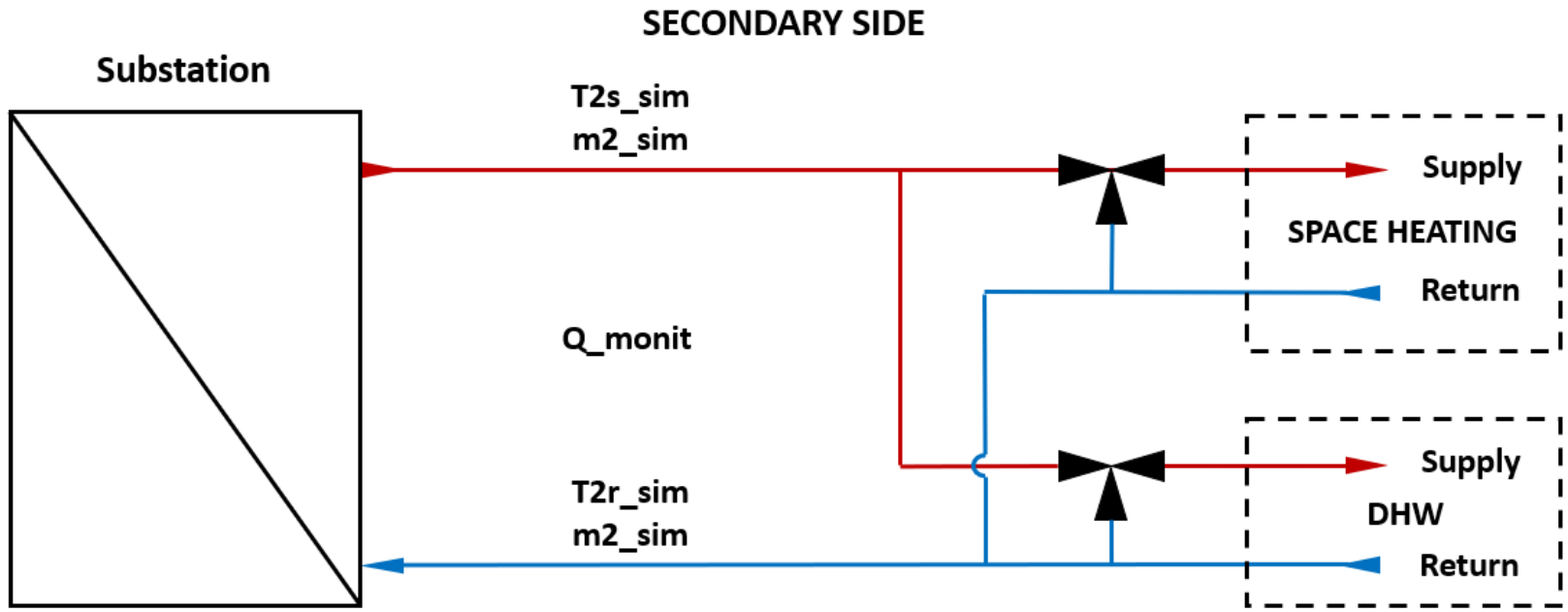
- 5 Multi-dwelling units
- 22 Buildings
- 609 Apartments
- Primary side
- Secondary side
- Substations
- Low Temperature



# Model Validation & Fault Detection

**Model validation:**

Q_monitoring



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Primary side fault detection

Average difference **< 2.30%**

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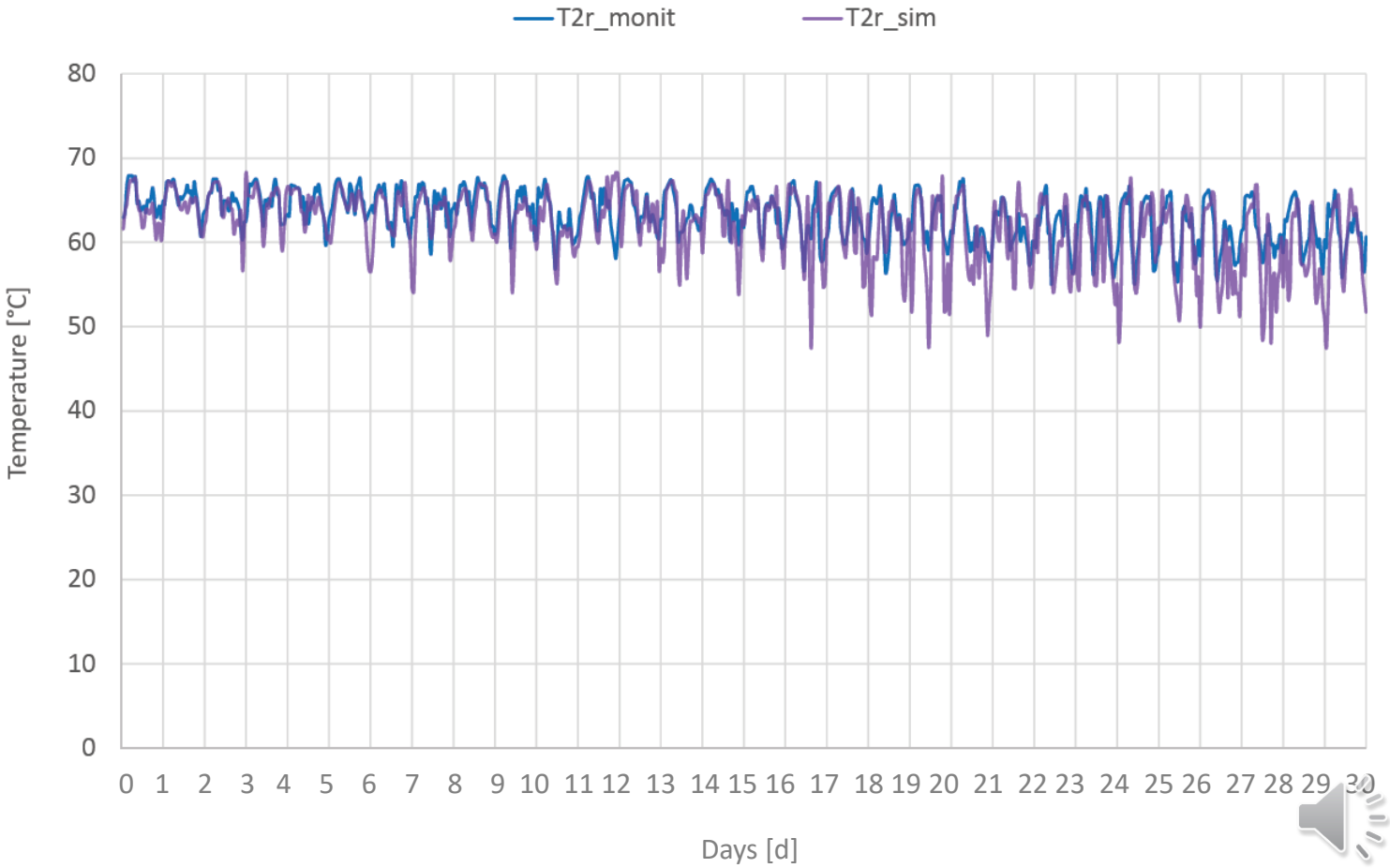
Secondary side fault detection

Average difference **< 2.80%**



# Model Validation & Fault Detection

**Model validation:**

Q_monitoring

Primary side fault detection

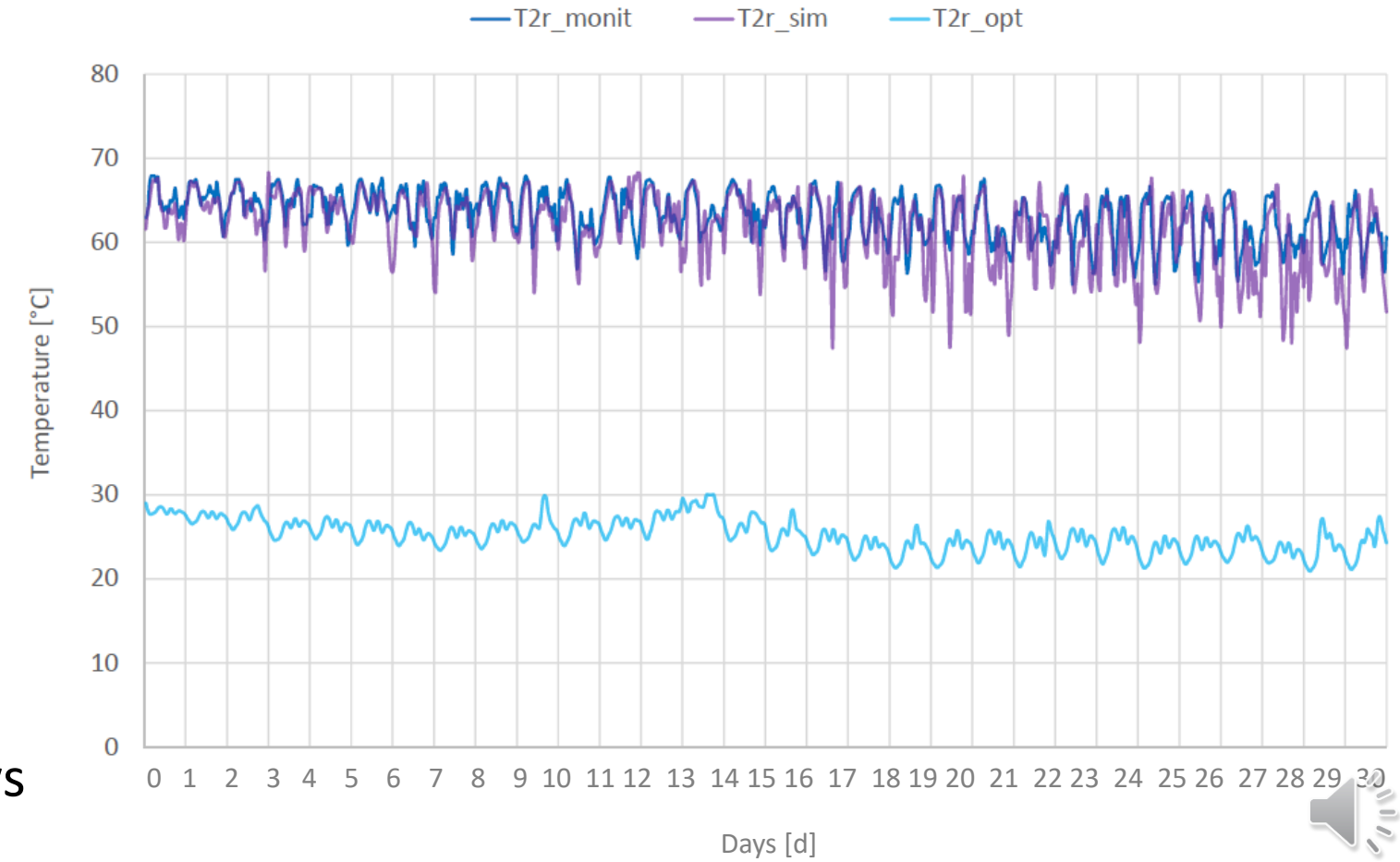
Average difference **< 2.30%**

Secondary side fault detection

Average difference **< 2.80%**

**Improving margins** to reduce

– Temperatures & Mass flows

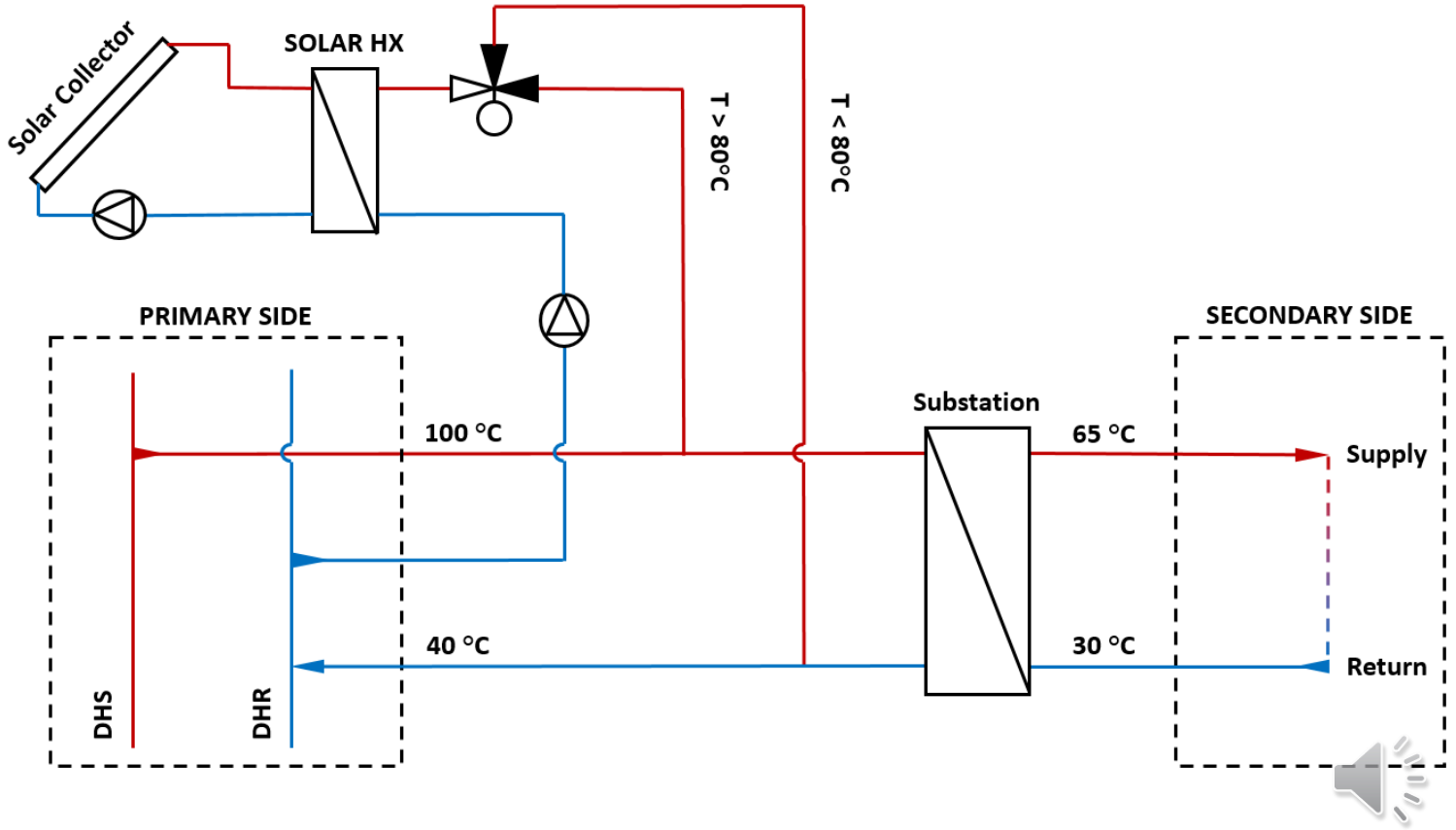


# Decentralised Solar System: High Temperature

**Return/return feed-in** connection

- Most common
- Return temperature >
- Simple control strategy
- Extra pipe needed

100 $m^2$ of solar panels for MDU05



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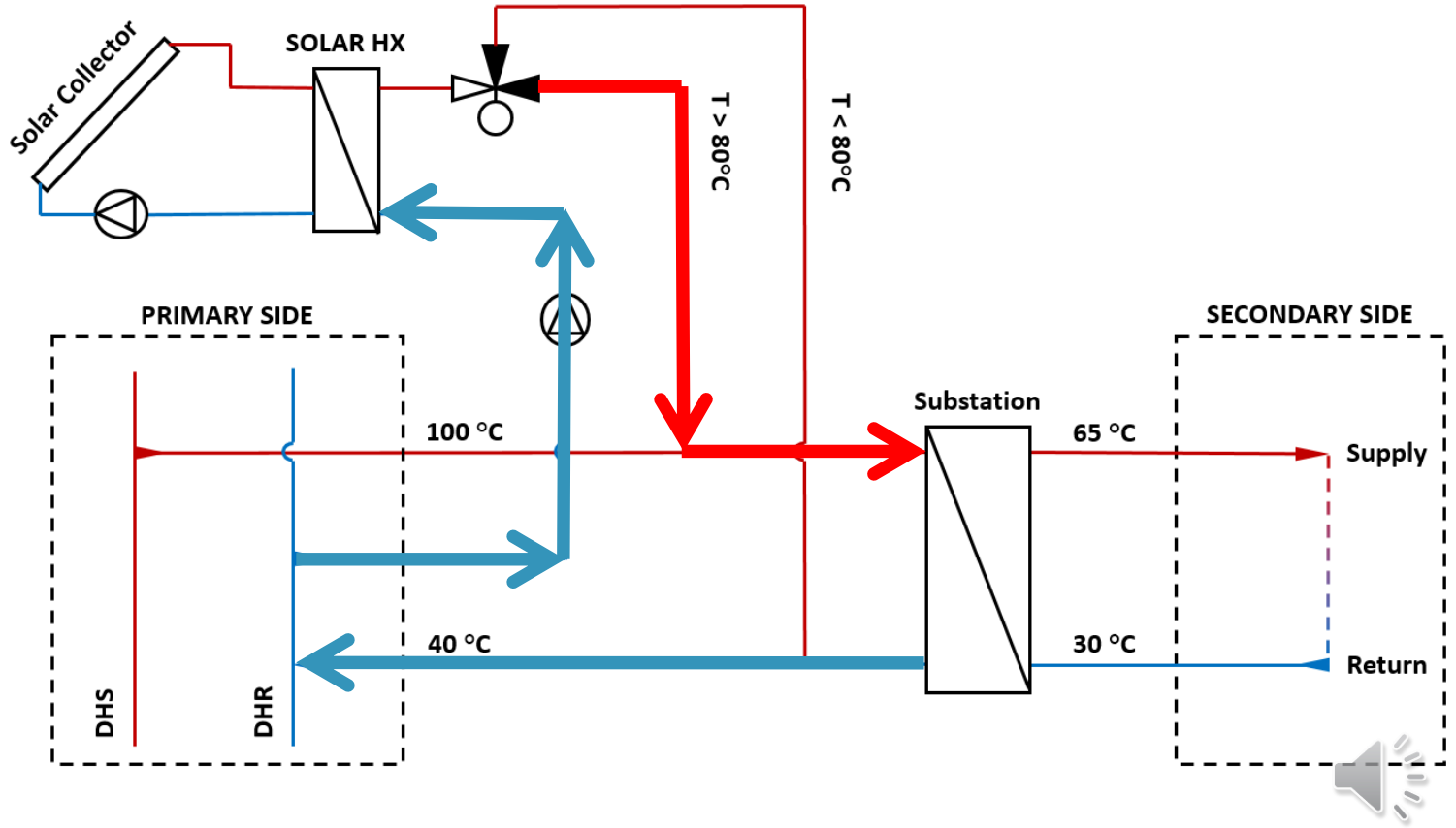
**T > 80 °C → user**



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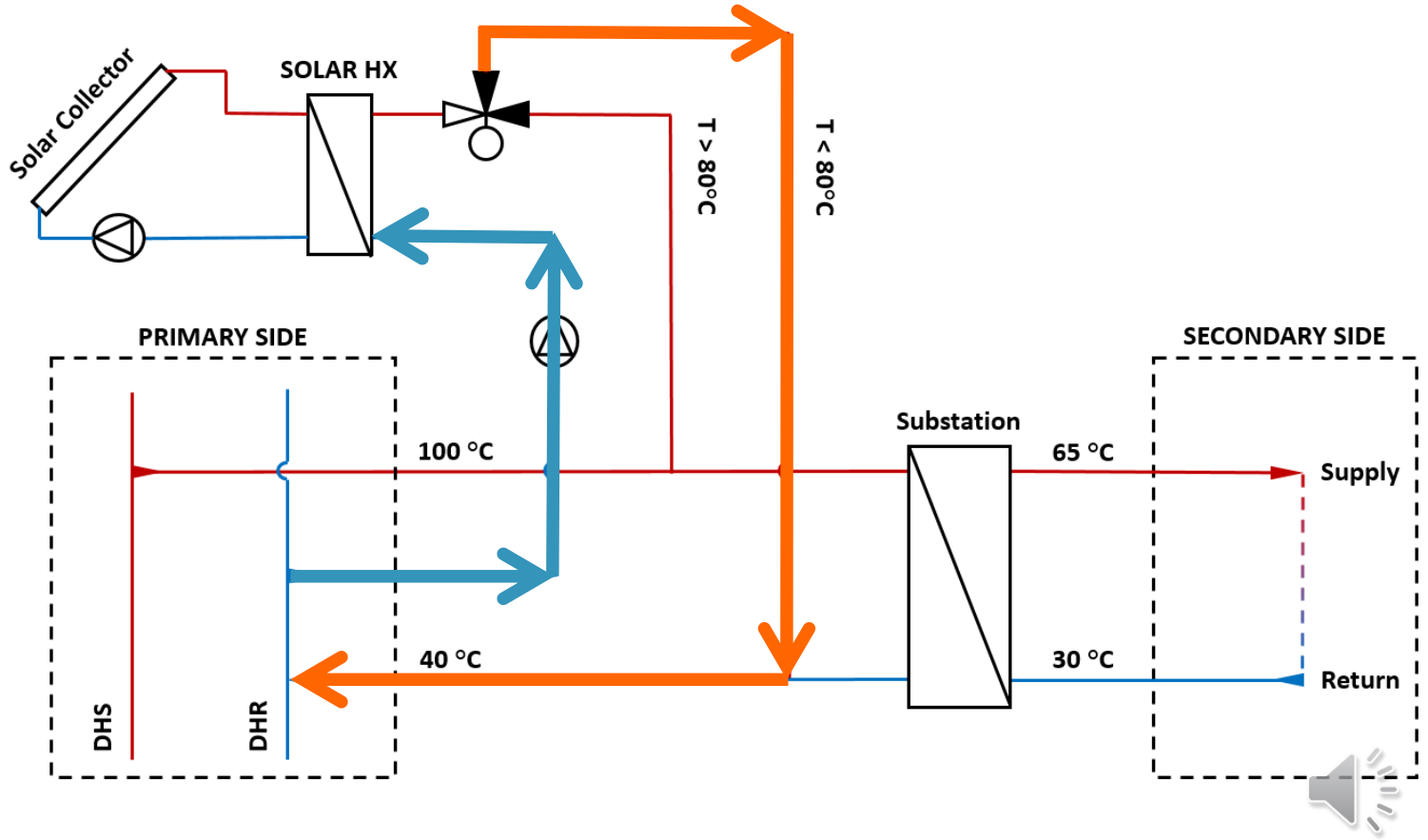
- **T > 80 °C → user**
- **T < 80 °C → network**



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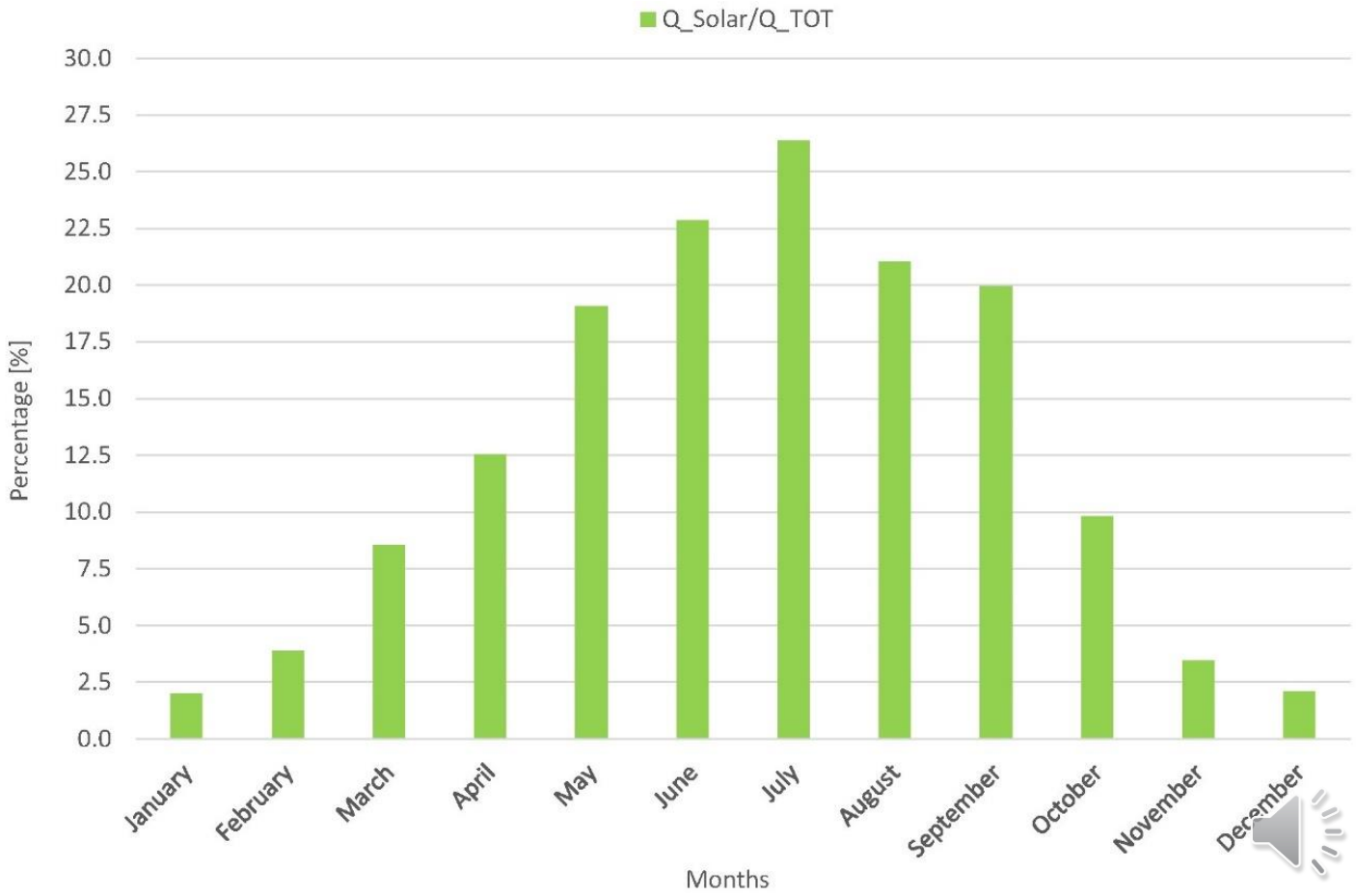
100 $m^2$ of solar panels for MDU05

- **T > 80 °C → user**
- **T < 80 °C → network**

The solar system can cover:

- **8.1 %** of the annual heating need

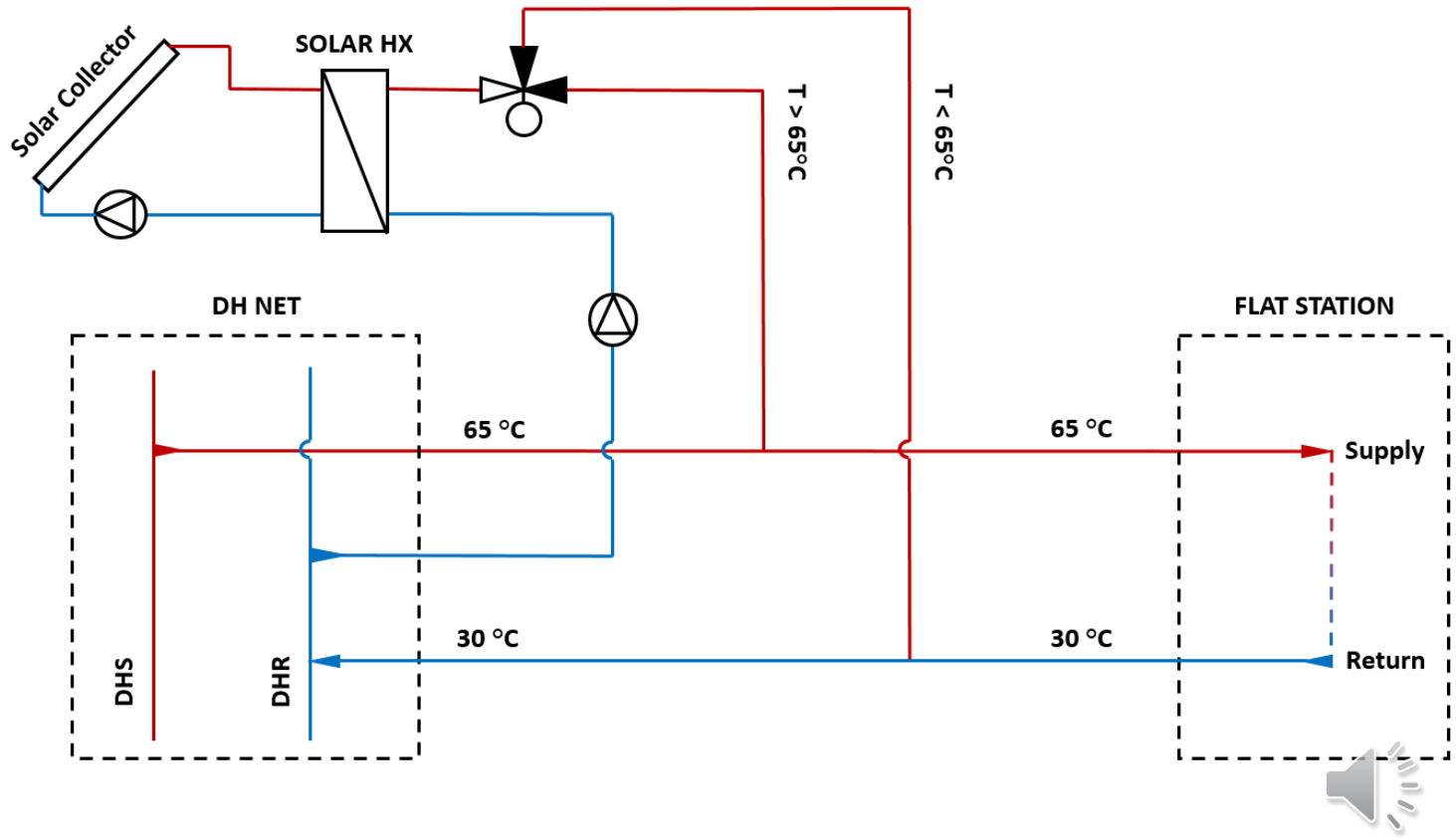


# Decentralised Solar System: Low Temperature

**Return/return feed-in** connection

- Construction point of view
- Solution can remain unchanged
- Simplify work on site

100 $m^2$ of solar panels for MDU05



# Decentralised Solar System: Low Temperature

**Return/return feed-in** connection

- Construction point of view
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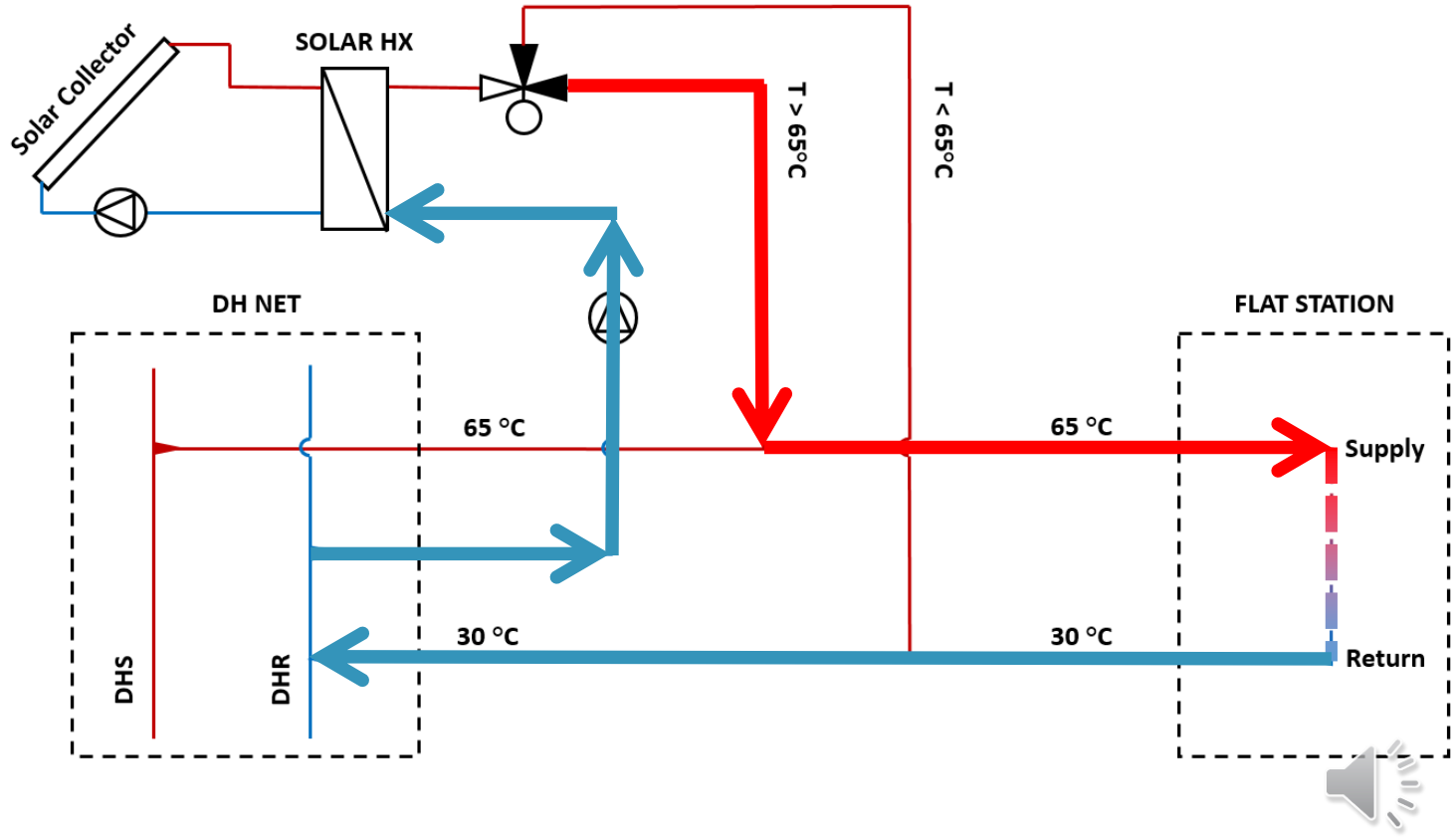
100 $m^2$ of solar panels for MDU05

**T > 65 °C → user**



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**Return/return feed-in** connection

- Construction point of view
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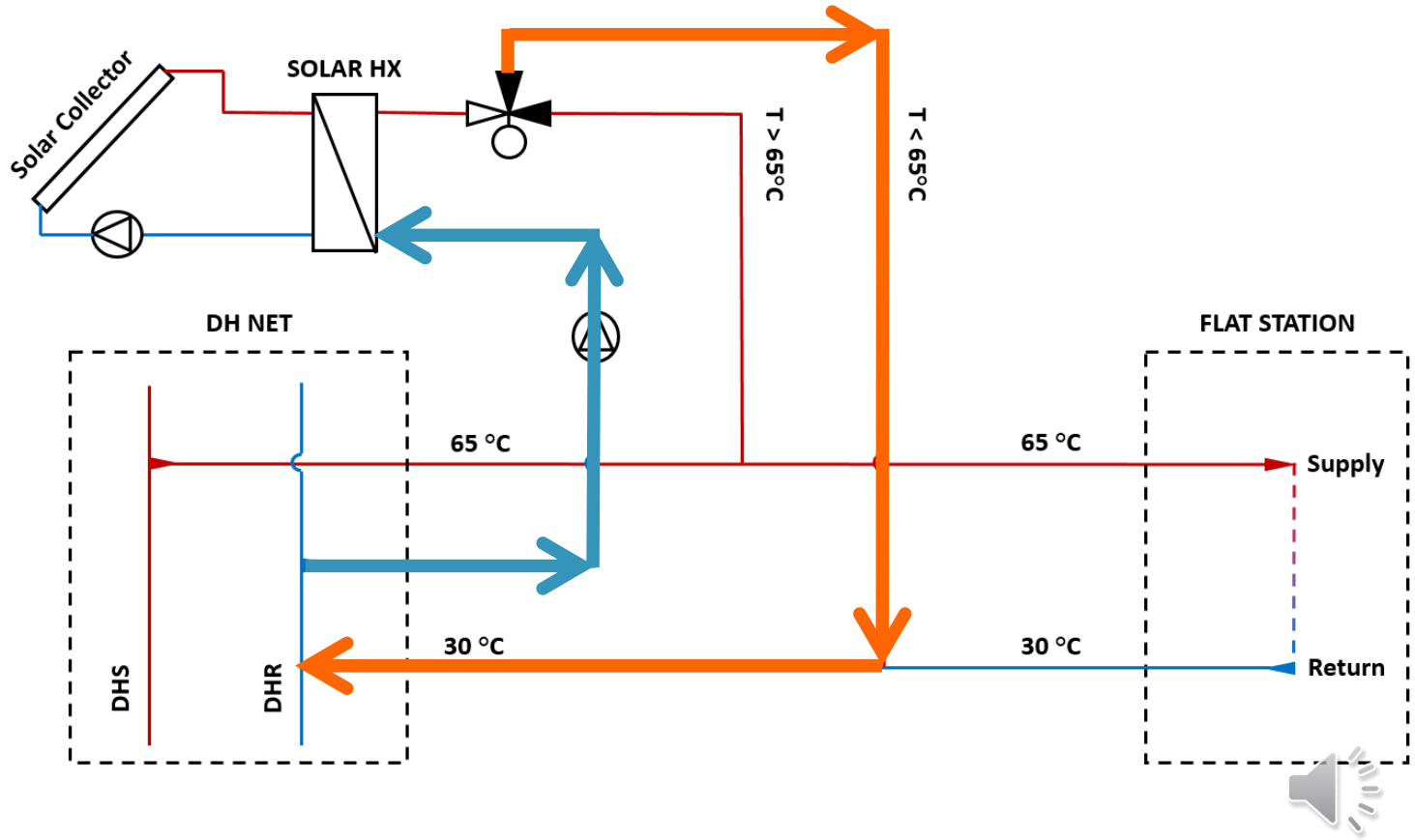
100 $m^2$ of solar panels for MDU05

- **T > 65 °C → user**
- **T < 65 °C → network**



# Decentralised Solar System: Low Temperature

**Return/return feed-in** connection

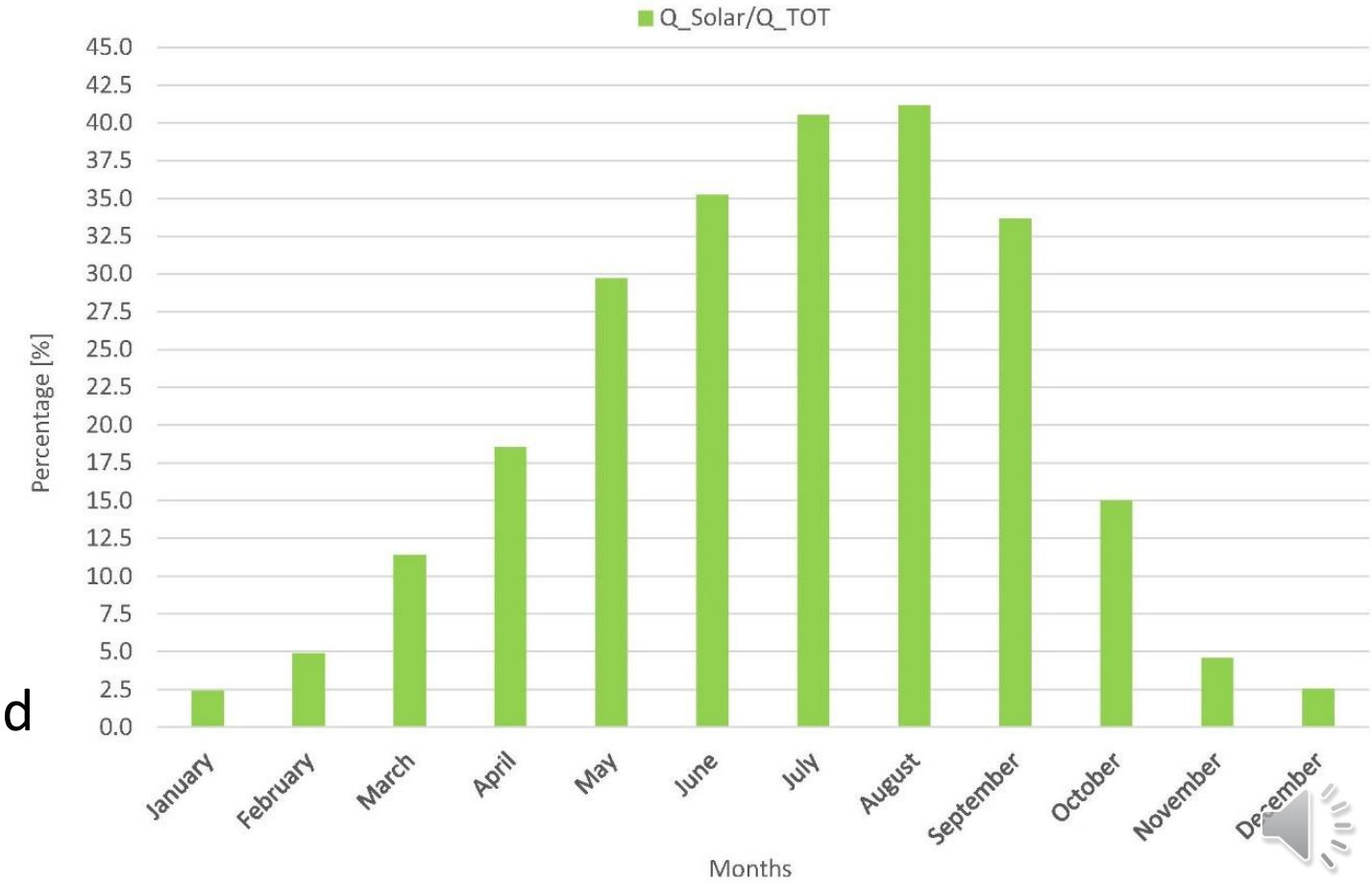
- Construction point of view
- Solution can remain unchanged
- Simplify work on site

100 $m^2$ of solar panels for MDU05

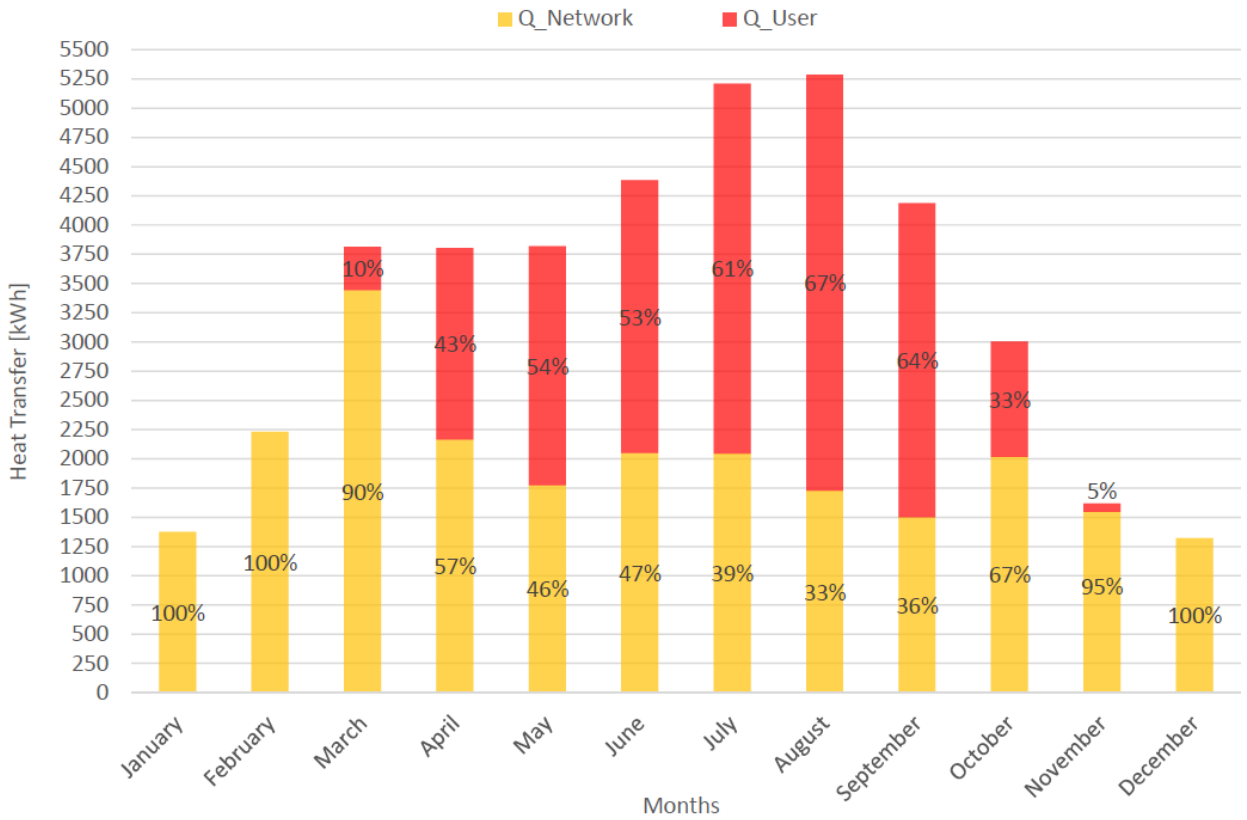
- **T > 65 °C → user**
- **T < 65 °C → network**

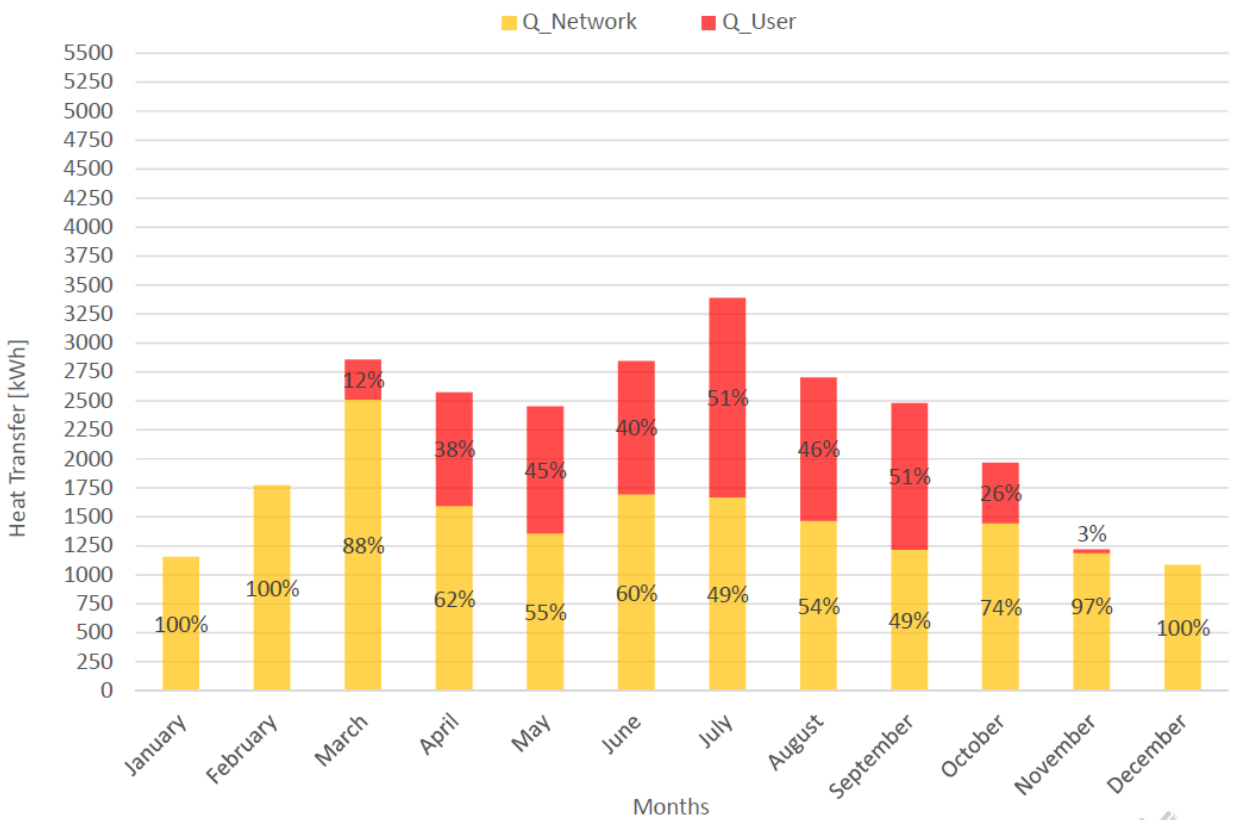
The solar system can cover:

- **12.2 %** of the annual heating need



# Decentralised Solar System: Comparison




LT save **40 MWh** per year VS HT save **26 MWh** per year

# Conclusion

- District heating: **good integration** of centralised and decentralised **renewable sources**
  - Optimized management
- Fundamental step: model validation to understand **reliability of results**
- LT network allows to enhance exploitation of **solar gains**
  - Improve **energy efficiency**
- Next steps: analysis of **different solar integrations**
  - Different feed-in connections
  - Different management of solar panels

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