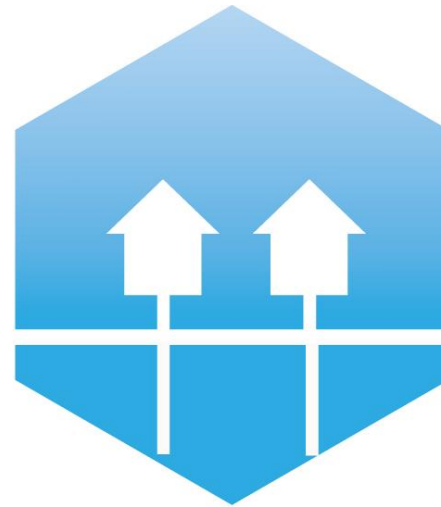
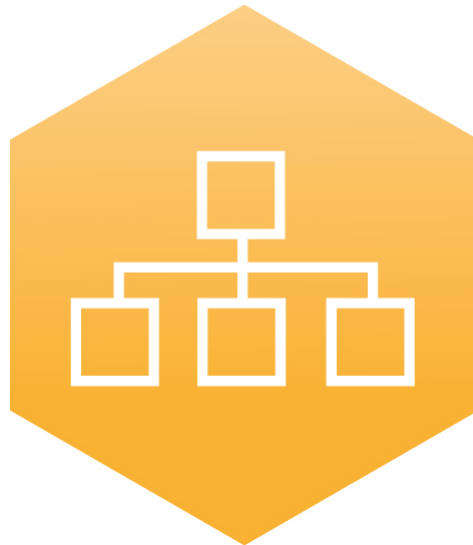


# The role of solar thermal in European high-renewable energy systems

Kenneth Hansen, Aalborg University



**AALBORG UNIVERSITY**  
DENMARK



# 4DH

4th Generation District Heating  
Technologies and Systems

# Content



- Introduction
- Scope of study
- Key findings
- The role of solar thermal

Introduction

Scope of study

Key findings

Role of solar thermal

# Introduction



- Research from IEA SHC Task 52 – Solar Heat and Energy Economics in Urban Environments

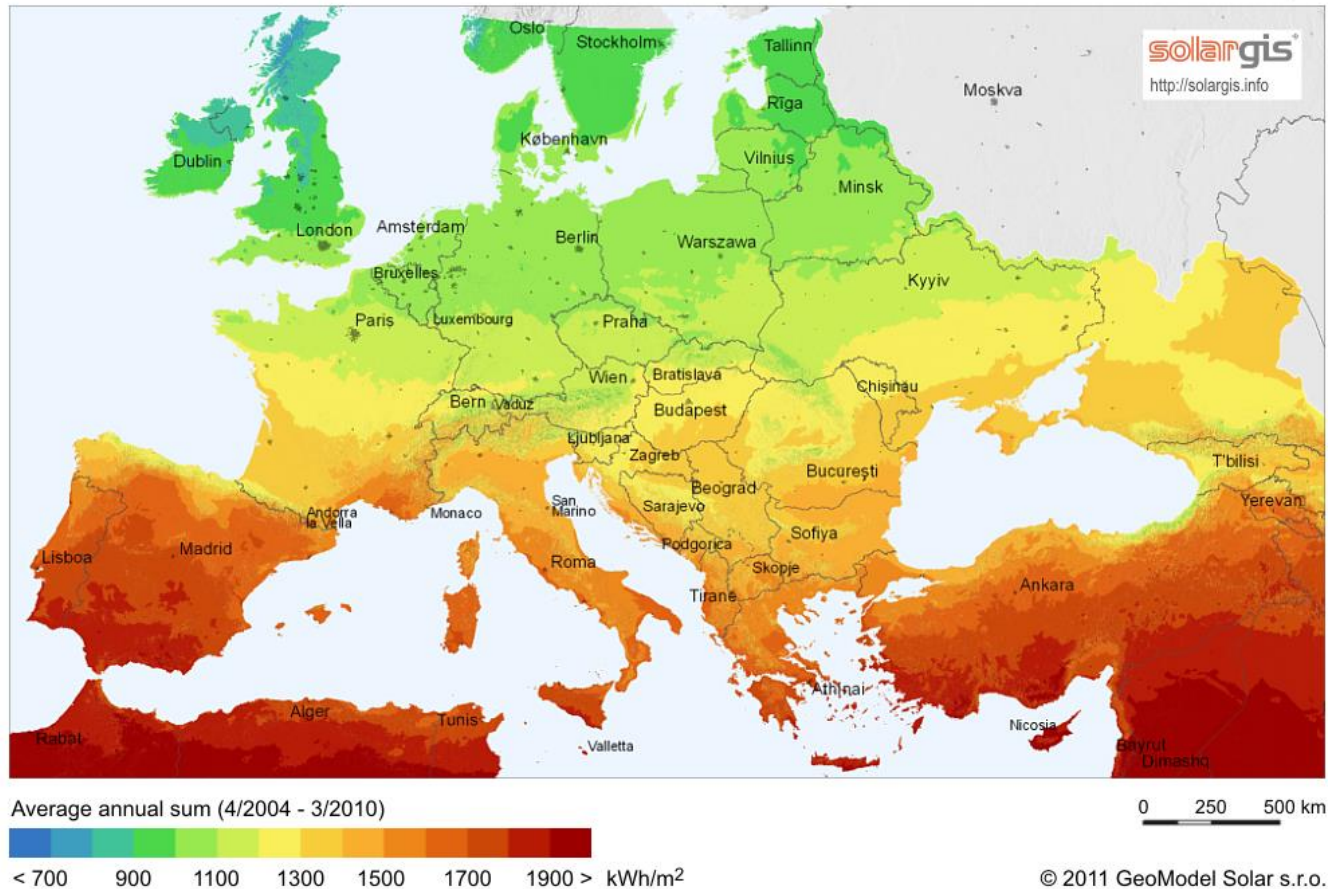


- Final phases of the project
- Initial findings and conclusions presented today

# Why looking into solar thermal?

Global horizontal irradiation

Europe



Solar irradiation → Solar yield → Levelized cost of heat (LCOH)

Introduction

Scope of study

Key findings

Role of solar thermal

# Objective of study



- The objective of the study is to identify the role of solar thermal in four European countries!
- From levelized costs perspective to energy systems perspective
- Levelized costs  $\neq$  suitability of solar thermal in an energy system
- Does not say anything about which type we should install
- Does not say anything about how much we should install



Task 52  
Solar Heat and Energy Economics  
in Urban Environments

Introduction

Scope of study

Key findings

Role of solar thermal

# Scope of study



- Four European countries are investigated:
  - Italy
  - Austria
  - Germany
  - Denmark
- Energy system analysis using EnergyPLAN:
  - Hourly simulations
  - All energy sectors
  - Primary energy, CO<sub>2</sub> and costs



# Solar thermal concepts

- Solar thermal concepts for hot water and space heating:
  - A) Marginal impact (1 TWh)
  - B) How much should be installed

1. Single-Family houses



2. Multi-Family houses



3. Block heating – larger storage



4. Solar District Heating – diurnal storage



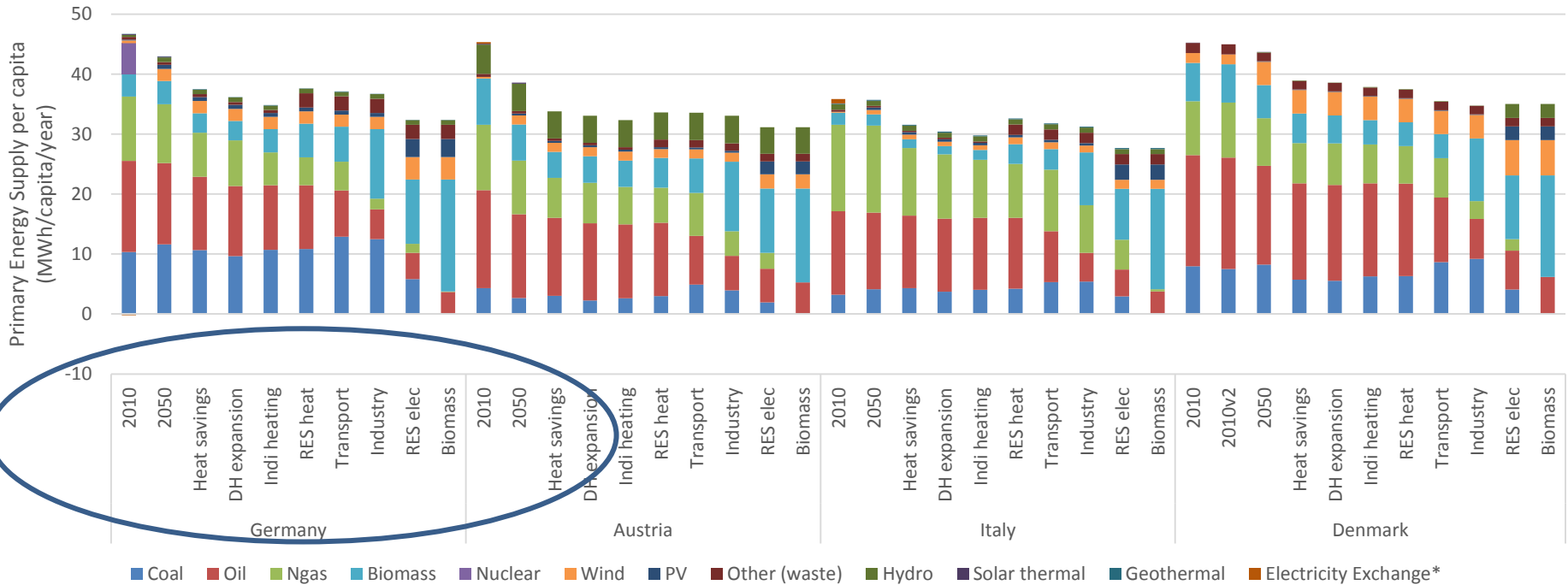
5. Solar District Heating – seasonal storage



# Models

Comprehensive analysis of solar thermal under different conditions

Steps towards a high-renewable energy system in electricity and heating sectors



Introduction

Scope of study

Key findings

Role of solar thermal



# Solar thermal findings



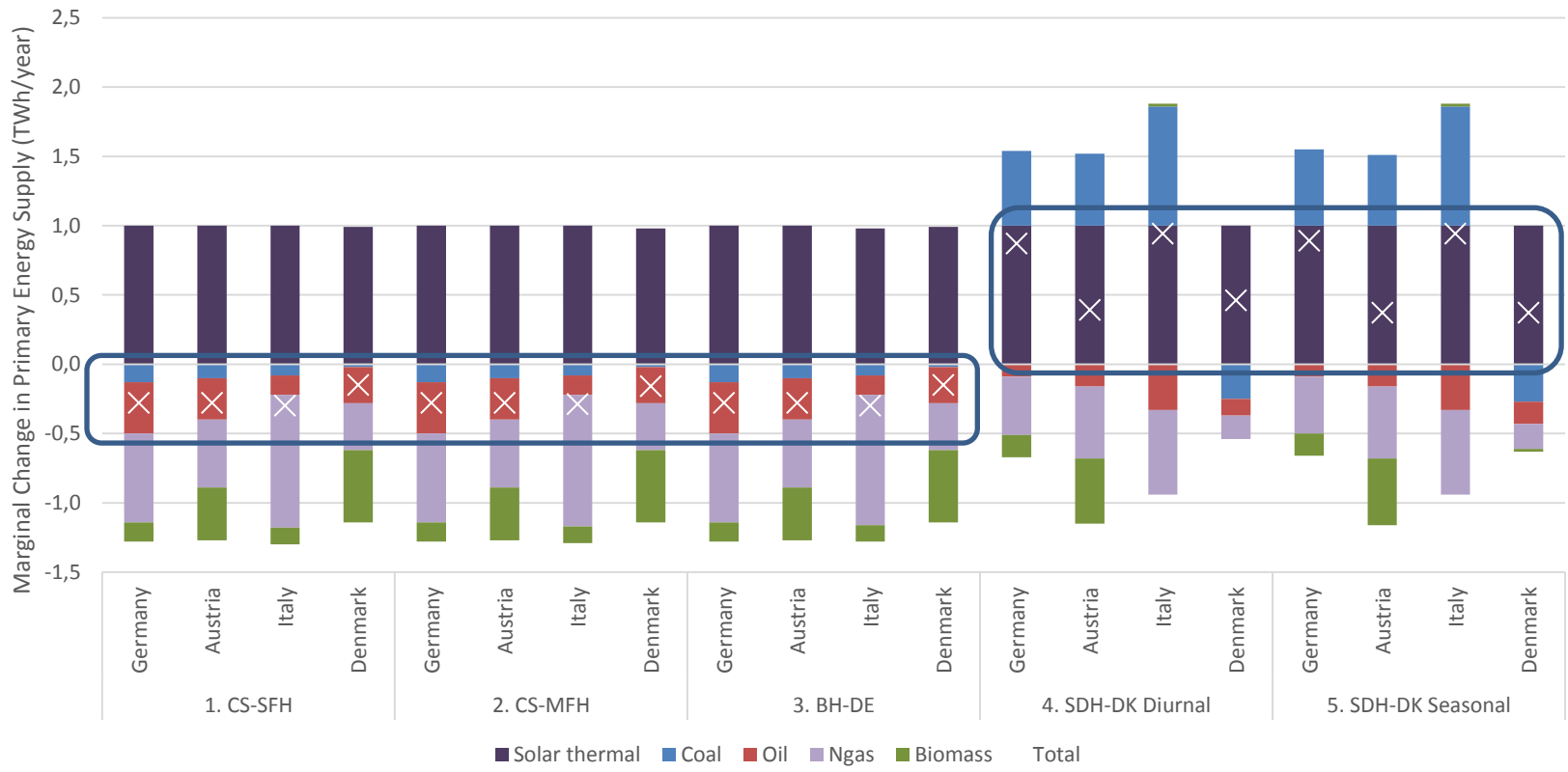
## Key findings:

1. Consider which technologies solar thermal replaces
  - A. Efficiency of system
  - B. CO<sub>2</sub> in system
2. The share of solar thermal is highly impacted by the solar penetration
3. Solar thermal is competing with other renewables in a high-renewable energy system

# Key finding 1 – technologies that are replaced



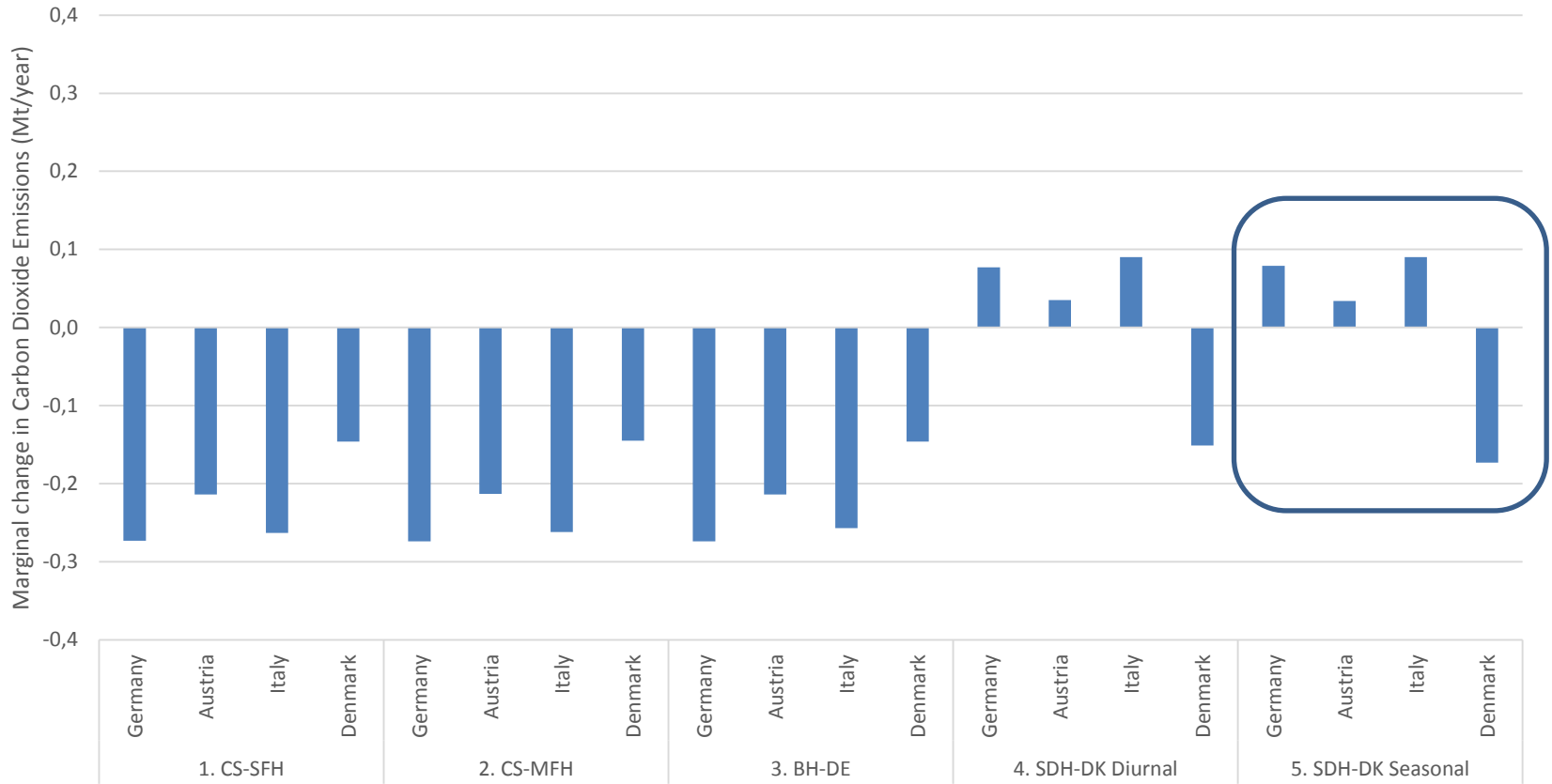
Marginal change in Primary energy supply when installing 1 TWh of solar thermal in a 2050 system



# Key finding 1 – technologies that are replaced



Marginal change in CO<sub>2</sub>-emissions when installing 1 TWh of solar thermal



# Key finding 1 – technologies that are replaced



Solar thermal district heating



Reduction in CHP production



Increase in condensing power plant production



Less heat production

Less electricity production

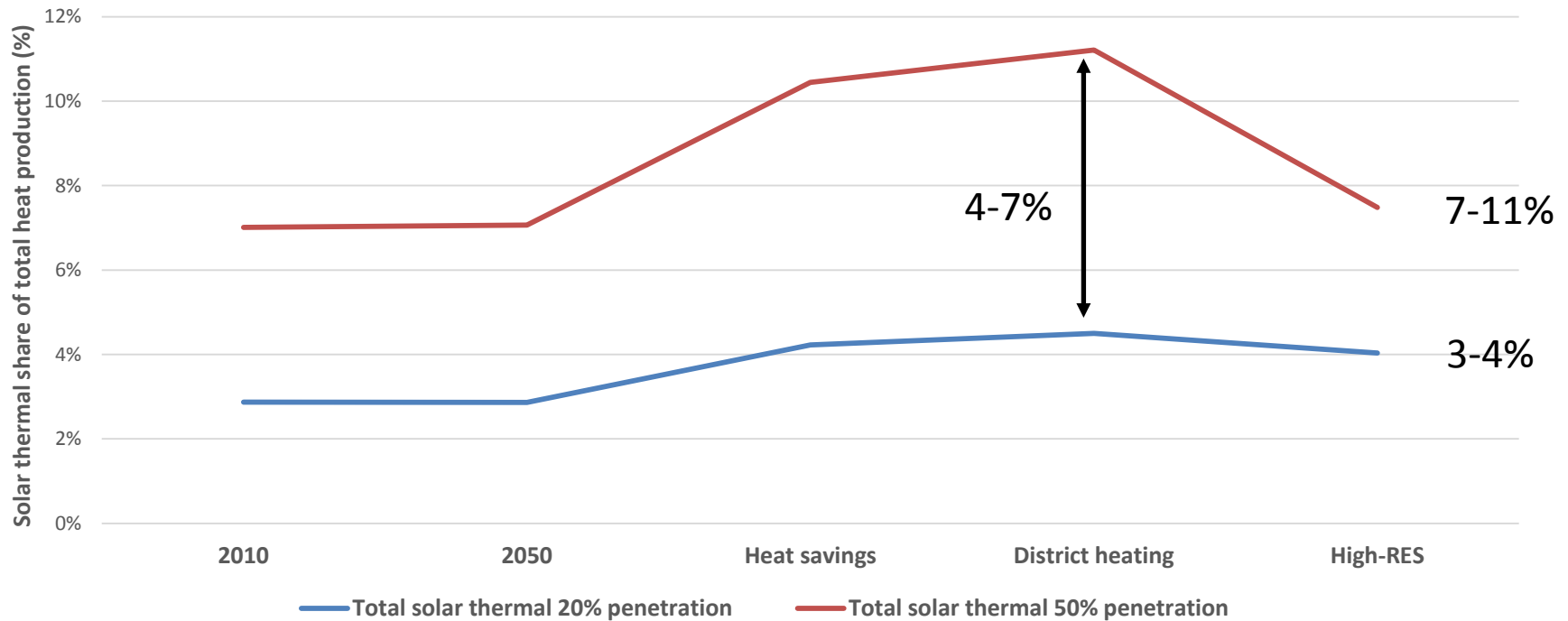
Reduction in natural gas and biomass

Increase in coal consumption

# Key finding 2 – Solar penetration

## Example of Germany

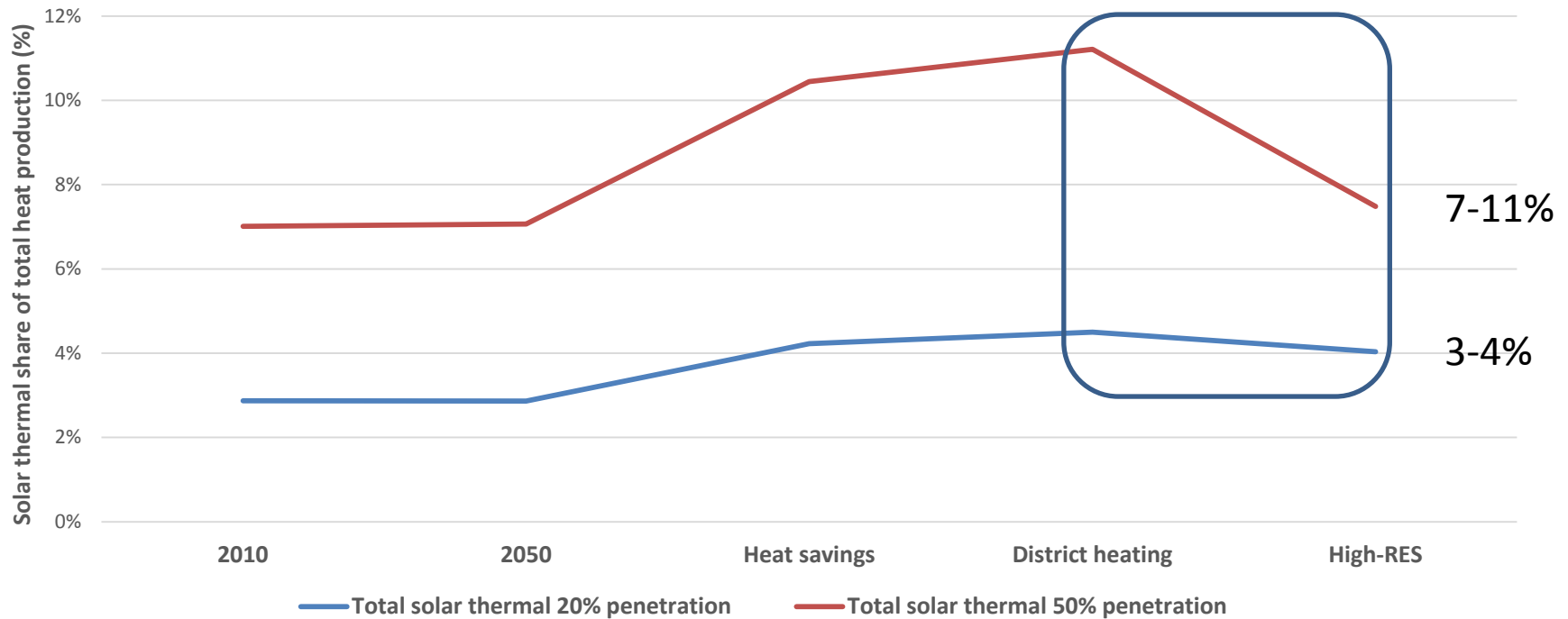
The solar penetration is crucial for the share of solar in the system  
- Example of Germany when 5% of the solar production is unused



# Key finding 3 – Competing with other renewables



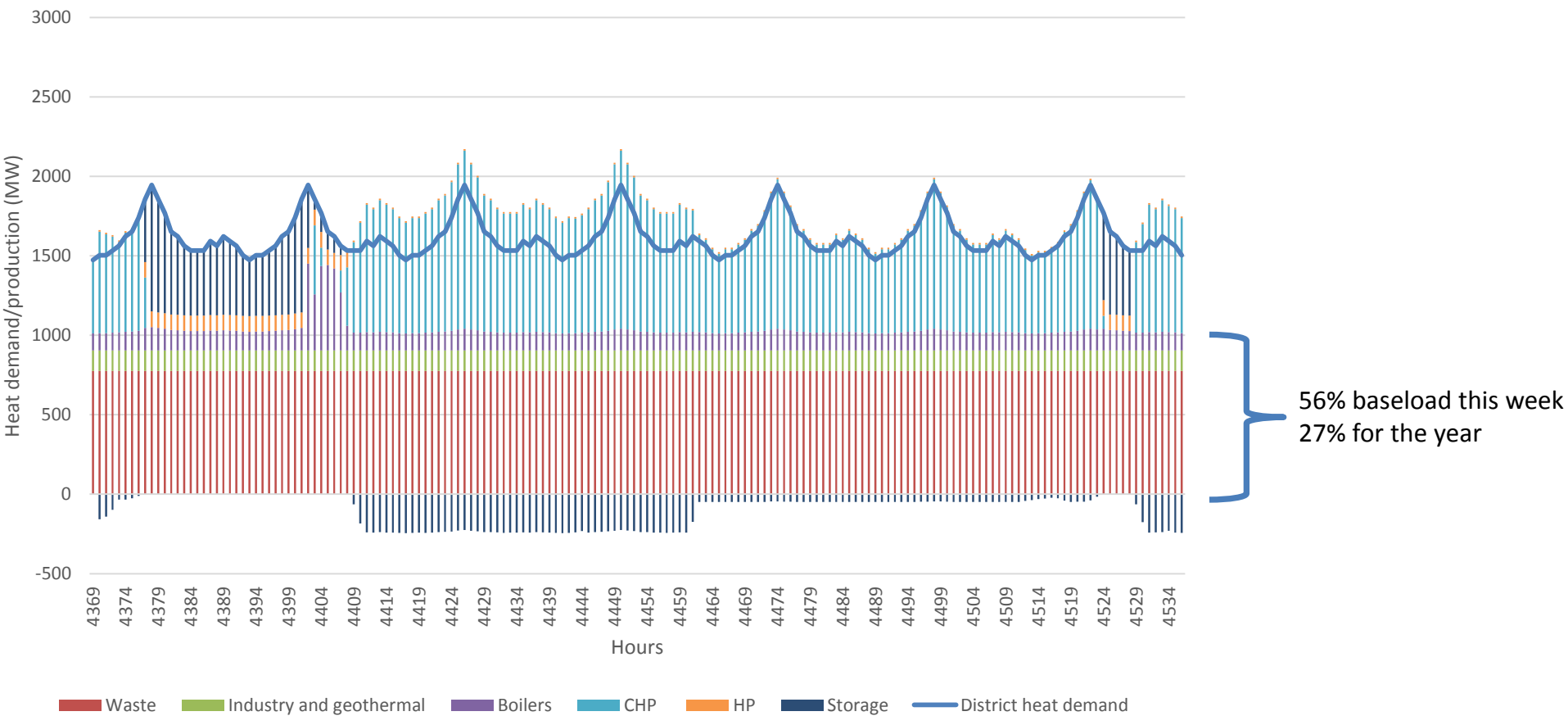
Solar thermal is competing with other technologies in a high-renewable energy system



# Key finding 3 – Competing with other renewables



Denmark 2050 district heating production before renewable integration – first week in July



Introduction

Scope of study

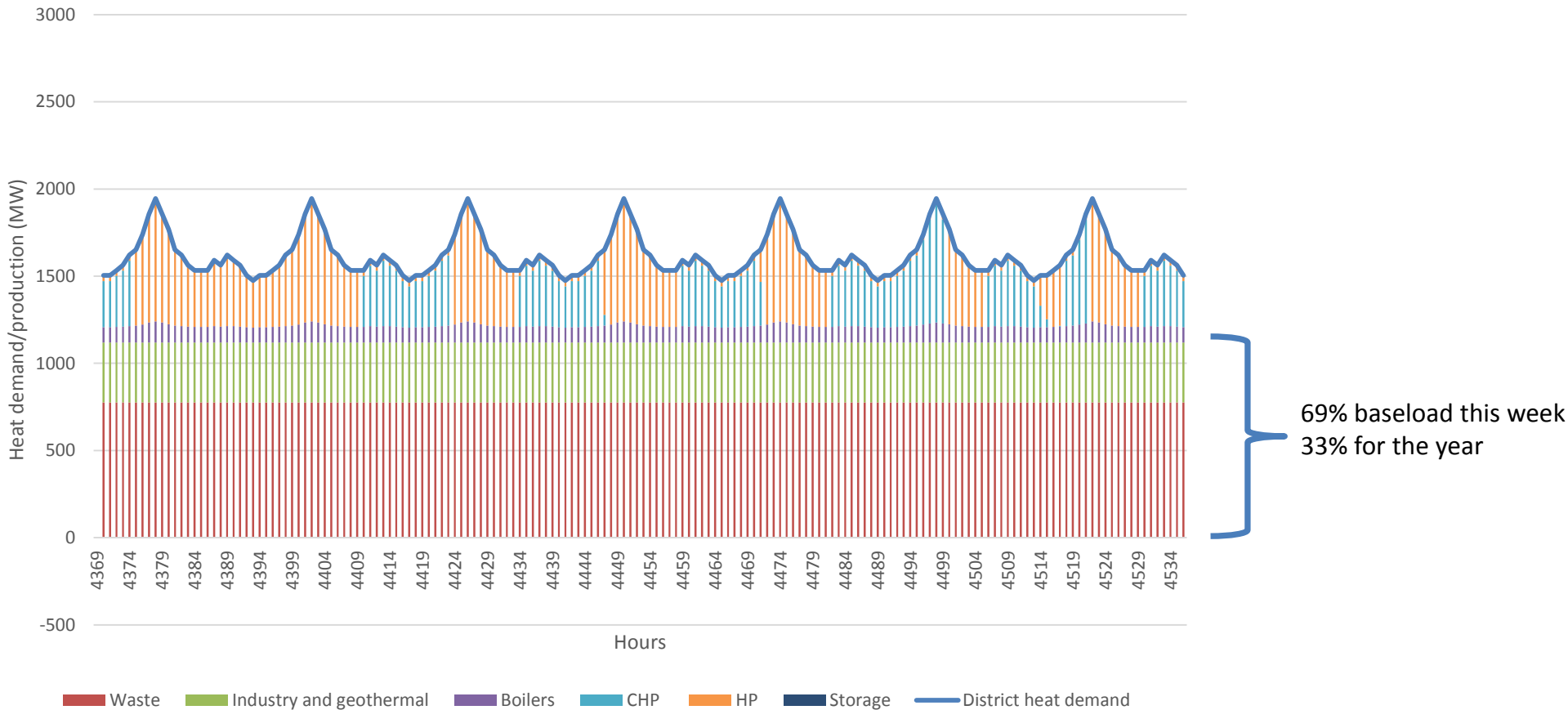
Key findings

Role of solar thermal

# Key finding 3 – Competing with other renewables



Denmark 2050 district heating production after renewable integration – first week in July



And solar thermal replaces cheaper fuels (RES electricity and biomass)



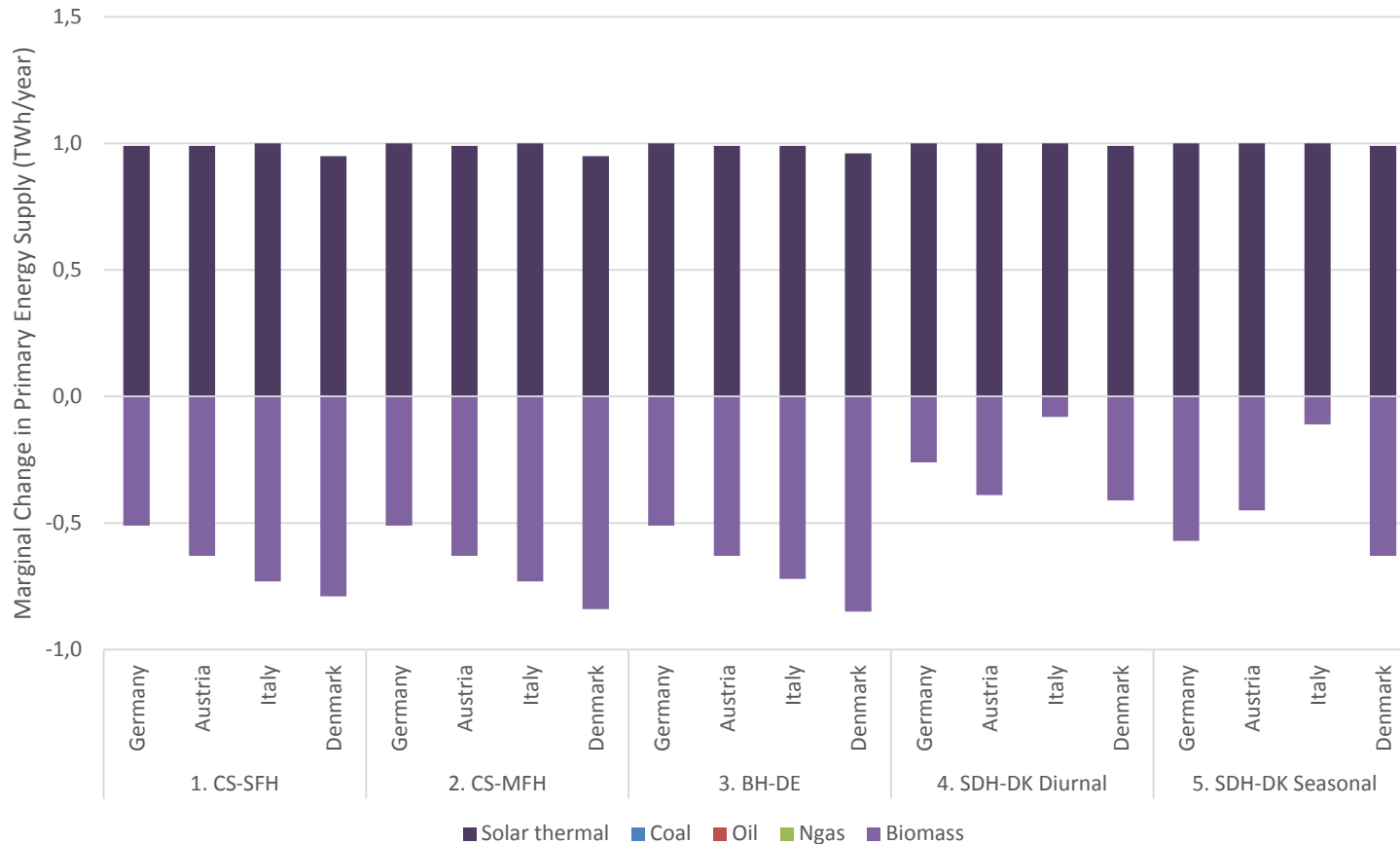
# The role of solar thermal



- There will be a high pressure on both renewable electricity sources and biomass resources when converting to a high-renewable energy system
- The role of solar thermal:
  - To reduce the dependency on biomass when converting to high-renewable energy systems
  - To enhance security of supply
  - To reduce the fluctuations in energy prices

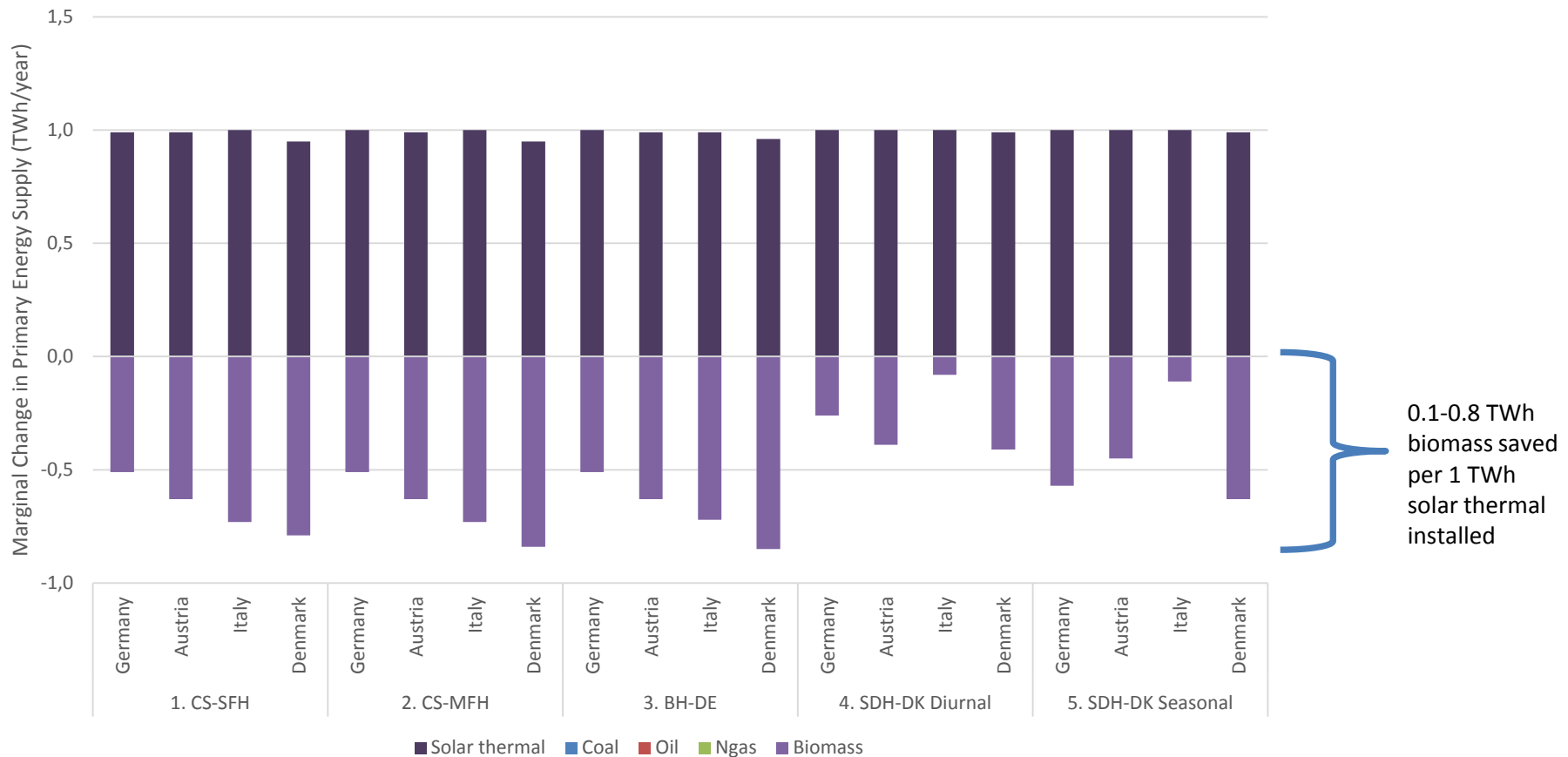
# Dependency on biomass

Marginal changes to Primary energy supply in a high-renewable scenario when installing 1 TWh of solar thermal



# Dependency on biomass

Marginal changes to Primary energy supply in a high-renewable scenario when installing 1 TWh of solar thermal

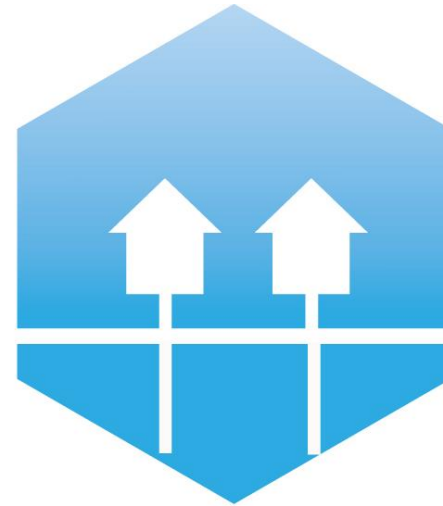
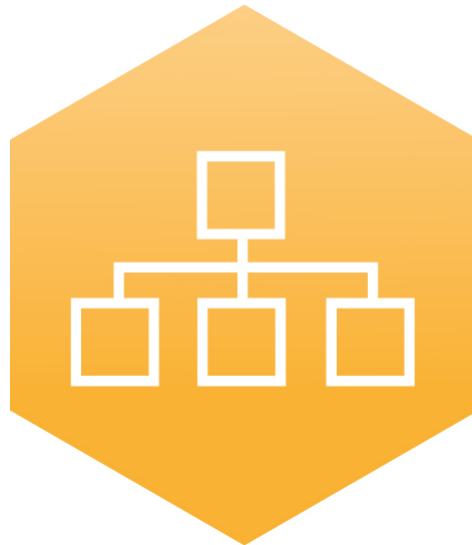


# Thank you for your attention!

Read more on <http://task52.iea-shc.org/>



**AALBORG UNIVERSITY**  
DENMARK



# 4DH

**4th Generation District Heating  
Technologies and Systems**