

#SES4DH2017

3<sup>rd</sup> International Conference on

# Smart Energy Systems and 4<sup>th</sup> Generation District Heating

12-13 September 2017 · National Museum · Copenhagen

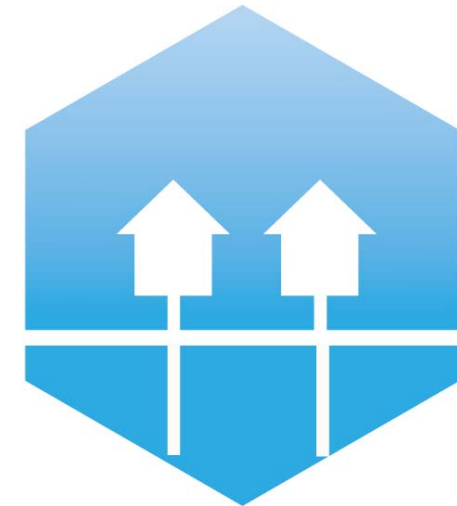
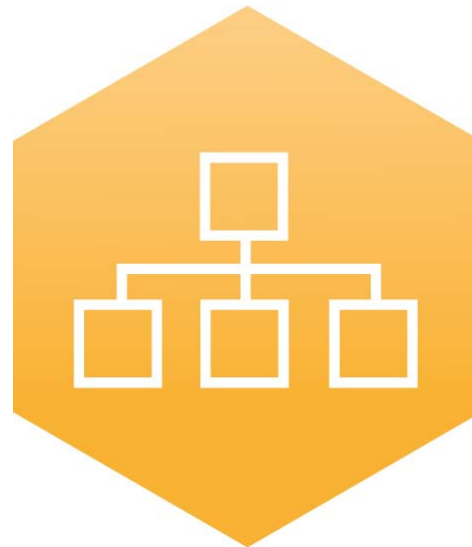


AALBORG UNIVERSITY  
DENMARK



Innovation Fund Denmark  
RESEARCH, TECHNOLOGY & GROWTH

# Welcome



AALBORG UNIVERSITY  
DENMARK



#SES4DH2017

reINVEST

# 4DH

4th Generation District Heating  
Technologies and Systems

3<sup>RD</sup> INTERNATIONAL CONFERENCE ON  
SMART ENERGY SYSTEMS AND  
4<sup>TH</sup> GENERATION DISTRICT HEATING

COPENHAGEN, 12-13 SEPTEMBER 2017



340 Participants



25 different countries



150 presentations



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#SES4DH2017

www.4DH.dk

# 4DH

4th Generation District Heating Technologies and Systems

HOME NEWS EVENTS PUBLICATIONS & REPORTS PROJECTS UNIVERSITY COURSES ABOUT 4DH LOGIN FLYER- 4DH 3RD A

## WELCOME TO 4DH

4DH is an international research centre which develops 4th generation district heating technologies and systems. This development is fundamental to the implementation of the Danish objective of being fossil fuel-free by 2050 and the European 2020 goals.

LATEST NEWS FROM 4DH

- 18 MAR 4DH 3rd Annual C Flyer
- 21 NOV 3rd annual Confer
- 04 OCT 2nd annual confer energy faces a ch

**Appendix B: Project description**  
**Strategic Research Centre for**  
**4th Generation District Heating Technologies and Systems (4DH)**

**University partners**

- AALBORG UNIVERSITET
- DTU
- SVEDANSK UNIVERSITET
- 清华大学 (Tsinghua University)
- CHALMERS
- Linnaeus University
- UNIVERSITÄT ZAGREB

**Private partners**

- RAMBOLL
- COWI
- NIRÅS
- EHD International A/S
- PlanEnergy

**District heating companies**

- VEVS
- ÅRSLEV KØPMØDE
- FORSYNINGSVIRKSOMHEDERNE
- københavn
- AFFALDVARME AARHUS
- Ringkøbing-Skjern Kommune
- VESTFORBRÆNDING
- Fjernvarme Fyn

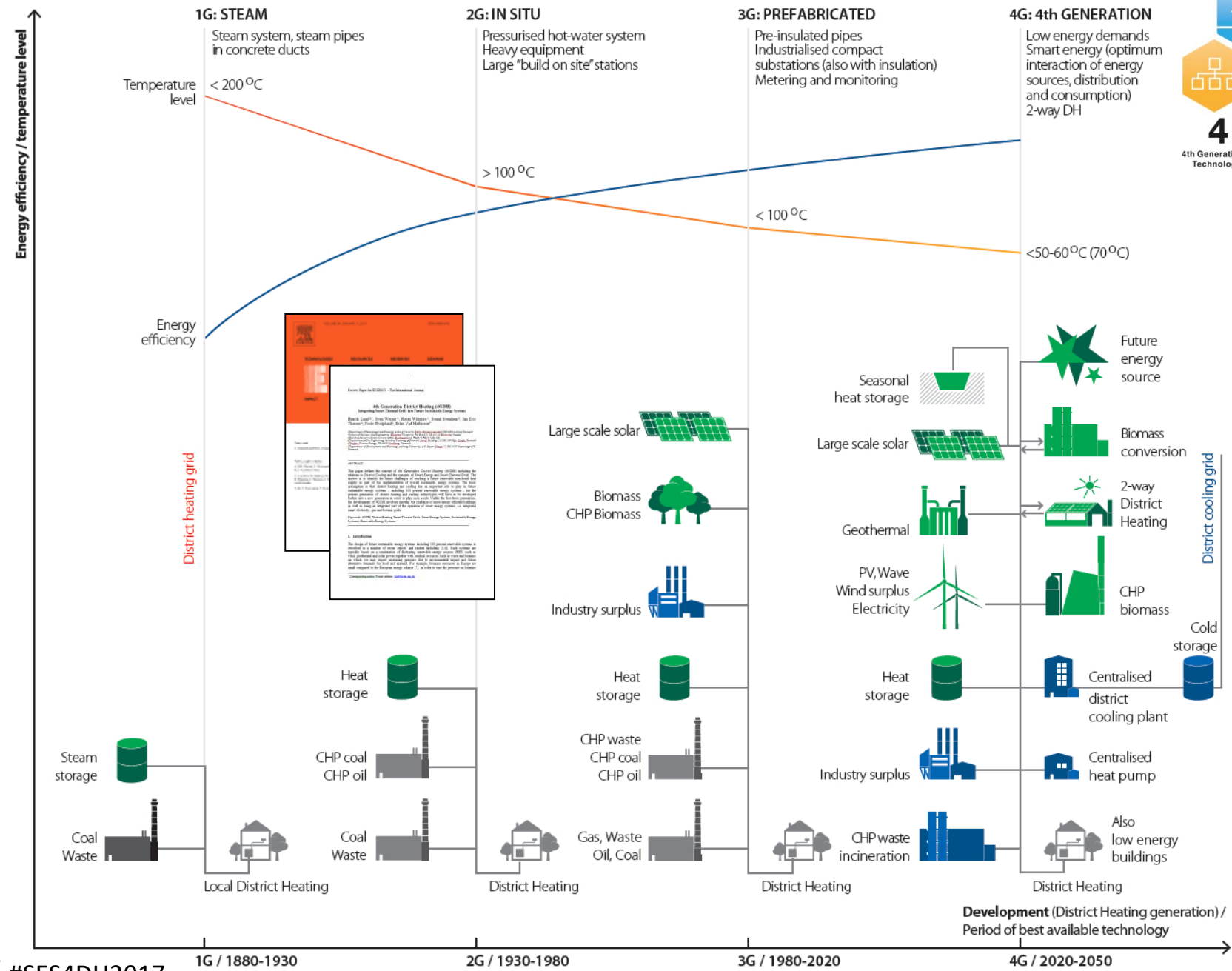
**Dissemination partners**

- Fjernvarmens Udviklingscenter
- Dansk Fjernvarme
- EUROHEAT & POWER
- CTR - Centralkommunernes Transmissionselskab I/S

**Industrial partners**

- LOGSTOR
- Danfoss
- Ålbækvej 10 Ribe Jernindustri
- SPX
- Kamstrup
- THE DESMI GROUP





## RENEWABLE ENERGY INVESTMENT STRATEGIES A TWO-DIMENSIONAL APPROACH

- Analyzing synergies in low-cost energy storages across sectors and potential energy savings with high amounts of renewable energy
- Identifying the role of international electricity and gas transmission in integrated renewable Smart Energy Systems
- Overcoming silo-thinking from traditional energy sectors and development of novel methodologies and results for renewable energy investment strategies in Denmark and Europe.
- Research based design of robust and cost-effective investment strategies

17 Partners

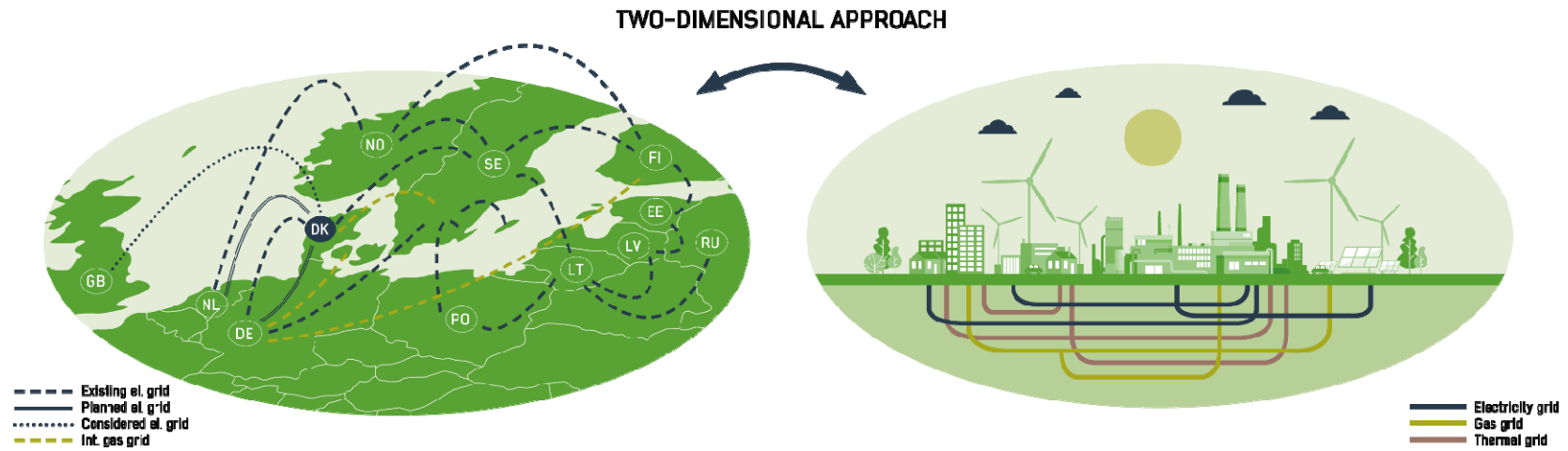


9 Advisory Board Members




# RENEWABLE ENERGY INVESTMENT STRATEGIES

## A TWO-DIMENSIONAL APPROACH



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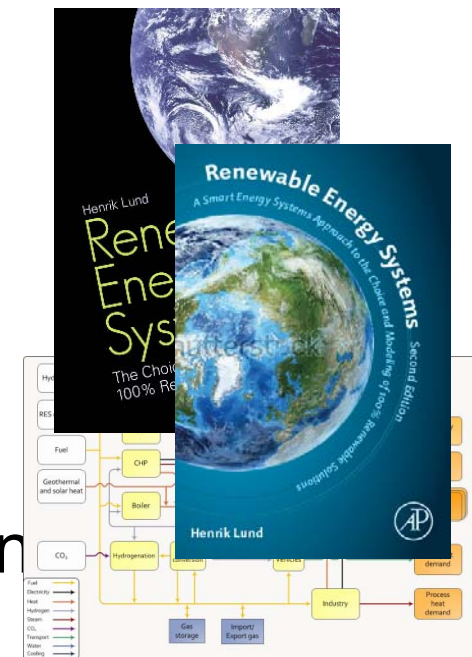
@ReInvestEU

#SmartEnergySystems & #4DH

# Smart Energy Systems

The key to cost-efficient 100% Renewable Energy

- A sole focus on renewable **electricity (smart grid)** production leads to electricity storage and flexible demand solutions!
- Looking at renewable electricity as a part **smart energy systems** including heating, industry, gas and transportation opens for cheaper and better solutions...



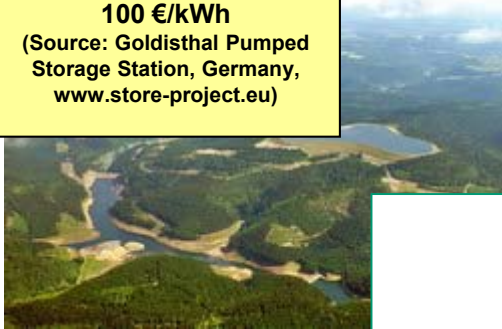
Power-to-Heat

Power-to-Gas  
Power-to-Transport

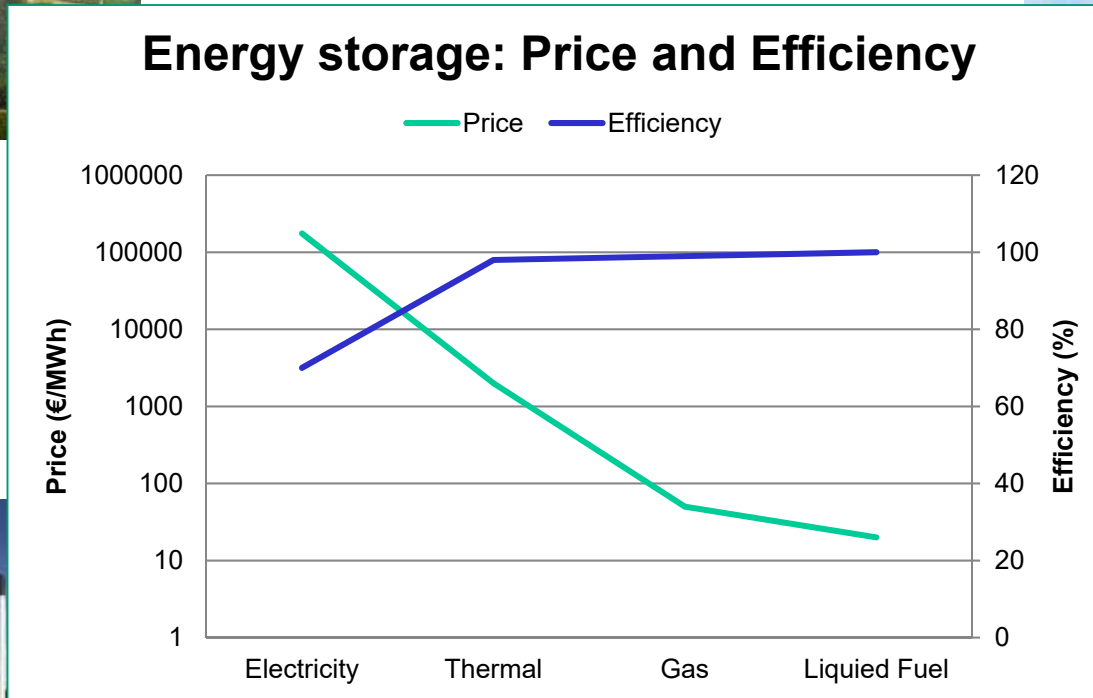


# Energy Storage

**Pump Hydro Storage**  
**100 €/kWh**  
(Source: Goldisthal Pumped Storage Station, Germany, [www.store-project.eu](http://www.store-project.eu))

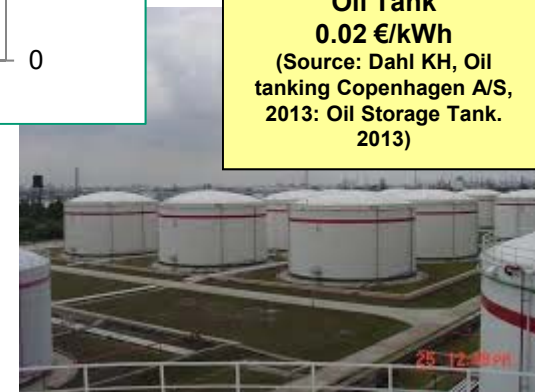


**Thermal Storage**  
**1-4 €/kWh**  
(Source: Danish Technology Catalogue, 2012)



**Natural Gas Underground Storage**  
**0.05 €/kWh**  
(Source: Current State Of and Issues Concerning Underground Natural Gas Storage. Federal Energy Regulatory Commission, 2004)

**Oil Tank**  
**0.02 €/kWh**  
(Source: Dahl KH, Oil tanking Copenhagen A/S, 2013: Oil Storage Tank. 2013)



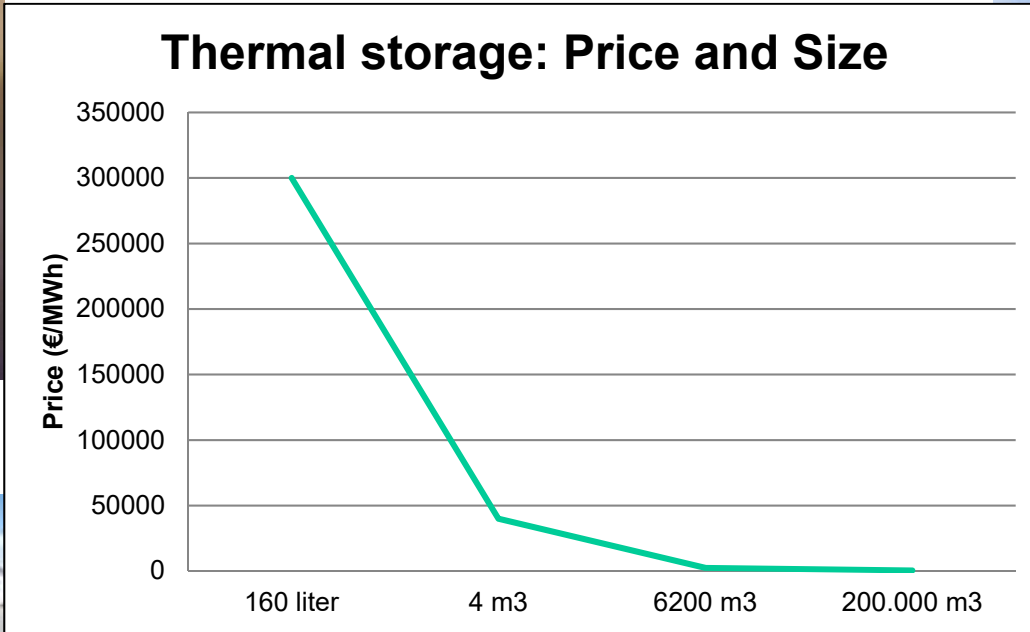


# Thermal Storage

**0.16 m3 Thermal Storage**  
**300.000 €/MWh**  
(Private house: 160 liter  
for 15000 DKK)



**6200 m3 Thermal Storage**  
**2500 €/MWh**  
(Skagen: 6200 m3  
for 5.4 mio. DKK)



**4 m3 Thermal Storage**  
**40,000 €/MWh**  
(Private outdoor: 4000 m3  
for 50,000 DKK)



**200,000 m3 Thermal Storage**  
**500 €/MWh**  
(Vojens: 200,000 m3  
for 30 mio. DKK)



# Smart Energy Systems



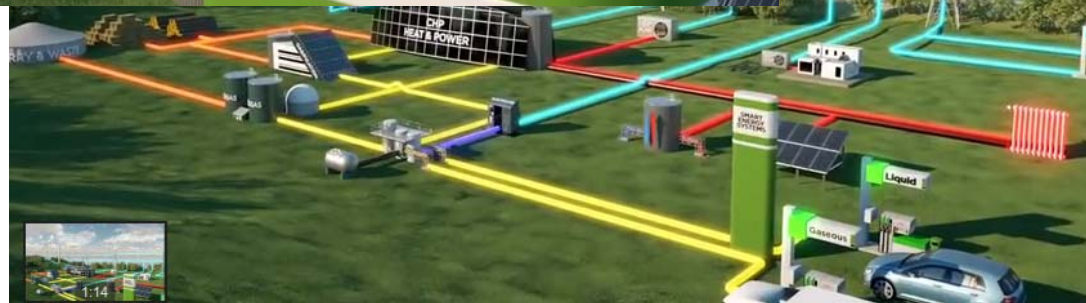
[www.energyplan.eu/smartenergysystems/](http://www.energyplan.eu/smartenergysystems/)



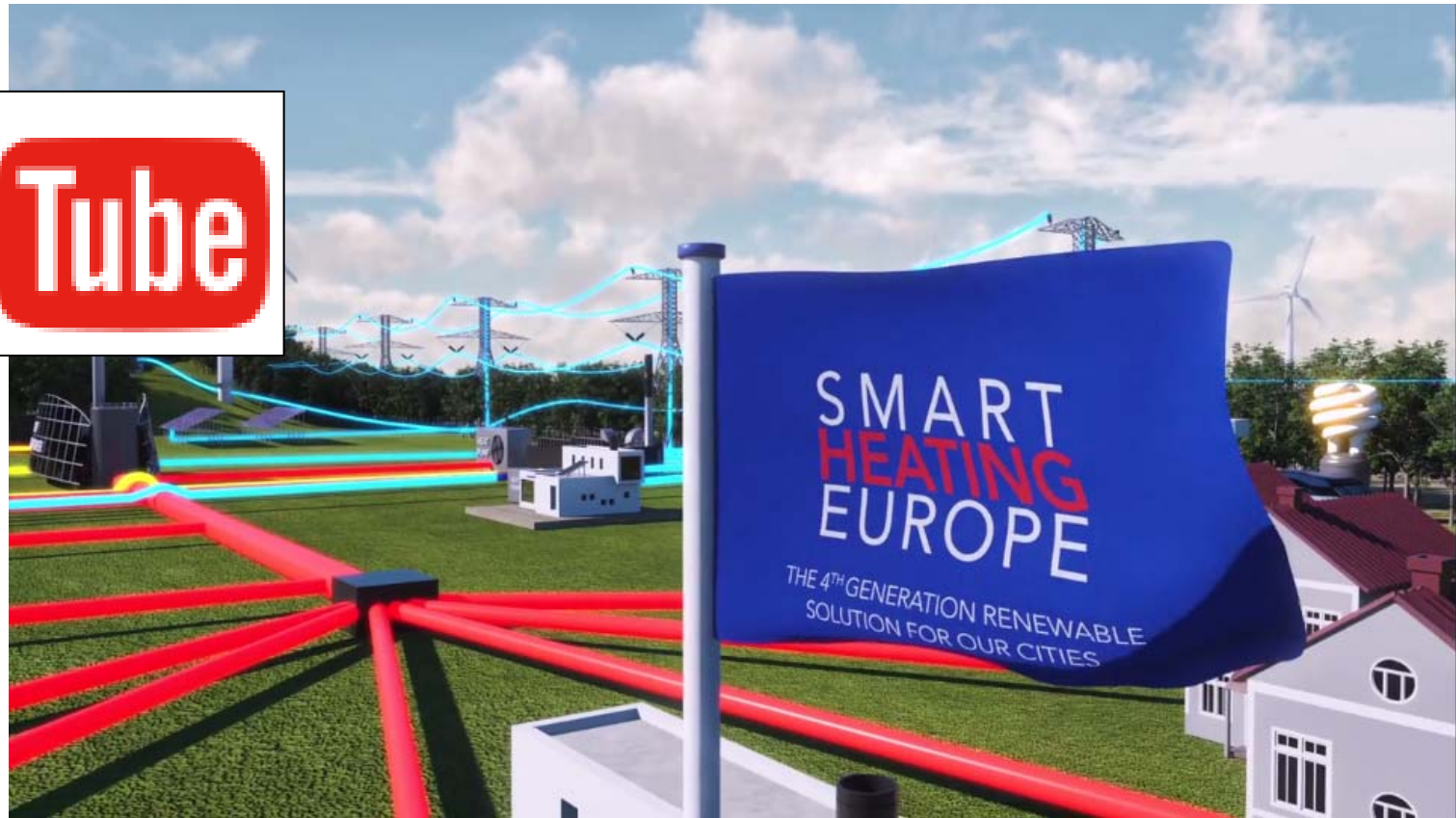
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# Smart Heating Europe



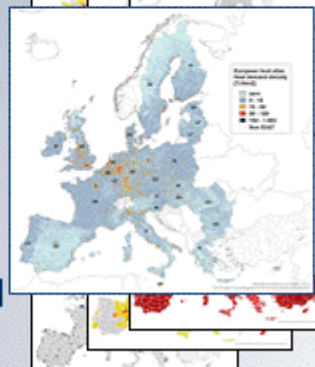
# Heat Roadmap Europe

**Heat Roadmap Europe 2050**

## GIS Mapping: Many Heat Sources

- Urban areas (Heating Demands)
- Power and Heat Generation
- Waste Management
- Industrial waste heat potential
- Geothermal heat
- Solar Thermal

the study indicates that the **market shares for district heating for buildings can be increased to 30% in 2030 and 50% in 2050.**



Logos: EUROHEAT & POWER, AALBORG UNIVERSITY DENMARK, ECOFYS, PlanEnergi

**HEAT ROADMAP EUROPE 2050**


FIRST PRE-STUDY FOR THE EU27



Aalborg University  
David Connolly

**HEAT ROADMAP EUROPE 2050**

SECOND PRE-STUDY FOR THE EU27



By

**Aalborg University**  
David Connolly  
Brian Vind Mathiesen  
Poul Albert Østergaard  
Berni Müller  
Steffen Nielsen  
Henrik Lund

**Halmstad University**  
Urban Persson  
Sven Werner

**Ecofys Germany GmbH**  
Jan Götzinger  
Thomas Boermans  
Michelle Bosquet

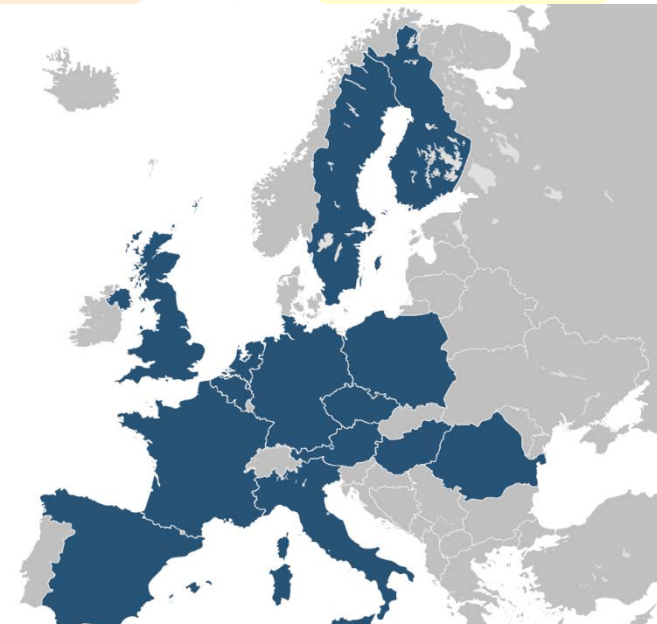
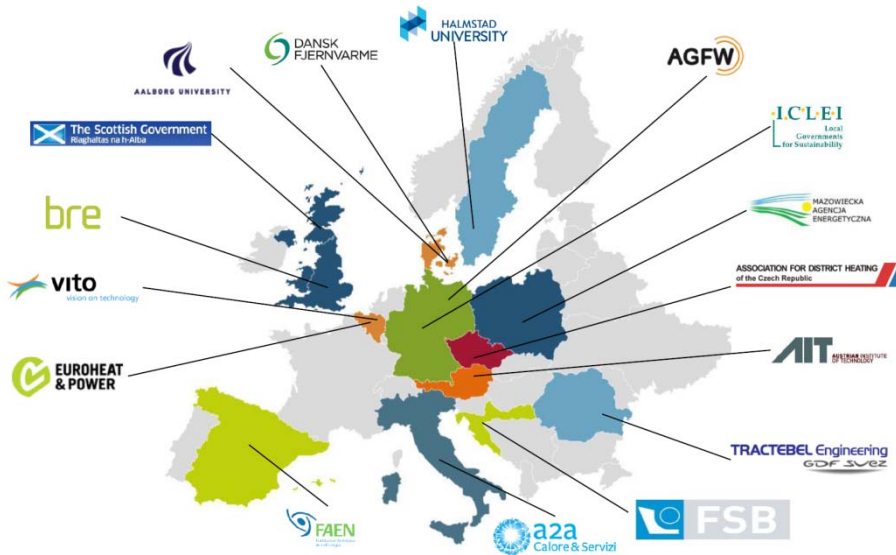
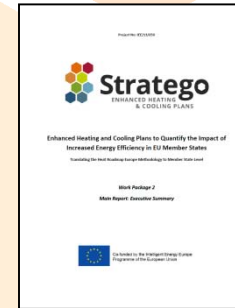
**PlanEnergi**  
Derek Triner

For **EUROHEAT & POWER**



## HRE 4

### Enhanced National Heating and Cooling Strategies



Co-funded by the Intelligent Energy Europe Programme of the European Union



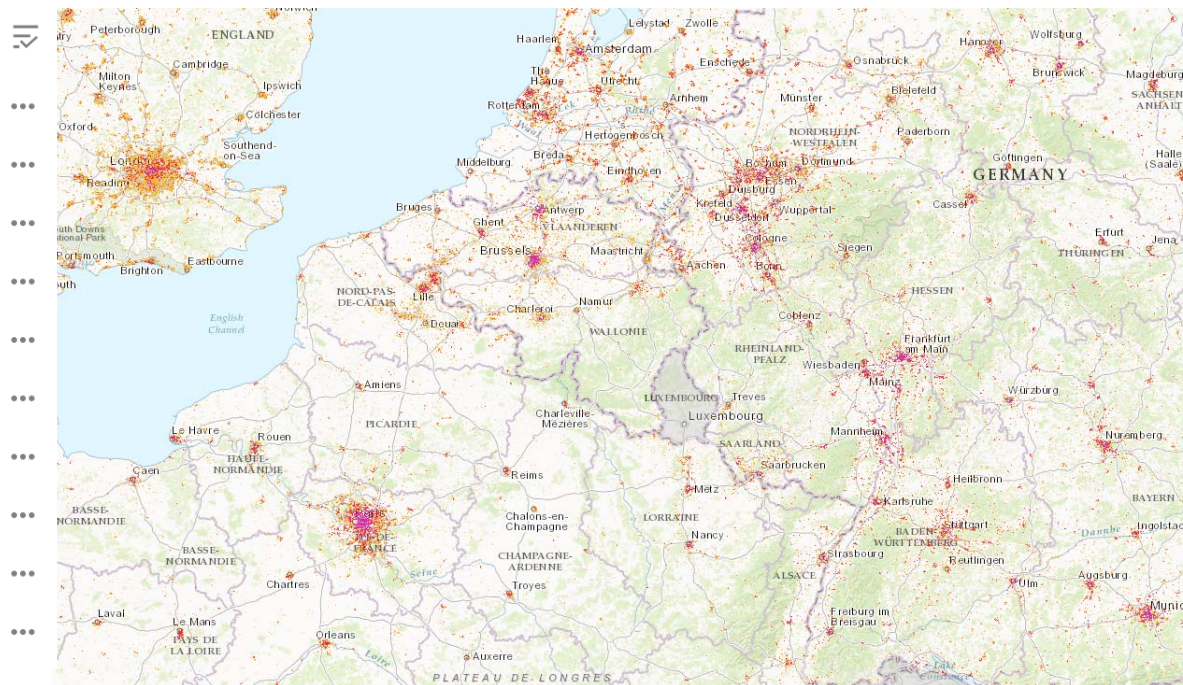
This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 695989.



# Peta 4.2 Launch

## Operational layers

- Heat Synergy Regions (HRE4): Priority
- Excess heat activities (HRE4)
- Biomass Resources (BioBoost)
- Solar thermal district heating, 1000m buffer
- Geothermal heat (GeoDH)
- Coherent urban areas with one or more district heating system(s) today (HRE4)
- Prospective supply areas (HRE4)
- DH distribution costs (HRE4)
- Heat Demand Densities 2015 (HRE4)
- Cold Demand Densities 2015 (HRE4)



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 695989.



#SES4DH2017

# 3<sup>rd</sup> International Conference on Smart Energy Systems and 4<sup>th</sup> Generation District Heating

12-13 September 2017 · Copenhagen

AALBORG UNIVERSITY  
DENMARK

## Tuesday 12 September 2017 · Overall programme

08:00-09:00 Registration and breakfast

OUTSIDE THE EGMONT HALL, 1ST FLOOR

09:00-10:30 *1st plenary session chaired by Brian Vad Mathiesen: 4GDH Perspectives and results*

09:00 Opening speech by Henrik Lund

09:15 Plenary keynote by Professor Sven Werner: World DH status and Transformation Roadmap for 4GDH

09:45 Plenary keynote by Morten Abildgaard; CEO Viborg District Heating: Data Centers and 4GDH in practice - the case of Viborg

10:15 Questions and discussion

THE EGMONT HALL, 1ST FLOOR

10:30-11:00 Coffee break

THE EGMONT HALL, 1ST FLOOR

Parallel sessions 1-6

11:00-12:30 EGMONT HALL, 1ST FLOOR  
Session 1: Smart Energy Systems  
Chair: Morten Abildgaard  
Session keynote and co-chair: Rasmus Aaen  
Pierre Vogler-Finck  
Borna Doračić  
Philipp Geyer  
Jay Hennessy

11:00-12:30 ASSEMBLY HALL, 1ST FLOOR  
Session 2: Future district heating production and systems  
Chair: Anders Dyrelund  
Session keynote and co-chair: Erik O. Ahlgren  
Bernd Windholz  
Renaldi Renaldi  
Hrvoje Dorotić  
Kristina Lygnerud

11:00-12:30 U1, 1ST FLOOR  
Session 3: Energy planning and planning tools  
Chair: Neven Duic  
Session keynote and co-chair: Peter Jorsal  
Jigeeshu Joshi  
Jürgen Knies  
Johan Dalgren  
Bram van der Heijde

11:00-12:30 U3, 1ST FLOOR  
Session 4: Low-temp district heating grids  
Chair: Helge Averfalk  
Session keynote and co-chair: Oddgeir Gudmundsson  
Kim Rolin  
Christian Engel  
Ashreeta Prasanna  
Markus Rabensteiner

11:00-12:30 U2, 1ST FLOOR  
Session 5: Low-temperature DH and buildings.  
Chair: Svend Svendsen  
Session keynote and co-chair: Anna Volkova  
Danhong Wang  
Andra Blumberga  
Asad Ashfaq  
Xiaochen Yang

11:00-12:30 CINEMA GF  
Session 6: Future district heating production and systems  
Chair: Anders N. Andersen  
Session keynote and co-chair: Linn Laurberg Jensen  
Nadège Vetterli  
Henrik Pieper  
Anna-Elisabeth Lehmkuhl  
Benjamin Zühlsdorf

12:30-13:30 Lunch

THE EGMONT HALL, 1ST FLOOR

12:30-13:00 *Steering Committee Meeting (4DH SC members only)*

Parallel sessions 7-12

13:30-15:00 EGMONT HALL, 1ST FLOOR  
Session 7: Smart Energy Systems  
Chair: Jesper Møller Larsen  
Session keynote and co-chair: Tobias Fleiter  
Hanmin Cai  
Sylvain Quoilin  
Foteini Rafaela Tsousi

13:30-15:00 ASSEMBLY HALL, 1ST FLOOR  
Session 8: Future district heating production and systems.  
Chair: Dagnija Blumberga  
Session keynote and co-chair: Louise Ödlund  
Jelena Ziemele  
Gunnar Lennermo  
Johannes Pelda  
Ivan Andrić

13:30-15:00 U1, 1ST FLOOR  
Session 9: Energy planning and planning tools  
Chair: Nina Detlefsen  
Session keynote and co-chair: Niels Frank  
Daniel Møller Sneum  
Matteo Giacomo Prina  
David Drysdale  
Hanne Kauko

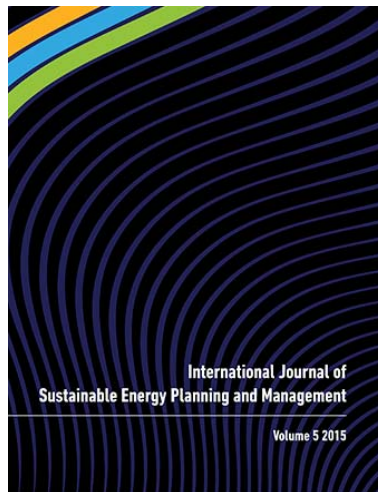
13:30-15:00 U3, 1ST FLOOR  
Session 10: Low-temp district heating grids  
Chair: Jan Erik Thorsen  
Session keynote and co-chair: Steen Schelle Jensen  
Dietrich Schmidt  
Paolo Leoni  
Stefan Blomqvist  
Max Bachmann

13:30-15:00 U2, 1ST FLOOR  
Session 11: Low-temperature DH and buildings.  
Chair: Sven Werner  
Session keynote and co-chair: Svend Svendsen  
Knut Bernotat  
Soma Mohammadi  
Natasa Nord  
Ivo Pothof

13:30-15:00 CINEMA, GF  
Session 12: Smart Energy Systems.  
Chair: Frede Hvelplund  
Session keynote and co-chair: Bent Ole Gram Mortensen  
Juan P. Jiménez  
Ambrose Dodoo  
Lennart Rogenhofer  
Wiebke Meesenburg

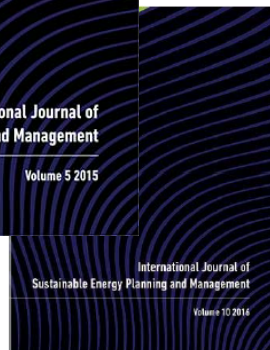


# Paper-flow: 2 Special Issues



Special Issue with Papers Based on Abstracts from the First International Energy Systems and 4<sup>th</sup> Generation District Heating in 2015

International Journal of Sustainable Energy Planning and Management, Vol 10 (2016)

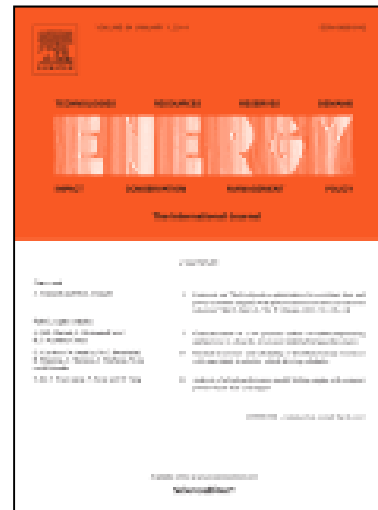


Smart energy systems and 4th generation district heating  
Poul Alberg Østergaard, Henrik Lund, Brian Vad Mathiesen

Comprehensive Assessment of the Potential for Efficient District Heating and Cooling and for High-Efficient Cogeneration in Austria  
Richard Büchele, Lukas Kranzl, Andreas Müller, Marcus Hummel, Michael Hartner, Yvonne Deng, Marian Bons

A genetic algorithm technique to optimize the configuration of heat storage in DH networks  
Amru Rizal Razani, Ingo Weidlich

Smart energy systems applied at urban level: the case of the municipality of Bressanone-Brixen  
Matteo Giacomo Prina, Marco Cozzini, Giulia Garegnani, David Moser, Ulrich Filippi Oberegger, Roberto Vaccaro, Wolfram Sparber



Special Issue Volume 110 (1 September 2016)  
on Smart Energy Systems and 4th Generation District Heating

Smart energy systems and 4th generation district heating  
Henrik Lund, Neven Duic, Poul Alberg Østergaard, Brian Vad Mathiesen

Smart energy systems and 4th generation district heating  
Neven Duic, Poul Alberg Østergaard, Brian Vad Mathiesen

Link heat and electricity in the transition towards future Smart Energy Systems  
Gianluigi Lo Basso

Impact of grid-orientated distributed cogeneration on the minutes reserve market and the operating mode impacts on CO<sub>2</sub> emissions  
Christine Krüger, Frank Merten, Arjuna Nebel

Optimization strategy for designing flexible multi-generation systems  
Jens Lythcke-Jørgensen, Adriano Viana Ensinas, Marie Münster, Fredrik Haglund

Impact of the constraints and potential contributions regarding wind curtailment in district heating  
Yu Wang, Brian Vad Mathiesen, Xiliang Zhang

Optimization of substations for low-temperature district heating with no Legionella risk, and low investment costs  
Hongwei Li, Svend Svendsen

Replacing critical radiators to increase the potential to use low-temperature district heating – A case study of 4 Danish single-family houses from the 1930s  
Dorte Skaarup Østergaard, Svend Svendsen

System dynamics model analysis of pathway to 4th generation district heating in Latvia  
Jelena Ziemele, Armands Gravelsins, Andra Blumberga, Girts Vigants, Dagnija Blumberga

Complex thermal energy conversion systems for efficient use of locally available biomass  
Jacek Kalina

Current and future prospects for heat recovery from waste in European district heating systems: A literature and data review  
Urban Persson, Marie Münster

Mapping of potential heat sources for heat pumps for district heating in Denmark  
Rasmus Lund, Urban Persson

Industrial surplus heat transportation for use in district heating  
J.N.W. Chiu, J. Castro Flores, V. Martin, B. Lacarrière

European space cooling demands  
Sven Werner

Optimal planning of heat supply systems in urban areas  
Valery A. Stennikov, Ekaterina E. Iakimetc

Ringkøbing-Skjern energy atlas for analysis of heat saving potentials in building stock  
Stefan Petrović, Kenneth Karlsson

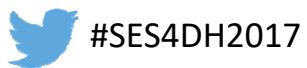




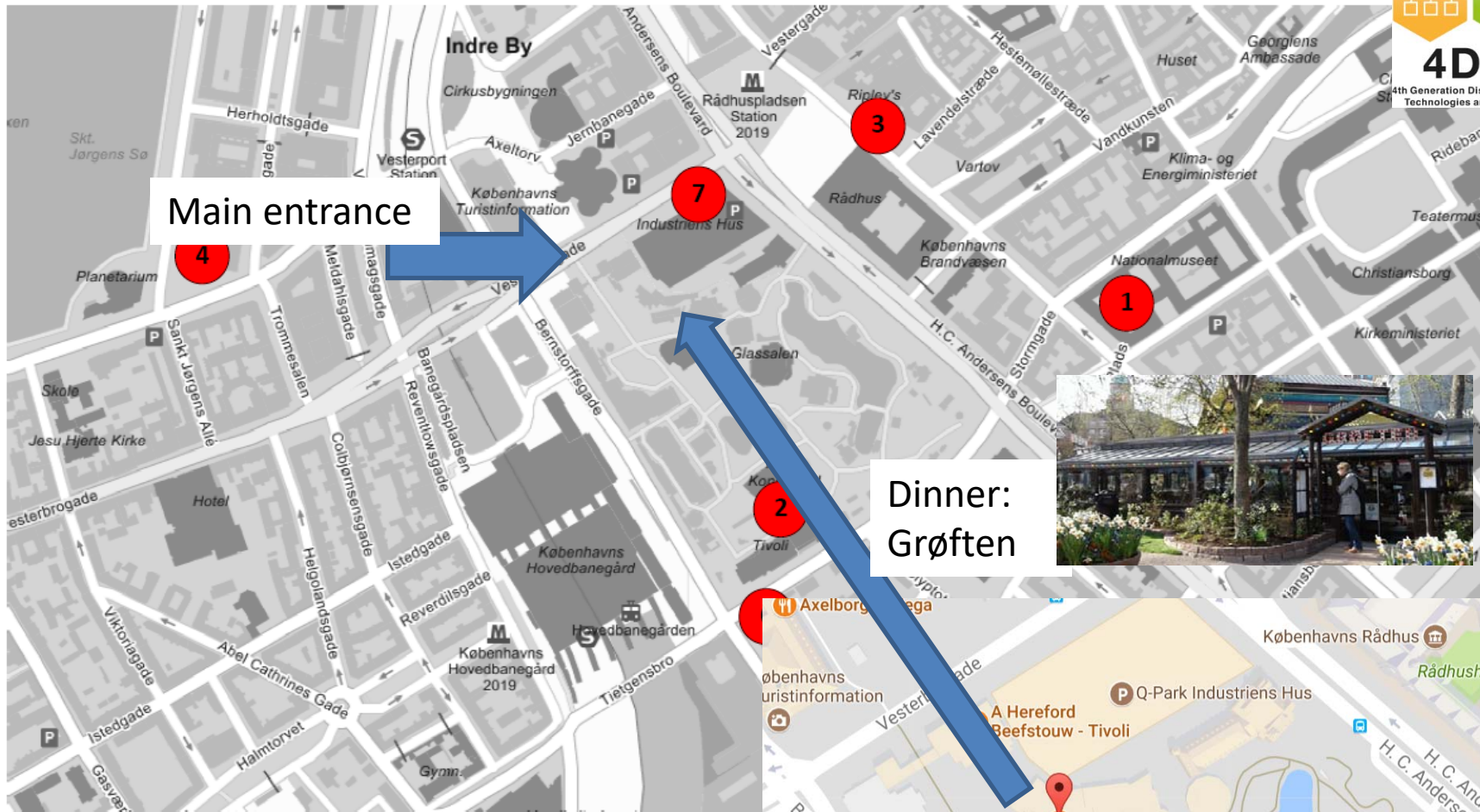
# Awards for Best Presentation Junior and Senior



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**MAP COPENHAGEN CITY CENTRE**



**1: The National Museum of Denmark**

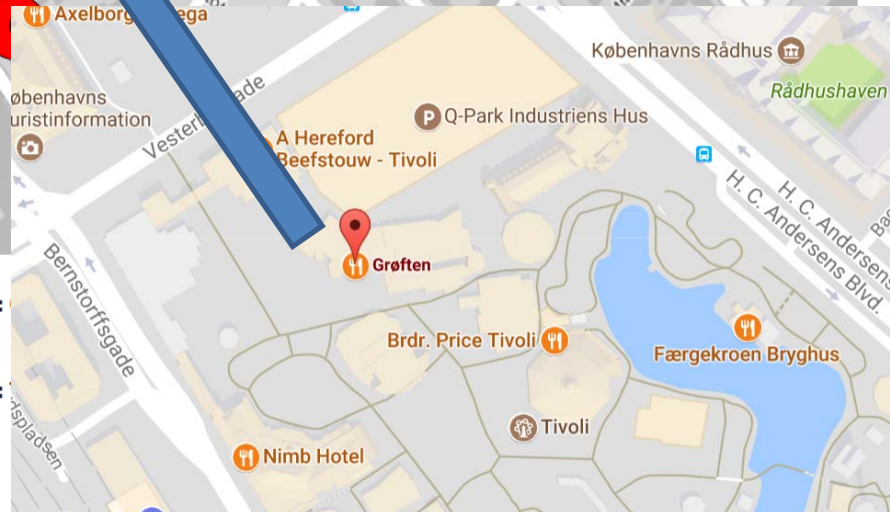
**3: Scandic Palace Hotel**

**5:**

**2: Tivoli, conference dinner**

**4: Scandic Copenhagen**

**6:**



3<sup>RD</sup> INTERNATIONAL CONFERENCE ON  
**SMART ENERGY SYSTEMS AND  
4<sup>TH</sup> GENERATION DISTRICT HEATING**

COPENHAGEN, 12-13 SEPTEMBER 2017

You have free  
entrance to the  
museum !!!

Location: The National Museum in Copenhagen



See more and sign up at  
[www.4dh.dk/conferences](http://www.4dh.dk/conferences)



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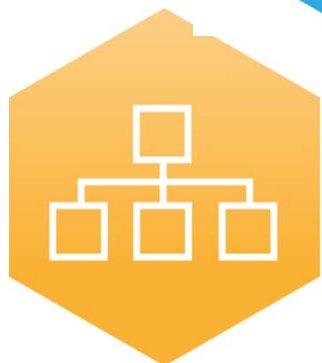
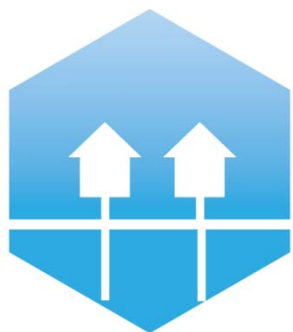
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Next year:  
4<sup>th</sup> International Conference on  
**Smart Energy Systems and**  
**4<sup>th</sup> Generation District Heating**  
13-14 November 2018, Aalborg



**AALBORG UNIVERSITY**  
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**Location:**  
**NORDKRAFT**



**See more and sign up at**  
**[www.4dh.dk/conferences](http://www.4dh.dk/conferences)**

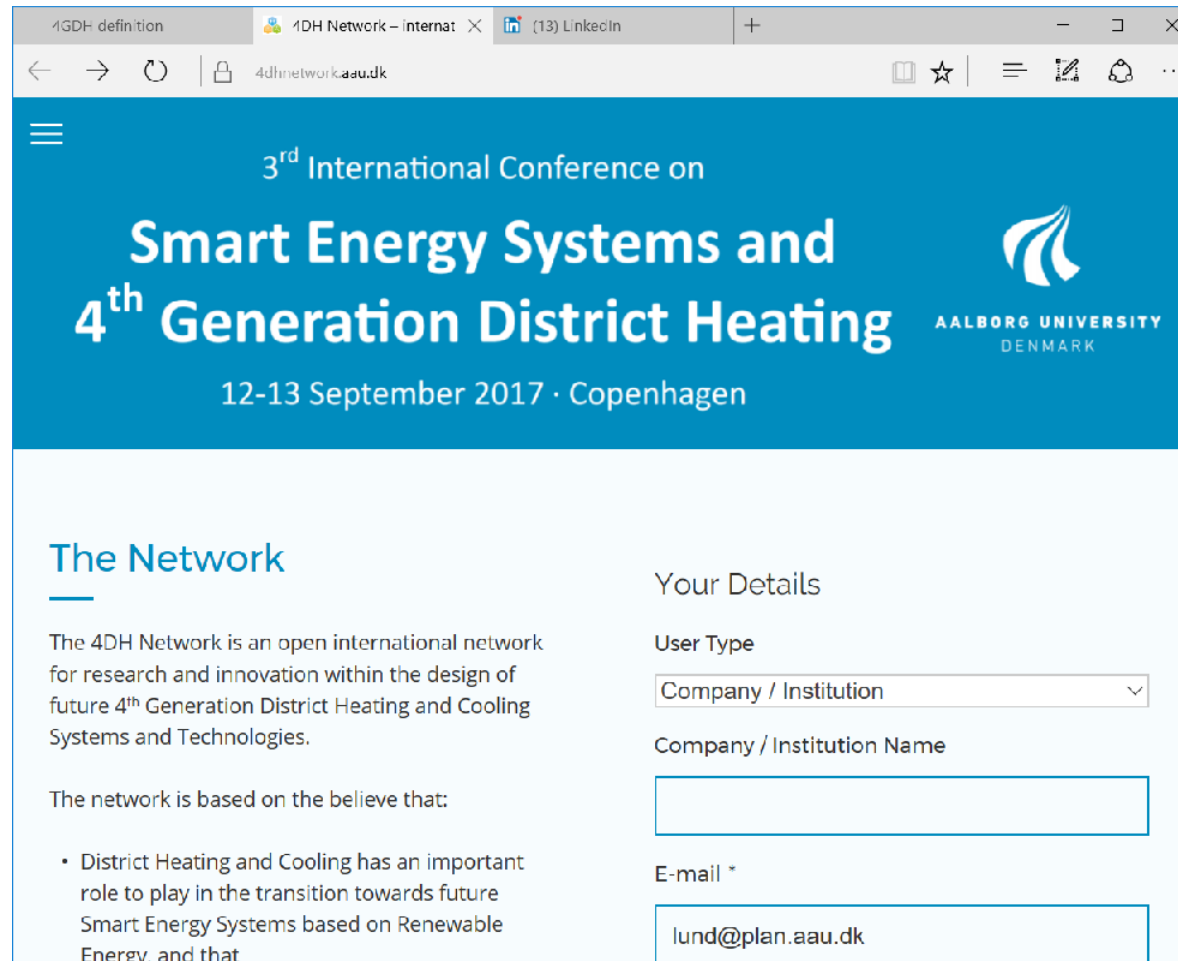


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**#SES4DH2017**

# 4DH Network



The screenshot shows a web browser window with the URL 4dhnetwork.aau.dk. The page features a blue header with the text "3<sup>rd</sup> International Conference on Smart Energy Systems and 4<sup>th</sup> Generation District Heating" and the Aalborg University logo. Below the header, the page is divided into two columns. The left column, titled "The Network", contains a description of the 4DH Network and a list of beliefs. The right column, titled "Your Details", contains a registration form with fields for "User Type" (set to "Company / Institution"), "Company / Institution Name", and "E-mail" (set to "lund@plan.aau.dk").

3<sup>rd</sup> International Conference on  
**Smart Energy Systems and  
4<sup>th</sup> Generation District Heating**  
12-13 September 2017 · Copenhagen

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## The Network

The 4DH Network is an open international network for research and innovation within the design of future 4<sup>th</sup> Generation District Heating and Cooling Systems and Technologies.

The network is based on the believe that:

- District Heating and Cooling has an important role to play in the transition towards future Smart Energy Systems based on Renewable Energy, and that

**Your Details**

User Type  
Company / Institution

Company / Institution Name

E-mail \*  
lund@plan.aau.dk

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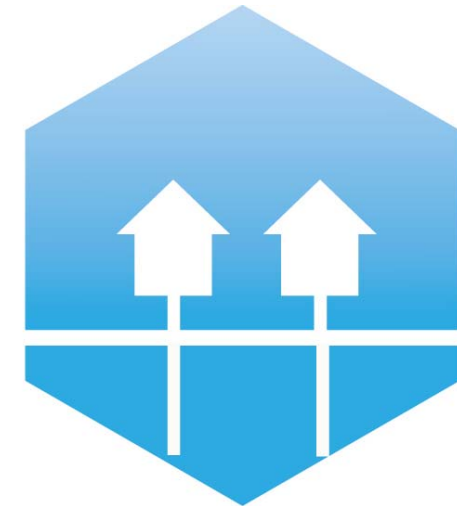
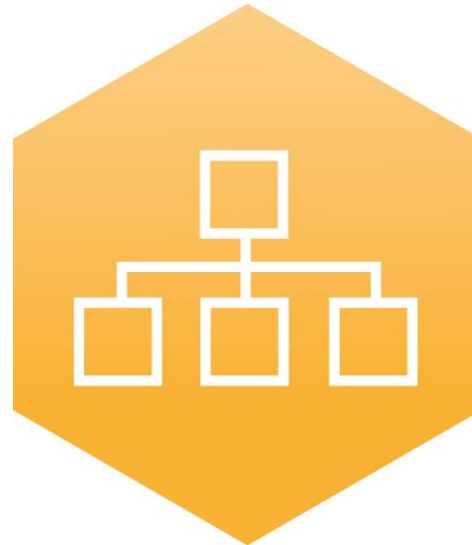


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# Thank you!



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# 4DH

4th Generation District Heating  
Technologies and Systems