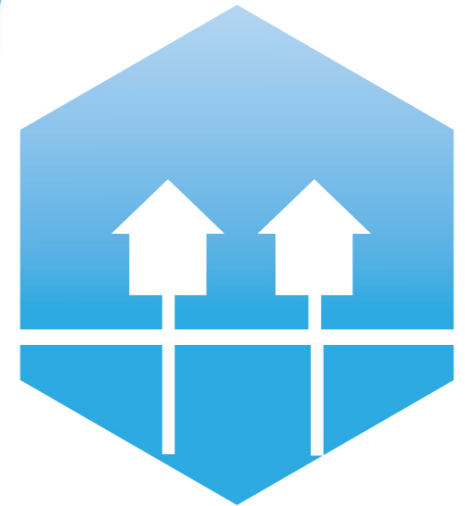
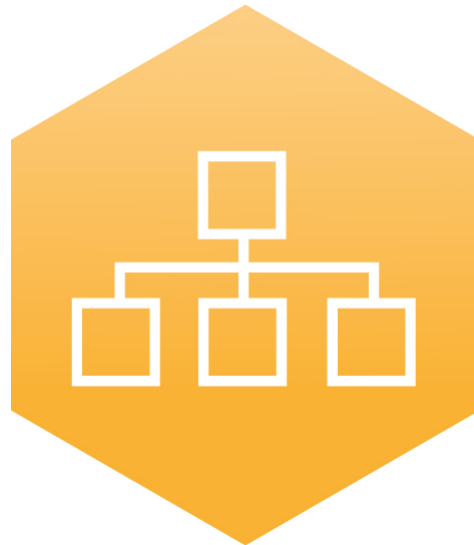


4th Generation District Heating Technologies and Systems
First Annual Conference 3 October 2012

Welcome



4DH

4th Generation District Heating
Technologies and Systems

Introduction

The 4DH Research Centre:

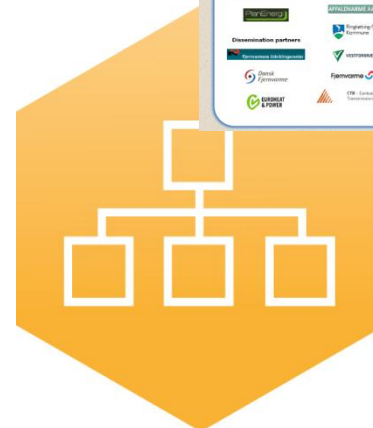
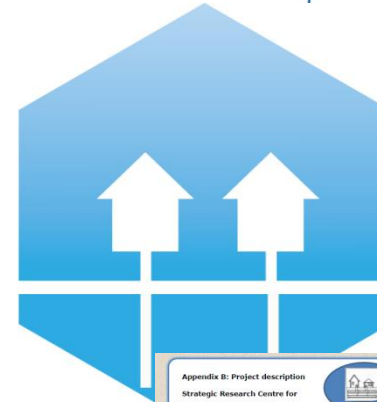
What and Who are 4DH ..?

4GDH concept and research:

What are we going to do in the next 6 years..?

Today's agenda:

Annual Conference and Consortium
meetings





What and who are 4DH?

- Strategic Research Centre financed by the Danish Research Council and the partners
- Universities and Industry including manufactories, consultants and DH companies
- International partners

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

University partners

- AALBORG UNIVERSITET
- DTU
- SYDDANSK UNIVERSITET
- 清华大学 Tsinghua University
- CHALMERS
- Linnæus University
- UNIVERSITETET I HELSINKI
- UNIVERSITETET I ZAGREB

Industrial partners

- LOGSTOR
- Danfoss
- Aktieselskabet Ribe Jernindustri
- SPX
- Kamstrup
- THE DESMI GROUP
- EFSEN ENGINEERING A/S

Private partners

- RAMBOLL
- COWI
- NIRÁS
- EMD International A/S
- PlanEnergy

Dissemination partners

- Fjernvarmens Udviklingscenter
- Dansk Fjernvarme
- EUROHEAT & POWER

District heating companies

- VEKS
- AALBORG FJERNVARME
- FORSYNINGSVIRKSOMHEDERNE
- københavns E
- AFFALDVARME AARHUS
- Ringkøbing-Skjern Kommune
- VESTFORBRÆNDING
- Fjernvarme Fyn
- CTR - Centralkommunernes Transmissionselskab I/S

The long-term Objective of Danish Energy Policy



Expressed by former Prime Minister Anders Fogh Rasmussen in his opening speech to the Parliament in 2006 and in several political agreements since then:

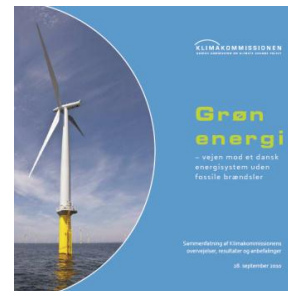
To convert to 100% Renewable Energy



Prime minister 16 November 2008:
"We will free Denmark totally from fossil fuels like oil, coal and gas"



Prime minister 16 November 2008:
"... position Denmark in the heart of green growth"



New Government September 2011



- 100% RES by 2050
- 100% RES for electricity and heating by 2035
- No coal on power plants and no oil for heating households by 2030
- 50% wind in electricity supply by 2020
- 40% CO2 reduction by 2020 compared to 1990



ET DANMARK,
DER STÅR SAMMEN

REGERINGSGRUNDLAG

OKTOBER 2011

REGERINGEN



Background

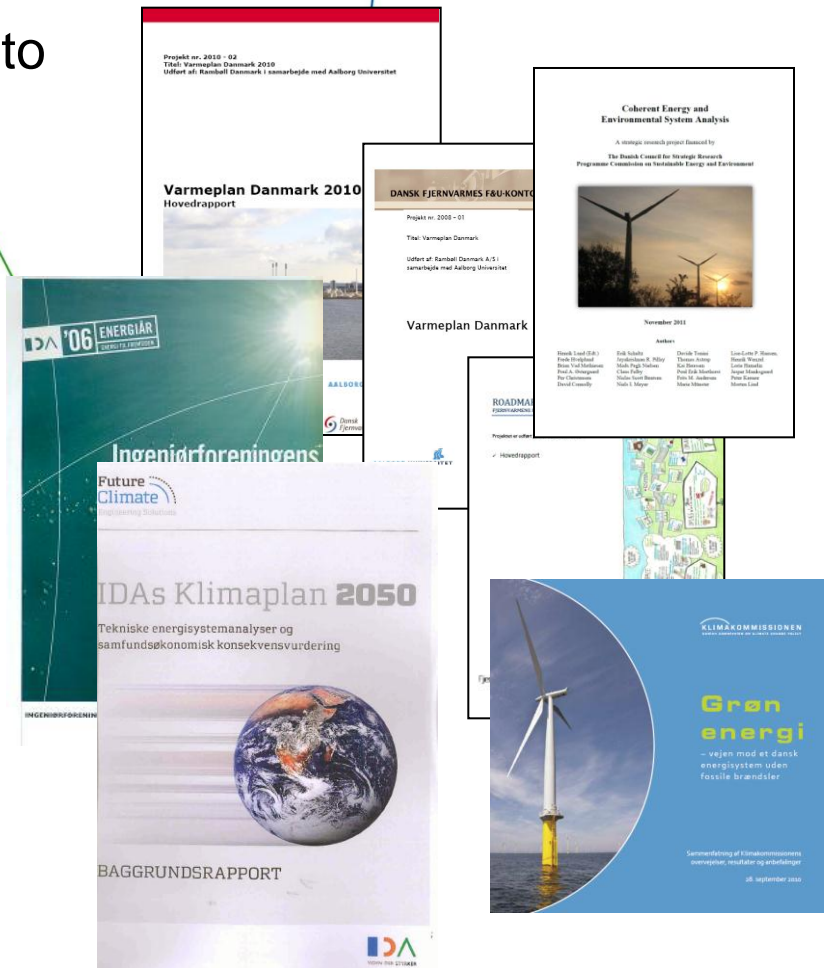


District heating has an important role to play in future Sustainable Energy Systems:

- Energy efficiency
- Renewable energy and waste
- System integration of wind etc.

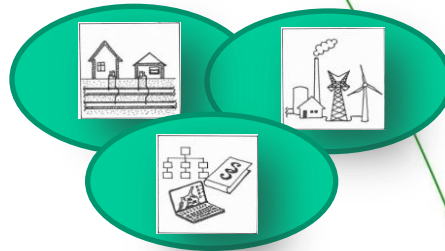
District heating technology has to be further developed (4GDH):

- Low energy buildings
- Low temperature sources
- Low Grid losses



Aim and Objectives

The **Aim** is to assist in the development of 4th Generation District Heating Technologies and Systems (4GDH).



Objectives:

- Scientific platform for research activities
- Societal understanding of the role of District Heating
- Further additional national and international projects



Why 4th Generation ?

First Generation (1880-1930):

Steam as heat carrier. Is today in use in e.g. Manhattan, Paris and partly in Copenhagen.



Second Generation (1930-1970):

Pressurised hot water as heat carrier with temperature above 100 C.
Can be found today in older parts of current water-based systems.



Third Generation (1970-present):

Pressurised water with temperatures below 100 C.
Used in replacements in Central and Eastern Europe
and all extensions in China, Korea, Europe, USA and Canada.



4DH

4th Generation District Heating
Technologies and Systems

Three pillars

Supply:

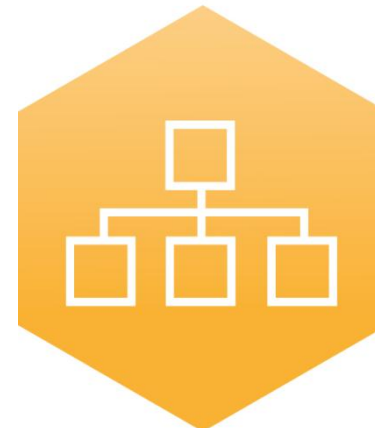
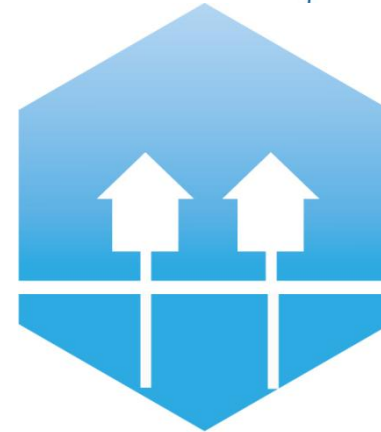
Low temperature District heating

Production:

Renewable Systems Integration

Organisation:

Planning and Implementation



4DH

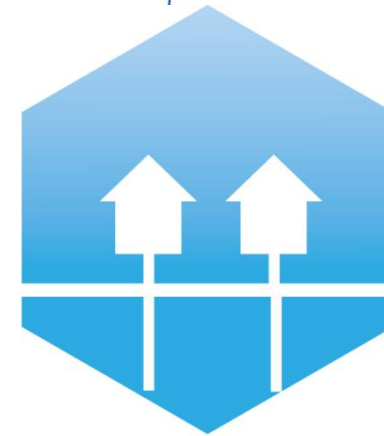
4th Generation District Heating
Technologies and Systems

Supply:

Low temperature District heating

Grids and components:

- low-temperature district heating systems based on renewable energy.
- new knowledge of the hardware and software technologies of the new generation of district heating systems
- existing energy renovated buildings and new low-energy buildings.



4DH

4th Generation District Heating
Technologies and Systems

Production: Renewable Systems Integration

Production and system integration:

- the development of energy systems analysis tools, methodologies and theories
- scenario building of future sustainable energy systems.
- The aim is to identify the role of district heating systems and technologies in various countries



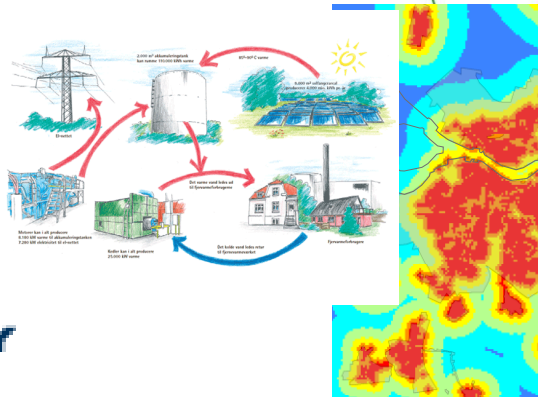
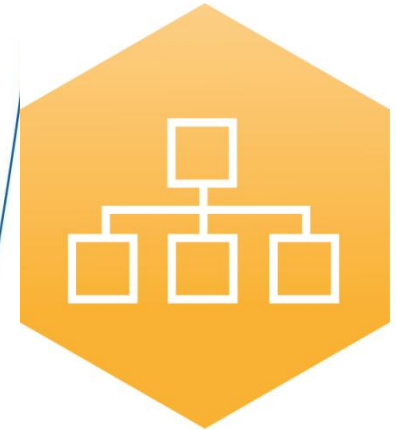
4DH

4th Generation District Heating
Technologies and Systems

Organisation: Planning and Implementation

Planning and implementation:

- further development of the planning and management systems
- spatial analysis and geographical information systems (GIS) as a tool for planners and decision-makers.
- organisation and design of specific public regulation measures including ownership, tariffs, reforms etc.



International Dimension



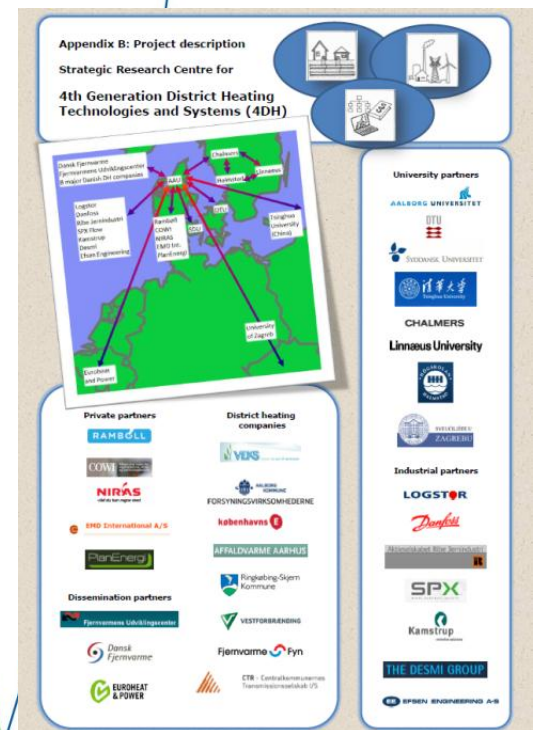
International Partners:

- Tsinghua University, China
- Chalmers, Halmstad and Linnaeus universities, Sweden
- Zagreb, Croatia
- Euro Heat and Power

First result:

Heat Road Map Europe

First pre-study



4DH

4th Generation District Heating
Technologies and Systems

Interdisciplinary

PhD courses

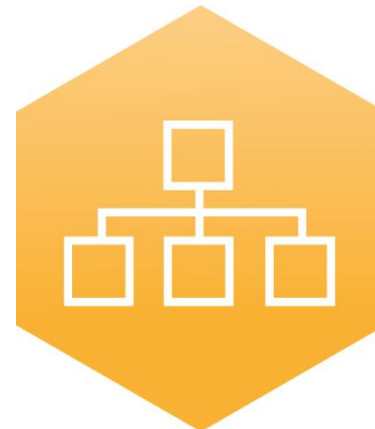
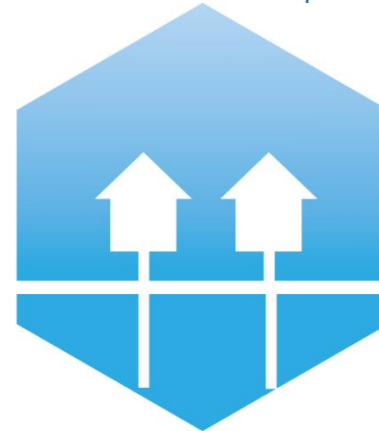
At the different participating universities

Management activities:

International collaboration, Consortium activities and dissemination

4GDH concept:

Further development of the concept.





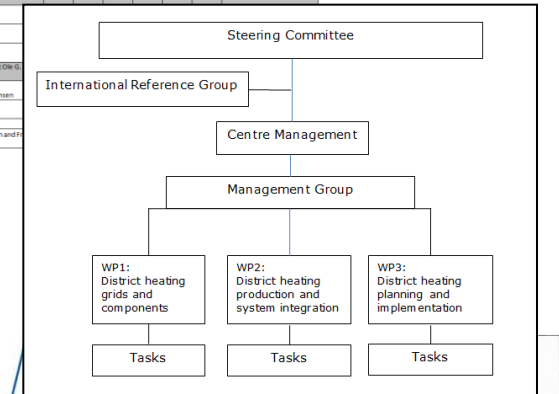
4DH

4th Generation District Heating Technologies and Systems

Consortium meetings

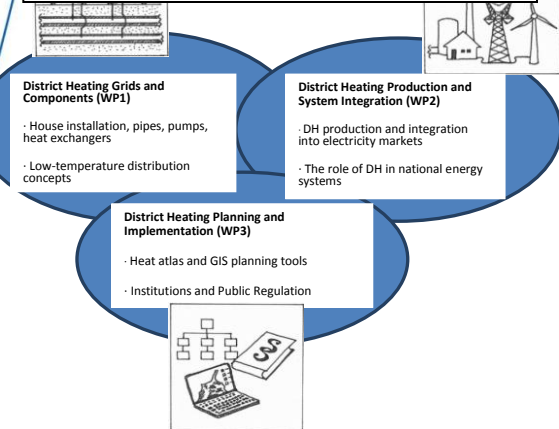
- Conference on 4GDH Technologies and Systems (Public)
 - Status and administrative meetings (4DH Participants)
- 6-year project (2012-2017) with on-going dissemination.

4th Generation District Heating Technologies and Systems (4DH)									
WP no.	Name	WP leaders / responsible	2012	2013	2014	2015	2016	2017	Participants
0	Administrative and development of overall concept	Henrik Lund and Brian V. Mathiesen							
	0.1 Scientific and theoretical development of the 4GDH concept	Henrik Lund and Brian V. Mathiesen							HL, SW and all
	0.2 PhD course activities and international collaboration	Henrik Lund and Brian V. Mathiesen							HL, BVM and all
	0.3 Dissemination	Henrik Lund and Brian V. Mathiesen							HL, BVM and Fyfe, Da Fjo, Eero Heel and Krøner
1	Centre administration	Henrik Lund and Brian V. Mathiesen							HL, BVM, MRS, PSA and WP-1
	District Heating Grids and Components	Svend Svendsen and Carsten Bojarsen							
	1.1 Heating of existing buildings by low-temperature district heating	Svend Svendsen							SS (PhD Stud), Kamstrup, Rio, Danfoss
	1.2 Supply of domestic hot water at comfort temperatures without Legionella	Svend Svendsen							SS (PhD Stud), Ethos, Danfoss
2	1.3 Conversion of existing district heating grids to low-temperature operation and extension to new areas of buildings	Carsten Bojarsen							CB (PhD Stud), SP, COWI
	1.4 Minimizing losses in the DH distribution grid	Carsten Bojarsen							CB (PhD Stud), Demin, Logstor
	District Heating Production and System Integration	Poul A. Østergaard and Anders N. Andersen							
	2.1 The role of DH in energy systems with focus on Denmark, Europe and China	Brian Vad Mathiesen							
3	2.2 Integration of Energy Systems	Anders N. Andersen							
	2.3 Energy resources for district heating systems	Poul Østergaard							
	District Heating Planning and Implementation	Bent Ole Gram Mortensen							
	3.1 Strategic energy planning in a municipal and legal perspective	Bent Ole Gram Mortensen							
4	3.2 Innovative strategic energy planning and socio-economic development	Frede Heibjænd							
	3.3 Energy assets to support planning	Bernd Müller							
	3.4 Price regulation, tariff models and sector ownership	Bent Ole G. Mortensen and Frede Heibjænd							
	Time schedule and allocation of resources								



Administrative and 4GDH concept (WP0)

PhD courses and seminars
International collaboration
Consortium activities
Dissemination



13 PhD projects

Strategic Research Centre for 4th Generation District Heating Technologies and Systems



PhD 1.1. Heating of existing buildings by low-temperature district heating

PhD 1.2. Supply of domestic hot water at comfort temperatures without Legionella

PhD 1.3. Conversion of existing district heating grids to low-temperature operation and extension to new areas of buildings

PhD 1.4 Minimising losses in the DH distribution grid



Ph.D. 2.1: Energy Scenarios for Denmark

Ph.D. 2.2 Thermal storage in district heating systems

Ph.D. 2.3 Distributed CHP-plants optimized across more electricity markets

Ph.D. 2.4 Low-temperature energy sources for district heating

Ph.D. 2.5 The role of district heating in the Chinese energy system

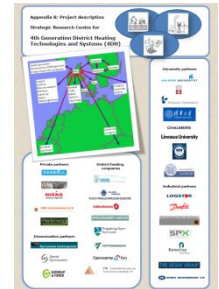


PhD 3.1: Strategic energy planning in a municipal and legal perspective

PhD 3.2: Price regulation, tariff models and ownership as elements of strategic energy planning

PhD 3.3: Geographical representations of heat demand, efficiency and supply

PhD 3.4: Geographical representations of renewable energy systems





4DH

4th Generation District Heating Technologies and Systems

HEAT ROADMAP EUROPE 2050

FIRST PRE-STUDY FOR THE EU27

Aalborg University

David Connolly
Brian Vad Mathiesen
Paul Alberg Østergaard
Bernd Möller
Steffen Nielsen
Henrik Lund

Halmstad University

Urban Persson
Daniel Nilsson
Sven Werner

PlanEnergi

Daniel Trier



Review
From electricity smart grids to smart energy systems – A market operation based approach and understanding

Henrik Lund^{a,*}, Anders N. Andersen^b, Paul Alberg Østergaard^c, Brian Vad Mathiesen^d, David Connolly^e
^aDepartment of Engineering and Planning, Aalborg University, North Havnsgade 6, DK-9000 Aalborg, Denmark
^b1000 International, 4000 University Park, Aalborg, Denmark
^cDepartment of Development and Planning, Aalborg University, AC, Møntes Vej 11, DK-9400 Silkeborg, Denmark

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ABSTRACT
The challenge of integrating fluctuating renewable energy sources in the electricity grid for the smart grid phase creates the need for an integrated market based approach to the use of various resources and challenges of operating highly renewable energy systems in general. Therefore, electricity smart grids must be developed with the utilization of renewable energy being governed by other forms of carbon that electricity including heat and biofuels, as well as energy conservation and efficiency improvements, such as CHP and improved efficiency, in the use of heat. All such resources have the potential to replace fossil fuels or improve the fuel efficiency of the system. However, they also add to the electricity balancing problem and contribute to the non-electricity production and storage in the system to drive the smart grid. The smart energy systems are those which seek resources are combined with energy conservation and system efficiency improvements. This article illustrates why electricity smart grids should be seen as part of smart energy systems and emphasizes the inclusion of flexible CHP production in the electricity balancing and grid stabilization. Furthermore, it highlights some recent developments in the flexible electricity market operation.
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1. Introduction
The challenge of integrating fluctuating renewable energy power sources, such as wind, solar and ocean energy depends strongly on the class of the input. The following three phases of implementing renewable energy technologies can be defined [1]:
The introduction phase: This phase represents a situation in which there is not only a small share of renewable energy in the existing energy system. The phase is characterized by strategic proposals for the introduction of renewable energy, e.g. wind turbines being sited in a system with only a limited share of renewable energy. The system is characterized by the same long planning horizon as the year, and the technical influence of the introduction on the system is generally considered to be negligible for several years. Moreover, the input of renewable power does not pose a challenge to the operation of the grid and the electricity balancing.
The large scale integration phase: This phase represents a situation in which there is already a major share of renewable energy in the system, e.g. when more wind turbines are added to a system which already has a high share of wind power. The phase is defined by the fact that further increases in renewable energy penetration will have an influence on the system and this will vary between heat to another e.g. depending on whether heat demand is high or low in the given hour, whether a heat storage is full or not or whether the electricity demand is high or low during the given hour. The integration of wind into a power system becomes complex and requires consideration with regard to grid stabilization.
The 100 percent renewable energy phase: This phase represents a situation in which the energy system is currently, or is being transformed to a system where 100 percent of renewable energy is used. The system is characterized by the fact that new investments in renewable energy will have to be compared not to nuclear or coal fired plants, but to the costs of maintaining the existing system technologies. These include conservation, efficiency improvements and storage and conversion technologies, e.g. wind turbine retrofits to replace the need for biomass resources. The influence on the system is not only with regard to differences from one hour to another but also with regard to the identification of a suitable combination of changes in conversion and storage technologies. Moreover, the challenge of operating the grid in terms of ensuring frequency and voltage stability is of major importance.

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E-mail address: h.lund@energy.dtu.dk.
0360-5462/\$ – see front matter © 2012 Elsevier Ltd. All rights reserved.
doi:10.1016/j.energy.2012.04.001

Publications

Bent Ole Gram Mortensen: *Fjernvarme – en monopolsektor i konkurrence*. Artikel i Festskrift til Jens Fejå, Jurist og Økonomforbundets Forlag, 2012, s. 299-310, ISBN 978-87-574-2573-4.

Bent Ole Gram Mortensen: *Status quo vedrørende forbrugerbeskyttelse*. Artikel i Tidsskrift for Miljø, Magnus Informatik, 4/2012, s. 102-105 (TFM 2012, 45), ISSN 1603-8398.

Bent Ole Gram Mortensen: *Fjernkøling i Jan-Erik Helenelund, Ilpo Luoto, Niina Mäntylä og Kristian Silikavirta (red.)*: Offentlig – privat, i Hurudana strukturer? Festskrift til Eija Mäkinen, Universitäs Wasensis (Finland), Acta Wasensis No 265, s. 452-467, 2012, ISBN 978-952-476-408-7.

David Connolly, Brian Vad Mathiesen, Paul Alberg Østergaard, Bernd Möller, Steffen Nielsen, Henrik Lund, Daniel Trier, Urban Persson, Daniel Nilsson & Sven Werner: *Heat Roadmap Europe 2050. First pre-study for EU27*. Performed by Aalborg University and Halmstad University for Euroheat & Power, Brussels 2012. [Link to report](#) [Link to further information: www.heatroadmap.eu](#)

Lund, H. Andersen, A.N. Østergaard: *SMART ENERGY SYSTEMS - A market operation based approach*, June 2012

Bernd Möller, Steffen Nielsen and Daniel Nilsson: *PHOTOVOLTAIC ELECTRICITY RESOURCES ASSESSMENT*. Dublin City University, Ireland

Bernd Möller: *A Danish Heat Atlas*

Presentations

Frede Hvelplund: *From smart electricity systems to smart energy systems (The subsidiarity principle, local ownership and wind power integration)*. Presentation August 2012, Salzburg Austria.

Bernd Möller, Steffen Nielsen and Karl Sperling: *A SOLAR ATLAS FOR BUILDING-INTEGRATED PHOTOVOLTAIC ELECTRICITY RESOURCE ASSESSMENT*. Paper presented at the SEEP conference, June 5-8, 2012, Dublin City University, Ireland. This paper won the Award for Best Presentation.

Bernd Möller: *A Danish Heat Atlas, or how existing public databases can be used for energy planning*. Paper presented at the Climate change adaptation workshop, 20-21 March 2012, Aalborg.

Bent Ole Gram Mortensen: *Regulatoriske rammer for fjernkøling*. Presentation den 8. marts 2012 på seminar om fjernkøling, Fjernvarmens Udviklingscenter. Afviklet over internettet

Bent Ole Gram Mortensen: *Den specielle konkurrence og forsyningsvirksomhed – fjernvarme som case*. Presentation den 4. september 2012 på Fokustseminar, Centre for European Studies (CESE) ved Jurisk Fakultet ved Københavns Universitet.

Henrik Lund: *From Smart Electricity Grids to Smart Energy Systems*. Keynote at [3rd International Conference on Contemporary Problems of Thermal Engineering \(CPCOTE 2012\)](#), Institute of Thermal Technology, Gliwice, Silesia, Poland, 18-20 September 2012.

Henrik Lund: *Heat Roadmap Europe 2050*. Presentation and panel debate at the [13th International Symposium on District Heating and Cooling](#), Copenhagen 3-4 September 2012.

Henrik Lund: *Heat Roadmap Europe 2050*. Presentation at [European Sustainable Energy Week](#), Euro Heat and Power and Cogen Europe, Charlemagne building 21, June 2012.

Henrik Lund: *From Smart Electricity Grids to Smart Energy Systems*. Keynote at [5th International Conference on Sustainable Energy & Environmental Protection \(SEEP 2012\)](#), Dublin City University, Dublin 5-8 June 2012.

Henrik Lund: *Heat Pump Integration in Energy Systems*. Keynote at Symposium on Advances in Refrigeration and Heat Pump Technology, DTU, 15-16 May 2012. [Link to proceedings](#).

Henrik Lund: *Heat Roadmap Europe 2050*. Presentation and panel debate at the Euroheat and Power Conference TEAMING UP FOR RENEWABLE HEATING AND COOLING, Copenhagen 26-27 April 2012.



4th Generation District Heating - First Annual Conference, 3 October 2012
Venue: Utzon Center, Slotspladsen 4, Aalborg



Programme

09.30-10.00 Breakfast and registration

10.00-10.30 Introduction to the 4DH project and the agenda for the first annual 4DH conference

Professor Henrik Lund, Aalborg University, Head of the 4DH Research Centre

10.30-12.00 Previous research in Sweden and Denmark on the future of district heating systems

Results of the Swedish sparse district heating project

Professor Sven Werner, Halmstad University

State-of-the-art of designing future sustainable energy systems - the role of district heating

Associate Professor Brian Vad Mathiesen, Aalborg University

Swedish experience of district heating, transportation and Biomass

Professor Leif Gustavsson, Linnaeus University

Panel debate: Which key knowledge from previous research can be brought into the 4DH project? Chairman: Technical Manager Per Wulff, Vestforbrænding.

Panel members: Speakers; Ass. Professor Erik Ahlgren, Chalmers University of Technology, Business Unit Director Lars Boye Mortensen, NIRAS; and Head of Energy Systems Department Anders N. Andersen, EMD.

12.00-13.00 Lunch



13.00-14.30 Status and challenges to the development of the 4GDH Concept

The work on 4GDH within the IEA and the EU DHC platform

Dr Robin Wiltshire, Building Research Establishment Ltd., UK

The work on 4GDH in Denmark

Professor Svend Svendsen, Technical University of Denmark

Organisational and institutional challenges to the 4GDH Concept

Professor Bent Ole Gram Mortensen, University of Southern Denmark

Panel debate: Which role does the 4DH project have in the further development of the 4GDH Concept? Chairman: Professor Poul Erik Morthorst, Technical University of Denmark.

Panel members: Speakers; Head of Division Per Alex Sørensen, PlanEnergi; Professor Sven Werner, Halmstad University; and Managing Director Astrid Birnbaum, Københavns Energi

14.30-15.00 Coffee break

15.00-16.30 International status and future perspectives of district heating and the 4GDH Concept

The case of China

Professor Xiliang Zhang, Tsinghua University

The case of Eastern Europe

Professor Neven Duic, University of Zagreb

EU and Heat Road Map Europe pre-study

Assistant Professor David Connolly, Aalborg University

Panel debate: Which international trends can be seen with regard to the development of district heating and how can the 4DH project contribute?

Chairman: Project Manager Torben Hermansen, COWI.

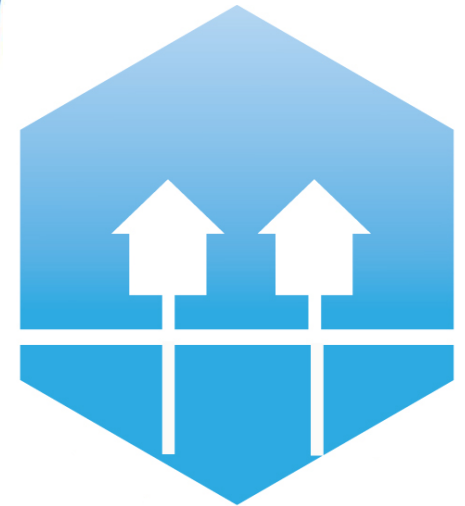
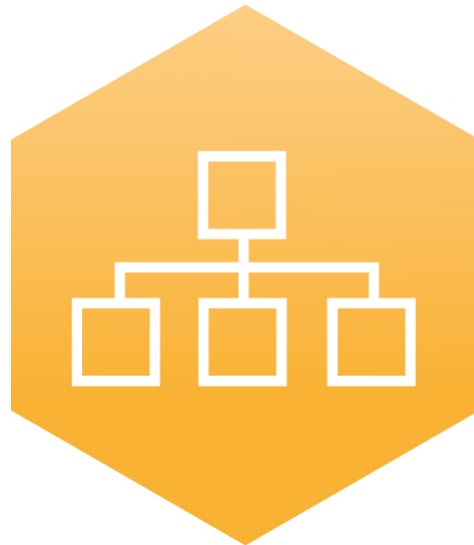
Panel members: Speakers; Project Manager Jan Eric Thorsen, Danfoss; Vice-President Birger Lauersen, Euro Heat and Power; and Dr Robin Wiltshire, Building Research Establishment Ltd.

16.30-17.00 Concluding remarks

Ass. Prof. Brian Vad Mathiesen, Aalborg University, Deputy Head of the 4DH Research Centre

4th Generation District Heating Technologies and Systems
First Annual Conference 3 October 2012

Welcome



AALBORG UNIVERSITY

4DH

4th Generation District Heating
Technologies and Systems

4th Generation District Heating - First Annual Conference, 3 October 2012
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14.30-15.00 Coffee break



AALBORG UNIVERSITY

International status and future perspectives of DH and 4GDH concept



15.00-16.30 International status and future perspectives of district heating and the 4GDH Concept

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The case of Eastern Europe

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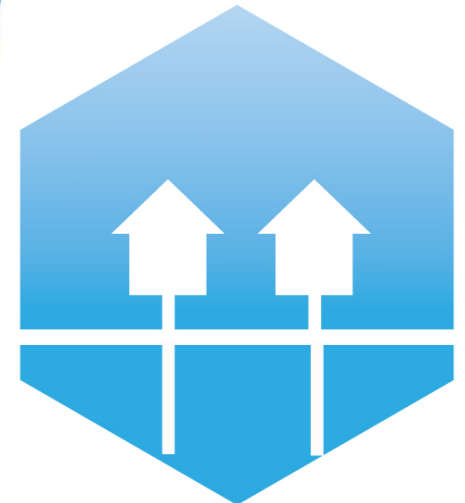
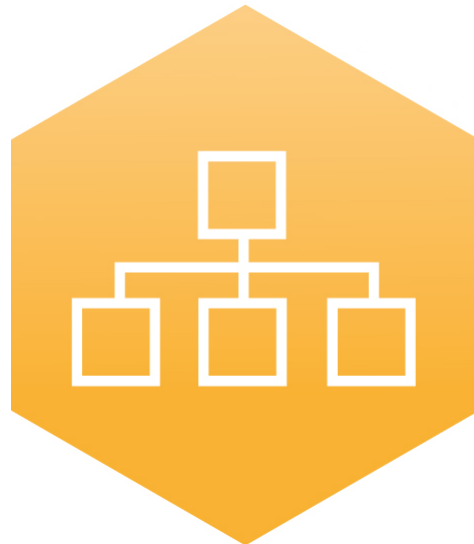
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Ass. Prof. Brian Vad Mathiesen, Aalborg University, Deputy Head of the 4DH Research Centre



4th Generation District Heating Technologies and Systems
First Annual Conference 3 October 2012

Thank you



Thursday 4 October 2012

Venue: Aalborg University, Skibbrogade 5, 1st floor, room C1/12, Aalborg

09.00-09.45 Presentation of WP1

Associate Professor Carsten Bojesen, Aalborg University

- Work programme for 2012 and 2013
- Presentation of PhD projects
- Presentation of demonstration project ideas

09.45-10.30 Presentation of WP2

Associate Professor Poul Alberg Østergaard, Aalborg University

- Work programme for 2012 and 2013
- Presentation of PhD projects
- Presentation of demonstration project ideas

10.30-11.00 Coffee Break

11.00-11.45 Presentation of WP3

Associate Professor Bernd Möller, Aalborg University

- Work programme for 2012 and 2013
- Presentation of PhD projects
- Presentation of demonstration project ideas

11.45-12.30 Formation of demonstration project working groups

12.30-13.30 Lunch

13.30-15.00 Steering Committee Meeting