



CITIES Consortium Meeting Alsion, Sønderborg October 2019

Status and Introduction to CITIES AGM

Henrik Madsen

Center Manager







Together, We Strive to Make Climate Neutrality a Reality

Every day, the news provide evidence that climate change is having an increasingly strong impact on the way we will live on Planet Earth. Cities of the world are key, along with nations, regions, universities and industry to find and implement solutions to this challenge.

By 2050, the majority of the world's population will be living in cities, causing the greatest emission of global greenhouse gases.

In the German/Danish region, we have already accepted this challenge to be an opportunity to demonstrate how coordinated actions can be created and implemented in a close public-private partnership cooperation.

We aim to bring government decision makers, researchers and industry representatives together to present and discuss best practice innovative green approaches to reaching 100% climate neutrality. Youth representatives will challenge traditional thinking by innovation and cross-pressure creation.



Home



About the Conference 2019

The 2019 conference, taking place on September 30th-October 2nd at Alsion in Sonderborg, will be the third conference to be held in Denmark, following the ones held back in 2015 and 2017.

How can we make sure that we achieve 100% climate neutrality? What is the role of science, industry and municipalities? – How do we use the municipal platforms to create more actions and impact?

This year's climate neutrality conference focusses on new technology developments, learnings from city demonstration projects, innovative business solutions, the UN's Sustainable Development Goals (SDGs) in a climate neutrality perspective, youth participation and strategies based on what a municipality can achieve by coordinated actions and strong political alignment.

Attendees from academia, industry and municipalities are invited to share and continue their important discussion about the best practice solutions to reach their climate goals at city, regional and national levels. In addition - this year, for the first time, a 'Youth' discussion will take place, represented by Youth Climate Councils from Germany and Denmark. The discussion will lead to a "Sonderborg Youth Declaration" to be presented and discussed at the final session of the conference.

Jointly Organized by: CITIES Project, EU ActKnow Project, Energibyerne.dk, and Youth Climate Council



CITIES' Vision on Accelerating the Green Transition



COULD WE BE 100% FOSSIL-FREE TOMORROW?



DTU

=









1. Linking energy sources

By linking traditionally separate energy systems it is possible to optimise renewable energy use, which will reduce the dependency on fossil fuels and cut CO2 emissions. The total amount of energy from renewable energy sources fully covers the world's existing and future energy needs....



2. Intelligent IT solutions

Linking is to take place via intelligent IT solutions which can handle and process large volumes of data. The total volume of knowledge is a prerequisite for being able to analyse, predict and utilise both energy production and energy needs. This makes it possible to switch between energy sources, depending on what is available and appropriate at any given time.....



3. Knowledge sharing

The total volume of knowledge and data across sectors, public and private stakeholders and research institutions is enormous, but also highly compartmentalised. A crucial component in creating a fossil-free future is therefore integration and the willingness to work towards a common goal – for the benefit of consumers, society and the environment.....







CITIES paves the way for a fossil-free future

Okay, we admit it: We won't be 100% fossil-free tomorrow. But it is both thought-provoking and motivating that it might be possible in theory. Just as the potential for utilising renewable energy sources such as solar, wind and biomass is enormous, there is an impressive amount of knowledge, advanced solutions, investments and best practice within each of the individual fields of energy.

What is missing is integration – and that is what we focus on in CITIES.

With Denmark as a fantastic live lab, support from Innovation Fund Denmark and extensive cooperation with leading Danish and global companies, researchers, engineers, computer scientists and project managers are working hard to pave the way for a fossil-free future.

By establishing and running an integrated research centre, covering all aspects of the energy system, CITIES will make a significant contribution to the Danish target of being 100% fossil-free by 2050.





Tuesday 1/10: 13.00-15.00: CITIES - From solutions to scalable solutions:

- Henrik Madsen, DTU: Introduction to CITIES AGM update
- Annemie Wyckmans, NTNU: CityxChange
- Kristina Bozhkova, Project Zero: SmartEnCity
- Louise Krog Jensen, AAU: Challenges and Opportunities of Implementing 100% Renewable Energy in Cities

Tuesday 1/10: 15.30-17.30:

CITIES - Smart technical solutions

- Anders Andersen, EMD: Optimization of private wire operation of wind production and district energy in Hvide Sande
- Nina Detlefsen, DFF: District heating the key to a smart integrated energy system
- Shmuel Oren, Berkeley: Firming Renewable Power with Demand Response:-An End-to-end Aggregator Business Model
- John Bagterp Jørgensen, DTU: Model Predictive Control for Smart-Energy Homes
- Christian von Scholten, NorthQ: Solutions for data driven buildings





Wednesday 2/10: 8.30-11.30:

CITIES - With a "building" focus?

- Benjamin Kroposki, NREL: Integrated Energy Systems at Scale Enabling more Renewable Energy
- Gerhard Zucker, AIT: Digital Building Twins What we can learn from industry
- Hans Bloem, INIVE-DYNASTEE: The Building as Cornerstone of our Future Energy System
- Magnus Hindsberger, Australian Energy Market Operator (AEMO): Preparing for a step change: Challenges of a fast transformation to a renewable future
- Søren Skov Bording, Center Denmark: Center Denmark
- Henrik Madsen, DTU: Accelerating the green transition using the flexibility of buildings



Challenges

The Challenge: Denmark Fossil Free 2050





A windy day Wind production = 135 pct of Load

I)]	ΓL	J
-			
2			





Possible Solutions and some Results from CITIES



Space of Solutions



Flexibility (eg enabled by AI and Energy Systems Integration)









The Challenge: Denmark Fossil Free 2050









Hypothesis

The **central hypothesis** of CITIES is that by **intelligently integrating** currently distinct energy flows (heat, power, gas and biomass) in urban environments we can enable flexibility for integrating large shares of renewables, and consequently obtain substantial reductions in CO2 emissions.

Intelligent integration will enable lossless 'virtual' storage and flexibility on a number of different time scales.







The *Smart-Energy Operating-System (SE-OS)* is used to develop, implement and test of solutions (layers: data, models, optimization, control, communication) for *operating flexible electrical energy systems* at **all scales**.





DTU

Integration based on *ICT solutions* (big data analytics, IoT, AI, automated learning, ..) leading to methods for *operation* and *planning* for future energy systems





Smart-Energy OS



Centre for IT Intelligent Energy Systems



Center Denmark – Control Room - EDS

DTU



Digitalized and dynamic market





Flexibility enabled using data intelligence

DTU





SE-OS Characteristics



- 'Bidding clearing activation' at higher levels
- Nested sequence of systems systems of systems
- Spatio-temporal based setup

e for IT Intelligent Energy Systems

- Hierarchy of optimization and control problems
- Control principles at higher spatial/temporal resolutions
- Cloud, Fog, Edge based (IoT, IoS) solutions eg. for forecasting and control
- Facilitates energy systems integration (power, gas, thermal, ...)
- Allow for new players (specialized aggregators)
- Simple setup for the communication and contracts
- Provides a solution for all ancillary services problems
- Harvest flexibility at all levels -> max. Virtual storage











- 30-40 journal papers
- 6 PhD summerschool events
- Dissemination through media and broad-audience events
- A dynamic and public website
- Models and strategies for integrated energy systems
- CITIES Innovation Centre (in parallel to CITIES)
- Support activities related to green/smart cities projects
- Establish an international network

Status (Sept. 1st, 2019)



Project management



- New brochures explaining some of the results from CITIES.
- A new communication and public media expert
 - (Hanne Kokkegård 50 pct. CITIES + 50 pct. SCA) started May 1st
- Homepage www.smart-cities-centre.org
- Twitter (@CITIES_Centre)
- CITIES Innovation Center (CIC) (incl. Homepage...)
- Center Denmark (facilitates also innovation projects)
- International influence:

EU Commission, EU JRC, DG ENER, DG CNECT

EERA JP ESI+SC+SG, Smart Cities, ..

Global: ESIG (Summer schools / Meetings / Workshops)

Global: IEA (Annex 67, 71, 73, 74 (living labs) and 79)

Innovation Networks:

INNO SE, TI, House of Energy, CLEAN, Climate KIC,



CITIES Solutions Brochures

Energy Taxes for the Transition to a

Low-Carbon Society

INTRODUCTION

CTT IS

ENDOCATION The Table A values para if and the share have been starts indefining a final start or the same table and the share is the same table and the same table and the same table and the same table and table and the same table and the same table and the same table denoming and table, the parameter same table and and table and tables and table and table and table and table and table and tables and and tables and tables and table and tables and and tables and tables and tables and tables and tables and tables and and tables and tables and tables and tables and tables and tables and and tables and tables and tables and tables and tables and tables and and tables and t

Adjustit has a dever Oat Millow play do an tax sector set of a grown to a faith with the faith of the faith of the adjustment of the set of the set of the set of the faith of address of the set of address of the set of t service or and he mared any the sugestal stress

The second secon



Dynamic CO2 based control

In resolution room () 2021 to 2020 and 2020 and 10% of the electricity load wave co-small by the functioning and parts is reproduced as one power generations of the large power the on the emission over power rhose index to balance providence. The Power shall be a large of power rhose and to balance providence. The Power shall be a large of the PO200 Describer Program, since all assessing Power shall be a large of the PO200 Describer Program.

the parasital of pression of arcillary services hors an appropriate of David survey at he away with entropy regions.

Another thanks and a low service grant of the service of the servi

Smart Meter Consumption

stability of electricity errort mater consumption dusters over time

INTRODUCTION

For more than a detaile rependent have supported analyzed seven meter details. In seventh somewhere patterns, thereas an anyonic takes append in measure and other tructure apportance takes matching severing to detaility various consumption patterns hidden is the sevent webse data.

Wat notivees but researchers and prodes devolutions in the publicity of producing consumption-could be address of public devolutions are find and an approximation for bands, and provide a database devolution for address of addressing address of the search band devolution of a database and addressing address of the search band devolution of a database addressing addressing addressing addressing addressing addressing field database and addressing addres

The piccer exactly pice of the clusted og tid. J construct parameter represent the of the set in sector analysis of provide constructions parametering an acade

 Are entire that even classes Lightly is a corth sha Sole Lightly is that all events, at
There are a result in closer and re-

Stability of electricity smart

Clustering-Based Analysis

dustering based analysis for residential district heating data

Permetadore rear-lativation in construction individually 10% and individuality table reargament points. The relating discussion is a construct which is reached using memorytes. There individuality is a second second second second provide these second points and a construction of a galaxies of the approximation of the second points and a construction of a galaxies of the memory and second points and a construction of the construction of a construction of the second second points and a construction of the second second points and the memory and second points and the second second points and a construction of the second second points and the second points are an expected second second points are an expected second points and the second points are an expected points are

meter clusters

🚰 critis , 👌 ------

INTRODUCTION.

HO FACTOR

Energy taxes for the

transition to a low-carbon

Integrated Energy Planning

Internet Control (1997) Allow and the second sec

Accuracy increases of these paper is to result as any fixed share of some image assesses a darks as dealback parts from these soft has resolve many assesses to darks in they fire mathematical and the mathematical assessments are able to have the mathematical and the mathematical approximation of the soft in the soft of the soft of the mathematical parts of the mathematical and the soft of the soft of the soft of the parts of the soft of the soft

1.1.1.1

UNREL

society

INTRODUCTION.

CASE STUDY

Descenic 30.0 rece-scorers informat, total prevary many

in some first, and

island

con, and the read h

Integrated energy

planning for a carribean

Dynamic CO2 based

control

INTRODUCTION



b) the sample to assume of strange study. Since the same strange is the same strange of based or of the sample system, so well at the same states is support, the same particle strange strates are strated with the of dataset. And of same with the same particle strates are strated with an electron of dataset. And of same with the same particle strates are strated with an and same strategies are strategies and in the same strate are strates and state strates are strategies and with the same strate are strates and state are same strategies are strategies and in the same strate are strates and states are strategies are strategies and in the same strate are strates and states are strategies are strategies and the same strate are strategies and are same strategies are strategies and the same strate are strategies and are same strategies are strategies and the same strate are strategies and are same strategies are strategies are strategies and the same strategies are are strategies are strategies are strategies are strategies are strategies are are strategies are strategies are strategies are strategies are strategies and are strategies are strategies are strategies are strategies are strategies are are strategies are strategies are strategies are strategies are strategies are are strategies are strategies are strategies are strategies are strategies are are strategies The first matrix is a factor length right field, for other 1 deviced marking 1923 or Theodore we approximately a priority of field do apply (FIG) or papers with the stand or work to many first instantion for barrow (FIG) and (FIG) or papers with the stand or work of the standard for barrow (FIG) and (FIG) or papers with the standard or paper of the standard or papers with the standard or paper with the standard or paper of the standard or papers of the standard or paper of the standard standard, and of the standard or papers of the standard or paper of the standard or papers with the standard or papers of the standard or paper of the standard or papers of the standard or paper



Potential of district cooling

Clustering based analysis of residential district heating data

these approximates a strategiest for the clustering for an The group of the studying of the dat My both approxi-dencial of a metanel for patient, and, patients, 1



Storage in Thermal Building Mass



🤹 cmis **Coupled Electricity and** Natural Gas Markets



Search ...

100% BY 2050 ABOUT US TOPICS PROJECTS EVENTS PARTNERS

We pioneer the green transition in a unique partnership with the industry, academia and state-actors.

100% renewable urban energy systems, is 100% possible. We are actors from the Danish industry, academia and public sector pioneering the green transition through integrated energy systems powered by intelligent data. Join us now for a safer and greener future.







Q





U







Status (Sept. 1^{st.}, 2019)

Some KPIs, statistics and dissemination results:

- Approx. 250 scientific publications in total (so far)
- Approx. 40 scientific oriented presentations (2018 only)
- Approx. 108 journal papers published (until September, 2019)
- Approx. 9 videos related to Forecasting and Integration (Jointly with Energinet, Ørsted, and EWII). Joint effort with ESIG, ESI 101 and EIT InnoEnergy (ongoing)
- 24 Workshops
- 12 PhD summer/winter-schools
- 3-4 extra PhD's (Indonesia, Malaysia, DSOs, ...)
- More than 18 Demo Projects
- Several successful H2020, IFD, EUDP, ... applications related to CITIES (see later on). (Ex. two new Grand Solution projects – FED and HEAT 4.0)

CITIES

Centre for IT-Intelligent Energy Systems in cities



Software solutions

Software for combined physical and statistical modelling

Continuous Time Stochastic Modelling (CTSM) is a software package for modelling and simulation of combined physical and statistical models. You find a technical description and the software at CTSM.info.

Software for Model Predictive Control

HPMPC is a toolbox for High-Performance implementation of solvers for Model Predictive Control (MPC). It contains routines for fast solution of MPC and MHE (Moving Horizon Estimation) problems on embedded hardware. The software is available on GitHub.

MPCR is a toolbox for building Model Predictive Controllers written in R, the free statistical software. It contains several examples for different MPC problems and interfaces to opensource solvers in R. The software is available on GitHub.

Latest news

Summer School at DTU, Lyngby, Denmark – July 4th-8th 2016

Summer School – Granada, Spain, June 19th-24th 2016

Third general consortium meeting – DTU, May 24th-25th 2016

Smart City Challenge in Copenhagen – April 20th 2016

Guest lecture by Pierluigi Mancarella at DTU, April 6th



International Collaboration



- Our partners Tecnalia, NREL, AIT, NTNU, LU, UCD, Konkuk, Samsung, ...
- Member of Advisory Board or Partner in many International Projects;
 The largest being:
 - Energy Systems Integration Partnership Programme (ESIPP) Ireland – 120 mill dkr
 - Centre for Energy Systems Integration (CESI) UK 300 mill dkr (project partner)
 - Research Centre on Zero Emission Neighbourhoods in Smart Cities (ZEN) – Norway – 400 mill NOK

In all cases a strong link to CITIES

- 8 EU projects building on results from CITIES
- COST TD1207 'Mathematical Optimization in the Decision Support Systems for Efficient and Robust Energy Networks.

Task Force on Framework Conditions and Test Zones



Status for CITIES Task Force

- Task Force was established at the SG meeting in December 2016
- Design of Energy Taxes, Tariffs, Test Zones, Markets and Framework conditions
- Consists of Grøn Energi, TI, DTU, AAU, Ørsted, Tomorrow, Danfoss, Grundfos core group: Nina, Frank, Christian, Torben, Henrik, Jan, Olivier, Karl
- Suggestion for a new design of energy taxes: Energiafgifter for Fremtiden (Energy Taxes for the Future)
- Suggestion for tests of framework conditions: Testzoner for Udvikling og Afprøvning af Fremtidens Energisystem og Rammebetingelser (Test Zones for a Development and Test of the Future Energy System and Frame Work Conditions).
- Meetings with the Ministries (EFKM, Taxation, Finance, Erhvervsm.)
- Meetings with 'Energistyrelsen'
- Meetings with IFD and EUDP
- Meetings with members of the Parliament (energiordførerne)



Energy Taxes for Accelerating the Green Transition



Figuren viser hvorledes elprisen tænkes sammensat af en markedspris (rå elpris), tariffer og dynamiske afgifter. I den videre tekst fokuseres på de dynamiske afgifter.



Center Denmark



Center Denmark Status - establishment



- Center Danmark Fund is established
- Board (not complete more will follow)
- ጵ 🛛 Direktør Lars Bonderup Bjørn, EWII (chair)
- ጵ 🛛 Direktør Søren Dupont Kristensen, Energinet
- ጵ Direktør Henrik Rold Thorsen, EnergyCOOL
- 📩 🛛 Dekan Henrik Bindslev, SDU
- ጵ 🛛 Dekan Jakob Stoustrup, AAU
- ጵ 🛛 Prodekan Søren Rud Keiding, AU
- ጵ 🛛 Professor Henrik Madsen, DTU (co-chair)
- AAU, SDU, AU and DTU now have coordination activies
- CEO (Søren Skov Bording) has started June 1st.
- First office space (approx. 300 m2) Nov. 1st.







Demo Projects



DTU

CITIES Innovation Center





Main priorities SC (Mar 2019 + June 2019)** and IAB (Sept 2018)



- SC Dec 2018: Discuss and define 10 success stories for CITIES
- More Demo Projects also involving the new partners
- Focus on framework conditions and testzones CITIES Task Force group
- Workshops related to smart district heating (Zagreb, April 2019) + upcoming workshops (Dansk Byggeri, Sept 24th + Grøn Energi/Nina + Gate21, Region H.)
- Workshop related to smart wastewater (Aalborg, June 2019)
- Workshop related to PVT system, IEA Task 60, October 2019
- Workshop CITIES (DK) + ZEN (N) (DTU, June 2019)
- Digitalisation is important. Continued education. (DTU Sektorudvikling..)
- Collaborate with Smart Cities projects
- Collaborate with Innovation Hubs (TI, CLEAN, INNO-SE, House of Energy, ..)
- Make results more understandable for everyone; remove the complexity. (public media, LinkedIn, Twitter, ..)
- Focus on Innovation activities (Center Denmark + CIC)
- Join international networks + international influence



Main priorities SC (June 2019) and IAB (Sept 2018)**



- Time to communicate and disseminate to the public and regulatory bodies
- CITIES should be more visible on regular basis (newspaper, YouTube, etc.)
- More focus on buildings and their flexibility (invitation to EU events)
- Important to focus on Flexibility Both related to operations and planning
- Focus on cyper security
- More focus on the need for end-users and consumers
- More focus on innovation and potential products
- More focus on risks and liability to customers
- Need for market mechanisms that could facilitate flexibility
- Split consortium meeting in technical and non-technical
- Short videos could help to publicize the information