Clustering-based analysis for residential district heating data

The wide use of smart meters enables collection of a large amount of fine-granular time series, which can be used to improve the understanding of consumption behavior and used for consumption optimization. This paper presents a clustering-based knowledge discovery in databases method to analyze residential heating consumption data and evaluate information included in national building databases. The proposed method uses the K-means algorithm to segment consumption groups based on consumption intensity and representative patterns and ranks the groups according to daily consumption. This paper also examines the correlation between energy intensity and the characteristics of buildings and occupants, load profiles of households, consumption behavior changes over time, and consumption variability. The results show that the majority of the customers can be represented by fairly constant load profiles. Calendar context has an impact not only on the patterns but also on the consumption intensity and user behaviors. The variability studies show that consumption patterns are serially correlated, the customers with high energy consumption have lower variability, and the consumption is more stable over time. These findings will be valuable for district heating utilities and energy planners to optimize their operations, design demand-side management strategies, and develop targeting energy-efficiency programs or policies.
Energy demand flexibility in buildings and district heating systems – a literature review

With the growing share of fluctuating renewable energy sources in our energy systems, providing sufficient flexibility on the demand side is becoming more and more important – also in the context of the emergence of Smart Grids. However, it will be difficult to achieve this by concentrating on electricity-only solutions. So, the next step is to focus on electricity-thermal solutions (e.g. heat pumps, electrical heating and cooling) and thermal system components. Here district heating and the building stock are important contributors due to their large share of energy demand. This literature review focuses on energy flexibility in context of heat demand in buildings and district heating systems. First, the theory regarding definitions of energy flexibility found in the literature, its quantification methods and indicators is discussed. Due to a lack of literature on the heating side, most of the theory in this review is based on electrical solutions. Then, the connection between electrical and thermal energy systems is described and the importance of integrated systems approach is explained. A schematic of flexibility sources in the built environment is proposed and technological solutions found in literature on buildings and district heating are presented based on the proposed framework.

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Contributors: Luc, K. M., Heller, A., Rode, C.
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Scopus rating (2013): CiteScore 1.1 SJR 0.481 SNIP 0.925
Scopus rating (2012): CiteScore 1.25 SJR 0.664 SNIP 0.81
Scopus rating (2011): CiteScore 0.55 SJR 0.327 SNIP 0.621
Scopus rating (2010): SJR 0.683 SNIP 0.731
Scopus rating (2009): SJR 0.265 SNIP 0.94
Scopus rating (2008): SJR 1.095 SNIP 1.159
Original language: English
Keywords: Flexibility, Demand-side management, Energy storage, Heating/space heating
DOIs:
10.1016/j.enconman.2018.03.015
Source: FindIt
Source-ID: 2418752045
Research output: Research - peer-review • Journal article – Annual report year: 2018

Estimation of temperature setpoints and heat transfer coefficients among residential buildings in Denmark based on smart meter data

Thermal comfort preferences of occupants and their interactions with building systems are top influential factors of residential space heating demand. Consequently, housing stock models are sensitive to assumptions made on heating temperatures. This study proposes a heat balance approach, inspired by the classical degree-day method, applied to an extensive urban dataset. The goal of this analysis is to determine heterogeneous characteristics, such as temperature setpoints of heating systems and thermal envelope characteristics from an overall population of residential buildings.
Measured energy data are utilized for the purpose of the study from the city of Aarhus, Denmark, where the energy usage for heating of circa 14,000 households was monitored over time via smart meters. These data are combined with actual weather data as well as data extracted by a national building database. Using linear regression and heat balance models, temperature setpoints for the whole dataset are determined with a median and average of 19 °C and 19.1 °C, respectively. Furthermore, building related characteristics such as thermal and ventilation losses per building and overall heat transfer coefficients are extracted at urban scale. The reliability of the method over its complexity is discussed with regards to the big sample that has been applied to. In general, the overall performance of the approach is satisfactory achieving a coefficient of determination with an average of 0.8, and is found to be in line with previous findings, considering also the high uncertainty associated with building-related input parameters. The extracted setpoint distribution should be transferrable across Scandinavia.
Heating system energy flexibility of low-energy residential buildings

Energy flexibility is proposed as a cost-effective solution facilitating secure operation of the energy system while integrating large share of renewables. With strict building regulations in Denmark, newly built buildings are low-energy buildings. In order to identify the role of low-energy buildings in the energy system, we investigated the physical potential for flexibility and analysed the thermal storage capacity existing inherently in the structural mass. Two building types were studied: single-family house and apartment block. The aim is to quantify the energy that can be added to or curtailed from each building during a time period without compromising thermal comfort. Different scenarios (starting time and duration), building design characteristics and boundary conditions were studied. The findings showed that low-energy buildings are highly robust and can remain autonomous for several hours. Although for individual buildings the available energy for curtailment is limited, if many buildings are aggregated energy flexibility becomes significant. The potential for storage in the thermal mass is considerable. The analysis presented high dependence of flexibility potential on boundary conditions (ambient temperature, solar radiation, internal gains) and underlined the importance of envelope insulation. Heat losses govern the potential for flexibility, while the walls’ thermal mass has a secondary influence.

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State: Published
Organisations: Department of Civil Engineering, Energy and Services, Materials and Durability
Contributors: Foteinaki, K., Li, R., Heller, A., Rode, C.
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Publication date: 2018
Peer-reviewed: Yes

Publication information
Journal: Energy and Buildings
Volume: 180
ISSN (Print): 0378-7788
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Scopus rating (2002): SJR 1.189 SNIP 1.671
Web of Science (2002): Indexed yes
Scopus rating (2001): SJR 0.972 SNIP 1.082
Scopus rating (2000): SJR 0.243 SNIP 1.235
Web of Science (2000): Indexed yes
Scopus rating (1999): SJR 0.241 SNIP 0.669
Original language: English
Keywords: Energy flexibility, Building thermal mass, Thermal energy storage, Low-energy building, Demand response
DOIs: 10.1016/j.enbuild.2018.09.030
Source: FindIt
Source-ID: 2439600878
Research output: Research - peer-review › Journal article – Annual report year: 2018

Implementation of Energy Strategies in Communities (Annex 63) Volume 3: Application of Strategic Measures
This report describes, for different scales (city, district and project level) and for 29 conceptualised case studies, how implementation champions can apply the strategic measures from Volume 2. Implementation champions are hereby understood as stakeholders in the city who take the initiative to lead and facilitate implementation processes.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics, Section for Building Energy, Kuben Management, Beratungs- und Service-Gesellschaft Umwelt mbH, Deutscher Verband für Wohnungswesen, Städtebau und Raumordnung e.V., European Institute for Energy Research, Energie-Consulting AG, Fraunhofer-Gesellschaft, Integrale Planung GmbH, Institute for Resource Efficiency and Energy Strategies - IREES GmbH, Sustainable Energy Authority of Ireland, SINTEF, Aalborg University, Natural Resources Canada, Norwegian University of Science and Technology, Osaka University, RWTH Aachen University, Salzburg Institute for Regional Planning and Housing, University of Minnesota, Hogeschool Zuyd
Number of pages: 91
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Electronic versions: Untitled.pdf
Source: PublicationPreSubmission
Source-ID: 146792023
Research output: Research › Report – Annual report year: 1800

Initiatives for the energy renovation of single-family houses in Denmark evaluated on the basis of barriers and motivators
The renovation of single-family houses in Denmark is progressing only slowly. Changes in current policy are needed if the political goal of a fossil-free building sector as part of a fossil-free society is to be achieved. Known barriers and motivators for energy renovation are identified, and arranged in a frame-work with three main fields (Information, Finance and Process), with a total of 14 sub-areas. With this framework, current Danish policy is analysed to identify shortcomings, found to mainly exist in connection with financing and decision support. Using experience from other countries, suggestions are made for improvement in four areas: (1) focus on non-energy benefits rather than investment, (2) enhancement of subsidy system, (3) including relevant renovation plans in the energy performance certificate (EPC), and (4) long-term regulation on the maximum allowed energy consumption of houses.

General information
State: Published
Organisations: Section for Building Energy, Department of Civil Engineering
Contributors: Grøn Bjørneboe, M., Svendsen, S., Heller, A.
Pages: 347-358
Publication date: 2018
Peer-reviewed: Yes
Utilizing thermal building mass for storage in district heating systems: Combined building level simulations and system level optimization

Higher shares of intermittent renewable energy in energy systems have raised the issue of the need for different energy storage solutions. The utilization of existing thermal building mass for storage is a cost-efficient solution. In order to investigate its potential, a detailed building simulation model was coupled with a linear optimization model of the energy system. Different building archetypes were modelled in detail, and their potential preheating and subsequent heat supply cut-off periods were assessed. Energy system optimization focused on the impact of thermal mass for storage on the energy supply of district heating. Results showed that longer preheating time increased the possible duration of cut-off events. System optimization showed that the thermal mass for storage was used as intra-day storage. Flexible load accounted for 5.5%–7.7% of the total district heating demand. Furthermore, thermal mass for storage enabled more solar thermal heating energy to be effectively utilized in the system. One of the sensitivity analyses showed that the large-scale pit thermal energy storage and thermal mass for storage are complimentary. The cut-off duration potential, which did not compromise thermal comfort, was longer in the newer, better insulated buildings, reaching 6h among different building archetypes.

General information
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Organisations: Department of Energy Conversion and Storage, Department of Civil Engineering, Section for Indoor Climate and Building Physics, Department of Management Engineering, Systems Analysis, Centre for IT-Intelligent Energy Systems in Cities
Pages: 949-966
Publication date: 2018
Peer-reviewed: Yes

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Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 5.6 SJR 1.99 SNIP 1.923
Web of Science (2017): Impact factor 4.968
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 5.17 SJR 1.974 SNIP 1.823
Web of Science (2016): Impact factor 4.52
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): CiteScore 5.03 SJR 2.22 SNIP 2.037
A Science Cloud for Smart Cities Research

Cities are densely populated and heavily equipped areas with a high level of service provision. Smart cities can use these conditions to achieve the goals of a smart society for their citizens. To facilitate such developments, the necessary IT-infrastructure has to be in place for supporting, amongst many other things, the whole lifecycle of big data management and analytics for research activities. At the Centre for IT-Intelligent Smart Energy for Cities, we have therefore been developing a flexible infrastructure, based on open sourcetechnologies. This paper presents this solution and its
CITIESData: a smart city data management framework
Smart city data come from heterogeneous sources including various types of the Internet of Things such as traffic, weather, pollution, noise, and portable devices. They are characterized with diverse quality issues and with different types of sensitive information. This makes data processing and publishing challenging. In this paper, we propose a framework to streamline smart city data management, including data collection, cleansing, anonymization, and publishing. The paper classifies smart city data in sensitive, quasi-sensitive, and open/public levels and then suggests different strategies to process and publish the data within these categories. The paper evaluates the framework using a real-world smart city data set, and the results verify its effectiveness and efficiency. The framework can be a generic solution to manage smart city data.
Evaluation of the renovation of a Danish single-family house based on measurements

Building renovation is too often carried out with only one objective: necessary maintenance, updating design and functions, or reducing energy consumption. But, if a necessary maintenance is exploited as an opportunity for renovation, energy improvements can be implemented, house functions can be updated, and indoor climate improved with minimal nuisance and expense. This paper illustrates this approach by documenting the renovation of a single-family house in Denmark, and monitoring its energy consumption and indoor climate before and after the renovation. Building elements were replaced where necessary, and the total energy consumption was reduced by 23%, giving the house owners a saving of about DKK 8400 per year. The energy consumption for heating was reduced by 53%, close to the 58% found using dynamic simulations. The temperatures reached a more comfortable level, and the house owners were satisfied with the result. The increased value of the house was estimated to cover about 77% of the investment.
Flexibility of Large-Scale Solar Heating Plant with Heat Pump and Thermal Energy Storage

In the future energy system, based wholly on renewable energy sources, biomass is likely to become a scarce resource because of high demand especially by the transport sector. The current paper investigates what is the possibility of utilizing excess electrical energy from renewable generation to decrease biomass use in a district heating system. The paper focuses on the renewable energy-based district heating system in Marstal, Denmark, with heat produced in central solar heating plant, wood pellet boiler, heat pump and bio-oil boiler. The plant has been the object of research and developments since its construction in 1996 and its operation is well documented. In the first part of the paper, the background of the current study is explained and the system in question is presented. Subsequently, the methodology of the study is explained and the model used in the study is described. Due to lack of widely accepted definition of a metrics for comparing system flexibility the paper proposes such an indicator. It was concluded, that cheap electricity can partially replace scarce biomass for heat production for district heating system.

General information
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Organisations: Department of Civil Engineering, Section for Building Energy, Section for Indoor Climate and Building Physics
Contributors: Luc, K. M., Heller, A., Rode, C.
Number of pages: 13
Publication date: 2017

Host publication information
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Keywords: Central Solar Heating Plant, District Heating, Heat Pump, Integrated Energy System
DOIs: 10.18086/eurosun.2016.05.10
Source: FindIt
Source-ID: 2398080012
Research output: Research › Article in proceedings – Annual report year: 2018

Heating of indoor swimming pools by solar thermal collectors in summerhouses in Denmark

General information
State: Published
Organisations: Department of Civil Engineering, Section for Building Energy, Department of Applied Mathematics and Computer Science, Dynamical Systems, Centre for IT-Intelligent Energy Systems in Cities, Eurisco Aps.
Contributors: Dannemand, M., Furbo, S., Andersen, C. A., Heller, A., Madsen, H.
Number of pages: 38
Publication date: 2017
Impact of Prosumers and their Clusters on the Energy System

General information
State: Published
Organisations: Department of Civil Engineering, Section for Building Energy, Department of Energy Conversion and Storage, Centre for IT-Intelligent Energy Systems in Cities
Contributors: Larma, M., Heller, A., Pedersen, A. S.
Number of pages: 1
Publication date: 2017
Peer-reviewed: Yes
Event: Poster session presented at Fourth General CITIES Consortium Meeting, Aarhus, Denmark.

Implementation of Energy Strategies in Communities (Annex 63) Volume 1: Inventory of measures
This report describes the existing national political framework conditions, energy and land-use planning processes, strategies for energy planning and existing national measures in the field of urban and energy planning. In this research, the term measure refers to any action, program, policy or other activity that can demonstrate or influence a change in process. Amongst other background information, 22 planning processes and 89 measures from 11 countries are described in detail in this report.

Bibliographical note
Implementation of Energy Strategies in Communities (Annex 63) Volume 2: Development of strategic measures

This report describes the further development of the analysed measures from Volume 1 into strategic measures. As with the term measure, a strategic measure refers to an essential measure in concept that can be used to develop individual implementation strategies on a local level for part or the whole life cycle of a project (from the first vision to monitoring of the implemented solution). The developed strategic measures deal with the following topics: Setting Vision and Targets Developing Renewable Energy Strategies Making Full use of Legal Frameworks Designing an Urban Competition ProcessesMaking use of Tools Supporting the Decision Making Process Implementing Monitoring of Energy Consumption and GHG Emission practices Enhancing Stakeholder Engagement & Involvement Including Socio Economic Criteria Implementing Effective and Efficient Organisational Processes <p> The report includes both a summary of each strategic measure supported by nine appendices, each a detailed description of each strategic measure.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics, Section for Building Energy, Aalborg University, Norwegian University of Science and Technology, Osaka University, RWTH Aachen University, University of Minnesota
Number of pages: 253
Publication date: 2017

Publication information
Publisher: International Energy Agency
Volume: 2
Original language: English
URLs:

Intelligent Scheduling of a Grid-Connected Heat Pump in a Danish Detached House

This study proposes a methodology for intelligent scheduling of a heat pump installed in a refurbished grid-connected detached house in Denmark. This scheduling is conducted through the coupling of a dynamic building simulation tool with an optimization tool. The optimization of the operation of the system is based on a price-signal considering a three-day period for different weather cases. The results show that the optimal scheduling of the system is successful in terms of reducing the peak load during times when electricity prices are high, thus achieving cost savings as well as maintaining good thermal comfort conditions. The proposed methodology bridges dynamic building modelling with optimization of real-time operation of HVAC systems offering a detailed model for building physics, especially regarding thermal mass and a stochastic price-based control.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics, Section for Building Energy
Contributors: Gianniou, P., Foteinaki, K., Heller, A., Rode, C.
Publication date: 2017
Peer-reviewed: Yes
Electronic versions:
Untitled.pdf
Source: PublicationPreSubmission
Source-ID: 137263270
Research output: Research › peer-review › Paper – Annual report year: 2017
SciCloud: A Scientific Cloud and Management Platform for Smart City Data
The pervasive use of Internet of Things and smart meter technologies in smart cities increases the complexity of managing the data, due to their sizes, diversity, and privacy issues. This requires an innovative solution to process and manage the data effectively. This paper presents an elastic private scientific cloud, SciCloud, to tackle these grand challenges. SciCloud provides on-demand computing resource provisions, a scalable data management platform and an in-place data analytics environment to support the scientific research using smart city data.

General information
State: Published
Organisations: Department of Management Engineering, Systems Analysis, Department of Civil Engineering, Section for Building Energy, Section for Indoor Climate and Building Physics
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Publication date: 2017

Host publication information
Title of host publication: 2017 28th International Workshop on Database and Expert Systems Applications (DEXA)
Publisher: IEEE
ISBN (Electronic): 978-1-5386-1051-0
Electronic versions:
output.pdf
DOIs:
10.1109/DEXA.2017.22
Source: PublicationPreSubmission
Source-ID: 135007179
Research output: Research - peer-review → Article in proceedings → Annual report year: 2017

Using a One-Stop-Shop Concept to Guide Decisions when Single-Family Houses are renovated
One way of reducing the use of fossil fuels in Denmark is to explore possible energy savings in the building stock, especially the large number of single-family houses built from 1960 through 1980. Energy renovation in this housing segment is progressing slowly. The aim of this project was to determine how a one-stop-shop (OSS) or full-service concept could be used to guide the extensive energy renovation of single-family houses. The purpose was partly to identify the benefits and disadvantages of using the concept and partly to evaluate the potential of the OSS concept for increasing the degree of renovation. The scope of the project was to carry out renovations on up to three houses. The project revealed that the concept on its own was not enough to motivate the house owners to engage in extensive renovation. However, interviews with the house owners indicated that the renovations that took place had probably been expanded and improved with the use of the concept and that the renovations in general benefitted from an independent adviser.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Building Energy
Contributors: Grøn Bjørneboe, M., Svendsen, S., Heller, A.
Publication date: 2017
Peer-reviewed: Yes

Publication information
Journal: Journal of Architectural Engineering
Volume: 23
Issue number: 2
ISSN (Print): 1076-0431
Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 0.82 SJR 0.284 SNIP 0.64
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 0.73 SJR 0.273 SNIP 0.491
BFI (2015): BFI-level 2
Scopus rating (2015): CiteScore 0.81 SJR 0.423 SNIP 0.749
BFI (2014): BFI-level 2
CITIESData: Towards Cloud Based Big Data Management for Smart Cities

General information
State: Published
Organisations: Department of Management Engineering, Systems Analysis, DTU Climate Centre, Department of Civil Engineering, Section for Building Energy, Centre for IT-Intelligent Energy Systems in Cities
Contributors: Liu, X., Heller, A., Nielsen, P. S.
Number of pages: 1
Publication date: 2016
Peer-reviewed: No
Event: Poster session presented at 3rd General Consortium Meeting of Smart Cities project, CITIES, Kgs. Lyngby, Denmark.
Electronic versions:
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URLs:
Research output: Research › Poster – Annual report year: 2016

Identification of parameters affecting the variability of energy use in residential buildings

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics, Section for Building Energy, Department of Management Engineering, Systems Analysis, DTU Climate Centre, Centre for IT-Intelligent Energy Systems in Cities
Identification of Parameters Affecting the Variability of Energy Use in Residential Buildings

Energy use of buildings varies significantly. When aggregating the demand profiles of a group of buildings, the variations of energy demand are critical to determine the aggregated load profile. Especially when dimensioning district energy systems, it is important to know the variability of energy demand that can guarantee the efficient operation of the system. For this reason, it is useful to distinguish the parameters that affect building energy performance the most and to estimate the magnitude of these variations on each parameter. The aim of the present study is to identify the parameters that lead to the largest variations in energy performance of residential buildings in Denmark. A set of sensitivity analysis has been carried out using an extensive search algorithm. These sensitivity analyses were then applied for modelling a reference building representing Danish single-family houses of the 1940’s. The study was able to determine the key variables that affect energy use in old Danish single-family houses using sensitivity analysis and proposes a methodology for parameter optimization. This analysis pointed out that the insulation in external walls and roof lead to the largest variations in space heating demand. Also, the infiltration rate and occupancy behavior play important role on space heating consumption. It was concluded that these findings highly depend on the specific case study and the characteristics of the buildings that are examined. If outdoor climate and location differ from the current case, a different set of parameters should be investigated upon its effect on building energy use.

Impact of Prosumer Buildings and their Clusters on the Energy System – project outline

Impact of Prosumer Buildings and their Clusters on the Energy System – project outline

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Impact of Prosumer Buildings and their Clusters on the Energy System – project outline

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Impact of Prosumer Buildings and their Clusters on the Energy System – project outline
Living Labs – From scientific labs to the smart city
Research laboratories are characterized by the fact that the experiments are carried out under very well controlled conditions. In some research fields, field trials are a well-established methodology where many of the parameters involved are not controlled by the researchers in their experiments. Living Labs can be compared with these field tests, trials and setups. However control of parameters is often not possible in living lab trials and experiments. Data collection is one of the important subjects and tasks in such research. Often, the researchers and research communities are part of these living labs. Hereby the scientific approach has to be carefully evaluated and methods adjusted accordingly.

Examples of living labs can be found across DTU. A very small living lab is made at the Library where a lighting system is established that can be influenced by students and researches through open interfaces. The basic idea is to enable innovators to perform their developments and research in this real world setup and learn to define solutions that are applicable there.

On a larger scale, DTU is promoting the whole campus as a living lab that can be used for research and development by its employees, but also partners from outside. This proposition can be found under the term “Smart Campus” with it’s own homepage. Here you find the example from the library above, the Smart Avenue that enables communication and IT solutions on the campus, enabled through intelligent street lightning that in the same time is part of the Doll Living Lab setup placed in the area.

Lyngby Smart City is a living lab approach facilitated by the City of Knowledge. Together with the labs presented above, we find a direct chain from scientific research labs at DTU over the campus lab, out into the real world living labs near Lyngby and from there into the big smart city of Copenhagen to be promoted to the world markets. This way the value chain “from research to invoice” is instantiated into not only an innovation and business strategy, but rather a research strategy that aims at elevating DTU’s research to an even more leading international position.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Building Energy
Contributors: Heller, A.
Number of pages: 1
Publication date: 2016
Peer-reviewed: Yes
URLs:
http://www.sustain.dtu.dk/

Bibliographical note
Sustain Abstract L-2
Research output: Research - peer-review › Conference abstract for conference – Annual report year: 2016

Mapping one year's design processes at an architecture firm specialized in sustainable architecture- How do sustainability certification systems affect design processes?
The current study mapped how a Danish architecture firm integrated sustainability in their projects over a year. All the projects concerned were aimed at being sustainable within the framework of the DGNB certification system. The focus of DGNB is equally divided between environmental, economic and social aspects. During the mapping process, a picture was drawn of the state of the art for integrating DGNB in design processes and of the challenges involved. Case studies formed the basis of the study and helped substantiate the complexity of integrating DGNB’s criteria as design parameters in practice.
The framework for the study is the increased focus in recent decades on minimizing the energy consumption used for operating buildings, because the building industry accounts for 40% of the total energy consumption in the EU. This focus has led to more optimized design processes within the framework of the Integrated Energy Design (IED) method, in which many decisions related to indoor climate and energy consumption are made in the early stages of the design process and have therefore become an important design factor for both architects and engineers. The tendency is now to widen the perspective to design decisions in all phases of the entire lifecycle of a building. Life Cycle Assessment (LCA) moves to the fore in the design process to make it possible to meet the overall purpose of reducing CO₂ emissions and the general environmental impact of the entire building industry.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Building Design, Section for Building Energy , JJW Arkitekter, Danske Arkitektvirkomheder
Contributors: Landgren, M., Jensen, L. B., Heller, A., Kiesslinger, J., Hornbek, O., Sattrup, P.
Pages: 423-434
Publication date: 2016
Mapping one year’s design processes at an architecture firm specialized in sustainable architecture - How do sustainability certification systems affect design processes?

General information
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Organisations: Department of Civil Engineering, Section for Building Design, Section for Building Energy
Number of pages: 1
Publication date: 2016
Peer-reviewed: Yes
Event: Abstract from International Conference on Integrated Design, Bath, United Kingdom.
Source: PublicationPreSubmission
Source-ID: 119061897
Research output: Research - peer-review › Conference abstract for conference – Annual report year: 2016

Modeling energy flexibility of low energy buildings utilizing thermal mass
In the future energy system a considerable increase in the penetration of renewable energy is expected, challenging the stability of the system, as both production and consumption will have fluctuating patterns. Hence, the concept of energy flexibility will be necessary in order for the consumption to match the production patterns, shifting demand from on-peak hours to off-peak hours. Buildings could act as flexibility suppliers to the energy system, through load shifting potential, provided that the large thermal mass of the building stock could be utilized for energy storage. In the present study the load shifting potential of an apartment of a low energy building in Copenhagen is assessed, utilizing the heat storage capacity of the thermal mass when the heating system is switched off for relieving the energy system. It is shown that when using a 4-hour preheating period before switching off the heating system, the thermal mass of the building releases sufficient heat to maintain the operative temperature above 20°C for 15 hours. This potential increases with longer preheating period. The thermal behaviour of the external envelope and internal walls is examined, identifying the heat losses of the external envelope and the thermal capacity of the internal walls as the main parameters that affect the load shifting potential of the apartment.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics, Section for Building Energy
Contributors: Foteinaki, K., Heller, A., Rode, C.
Number of pages: 8
Publication date: 2016

Online Anomaly Energy Consumption Detection Using Lambda Architecture
With the widely use of smart meters in the energy sector, anomaly detection becomes a crucial mean to study the unusual consumption behaviors of customers, and to discover unexpected events of using energy promptly. Detecting consumption anomalies is, essentially, a real-time big data analytics problem, which does data mining on a large amount of parallel data streams from smart meters. In this paper, we propose a supervised learning and statistical-based anomaly detection method, and implement a Lambda system using the in-memory distributed computing framework, Spark and its extension Spark Streaming. The system supports not only iterative refreshing the detection models from scalable data sets, but also real-time anomaly detection on scalable live data streams. This paper empirically evaluates the system and the detection algorithm, and the results show the effectiveness and the scalability of the lambda detection system.
Building automation - providing data for business opportunities: Building technologies impact the bigger picture

General information
State: Published
Organisations: Department of Civil Engineering, Section for Building Energy, Centre for IT-Intelligent Energy Systems in Cities
Contributors: Heller, A.
Pages: 6-7
Publication date: 2015

Host publication information
Title of host publication: Smart Buildings: Combining energy efficiency, flexibility and comfort
Publisher: State of Green
Electronic versions:
Source: PublicationPreSubmission
Source-ID: 116930224
Research output: Communication › Report chapter – Annual report year: 2015

Building energy demand aggregation and simulation tools: a Danish case study
Nowadays, the minimization of energy consumption and the optimization of efficiency of the overall energy grid have been in the agenda of most national and international energy policies. At the same time, urbanization has put cities under the microscope towards achieving cost-effective energy savings due to their compact and highly dense form. Thus, accurate estimation of energy demand of cities is of high importance to policy-makers and energy planners. This calls for automated methods that can be easily expandable to higher levels of aggregation, ranging from clusters of buildings to neighbourhoods and cities. Buildings occupy a key place in the development of smart cities as they represent an important potential to integrate smart energy solutions. Building energy consumption affects significantly the performance of the entire energy network. Therefore, a realistic estimation of the aggregated building energy use will not only ensure security of supply but also enhance the stabilization of national energy balances.

In this study, the aggregation of building energy demand was investigated for a real case in Sønderborg, Denmark. Sixteen single-family houses -mainly built in the 1960s- were examined, all connected to the regional district heating network. The aggregation of building energy demands was carried out according to typologies, being represented by archetype buildings. These houses were modelled with dynamic energy simulation software and with a simplified simulation tool, which is based on monthly quasi-steady state calculations, using a visual parametric programming language (Grasshopper) coupled with a 3D design interface (Rhinoceros). The estimated heat demand of the examined houses from both simulation tools is compared to actual measured data of heat consumption. An assessment of the two different types of tools follows, which will indicate the suitability of each tool depending on the desired accuracy of results and on the purpose of analysis.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics, Section for Building Energy, Centre for IT-Intelligent Energy Systems in Cities
Contributors: Gianniou, P., Heller, A., Rode, C.
Number of pages: 6
Publication date: 2015

Host publication information
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Keywords: Building energy, Heat demand, Archetypes, Energy Simulation Tools
Electronic versions:
Gianniou_et_al_CISBAT_2015.pdf
Source: PublicationPreSubmission
Source-ID: 116836597
Research output: Research › peer-review › Article in proceedings – Annual report year: 2015

The goal towards a fossil free energy system is expressed in amongst others European and national targets, and puts pressure on the application of renewable energy sources combined with energy efficiency. Many cities are even more ambitious than their national targets and want to be among the first to demonstrate that they can become not only smart fossil-free energy cities but sustainable in a wider sense, including water, waste, transportation and more. In the current paper, the research agenda to support such goals through smart city efforts is presented for a few European cases as examples, focusing on the impacts that buildings play in the overall energy system. Here buildings are not only consumers but rather prosumers that are able to produce renewable energy themselves. Buildings moreover offer potential storage capacities that can be utilized in demand shifting, which is necessary to enable increased penetration of renewable energy in the energy grids.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Building Energy, Centre for IT-Intelligent Energy Systems in Cities, Norwegian University of Science and Technology, Austrian Institute of Technology
Number of pages: 9
Publication date: 2015

Host publication information
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Keywords: Smart Cities, Research agenda, Energy, Building
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Presentation
Research output: Research - peer-review > Article in proceedings – Annual report year: 2015

Bygninger – en aktiv del af fremtidens energiforsyning

General information
State: Published
Organisations: Department of Civil Engineering, Section for Building Physics and Services
Contributors: Heller, A.
Publication date: 2015
Media of output: PowerPoint

Event information
Event: Energyforum Denmark
Location: Nyborg, Denmark
Electronic versions:
Presentation_Alfred_Heller_DTU_04_03_2015.pdf
Research output: Research > Sound/Visual production (digital) – Annual report year: 2015

Centre for IT-Intelligent Energy Systems for Cities

General information
State: Published
Organisations: Department of Civil Engineering, Section for Building Physics and Services
Contributors: Heller, A.
Publication date: 2015
Media of output: PowerPoint
Electronic versions:
CLEAN_rsm_de_2015_CITIES_pr_ssentation_Alfred_Heller_22_05_2015.pdf
Research output: Research > Sound/Visual production (digital) – Annual report year: 2015

CITIES – Centre for IT-Intelligent Energy Systems for Cities

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Organisations: Department of Civil Engineering, Section for Building Physics and Services
Contributors: Heller, A.
Publication date: 2015
Media of output: PowerPoint
Energy Lab Nordhavn: Sustainability defined by certification

General information
State: Published
Organisations: Department of Civil Engineering, Section for Building Energy, DOMUS Architects, By og Havn I/S
Contributors: Ledgaard, K., Ingemann Mogensen, J., Heller, A.
Publication date: 2015
Media of output: PowerPoint

Event information
Event: SMART CITIES
Location: Stockholm, Sweden
Electronic versions:
Energy_Lab_Nordhavn_Sustainability_by_certification_Alfred_Heller_Oct_2015.pdf
Research output: Research › Sound/Visual production (digital) – Annual report year: 2015

Models for flexible operation of buildings in district energy system Nordhavn

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics, Section for Building Energy
Contributors: Foteinaki, K., Heller, A., Rode, C.
Number of pages: 1
Publication date: 2015

Host publication information
Title of host publication: Book of Abstracts. DTU's Sustain Conference 2015
Place of publication: Lyngby
Publisher: Technical University of Denmark (DTU)
Article number: L-14
Electronic versions:
L14_DTU_Sustain_2015.pdf

Bibliographical note
Poster presentation
Research output: Research - peer-review › Conference abstract in proceedings – Annual report year: 2015

Quantifying Sustainability in Architecture

General information
State: Published
Organisations: Department of Civil Engineering, Section for Building Design, Section for Building Energy, Technical University of Denmark
Number of pages: 1
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Title of host publication: Book of Abstracts. DTU's Sustain Conference 2015
Place of publication: Lyngby
Publisher: Technical University of Denmark (DTU)
Article number: L-15
Electronic versions:
sustain_abstract.pdf
Source: PublicationPreSubmission
Smart Buildings: Combining energy efficiency, flexibility and comfort

General information
State: Published
Number of pages: 17
Publication date: 2015

Publication information
Publisher: State of Green
Original language: English
Electronic versions:
Final_publication_Smart_Buildings_White_Paper_for_green_transition_3.pdf
Source: PublicationPreSubmission
Source-ID: 118346796
Research output: Communication › Report – Annual report year: 2015

Smart Energy Cities: Centre for IT-Intelligent Energy Systems in Cities (CITIES)

General information
State: Published
Organisations: Department of Civil Engineering, Section for Building Physics and Services
Contributors: Heller, A.
Publication date: 2015
Media of output: PowerPoint
Electronic versions:
From_Grid_to_Society_Arup_University_10_3_2015.pdf
Research output: Research › Sound/Visual production (digital) – Annual report year: 2015

The Sensing Internet: A Discussion on Its Impact on Rural Areas
This paper is based on the experience of introducing wireless sensor networks (WSNs) into the building industry in Denmark and in a rural area of Greenland. There are very real advantages in the application of the technology and its consequences for the life cycle operation of the building sector. Sensor networks can be seen as an important part of the Internet of Things and may even constitute an Internet of Sensors, since the communication layers can differ from the Internet standards. The current paper describes the case for application, followed by a discussion of the observed adaptive advantages and consequences of the technology. Essentially, WSNs constitute a highly sophisticated technology that is more robust in a rural context due to its extremely simple installation procedures (plug and play) allowing the use of local less-skilled labour, and the possibility of reconfiguring and repurposing its use remotely.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Building Energy, Centre for IT-Intelligent Energy Systems in Cities
Contributors: Heller, A.
Pages: 363-371
Publication date: 2015
Peer-reviewed: Yes

Publication information
Journal: Future Internet
Volume: 7
ISSN (Print): 1999-5903
Ratings:
Scopus rating (2017): CiteScore 1.25 SJR 0.219 SNIP 1.038
Approaching Sentient Building Performance Simulation Systems

Sentient BPS systems can combine one or more high precision BPS and provide near instantaneous performance feedback directly in the design tool, thus providing speed and precision of building performance in the early design stages. Sentient BPS systems are essentially combining: 1) design tools, 2) parametric tools, 3) BPS tools, 4) dynamic databases 5) interpolation techniques and 6) prediction techniques as a fast and valid simulation system, in the early design stage.

General Information

State: Published
Organisations: Department of Civil Engineering, Section for Building Physics and Services, Technical University of Denmark
Contributors: Negendahl, K., Perkov, T., Heller, A.
Number of pages: 11
Pages: 49-60
Publication date: 2014

Host publication Information

Title of host publication: Proceedings of eCAADe 2014
Volume: 2
Editor: Thompson, E. M.
Keywords: Building performance simulation, Parametric modelling, Visual Programming language, Database, Responsive system, Integrated dynamic model
Electronic versions:
Sentient.BPS.System.preprint.pdf
Source: PublicationPreSubmission
Source-ID: 93296183
Research output: Research - peer-review › Article in proceedings – Annual report year: 2014

Building for the future smart energy cities

General Information

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Organisations: Department of Civil Engineering, Section for Building Physics and Services, Centre for IT-Intelligent Energy Systems in Cities
Contributors: Heller, A.
Number of pages: 1
Pages: 17
Publication date: 2014

Host publication Information

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Publisher: Technical University of Denmark, Department of Civil Engineering
ISBN (Electronic): 978-87-87336-03-1
URLs:
http://quickpaper.rosendahls.dk/DTU/AnnualReport2013/#/2/
Source: PublicationPreSubmission
Central Solar (District) Heating Plants

General information
State: Published
Organisations: Centre for IT-Intelligent Energy Systems in Cities, Department of Civil Engineering, Section for Building Physics and Services, PlanEnergi
Contributors: Heller, A., Sørensen, P. A.
Number of pages: 1
Publication date: 2014
Peer-reviewed: Yes
Event: Poster session presented at CITIES Annual Conference, Kgs. Lyngby, Denmark.
Electronic versions:
Poster_Central_Solar_Heating_Plants_Per_Alex_S_rensen_and_Alfred_Heller_CITIES_General_Meeting_IIESI_Workshop_May_2014.pdf
Source: PublicationPreSubmission
Source-ID: 104580295
Research output: Research - peer-review › Poster – Annual report year: 2015

Change in design targets for building energy towards smart cities
Designing cities from an overall energy optimization system point of view, demands changes in engineering procedures. Traditionally the design was driven independently between the involved domains and energy system components. By modelling the whole energy system in one, it is expected that there are exposed solutions where synergy effects arise that unleash extra saving potentials. Based on the insight gained by the simulations, IT intelligence and cross-component communication are to be invented to control the components and hereby to optimize the total system performance. One main strategy in doing so is, to move demands from high demand periods to low demand periods and hereby to avoid “peak” demands. This is called “flexibility” within the terminology of “smart grids”. In early solutions the search was for energy capacities within the domain of the electrical grid, hence car batteries where seen as relevant solutions for providing flexibility. However, it seems that the demand is too large for electricity-only solutions. A next search for flexibility is aimed at finding electricity-thermal energy solutions such as electrical heating and cooling, heat pumps and cooling technologies that can help to stabilize the el-grid. To acquire even higher potentials, thermal system components are studied these days upon their flexibility potentials, such as heating and cooling of whole building structures. Hereby the question arises, how much “flexibility” there is in relation to the thermal capacities of buildings that enable shifting energy demand for heating and cooling over periods of hours? While the availability of these capacities is a topic of current research, the consequences for building design are obvious. While we in the past could focus on energy optimization, we now have to design our buildings to its context, offering flexibility to the surrounding energy system. No final answers are given due to the fact that this is the edge of current research in this field, while a first concept draft is presented here.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Building Physics and Services, Centre for IT-Intelligent Energy Systems in Cities, Technical University of Denmark, Samsung
Contributors: Heller, A., Gianniou, P., Katsigiannis, E., Mortensen, A., Hun Woo, K.
Pages: 11-15
Publication date: 2014

Host publication information
Title of host publication: Proceedings of the 3rd International Workshop on Design in Civil and Environmental Engineering
Publisher: DCEE
Editors: Bjerregaard Jensen, L., Thompson, M. K.
ISBN (Electronic): 978-0-9894658-3-0
Keywords: Building design, Flexibility, Thermal capacity, Energy optimization, City design
Electronic versions:
Alfred_Heller_DTU_Paper_for_DCEE_for_proof_reading_1.pdf
Source: PublicationPreSubmission
Source-ID: 98172009
Research output: Research - peer-review › Article in proceedings – Annual report year: 2014

CITIES: Centre for IT-Intelligent Energy Systems in Cities
This extended abstract provides an introduction to an interdisciplinary strategic research project, CITIES which has been funded with an excess of € 7 million from a wide range of industrial and academic partners, and the Danish Council for Strategic Research. CITIES was
launched January 1, 2014 and aims at developing methodologies and ICT solutions for the analysis, operation, planning and development of fully integrated urban energy systems. A holistic research approach will be developed, to provide solutions at all levels between the appliance and the overall system, and at all-time scales between operations and planning. This extended abstract outlines the challenges to be met by city and energy planning bodies in an energy efficient future. The necessity of novel, data driven and IT intelligent solutions is stressed. A focus is placed on energy system planning in systems with high penetrations of renewable energy, or those entirely independent of fossil fuels.

Creating an information quantum leap in early design phases

The poster will outline the dynamic simulations tools developed in the building industry during the last two decades for integrating knowledge of indoor climate and energy in early phases of a building design and give a brief up date of the present quest to include and integrate information from urban environment climatic conditions, broad multi—criteria sustainability certification in early design phases aiming a.o. at meeting the obligations defined by smart cities challenges. Civil and Environmental Engineering has special challenges concerning design processes. These design projects are always influenced by their location and the topography (be it natural or manmade), climate, etc. This means that each project is unique and must be viewed in its own right. This reduces the benefits of mass production and standardization that are so heavily emphasized in mechanical design and manufacturing. This also means that design theories, tools, and techniques cannot be adopted directly from other design disciplines such as product design where different solutions can be developed for each individual or group. The natural environment has dynamic, unpredictable, and sometimes chaotic properties and behavior. This is more true than ever when considering the challenge of climate change. The requirements and behavior of the human users also vary in time. To meet these challenges, Civil and Environmental Engineering projects must be designed to be flexible so they can adjust for temporary changes in natural or human conditions. They must also be adaptable so they can evolve with technology, society, and the environment. The recent years, increasing application of renewable energy sources put extreme pressure onto the energy grids and need for demands side management, where buildings play a decisive role in stabilizing the energy demand through e.g. thermal storage in building components. Design in Civil and Environmental Engineering also defines the reality in which we live, work, and play. Thus, it borders other fields such as architecture, landscape design, and urban planning — influencing them and being influenced in exchange. The design of sustainable and climate adaptive systems and structures requires a very high level of information in all of the design phases. Addressing the challenges will require even more information with a better level of integration than is currently available today in either industry or education. Interdisciplinary design methods building on the know—how created during the past 2 decades is at the fore. How can we better integrate the knowledge at hand in Civil and Environmental Engineering in interdisciplinary design processes?
Introduction of flexible monitoring equipment into the Greenlandic building sector

Greenlandic winters are long and cold so living inside the heated and properly ventilated space requires quite some energy. It is assumed that in mechanically ventilated buildings, significant amounts of energy for heating can be conserved by adjusting the ventilation flow rates according to actual demand of the occupants. Traditional solutions available on market consist of controller and sensors in the living space detecting the occupancy and activity (movement sensors, CO2 sensors, Humidity sensors, etc.). The controller needs to be programmed and maintained by an expert and sensors need to be hardwired to the controller. In Greenland where price of the labor is very high and availability of experts limited the installation of such control system becomes unacceptably expensive, particularly in case of renovation of existing buildings. One possible solution to the above is to introduce wireless sensor network (WSN) technologies. The design of a prototype wireless monitoring and control system is demonstrated in the new dormitory Apisseq in Sisimiut, Greenland.

The existing mechanical ventilation was running at a constant air volume even during unoccupied hours which resulted in a very high heat demand. It was estimated that installing the WSN system will bring annual savings of 1,600 € at the investment of 8,000 €. This paper describes the initial setup of the system and discusses its advantages and drawbacks.
requirements for alternative technologies. The motivation of the current work is to find upcoming technologies that bring improvements into the sector, for example improved life cycle costs and energy efficiencies, increasing quality, construction and operation efficiency and reducing faults and losses.

The paper also lays out requirements expected by the sector. It will be shown that the wireless sensor network technology is a strong competitor that may meet the requirements. By analysing the application of such technologies throughout the building lifecycle, the utilization can be manifold, hereby minimising overall economic costs and maximising the added values for all involved stakeholders.

Based on the expectations of the sector, the experiences with the introduction of the RFID technology and by estimating the applicability of the extra services that follow the wireless sensor network, the paper will line up the requirements that the new technology has to meet to be introduced successfully.

**General information**
State: Published
Organisations: Department of Civil Engineering, Section for Building Physics and Services, Technical Information Center of Denmark
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**Publication information**
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Volume: 73
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- BFI (2018): BFI-level 2
- Web of Science (2018): Indexed yes
- BFI (2017): BFI-level 2
- Scopus rating (2017): CiteScore 4.96 SJR 2.061 SNIP 2.12
- Web of Science (2017): Impact factor 4.457
- Web of Science (2017): Indexed yes
- BFI (2016): BFI-level 2
- Scopus rating (2016): CiteScore 4.64 SJR 2.055 SNIP 1.968
- Web of Science (2016): Impact factor 4.067
- Web of Science (2016): Indexed yes
- BFI (2015): BFI-level 2
- Scopus rating (2015): CiteScore 4.07 SJR 2.04 SNIP 2.146
- Web of Science (2015): Impact factor 2.973
- Web of Science (2015): Indexed yes
- BFI (2014): BFI-level 2
- Scopus rating (2014): CiteScore 4.21 SJR 2.079 SNIP 2.875
- Web of Science (2014): Impact factor 2.884
- Web of Science (2014): Indexed yes
- BFI (2013): BFI-level 2
- Scopus rating (2013): CiteScore 3.79 SJR 1.852 SNIP 2.404
- Web of Science (2013): Impact factor 2.465
- ISI indexed (2013): ISI indexed yes
- Web of Science (2013): Indexed yes
- BFI (2012): BFI-level 2
- Scopus rating (2012): CiteScore 3.36 SJR 1.745 SNIP 2.696
- Web of Science (2012): Impact factor 2.679
- ISI indexed (2012): ISI indexed yes
- Web of Science (2012): Indexed yes
- BFI (2011): BFI-level 2
- Scopus rating (2011): CiteScore 3.23 SJR 1.476 SNIP 2.531
- Web of Science (2011): Impact factor 2.386
- ISI indexed (2011): ISI indexed yes
energisimuleringsprogrammer for reduktion af elforbruget i bygninger.
Source: dtu
Source-ID: u::7150
Research output: Research › Report – Annual report year: 2012

Business Models within DataCite
DataCite provides persistent identifiers, especially DOIs for research data. What is the Business Model for DataCite and its members? How to run international research infrastructures?

General information
State: Published
Organisations: Technical Information Center of Denmark
Contributors: Heller, A.
Publication date: 2011

Event information
Event: IDSC Workshop: Persistent Identifiers for the Social Sciences
Location: University Club, Bonn, Germany
Electronic versions:
Business Models within DataCite.pdf
Source: orbit
Source-ID: 280638
Research output: Research › Sound/Visual production (digital) – Annual report year: 2011

Forskningsdata Down Under - og måske right here?

General information
State: Published
Organisations: Technical Information Center of Denmark, Copenhagen Business School
Contributors: Heller, A., Nondal, L.
Pages: 16-18
Publication date: 2011
Peer-reviewed: Unknown

Publication information
Journal: D F Revy
Volume: 34
Issue number: 1
ISSN (Print): 0106-0503
Ratings:
ISI indexed (2013): ISI indexed no
ISI indexed (2012): ISI indexed no
ISI indexed (2011): ISI indexed no
BFI (2008): BFI-level 1
Original language: Danish
URLs:
http://www.issuu.com/revy/docs/nummer_1_-_2011_for_web_use
Source: orbit
Source-ID: 272721
Research output: Communication › Journal article – Annual report year: 2011

Forskningsdata og Open Access: et Deff-Projekt

General information
State: Published
Organisations: Technical Information Center of Denmark, Aalborg University, Dansk Data Arkiv, Kongelig Bibliotek, University of Copenhagen
Contributors: Heller, A., Blaabjerg, N. J., Clausen, N. F., Christensen-Dalsgaard, B., Dorch, B.
Number of pages: 33
Publication date: 2011

Publication information
Place of publication: København
Approach for a joint global registration agency for research data

The scientific and information communities have largely mastered the presentation of, and linkages between, text-based electronic information by assigning persistent identifiers to give scientific literature unique identities and accessibility. Knowledge, as published through scientific literature, is often the last step in a process originating from scientific research data. Today scientists are using simulation, observational, and experimentation techniques that yield massive quantities of research data. These data are analyzed, synthesized, interpreted, and the outcome of this process is generally published as a scientific article. Access to the original data as the foundation of knowledge has become an important issue throughout the world and different projects have started to find solutions. Global collaboration and scientific advances could be accelerated through broader access to scientific research data. In other words, data access could be revolutionized through the same technologies used to make textual literature accessible. The most obvious opportunity to broaden visibility of and access to research data is to integrate its access into the medium where it is most often cited: electronic textual information. Besides this opportunity, it is important, irrespective of where they are cited, for research data to have an internet identity. Since 2005, the German National Library of Science and Technology (TIB) has offered a successful Digital Object Identifier (DOI) registration service for persistent identification of research data. In this white paper we discuss the possibilities to open this registration to a global consortium of information institutes and libraries.

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State: Published
Pages: 13-27
Publication date: 2009
Peer-reviewed: Yes

Publication information
Journal: Information Services & Use
Volume: 29
Issue number: 1
ISSN (Print): 0167-5265
Ratings:
BFI (2018): BFI-level 1
BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 0.39 SJR 0.244 SNIP 0.494
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 0.31 SJR 0.166 SNIP 0.466
BFI (2015): BFI-level 1
Scopus rating (2015): CiteScore 0.35 SJR 0.265 SNIP 0.426
BFI (2014): BFI-level 1
Scopus rating (2014): CiteScore 0.34 SJR 0.225 SNIP 0.415
BFI (2013): BFI-level 1
Scopus rating (2013): CiteScore 0.43 SJR 0.249 SNIP 0.418
ISI indexed (2013): ISI indexed no
BFI (2012): BFI-level 1
Scopus rating (2012): CiteScore 0.43 SJR 0.277 SNIP 0.986
ISI indexed (2012): ISI indexed no
BFI (2011): BFI-level 1
Scopus rating (2011): CiteScore 0.42 SJR 0.342 SNIP 0.953
ISI indexed (2011): ISI indexed no
DataCite - A Global Registration Agency for Research Data
Since 2005, the German National Library of Science and Technology (TIB) has offered a successful Digital Object Identifier (DOI) registration service for persistent identification of research data. In 2009, TIB, the British Library, the Library of the ETH Zurich, the French Institute for Scientific and Technical Information (INIST), the Technical Information Center of Denmark, Canada Institute for Scientific and Technical Information (CISTI) the Australian National Data Service (ANDS) and the Dutch TU Delft Library all signed a Memorandum of Understanding to improve access to research data on the internet. The goal of this cooperation is to establish a not-for-profit agency called DataCite that enables organisations to register research datasets and assign persistent identifiers to them, so that research datasets can be handled as independent, citable, unique scientific objects.

General information
State: Published
Organisations: Technical Information Center of Denmark
Contributors: Heller, A.
Number of pages: 4
Pages: 257-261
Publication date: 2009

Host publication information
Title of host publication: Proceedings : 4. International Conference on Cooperation and Promotion of Information Resources in Science and Technology
Volume: 1
Place of publication: Beijing, China
Publisher: IEEE Computer Society Press
ISBN (Print): 978-0-7695-3898-3
DOIs:
10.1109/COINFO.2009.66
Source: orbit
Source-ID: 269204
Research output: Research - peer-review > Article in proceedings – Annual report year: 2009

Fedora Content Modelling for Improved Services for Research Databases
A re-implementation of the research database of the Technical University of Denmark, DTU, is based on Fedora. The backbone consists of content models for primary and secondary entities and their relationships, giving flexible and powerful extraction capabilities for interoperability and reporting. By adopting such an abstract data model, the platform enables new and improved services for researchers, librarians and administrators.
Numeric Data: Citation Techniques and Integration with Text

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Publication date: 2009

Bibliographical note
This report is the outcome of the project "Numeric Data: Citation Techniques and Integration with Text" from the Technical Activities Coordinating Committee (TACC) of the International Council for Scientific and Technical Information (ICSTI).
Research output: Research - peer-review › Report – Annual report year: 2009

Præsentation af forskningsdatabaseregistreringssystemet ORBIT

General information
State: Published
Organisations: Technical Information Center of Denmark
Contributors: Heller, A.
Publication date: 2006

Event information
Event: DEFF-temadag om forskningsregistrering fra mindre institutioner
Location: Forsikringens Hus, København
Source: orbit
Source-ID: 192095
Research output: Communication › Sound/Visual production (digital) – Annual report year: 2006

Fedora, DSpace og de andre: Kort gennemgang af Open Source arkivsoftware - bl.a. til brug for "Institutional Repositories"

General information
State: Published
Organisations: Center of Knowledge Technology, Technical Information Center of Denmark
Contributors: Heller, A.
Pages: 4-6
Publication date: 2005
Peer-reviewed: Unknown

Publication information
Journal: DF Revy
ISSN (Print): 0106-0503
Local research data registration for improved visibility, reusability and promotion

General information
State: Published
Organisations: Technical Information Center of Denmark
Contributors: Heller, A.
Publication date: 2005

Event information
Event: Joint Workshop on Electronic Publishing
Location: Lund, Sweden
Source: orbit
Source-ID: 181261
Research output: Research › Sound/Visual production (digital) – Annual report year: 2005

Introduction to the Solar Heating Simulation Program PROSOL

General information
State: Published
Organisations: Department of Civil Engineering
Contributors: Heller, A.
Publication date: 2004

Publication information
Original language: English
Source: orbit
Source-ID: 116813
Research output: Research › Report – Annual report year: 2004

Heat-load modelling for large systems

General information
State: Published
Organisations: Section for Building Physics and Services, Department of Civil Engineering
Contributors: Heller, A.
Pages: 371-387
Publication date: 2002
Peer-reviewed: Yes

Publication information
Journal: Applied Energy
Volume: 72
Issue number: 1
ISSN (Print): 0306-2619
Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 8.44 SJR 3.162 SNIP 2.765
Web of Science (2017): Impact factor 7.9
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 7.78 SJR 3.011 SNIP 2.61
Web of Science (2016): Impact factor 7.182
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Udvikling af flydende lågkonstruktioner til damvarmelagre: Løsning: tyndpladestål
Large Scale Solar Heating: Evaluation, Modelling and Designing
The main objective of the research was to evaluate large-scale solar heating connected to district heating (CSDHP), to build up a simulation tool and to demonstrate the application of the simulation tool for design studies and on a local energy planning case.

The evaluation was mainly carried out based on measurements on the Marstal plant, Denmark, and through comparison with published and unpublished data from other plants. Evaluations on the thermal, economical and environmental performance are reported, based on experiences from the last decade.

For detailed designing, a computer simulation model is designed and validated on the Marstal case. Applying the Danish Reference Year, a design tool is presented.

The simulation tool is used for proposals for application of alternative designs, including high-performance solar collector types (trough solar collectors, vacuum pipe collectors).

Simulation programs are proposed as control supporting tool for daily operation and performance prediction of central solar heating plants.

Finally the CSHP technology is put into perspective with respect to alternatives and a short discussion on the barriers and breakthrough of the technology are given.

General information
State: Published
Organisations: Department of Buildings and Energy, Section for Building Physics and Services, Department of Civil Engineering
Contributors: Heller, A., Svendsen, S., Furbo, S.
Number of pages: 164
Publication date: Mar 2001
Publication information
ISBN (Print): 87-7877-050-5
Original language: English
(Report; No. R-046).
Electronic versions:
R-046_PhD_Thesis.pdf
Hejtemperatursofanger til solvarmecentraler: Indledende sammenligninger

General information
State: Published
Organisations: Department of Civil Engineering
Contributors: Heller, A., Vejen, N. K.
Publication date: 2001

Publication information
ISBN (Print): 87-7877-078-5
Original language: Danish
(ByG Rapport; No. R-013).
Electronic versions:
byg-r013.pdf
URLs:
Source: orbit
Source-ID: 61782
Research output: Research - peer-review › Report – Annual report year: 2001

Notat vedr. afstand mellem lukkede, murede ildsteder til brændbart materiale - Et oplæg til diskussion om revision af bygningsreglementet

General information
State: Published
Organisations: Department of Civil Engineering
Contributors: Heller, A.
Publication date: 2001

Publication information
Original language: Danish
Source: orbit
Source-ID: 63896
Research output: Research - peer-review › Report – Annual report year: 2001

Notat vedr. UVE-ansøgning Røgerivej 3, energilindpakning: Udredning til udvalg under Energistyrelsen

General information
State: Published
Organisations: Department of Civil Engineering
Contributors: Heller, A.
Publication date: 2001

Publication information
Original language: Danish
(ByG Sagsrapport; No. SR 01-13).
Electronic versions:
byg-sr0113.pdf
Source: orbit
Source-ID: 190316
Research output: Research › Report – Annual report year: 2001

Notat vedr. UVE-projektansøgning "Røgerivej 3, Energiindpakning"
Optimering af energisystemer: Et indledende forsøg på dimensionering af energisystemer ved hjælp af optimeringsmetoder (space mapping metoden)

Solvarmeanlæg ved biomassefyrede fjernvarmecentraler

Solvarmeanlæg ved biomassefyrede fjernvarmecentraler m.m. - Simuleringsresultater
Teoretisk diskussion af temperaturer i lukkede, murede ildsteder (masseovne)

**General information**
State: Published
Organisations: Department of Civil Engineering
Contributors: Heller, A.
Publication date: 2001

**Publication information**
Original language: Danish
(ByG Sagsrapport; No. SR 01-14).
Electronic versions:
byg-sr0114.pdf
Source: orbit
Source-ID: 190317
Research output: Research › Report – Annual report year: 2001

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15 Years of R&D in Central Solar Heating in Denmark
Danish R&D activities during the last two decades in the field of Central Solar Heating Plants and Thermal Energy Storage Technologies are presented. The most relevant central solar heating plants (CSHPs), with and without seasonal storage, are examined and essential experiences highlighted. The Saltum and Ry plants represent the type of CSHPs with preheating the return stream of a district heating net and no storage involved. The Marstal plant represents an alternative approach, connecting the CSHP to the delivery pipe for summer operation. Here the plant involves short-term storage and the application of variable flow that lead to novelties in the control strategy. The plant is described and experiences are analysed. The presented cases show that the technology, under special conditions, can be economically competitive with other heating technologies. Under normal conditions, public funding and acceptance of higher energy price are necessary. Further technical development and push towards a market is required. Especially the development of economical storage technologies is decisive. Work with steel tanks, concrete tanks, aquifer storage, bore hole storage and most importantly, from a Danish view, pit water storage is presented and conclusions are drawn. R&D in the field of CSHPs call for international co-operation, knowledge transfer and not least financing. The structural and political climate that shapes the boundaries of the R&D activities and also makes up the dominant barrier for the dissemination of CSHPs is discussed. Conclusions are drawn and future work outlined.

**General information**
State: Published
Organisations: Department of Buildings and Energy
Contributors: Heller, A.
Pages: 437-447
Publication date: 2000
Peer-reviewed: Yes

**Publication information**
Journal: Solar Energy
Volume: 69
Issue number: 6
ISSN (Print): 0038-092X
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 4.89 SJR 1.615 SNIP 1.791
Web of Science (2017): Impact factor 4.374
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 4.52 SJR 1.504 SNIP 1.746
Web of Science (2016): Impact factor 4.018
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): CiteScore 4.61 SJR 1.912 SNIP 2.085
Web of Science (2015): Impact factor 3.685
According to (the) information from the European Large-Scale Solar Heating Network, (See http://www.hvac.chalmers.se/cshp/), the area of installed solar collectors for large-scale application is in Europe, approximately 8 mill m², corresponding to about 4000 MW thermal power. The 11 plants of the total 51 plants are equipped with long-term storage. In Denmark, 7 plants are installed, comprising of approx. 18,000-m² collector area with
new plants planned. The development of these plants and the involved technologies will be presented in this paper, with a focus on the improvements for Danish Central Solar Heating Plants, servicing District Heating and related developments in large-scale thermal storage. Central solar heating today is a mature and economic realistic solution for district heating based on a renewable source. The cost for solar collectors has decreased by nearly ¼ during the last 10 years and the corresponding cost per collector area for the final installed plant is kept constant, even so the solar production is increased. Unfortunately large-scale seasonal storage was not able to keep up with the advances in solar technology, at least for pit water and gravel storage technologies. There are severe problems with the tightening of pit and lid constructions. First solutions applying thin stainless steel liners are found and demonstrated for pit lining. Similar solutions based on polymer liners are many times cheaper, but seem not reliable at the moment due to material degradation and resulting reduction of the lifetime. The improvements of polymer liners seem realistic and is expected to be solved in the coming years. Floating pit lid designs are in the phase of being tested this year and first results are expected soon.

**General information**
State: Published
Organisations: Department of Buildings and Energy
Contributors: Heller, A.
Number of pages: 7
Publication date: 2000

**Host publication information**
Title of host publication: Proceedings for EuroSun’2000
Electronic versions:
- 08_Alfred_Josef_Heller_Advances_in_Large_Scale_Solar_Heating_.pdf
Source: orbit
Source-ID: 184897
Research output: Research - peer-review › Article in proceedings – Annual report year: 2000

**BEREGNINGSPROGRAMMER FOR SOLVARMEANLÆG. STATUS OG HANDLINGSPLAN**

**General information**
State: Published
Organisations: Department of Buildings and Energy, Danish Technological Institute
Number of pages: 36
Publication date: 2000

**Publication information**
Original language: Danish
Source: orbit
Source-ID: 173791
Research output: Research - peer-review › Report – Annual report year: 2000

**Demand Modelling for Central Heating Systems**

**General information**
State: Published
Organisations: Department of Buildings and Energy
Contributors: Heller, A.
Publication date: 2000

**Publication information**
Place of publication: Lyngby, Denmark
Publisher: Department of Buildings and Energy, Technical University of Denmark
ISBN (Print): 87-7877-042-4
Original language: English
(Report; No. R-040).
Electronic versions:
- ibe_r040_2000_Demand_modelling_for_central_heating_systems.pdf
Source: orbit
Source-ID: 184898
Research output: Research › Report – Annual report year: 2000
Development of Seasonal Storage in Denmark: Status of Storage Programme 1997-2000

**General information**
State: Published
Organisations: Department of Buildings and Energy
Contributors: Heller, A.
Pages: 47-52
Publication date: 2000

**Host publication information**
Title of host publication: Terrastock 2000, Proceedings
Place of publication: Stuttgart, Germany
Publisher: University of Stuttgart
Electronic versions:
Terrastock_2000_Development_of_Seasonal_Storage_in_Denmark.pdf
Source: orbit
Source-ID: 176017
Research output: Research - peer-review › Article in proceedings – Annual report year: 2000

Pit Water Storage Ottrupgaard: A follow up

**General information**
State: Published
Organisations: Department of Buildings and Energy
Contributors: Heller, A.
Pages: 267-274
Publication date: 2000

**Host publication information**
Title of host publication: Terrastock 2000, Proceedings
Place of publication: Stuttgart, Germany
Publisher: Stuttgart University
Source: orbit
Source-ID: 176018
Research output: Research - peer-review › Article in proceedings – Annual report year: 2000

BEREGNINGSPROGRAMMER FOR SOLVARMEANLÆG. STATUS

**General information**
State: Published
Organisations: Department of Buildings and Energy, Danish Technological Institute
Number of pages: 35
Publication date: 1999

**Publication information**
Original language: Danish
Source: orbit
Source-ID: 173786
Research output: Research - peer-review › Report – Annual report year: 1999

Brugervejledning til solvarmesimuleringsprogram PROSOL

**General information**
State: Published
Organisations: Department of Buildings and Energy
Contributors: Heller, A.
Number of pages: 9
Publication date: 1999

**Publication information**
Original language: Danish
Source: orbit
Source-ID: 173617
Optimisation of Control Strategy at the Central Solar Heating Plant in Marstal, Denmark

General information
State: Published
Organisations: Department of Buildings and Energy
Contributors: Heller, A.
Number of pages: 38
Publication date: 1999

Solvarmecentraler

General information
State: Published
Organisations: Department of Buildings and Energy
Contributors: Heller, A.
Number of pages: 17
Publication date: 1999

Store Lagre 5: Rapport fra etablering af jordslangelager i Marstal

General information
State: Published
Organisations: Department of Buildings and Energy, Marstal Fjernvarme A/S, Geoteknisk Institut, Plastconsult, Ramboll Group AS, PlanEnergi
Number of pages: 200
Publication date: 1999

The Marstal Central Solar Heating Plant: Design and Evaluation

General information
State: Published
Organisations: Department of Buildings and Energy, Chalmers University of Technology
Contributors: Heller, A., Jochen, D.
Publication date: 1999

Host publication information
Title of host publication: The Marstal Central Solar Heating Plant
Place of publication: Jerusalem
Source: orbit
Source-ID: 173620
Research output: Research - peer-review » Article in proceedings – Annual report year: 1999
Warm water pit storages with floating lid/Erdbeckenspeicher mit schwimmender Abdeckung - Eine Übersicht

General information
State: Published
Organisations: Department of Buildings and Energy
Contributors: Heller, A., Maureschat, G., Duer, K.
Pages: 109-114
Publication date: 1998

Host publication information
Title of host publication: Statusbericht '98. Solarunterstützte Nahwärmeversorgung. Saisonale Wärmespeicherung
Place of publication: Stuttgart, Germany
Publisher: Steinbeis-Transferzentrum STZ-EGS
Source: orbit
Source-ID: 170928
Research output: Research › Article in proceedings – Annual report year: 1998

Experimental investigation on heat transport in gravel-sand materials.

General information
State: Published
Organisations: Department of Buildings and Energy
Contributors: Maureschat, G., Heller, A.
Number of pages: 10
Publication date: 1997

Publication information
Original language: Danish
Source: orbit
Source-ID: 169066
Research output: Research - peer-review › Report – Annual report year: 1997

First Experience from the World Largest fully commercial Solar Heating Plant

General information
State: Published
Organisations: Department of Buildings and Energy
Contributors: Heller, A., Furbo, S.
Publication date: 1997

Host publication information
Title of host publication: First Experience from the World Largest fully commercial Solar Heating Plant
Place of publication: Taejon
Source: orbit
Source-ID: 168917
Research output: Research - peer-review › Article in proceedings – Annual report year: 1997

Floating Lid Constructions for Large Pit Water Heat Storage

General information
State: Published
Organisations: Department of Buildings and Energy
Contributors: Heller, A.
Pages: 503-508
Publication date: 1997

Host publication information
Title of host publication: Proceeding of Megastock'97
Volume: 1
Source: orbit
Source-ID: 184894
Research output: Research - peer-review › Article in proceedings – Annual report year: 1997
Floating Lid Constructions for Pit Water Storage: A Survey.

General information
State: Published
Organisations: Department of Buildings and Energy
Contributors: Heller, A.
Number of pages: 22
Publication date: 1997

Publication information
Original language: English
Source: orbit
Source-ID: 164998
Research output: Research - peer-review › Report – Annual report year: 1997

Investigation on Floating Lid Construction, pit Water Storage, Ottrupgaard, Denmark.

General information
State: Published
Organisations: Department of Buildings and Energy
Contributors: Heller, A.
Number of pages: 61
Publication date: 1997

Publication information
Publisher: Department of Buildings and Energy, Technical University of Denmark
ISBN (Print): 87-7877-009-2
Original language: English
Electronic versions:
ibe_r010_1997_Investigation_on_floating_lid_construction.pdf
Source: orbit
Source-ID: 164995
Research output: Research - peer-review › Report – Annual report year: 1997

Megastock'97 Kongres, Juni, 1997, Sapporo, Japan

General information
State: Published
Organisations: Department of Buildings and Energy
Contributors: Heller, A.
Number of pages: 20
Publication date: 1997

Publication information
Original language: English
Source: orbit
Source-ID: 169068
Research output: Research - peer-review › Report – Annual report year: 1997

Investigation on Kombiterm GE Domestic Hot Water Tank: Performance Measurements and Calculations.

General information
State: Published
Organisations: Department of Buildings and Energy
Contributors: Heller, A., Heuer, A. W.
Number of pages: 16
Publication date: 1996

Publication information
Original language: Danish
Source: orbit
Source-ID: 164956

General information
State: Published
Organisations: Department of Buildings and Energy
Contributors: Heller, A.
Number of pages: 60
Publication date: 1996

Publication information
Original language: Danish
Source: orbit
Source-ID: 164960
Research output: Research - peer-review → Report – Annual report year: 1996

Papers presented at EuroSun'96 Congress 1996 in Freiburg, Germany.

General information
State: Published
Organisations: Department of Buildings and Energy
Publication date: 1996

Publication information
Original language: English
Source: orbit
Source-ID: 164824
Research output: Research - peer-review → Report – Annual report year: 1996


General information
State: Published
Organisations: Department of Buildings and Energy
Contributors: Heller, A.
Number of pages: 20
Publication date: 1996

Publication information
Original language: Danish
Source: orbit
Source-ID: 164981
Research output: Research - peer-review → Report – Annual report year: 1996

Projects:

SCA: Smart Cities Accellerator
European Interreg Project with 6 municipality implementing the research findings of the CITIES project in cooperation with other universities in the area Copenhagen, Southern Sweden.
Heller, A., Project Participant, Department of Civil Engineering
Madsen, H., Project Manager, Department of Applied Mathematics and Computer Science
Nielsen, P. S., Project Participant, Department of Management Engineering
20/04/2018 → 20/07/2018
Project: Research

Building clusters and their impact on flexibility when including the prosumer aspect
Larma, M., PhD Student, Department of Civil Engineering
Rode, C., Main Supervisor, Department of Civil Engineering
Heller, A., Supervisor, Department of Civil Engineering
Building clusters and their impact on flexibility when including the prosumer aspect
Larma, M., PhD Student
Heller, A., Main Supervisor, Department of Civil Engineering
Forskningsrådsfinansiering
01/10/2016 → 30/09/2019
Award relations: Building clusters and their impact on flexibility when including the prosumer aspect
Project: PhD

Metode til planlægning af vidtgående energirenovering af enfamiliehuse
Grøn Bjørneboe, M., PhD Student, Department of Civil Engineering
Svendsen, S., Main Supervisor, Department of Civil Engineering
Heller, A., Supervisor, Department of Civil Engineering
Gustavsson, L., Examiner, Department of Civil Engineering
Varming, N., Examiner, Department of Civil Engineering
Institut, samfinansiering
01/10/2011 → 07/09/2017
Award relations: Metode til planlægning af vidtgående energirenovering af enfamiliehuse
Project: PhD

Science Cloud for Cities
A Deic/Deff project developing a science cloud for research (in cities).
Heller, A., Project Manager, Department of Civil Engineering
Nielsen, P. S., Project Participant, Department of Management Engineering
Madsen, H., Project Participant
01/09/2016 → 16/12/2017
Collaborators: Aarhus University, University of Southern Denmark, Aalborg University
Project: Research

IEA EBC Annex 63 - Implementation of Energy Strategies in Communities
The outcomes from previously completed projects on energy optimization at a community scale showed that the transformation of approaches suitable for buildings to communities needs more than simply an up-scaling of individual building solutions. This newly approved project will therefore focus on development of standards for implementation of optimized energy strategies at the scale of communities. The project objectives will be - Development of a methodology for the effective translation of a city’s energy / CO2 reduction goals to the community scale – Optimization of policy instruments for the integration of energy / CO2 reduction goals into ordinary urban planning, – Development of new techniques for stakeholder cooperation along with holistic business models, and – Creation of methods for the monitoring and evaluation of both energy-related criteria, as well as the effectiveness of policy instruments. The target audiences will primarily be government and urban decision makers and urban planning departments. Participants: Austria, Belgium, Canada, Denmark, France, Ireland, Japan, the Netherlands, Switzerland, USA
Heller, A., Project Participant, Department of Civil Engineering, Section for Building Energy
Petersen, J., Project Participant, Department of Civil Engineering
Rode, C., Project Participant, Department of Civil Engineering
01/06/2013 → 01/06/2018
Project: Research

IEA EBC Annex 67 - Energy Flexible Buildings
Energy flexibility in buildings will play an important role in facilitating energy systems based entirely on renewable energy sources. Flexibility is necessary to control the energy consumption to match the actual energy generation from various energy sources such as solar and wind power. However, there is lack of comprehensive knowledge about how much energy flexibility different building types and their usage may be able to offer to the future energy systems. The aim of this project is to demonstrate how energy flexibility in buildings can provide generating capacity for energy grids, and to identify critical aspects and possible solutions to manage such flexibility. This knowledge is important in order to incorporate energy flexibility of buildings into future smart energy systems and to better accommodate renewable sources in energy systems. It is also important when developing the business case for using building energy flexibility within future systems to potentially reduce costly upgrades of energy distribution grids. The project objectives are: – development of common
terminology, a definition of 'energy flexibility in buildings' and a classification method, – investigation of user comfort, motivation and acceptance associated with the introduction of energy flexibility in buildings, – investigation of the energy flexibility potential in different buildings and contexts, and development of design guidelines, control strategies and algorithms – investigation of the aggregated energy flexibility of buildings and the potential effect on energy grids, and – demonstration of energy flexibility through experimental and field studies. Participants: Austria, Belgium, Denmark, France, Italy, the Netherlands, Norway, Portugal, Spain, Switzerland, United Kingdom

Heller, A., Project Participant, Department of Civil Engineering
Madsen, H., Project Participant, Department of Applied Mathematics and Computer Science
Gianniou, P., Project Participant, Department of Civil Engineering
Foteinaki, K., Project Participant, Department of Civil Engineering

Project ID: 26461
01/06/2014 → 01/06/2019
Project: Research

Thermal Smart Grid - Innovation project under INNO-SE
First investigation on the development of a thermal smart grid for the company GeoDrilling. Innovation project under INNO-SE, CLEAN.
Heller, A., Project Participant, Department of Civil Engineering, Section for Building Energy
Project ID: 26549
01/05/2016 → 31/12/2016
Keywords: borehole heat exchanger, heat pumps, system, innovation
Collaborators: GeoDrilling
Project: Research

Implementation of flexible operational schemes for buildings in a district with smart energy systems
Luc, K. M., PhD Student, Department of Civil Engineering
Nielsen, T. R., Main Supervisor, Department of Civil Engineering
Heller, A., Supervisor, Department of Civil Engineering
Li, R., Supervisor, Department of Civil Engineering
Samfinansieret - Andet
01/11/2015 → 21/12/2018
Award relations: Implementation of flexible operational schemes for buildings in a district with smart energy systems
Project: PhD

Models for flexible operation of buildings in district energy system Nordhavn
Foteinaki, K., PhD Student, Department of Civil Engineering
Rode, C., Main Supervisor, Department of Civil Engineering
Heller, A., Supervisor, Department of Civil Engineering
Li, R., Supervisor, Department of Civil Engineering
Samfinansieret - Andet
15/09/2015 → 14/12/2018
Award relations: Models for flexible operation of buildings in district energy system Nordhavn
Project: PhD

Assessment and Optimization Methods for Implementation of Energy Strategies in Communities
Petersen, J., PhD Student, Department of Civil Engineering
Rode, C., Main Supervisor, Department of Civil Engineering
Heller, A., Supervisor, Department of Civil Engineering
Nielsen, P. S., Examiner
Nielsen, S. B., Examiner, Department of Civil Engineering
Nielsen, S. B., Examiner, Department of Civil Engineering
Pahl-Weber, E., Examiner
Samfinansieret - Andet
15/02/2015 → 17/03/2018
Award relations: Assessment and Optimization Methods for Implementation of Energy Strategies in Communities
Project: PhD

Buildings for Smart Energy Cities
Gianniou, P., PhD Student, Department of Civil Engineering
Rode, C., Main Supervisor, Department of Civil Engineering
Heller, A., Supervisor, Department of Civil Engineering
Nielsen, P. S., Supervisor
Kolarik, J., Examiner, Department of Civil Engineering
Hensen, J., Examiner, Department of Civil Engineering
Jensen, S. Ø., Examiner
Samfinansieret - Andet
15/09/2014 → 07/05/2018
Award relations: Buildings for Smart Energy Cities
Project: PhD

Optimal Building Integration of district Heating Units
Brand, M., PhD Student, Department of Civil Engineering
Svendsen, S., Main Supervisor, Department of Civil Engineering
Olesen, B. W., Supervisor, Department of Civil Engineering
Thorsen, J. E., Supervisor
Heller, A., Examiner, Department of Civil Engineering
Schmidt, D., Examiner
Vestergaard, J. B., Examiner
Institut, samfinansiering
01/10/2009 → 28/04/2014
Award relations: Optimal Building Integration of district Heating Units
Project: PhD

low energy buildings and heat supply systems based on renewable energy
Dalla Rosa, A., PhD Student, Department of Civil Engineering
Svendsen, S., Main Supervisor, Department of Civil Engineering
Christensen, J. E., Supervisor, Department of Civil Engineering
Li, H., Supervisor, Department of Civil Engineering
Heller, A., Examiner, Department of Civil Engineering
Wiltshire, R., Examiner
Wollerstrand, J., Examiner
Institut, samfinansiering
01/03/2009 → 24/08/2012
Award relations: low energy buildings and heat supply systems based on renewable energy
Project: PhD

Climate Change and its Impact on Lifetime and Maintenance of Buildings
Cox, R. A., PhD Student, Department of Civil Engineering
Rode, C., Main Supervisor, Department of Civil Engineering
Nielsen, S. B., Supervisor, Department of Civil Engineering
Heller, A., Examiner, Department of Civil Engineering
Jones, K., Examiner
Sasic Kalagasidis, A., Examiner
1/3 FUU, 1/3 inst 1/3 Andet
15/08/2011 → 09/12/2015
Award relations: Climate Change and its Impact on Lifetime and Maintenance of Buildings
Project: PhD

Large-Scale Solar Heating
Heller, A., PhD Student, Department of Civil Engineering
Furbo, S., Main Supervisor, Department of Civil Engineering
Svendsen, S., Supervisor, Department of Civil Engineering
Bahm, B., Examiner
Lawaetz, H., Examiner
DTU-Su Stipendium, Eksperiment
01/02/1997 → 09/04/2001
Award relations: Large-Scale Solar Heating
Project: PhD

Models for flexible operation of buildings in district energy system Nordhavn
Foteinaki, K., PhD Student, Department of Civil Engineering, Section for Indoor Climate and Building Physics
Rode, C., Main Supervisor, Department of Civil Engineering, Section for Indoor Climate and Building Physics
Heller, A., Supervisor, Department of Civil Engineering, Section for Building Energy
15/09/2015 → ...
Buildings for Smart Energy Cities
Gianniou, P., PhD Student, Department of Civil Engineering, Section for Indoor Climate and Building Physics
Rode, C., Main Supervisor, Department of Civil Engineering, Section for Indoor Climate and Building Physics
Nielsen, P. S., Supervisor, Department of Management Engineering, Systems Analysis, DTU Climate Centre, Energy Systems Analysis
Heller, A., Supervisor, Department of Civil Engineering, Section for Building Energy
15/09/2014 → 15/09/2017

Inno-SE: Innovationsnetwork Smart Energy (CLEAN)
Innovation network under CLEAN for smart energy innovation activities.
Heller, A., Project Participant, Department of Civil Engineering, Section for Building Physics and Services
Madsen, H., Project Participant, Department of Applied Mathematics and Computer Science
15/08/2014 → 31/12/2017

Wireless sensor networks applied in the building sector
Can we improve the building industry by introducing wireless sensor networks in the building life cycle? What requirements does the technology meet? What are the limitations of the technology?
Heller, A., Project Participant, Department of Civil Engineering, Section for Building Physics and Services
Kotol, M., Project Participant, Department of Civil Engineering, Section for Building Physics and Services
Torbensen, R., Project Participant, University of Southern Denmark
Bjarne Saxhof Fond: DKK504.00
01/10/2013 → 31/12/2014

CITIES: Center for IT-Intelligent Energy Systems for Cities
A wide range of research activities have arisen to support the Danish target of a 100% renewable energy system by 2050. Projects focused on individual aspects of the energy system, such as zero emissions buildings or intelligent power systems provide valuable insight, that facilitates flexibility throughout the energy system. CITIES will address this deficiency by establishing an integrated research centre covering all aspects of the energy system, including gas, power, district heating/cooling and biomass, and most importantly methods to forecast, control and optimize their interactions through the use of advanced ICT solutions. The high densities of population, energy consumption, and energy and communications networks in cities offer the greatest potential for flexibility at the lowest cost, and the fact that cities account for 80% of global energy consumption and emissions [1] make the urban environment an ideal setting for energy systems integration research. CITIES will pioneer research into fully integrated city energy systems, building short-term operational models that feed longer term planning models, considering the spatiotemporal variations, interactions, dynamics and stochastics in the energy system. Low level models of system components will inform higher-level aggregate models employed in market and control framework design. The leading position of European academia and industry and the rapidly growing market for smart energy solutions indicates substantial scope for increased competitiveness and job creation within this field. CITIES will, in collaboration with its industrial and academic partners, conduct research with a view to developing tools for the implementation of integrated energy system solutions. Center granted by Strategic Research Council. To be a sustainable organisation.
Madsen, H., Project Participant, Department of Applied Mathematics and Computer Science
Heller, A., Project Participant, Department of Civil Engineering
Herrmann, I. T., Project Manager, Department of Management Engineering
Nielsen, P. S., Project Participant, Department of Management Engineering
Pedersen, A. S., Project Participant, Department of Energy Conversion and Storage
Rode, C., Project Participant, Department of Civil Engineering
Pinson, P., Project Participant, Department of Informatics and Mathematical Modeling
Jørgensen, J. B., Project Participant, Department of Applied Mathematics and Computer Science
Energy Programme: DKK44.00
01/01/2014 → 31/12/2019
Keywords: Strategic
Collaborators: Aalborg University
Award relations: Center for IT-Intelligent Energy Systems for Cities
Project: Research

Traditional solar heating systems cover between 5 and 10% of the heat demand for domestic hot water and comfort heating. By applying storage capacity this share can be increased much. The Danish producer of solar heating systems, Aidt-Miljø, markets such a system including storage of dry sand heated by PP-pipe heat exchanger. Heat demand is reduced due to direct solar heating, and due to storage. The storage affects the heat demand passive due to higher temperatures. Hence heat loss is reduced and passive heating is optioned. In theory, by running the system flow backwards, active heating can be achieved. The objective of the project was to evaluate this system by measurement and simulation. Measurements on a low-energy building unfortunately gave rather poor results, simulations were carried out by the computer program EMGP3. The results of the project are among others: The system is rather simple. Much work can be self-made to keep the price down. The system is working, but heat exchange from plastic piping to sand is rather poor. The dimensioning of the volume is rather difficult based on common knowledge. Passive heating, hence reduction of heat demand, due to the storage and especially due to the oversized solar collector area of the system, was achieved. Active heating from the sand storage was not observed. The pay-back time for the system can be estimated to be similar to solar heated domestic hot water systems in general. A number of minor improvements on the system could be pointed out.

Heller, A., Project Manager, Department of Buildings and Energy
Jensen, F. F., Project Participant, Department of Buildings and Energy

Ukendt: DKK349,000.00
01/06/1995 → 31/12/1996
Collaborators: Aidt Miljø A/S
Project: Research

Solvarmeanlæg ved biomassefyrede fjernvarmecentraler

Heller, A., Project Manager, Department of Civil Engineering, Section for Building Physics and Services
Forskningsprojekter - Miljø- og Energiministeriet: DKK400,000.00
21/12/1999 → 31/10/2001
Collaborators: Jørgen Bladt A/S, Ramboll Group AS
Award relations: Solvarmeanlæg ved biomassefyrede fjernvarmecentraler
Project: Research

Monitoring for Project - Solar Heating in Ottrupgaard, Denmark.

Monitoring performance of seasonal pit water storage with hybrid liner of clay and plastic at Ottrupgaard, Denmark. The objective of the project is to investigate the performance and efficiency of the Ottrupgaard central solar heating, prove the applicability of the applied materials, obtain the heat losses and to verify the simulations made with the program SEASONSOL.

Heller, A., Project Manager, Department of Buildings and Energy
Maureschat, G., Project Participant, Department of Buildings and Energy

Ukendt: DKK422,000.00
01/07/1995 → 30/05/1997
Collaborators: PlanEnergi
Award relations: Monitoring for Project - Solar Heating in Ottrupgaard, Denmark.
Project: Research

Floating Lid Construction for Pit Water Storage - Phase I.

At Ottrupgaard, Denmark, a pit water heat store of 1,500 m3 and a lid area of about 700 m2 are built for seasonal storage of a solar collector field of 560 m2. The lid price is the largest component of a pit water store with a cost share of about 57%, more precisely 1,163 Dkr./m2. The development of lid constructions is crucial for the development of pit water storage as it seems that the development of the other main component for large-scale solar heating, the solar collectors will not have a breakthrough in the near future. The Ottrupgaard lid design is basically a sandwich element construction of PUR-foam between two metallic covers. The elements are joint in situ by special steel profiles. A two-step sealing with silicone mass and bitumen-tape is applied to tighten the construction. The project is to find and evaluate a floating lid design at Ottrupgaard and give a survey of the known floating lid design for pit water storage.

Heller, A., Project Manager, Department of Buildings and Energy
Jensen, F. F., Project Participant, Department of Buildings and Energy

Ukendt: DKK329,000.00
01/06/1995 → 30/03/1997
Collaborators: Nællemann Consultans, Plastconsult, ZW Energiteknik AB, PlanEnergi
Award relations: Floating Lid Construction for Pit Water Storage - Phase I.
Project: Research

Solar heating plants and bio-mass supplied district heating.

The purpose of the project is to establish a basis from which consultants can perform design outlines of solar heating plants in combination with bio-mass supplied district heating systems. The basis will be established by - analysing system designs - investigating various calculation models - determining realistic prices for different sizes of water storages -
performing economical optimisation of system design.
Duer, K., Project Manager, Department of Buildings and Energy
Heller, A., Project Participant, Department of Buildings and Energy
Furbo, S., Project Participant, Department of Buildings and Energy
Ukendt: DKK61,500.00
01/12/1999 → 01/06/2000
Collaborators: Jørgen Bladt A/S, Ramboll Group AS, Danish Technological Institute
Award relations: Solar heating plants and bio-mass supplied district heating.
Project: Research

Integration of solar heat storage in the ground floor.
In connection with making the building energy regulations more rigorous in Denmark in the year of 2005, it makes sense to apply solar heating in the methods for fulfilling the requirements of the goal of Energy 21. In this case it is important to develop new applications which combine solar heating with integration of energy storage in new buildings. Using conventional floor constructions usable for saving of energy, there is a benefit in saving cost in connection with the establishment of the heat storage, this can influence the building sector to increase the spreading of this kind of solar heating applications. The main effort in the project concerns detailed combined calculations of the heat storage. These calculations will examine the following: 1) The actual heat losses to the ground in agreement with the code DS 418 appendix 4. 2) Heat transfer to air with an accurate determination of the temperature of the surface of the floor, which is important for the indoor climate in the building. 3) Active transmissions of heat from the collector to the floor which according to previous speculations of sand storage make the system more profitable. The storage will retrieve huge alternation effect, which is disposed as small effects over a long period in the floor heating system. This can have importance for the optimal control of the system. The op-timal control depend former on the self adjustment mechanism given by the surface temperature of the floor and next on the possibility of active transferring of heat from the storage to the floor and finely on benefit of heat for domestic water heating and comfort from heat in tile floor in bathrooms.

Svendsen, S., Project Manager, Department of Buildings and Energy
Holck, O., Project Participant, Department of Buildings and Energy
Duer, K., Project Participant, Department of Buildings and Energy
Heller, A., Project Participant, Department of Buildings and Energy
Ukendt: DKK407,000.00
15/12/1999 → 01/01/2001
Collaborators: Danish Technological Institute
Award relations: Integration of solar heat storage in the ground floor.
Project: Research

Supplementary monitoring of Central Solar Heating Plant in Marstal, Denmark.
The Central Solar Heating Plant in Marstal, Denmark, is one of the largest of its kind. The plant consists of 9000 m2 solar collectors, a steel tank of 2100 m3 and a 3700 m3 seasonal gravel-pipe storage. The plant has been monitored since 1996. The first analysis showed lack of data collected at the plant for research purposes. Hence a supplementary monitoring programme was carried out during the Summer 1999. A large amount of data has been collected about temperatures, mass and energy flows in the system, control values for the control system and much more. One collector row has been monitored in detail by measuring all the temperatures between the individual collector modules. One-minute intervals have been chosen for data collection. The data will be applied for a.o. computer simulation program validation in the Ph.D.-Thesis of the author.

Heller, A., Project Manager, Department of Buildings and Energy
Ukendt: DKK81,000.00
01/05/1999 → 30/10/1999
Collaborators: Marstal District Heating A/S
Award relations: Supplementary monitoring of Central Solar Heating Plant in Marstal, Denmark.
Project: Research

Experimental model for heat transfer between heat pipe and gravel storage.
The project is a basic study on the expected thermal behaviour of gravel storage initiated as a part of a research and demonstration gravel storage for seasonal heat storage. The goal of the investigation is to determine the heat transfer between heat pipes and sand-gravel storage media is carried out. A small size experiment is carried out consists of a highly insulated box filled with two kinds of sand material crossed by a plastic heat pipe. Heat transfer is measured under dry and water saturated conditions in one plane. The conclusions are clear. To obtain necessary heat conduction in sand-gravel material, the storage media is to be water saturated. In this case, handling of such material on site is rather complex. The conduction is highly dependent on the thermal properties of the storage media and so is the overall thermal performance of a storage applying such media. For sandy media no convectional heat transport is found. It would be relevant to extend the investigation to media that enables convectional heat transport. A last conclusion is that such experiments, necessary for proper designing of sand-gravel storage types, are a very cheap form of collecting information about the expected behaviour of large storage systems.

Heller, A., Project Manager, Department of Buildings and Energy
Activities on solar heating systems
The aim of the project is to further develop solar heating systems and components for solar heating systems. In cooperation with manufacturers within the solar energy branch different projects are carried out: -Investigation of efficiency and strength for a solar collector with a new cover plate in cooperation with Djurs Solvarme I/S. -Investigation of a hot water tank with a high heat exchanger spiral with a small pipe diameter in the upper part of the heat exchanger spiral and a large pipe diameter in the lower part of the heat exchanger spiral in cooperation with Kähler&Breum Beholder- og Maskinfabrik K/S. -Investigation of a low flow solar heating system for space heating and domestic hot water supply with a wood burner as the auxiliary energy supply system in cooperation with Aidt Miljø A/S. -Investigations of deformations of solar collectors caused by mechanical loads and by temperature variations. -Investigations of heat exchange capacity rates inside mantle tanks. -Measurements of the thermal performance of small SDHW systems in a laboratory test facility. -Investigation of how the time step of weather data will influence the calculated thermal performance of solar heating systems.

Furbo, S., Project Manager, Department of Buildings and Energy
Holck, O., Project Participant, Department of Buildings and Energy
Vejen, N. K., Project Participant, Department of Buildings and Energy
Nielsen, L. T., Project Participant, Department of Buildings and Energy
Shah, L. J., Project Participant, Department of Buildings and Energy
Heller, A., Project Participant, Department of Buildings and Energy

Driver-Ii: Networking European Scientific Repositories
Considered the largest initiative of its kind in helping to enhance repository development worldwide, DRIVER is a multi-phase effort whose vision and primary objective is to create a cohesive, robust and flexible, pan-European infrastructure for digital repositories, offering sophisticated services and functionalities for researchers, administrators and the general public. DRIVER has established a network of relevant experts and Open Access repositories. DRIVER-II will consolidate these efforts and transform the initial testbed into a fully functional, state-of-the-art service, extending the network to a larger confederation of repositories. DRIVER is integral to the suite of electronic infrastructures that have emerged in the worldwide GÉANT network and is hence funded under the e-Infrastructures call of the European Commission’s 7th framework programme. It aims to “…optimise the way the e-Infrastructure is used to store knowledge, add value to primary research data and information making secondary research more effective, provide a valuable asset for industry, and help bridging research and education.”

Lossau, N., Project Manager, Goettingen State and University Library
Peters, D., Project Manager, Goettingen State and University Library
Neuroth, H., Project Participant, Goettingen State and University Library
Elbæk, M. K., Project Participant, Technical Information Center of Denmark
Sandfær, M., Contact Person, Technical Information Center of Denmark
Heller, A., Contact Person, Technical Information Center of Denmark
Pedersen, G. S., Project Participant, Technical Information Center of Denmark

Forsk. EU - Rammeprogram: DKK20,000,000.00
01/12/2007 → 01/12/2009
Collaborators: Goettingen State and University Library
Award relations: DRIVER-II: Networking European Scientific Repositories
Project: Research

Undersøgelse af masseovnes termiske egenskaber
Heller, A., Project Manager, Department of Civil Engineering, Section for Building Physics and Services

Forskningsprojekter - Miljø- og Energiministeriet: DKK50,000.00
29/05/2000 → 31/12/2001
Collaborators: Ovnbyggerlaug OLE, Fornyet Energi ApS
Award relations: Undersøgelse af masseovnes termiske egenskaber
Project: Research
Marstal følgeprojekt til EU-projekt om udvidelse af solvarmecentralen i Marstal
Heller, A., Project Manager, Department of Civil Engineering, Section for Building Physics and Services
Forskningsprojekter - Miljø- og Energiministeriet: DKK250,000.00
21/10/2001 → 31/12/2002
Collaborators: Danish Technological Institute
Award relations: Marstal følgeprojekt til EU-projekt om udvidelse af solvarmecentralen i Marstal
Project: Research

START-program: EU's 5. rammeprogram, ansøgning, Thematic Network
Heller, A., Project Participant, Department of Civil Engineering
Forskningsrådene - STVF: DKK100,000.00
28/06/2001 → 31/12/2001
Award relations: START-program: EU's 5. rammeprogram, ansøgning, Thematic Network
Project: Research

Lågkonstruktioner for damvarmelagre - Fase IV
Heller, A., Project Participant, Department of Civil Engineering, Section for Building Physics and Services
Forskningsprojekter - Miljø- og Energiministeriet: DKK1,500,000.00
01/01/2000 → 31/12/2002
Collaborators: NIRAS A/S, Plastconsult, Jakobsen & Blindkilde A/S, PlanEnergi, Marstal VVS Holding Aps, Ramboll Group AS
Award relations: Lågkonstruktioner for damvarmelagre - Fase IV
Project: Research

Måleprogram, jordslangelager i Marstal
Heller, A., Project Manager, Department of Civil Engineering, Section for Building Physics and Services
Forskningsprojekter - Miljø- og Energiministeriet: DKK100,000.00
21/06/1999 → 31/10/2001
Collaborators: Marstal Fjernvarme A/S, PlanEnergi
Award relations: Måleprogram, jordslangelager i Marstal
Project: Research

Videnshjemtagning og prøvning af højtemperatursofangere
Heller, A., Project Participant, Department of Civil Engineering
Forskningsprojekter - Miljø- og Energiministeriet: DKK180,000.00
19/10/2000 → 31/01/2002
Award relations: Videnshjemtagning og prøvning af højtemperatursofangere
Project: Research

Activities:

Presentation - Energy and Building Technology - A look into the future
Period: 30 Sep 2019
Alfred Heller (Guest lecturer)
Department of Civil Engineering

Description
Presentation of ideas for the future of building automation, cloud services, IoT and more
Documents:
CKI Conference DTU - sept 2017 - Next gen Building Tec (v2)

Related event
Siemens-DTU CKI conference 2017
19/09/2017 → …
Kgs. Lyngby, Denmark
Activity: Talks and presentations › Talks and presentations in private or public companies and organisations
High Tech Summit
Period: 20 Sep 2017 → 21 Sep 2017
Alfred Heller (Organizer)
Department of Civil Engineering
Centre for IT-Intelligent Energy Systems in Cities

Description
Organizer Smart Cities and Smart Buildings Tracks

Related event
High Tech Summit
20/09/2017 → 21/09/2017
Kongnes Lyngby, Denmark
Activity: Attending an event › Participating in or organising workshops, courses, seminars etc.

Smart Cities Day Vienna
Period: 2 May 2017 → 3 May 2017
Alfred Heller (Speaker)
Department of Civil Engineering
Centre for IT-Intelligent Energy Systems in Cities

Description
International expert for international and national smart cities projects.
Presenter for the lab to living lab to business - value chain.
Degree of recognition: International

Related event
Smart Cities Day Vienna
02/05/2017 → 03/05/2017
Vienna, Austria
Activity: Talks and presentations › Talks and presentations in private or public companies and organisations

Trends i byggeriet – IoT, Big data - Inspiration fra DTU, CITIES og Vidensbyen
Period: 23 Mar 2017
Alfred Heller (Speaker)
Department of Civil Engineering
Centre for IT-Intelligent Energy Systems in Cities

Description
Inviteret præsentation af de erfaringer der er lavet i CITIES og Vidensbyen omkring Internet of Things, Science Cloud for Cities og mere
Documents:
Bygnetværk - Alfred Heller - marts 2017

Related external organisation
Byggeriets netværk
København
Activity: Talks and presentations › Conference presentations

Cities research for District Heating Innovation
Period: 6 Mar 2017
Alfred Heller (Speaker)
Henrik Madsen (Speaker)
Centre for IT-Intelligent Energy Systems in Cities
Department of Civil Engineering

Department of Applied Mathematics and Computer Science

**Description**

Workshop on further development of district heatings after 4DH.
Henrik presented mathematical tools for district heating, and Alfred presented the Science Cloud for District Heating Innovation.

**Documents:**

Data Infrastruktur - Niras møde Århus marts 2017 - Alfred Heller

**Related external organisation**

**NIKAS A/S**
Denmark

Activity: Talks and presentations › Conference presentations

**Smart City workshop between TUBerlin, NTNU and DTU**

Period: 7 Feb 2017
Alfred Heller (Speaker)

Department of Civil Engineering
Centre for IT-Intelligent Energy Systems in Cities

**Description**

Science Hub for Cities - a common platform for city research (presentation)

**Documents:**

Alfred Heller et al.- NTNU-MTU-DTU, Nov 2015 (at DTU)

**Related event**

**Smart City workshop between TUBerlin, NTNU and DTU**

06/02/2017 → 07/02/2017
Kgs. Lyngby, Denmark

Activity: Talks and presentations › Conference presentations

**Steering Committee meeting Water DTU**

Period: 17 Jan 2017
Alfred Heller (Participant)

Department of Civil Engineering
Centre for IT-Intelligent Energy Systems in Cities

**Description**

Presentation of Science Cloud for Water DTU Steering Committee

**Related event**

**Steering Committee meeting Water DTU**

17/01/2017 → ...

Activity: Attending an event › Participating in or organising workshops, courses, seminars etc.

**WP3 CITIES Workshop on ‘Value creation by use of city data’**

Period: 12 Jan 2017
Alfred Heller (Participant)

Department of Civil Engineering
Centre for IT-Intelligent Energy Systems in Cities

**Description**

Presentation of Science Cloud for Cities
Related event

WP3 CITIES Workshop on 'Value creation by use of city data'
12/01/2017 → …
Aarhus, Denmark
Activity: Attending an event › Participating in or organising workshops, courses, seminars etc.

Vidensby Netværk for Klima og grøn teknologi
Period: 7 Jan 2017
Alfred Heller (Participant)
Department of Civil Engineering
Section for Building Energy

Description
IT infrastruktur for byer - Cloud, IoT i Lyngby, Vidensby Hub
Præsentation ved Vidensby Netværk for Klima og grøn teknologi

Related event

Vidensby Netværk for Klima og grøn teknologi
07/02/2017 → …
Activity: Attending an event › Participating in or organising workshops, courses, seminars etc.

Sustain-ATV Conference 2016
Period: 30 Nov 2016
Alfred Heller (Participant)
Department of Civil Engineering
Section for Building Energy
Centre for IT-Intelligent Energy Systems in Cities

Description
Living Labs – From scientific labs to the smart city
Documents:
City of Knowledge - Alfred Heller - Sustain2016 - Nov 2016

Related event

Sustain-ATV Conference 2016
30/11/2016 → 30/11/2016
Kgs. Lyngby, Denmark
Activity: Attending an event › Participating in or organising workshops, courses, seminars etc.

EERA Conference 2016
Alfred Heller (Speaker)
Department of Civil Engineering
Centre for IT-Intelligent Energy Systems in Cities

Description
Triple Helix Cooperation in Research
Documents:

Related event

EERA Conference 2016
24/10/2016 → 25/10/2016
Burmingham, United Kingdom
ATV årsmøde
Period: 14 Nov 2016
Alfred Heller (Invited speaker)
Department of Civil Engineering
Centre for IT-Intelligent Energy Systems in Cities

Description
Integrated and Intelligent Energy Systems

Documents:
ATV Conference - Integrated and Intelligent Energy Systems - Nov 2016 - Alfred Heller

Related event
ATV årsmøde: Akademy of Technical Sciences - Annual meeting
14/11/2016 → …
Kgs. Lyngby, Denmark

Activity: Talks and presentations › Guest lectures, external teaching and course activities at other universities

EERA JP Energy Integration
Period: 2 Nov 2016 → 4 Nov 2016
Alfred Heller (Participant)
Department of Civil Engineering
Centre for IT-Intelligent Energy Systems in Cities

Description
EERA Joint Programme in Energy Integration - half-annual workshop.

Related event
EERA JP Energy Integration
02/11/2016 → 04/11/2016
Kgs. Lyngby, Denmark

Activity: Attending an event › Participating in or organising workshops, courses, seminars etc.

Carbon Track and Trace workshop
Period: 1 Nov 2016
Alfred Heller (Participant)
Department of Civil Engineering
Centre for IT-Intelligent Energy Systems in Cities

Description
Workshop on Carbon Track and Trace - CITIES cooperation

Related event
Carbon Track and Trace workshop
01/11/2016 → …
Trondheim, Norway

Activity: Attending an event › Participating in or organising workshops, courses, seminars etc.

DTU visit at NTNU
Period: 31 Oct 2016
Alfred Heller (Participant)
Department of Civil Engineering
Centre for IT-Intelligent Energy Systems in Cities

**Description**
Deans visit for cooperation between the universities

**Related event**

**DTU visit at NTNU: Deans visit**
31/10/2016 → 01/11/2016
Trondheim, Norway
Activity: Attending an event › Participating in or organising workshops, courses, seminars etc.

**The City of Knowledge - A triple-helix organization**
Alfred Heller (Speaker)
Department of Civil Engineering
Centre for IT-Intelligent Energy Systems in Cities

**Description**
How triple helix organization bring sucess to smart energy systems.

**Related event**

**EERA Conference 2016**
24/10/2016 → 25/10/2016
Birmingham, United Kingdom
Activity: Talks and presentations › Conference presentations

**CITIES - Research Centre for Cities**
Period: 25 Sep 2016
Alfred Heller (Lecturer)
Department of Civil Engineering
Centre for IT-Intelligent Energy Systems in Cities
Documents:
CITIES - Singapore -BCA - Alfred Heller 25-09-2016

**Related event**

**Smart and sustainable cities: DTU-BCA Executive Development Programme 2016**
26/09/2016 → 30/09/2016
Copenhagen, Denmark
Activity: Talks and presentations › Conference presentations

**Executive Development Programme with Technical University of Denmark**
Period: 25 Sep 2016 → 1 Oct 2016
Alfred Heller (Organizer)
Department of Civil Engineering
Centre for IT-Intelligent Energy Systems in Cities

**Description**
Scientific organizer of Master Track for Executive Masters from Singapore.

Executive Development Programme for BCA Singapore

**Related event**

**Executive Development Programme with Technical University of Denmark: Master Course**
25/09/2016 → 01/10/2016
Kgs. Lyngby, Denmark
Activity: Attending an event › Participating in or organising a conference

**Top meeting CITIES - DiCyPS**
Period: 3 Mar 2016
Alfred Heller (Participant)
Department of Civil Engineering
Centre for IT-Intelligent Energy Systems in Cities

**Description**
Presenter of CITIES
Top meeting between CITIES and DiCyPS

**Related event**
**Top meeting CITIES - DiCyPS**
03/03/2016 → ...
Ålborg, Denmark
Activity: Attending an event › Participating in or organising workshops, courses, seminars etc.

**Urban Living Labs**
Period: 25 Feb 2016 → 26 Feb 2016
Alfred Heller (Participant)
Department of Civil Engineering
Section for Building Energy
Centre for IT-Intelligent Energy Systems in Cities

**Description**
Presentation of Innovation Cycle for Living Labs at DTU and Copenhagen area
International seminar on living labs

**Related event**
**Urban Living Labs**
25/02/2016 → 26/02/2016
Newcastle, United Kingdom
Activity: Attending an event › Participating in or organising workshops, courses, seminars etc.

**Inno-SE Integrated Energy Systems (External organisation)**
Period: 2016 → …
Alfred Heller (Chairman)
Department of Civil Engineering
Section for Building Energy

**Description**
Head of Advisory Board
Body type: National Innovation Cluster

**Related external organisation**
**Inno-SE Integrated Energy Systems**
Activity: Membership › Membership of committees, commissions, boards, councils, associations, organisations, or similar

**Smart Buildings: Combining energy efficiency, flexibility and comfort**
Period: 26 Nov 2015
Alfred Heller (Invited speaker)
Introduction of the event topic on smart buildings and energy systems - A Nordic perspective.

Documents:
Smart Buildings - White Paper for a green transition

Links:

Related event

Nordic diplomacy event on Smart Buildings Technologies: A Nordic-Danish Perspective
26/11/2015 → …
Vilnius, Lithuania
Activity: Talks and presentations › Conference presentations

Triple Helix Cooperation for Scalability - Presentation
Period: 9 Nov 2015
Alfred Heller (Invited speaker)

Department of Civil Engineering
Section for Building Energy
Centre for IT-Intelligent Energy Systems in Cities

Documents:
Triple Helix Cooperation for Scalability - Alfred Heller - 09-11-2015 Helsinki

Related event

0: Nordic Smart & Clean Cities
05/11/2015 → 06/11/2015
Helsinki, Denmark
Activity: Talks and presentations › Conference presentations

Forskningsbibliotekernes Lederkollegiets Seminar
Period: 28 Oct 2015
Alfred Heller (Participant)

Department of Civil Engineering
Section for Building Energy
Centre for IT-Intelligent Energy Systems in Cities

Description
Seminar omkring spørgsmålet, om forskningsbiblioteker har en rolle at spille i forhold til forskningsdata, -systemer og -services.

Documents:
Forskningsbiblioteker - Forskeres behov for data services - Alfred Heller - Oct 2015

Related event

Forskningsbibliotekernes Lederkollegiets Seminar: Har biblioteker en rolle i forhold til forskningsdata?
28/10/2015 → …
Odense, Denmark
Activity: Attending an event › Participating in or organising workshops, courses, seminars etc.
EnergyLab Nordhavn: Sustainability through Certification
Period: 20 Oct 2015
Alfred Heller (Invited speaker)
Department of Civil Engineering
Section for Building Energy

Related event
SMART CITIES: Building the City 2.0
20/10/2015 → 21/10/2015
Stockholm, Sweden
Activity: Talks and presentations › Conference presentations

Smart Cities Live
Alfred Heller (Speaker)
Department of Civil Engineering
Section for Building Energy
Centre for IT-Intelligent Energy Systems in Cities

Related event
SMART CITIES: Building the City 2.0
20/10/2015 → 21/10/2015
Stockholm, Sweden
Activity: Talks and presentations › Conference presentations

*Sustainability by certification* - Experiences on the DGNB certification of the Nordhavn district in Copenhagen
Period: 20 Oct 2015
Alfred Heller (Invited speaker)
Department of Civil Engineering
Section for Building Energy
Centre for IT-Intelligent Energy Systems in Cities
Documents:
Energy Lab Nordhavn - Sustainability by certification - Alfred Heller - Oct 2015

Related event

Den digitale by
Period: 6 Oct 2015
Alfred Heller (Lecturer)
Department of Civil Engineering
Section for Building Energy
Description
Folkeuniversitet Århus, foredrag om den digitale by

Related external organisation
Unknown external organisation
EU-Israel Innovation (External organisation)
Period: 10 Sep 2015
Alfred Heller (Participant)
Department of Civil Engineering
Section for Building Energy
Centre for IT-Intelligent Energy Systems in Cities

Description
Advisor for the EU-Israel Innovation Cooperation

Body type: Committee
Degree of recognition: International

Related external organisation
EU-Israel Innovation
Activity: Membership › Membership of committees, commissions, boards, councils, associations, organisations, or similar

EU-Israel Innovation Seminar
Period: 10 Sep 2015
Alfred Heller (Invited speaker)
Department of Civil Engineering
Section for Building Energy
Centre for IT-Intelligent Energy Systems in Cities

Description
Invited to provide recommendation and advices for innovation based on research in Smart Cities and Energy related issues.

Related event
EU-Israel Innovation Seminar
10/09/2015 → …
Tel Aviv, Israel
Activity: Talks and presentations › Conference presentations

Nordic Climate KIC - CITIES workshop
Period: 1 Sep 2015
Alfred Heller (Organizer)
Centre for IT-Intelligent Energy Systems in Cities
Department of Civil Engineering
Section for Building Energy

Description
Organizer of workshop activities

Related event
Nordic Climate KIC - CITIES workshop
01/09/2015 → …
Copenhagen, Denmark
Activity: Attending an event › Participating in or organising a conference

PhD evaluation committee - Rimante Cox (External organisation)
Period: Sep 2015 → Nov 2015
Alfred Heller (Chairman)
Department of Civil Engineering
Section for Building Energy

**Description**
Body type: Evaluation Committee

**Related external organisation**

**PhD evaluation committee - Rimante Cox**
Activity: Membership › Membership in review committee

**How does the research centre CITIES contribute to Innovation**
Period: 22 May 2015
Alfred Heller (Invited speaker)
Department of Civil Engineering
Section for Building Physics and Services
Centre for IT-Intelligent Energy Systems in Cities

**Description**
Presentation at the annual meeting of the CLEAN innovation organisation.
Documents:

**Related external organisation**

**Unknown external organisation**
Activity: Talks and presentations › Conference presentations

**Det intelligente energisystem**
Period: 26 Mar 2015
Alfred Heller (Participant)
Department of Civil Engineering
Section for Building Physics and Services
Centre for IT-Intelligent Energy Systems in Cities
Documents:
Det intelligente energisystem - CITIES 26-04-2015

**Related event**

**Det intelligente energisystem**
26/03/2015 → …
Vejle, Denmark
Activity: Attending an event › Participating in or organising workshops, courses, seminars etc.

**From Grid to Society: Some thoughts about Smart Cities**
Period: 10 Mar 2015
Alfred Heller (Lecturer)
Department of Civil Engineering
Section for Building Physics and Services
Centre for IT-Intelligent Energy Systems in Cities

**Description**
Inspiration lecture for Arup University and Imperial Collage, UK.
Documents:
Energyforum Denmark
Period: 4 Mar 2015
Alfred Heller (Invited speaker)
Department of Civil Engineering
Section for Building Physics and Services
Centre for IT-Intelligent Energy Systems in Cities

Description
Bygninger – en aktiv del af fremtidens energiforsyning

Documents:
Presentation Alfred Heller DTU 04-03-2015

Smart City Think Tank (External organisation)
Period: 1 Mar 2015 → 31 Dec 2015
Alfred Heller (Participant)
Department of Civil Engineering
Section for Building Physics and Services

Description
The Ministry for Cities, Buildings and Rural areas did point out a Smart City Think Tank that has to come up with a recommendation on subjects like smart cities, data in relation to smart technologies, privacy and such like.

Teknisk ekspert

Body type: Think Tank for Ministry
Documents:
Artikel JP smart city tænketank

EuroTech Winter School
Period: 5 Feb 2015 → 9 Feb 2015
Alfred Heller (Participant)
Department of Civil Engineering
Section for Building Physics and Services
Centre for IT-Intelligent Energy Systems in Cities

Description
The winter school presents the participant in a wide range of energy technologies and issues. Working with the holistic topic of Smart Energy Cities brings up the question of "How do we design research in the holistic field of Smart Energy Cities?" The workshop will present some theoretical background and promote the students to define proposals in this agenda.
Related event

EuroTech Winter School: Smart Energy
02/02/2015 → 15/02/2015
Lausanne, Switzerland
Activity: Attending an event › Participating in or organising workshops, courses, seminars etc.

Future Digital Cities - for and with citizens (External organisation)
Period: 1 Feb 2015 → 31 Dec 2031
Alfred Heller (Participant)
Department of Civil Engineering
Section for Building Physics and Services
Centre for IT-Intelligent Energy Systems in Cities
Description
Ministerial think tank on cities, digital opportunities and services in the city perspective by the Ministry of Housing, Urban and Rural Affairs
Body type: Ministerial tænkertank

Related external organisation

Future Digital Cities - for and with citizens
Activity: Membership › Membership of committees, commissions, boards, councils, associations, organisations, or similar

Head of activity - Integrated Energy Systems (External organisation)
Period: 2015 → 2016
Alfred Heller (Chairman)
Department of Civil Engineering
Centre for IT-Intelligent Energy Systems in Cities
Description
Head of working group on Integrated Energy System Innovation under CLEAN, Inno-SE innovation cluster.
Body type: Committee
Links:
(Link to CLEAN Inno-SE web description)

Related external organisation

Head of activity - Integrated Energy Systems
Activity: Membership › Membership of committees, commissions, boards, councils, associations, organisations, or similar

Nordic Research Council (External organisation)
Period: 2015 → …
Alfred Heller (Participant)
Department of Civil Engineering
Section for Building Energy
Description
Evaluator for the Nordic Research Council

Related external organisation

Nordic Research Council
Activity: Membership › Membership in review committee
Big Data as a tool for controlling the cities energy: Data aspects and data management
Period: 27 Nov 2014
Alfred Heller (Invited speaker)
Department of Civil Engineering
Section for Building Physics and Services
Centre for IT-Intelligent Energy Systems in Cities

Description
Data are essential for smart cities research. How do we handle them? What kinds of data do we have, how do we manage them? ...
Documents:
Big data for Smart Energy Cities IDA Presentation 27-01-2014

Related event

Big Data som værktøj til at styre byens energi
27/11/2014 → …
København, Denmark
Activity: Talks and presentations › Conference presentations

Idea catalogue by Vidensby Lyngby to Workshop Water DTU
Period: 29 Oct 2014
Alfred Heller (Invited speaker)
Department of Civil Engineering
Section for Building Physics and Services

Description
Presentation of the opportunities in the Lyngby Videnby cooperation, the Cities centre project and Water DTU - DTU internal workshop.
Documents:

Related external organisation
Unknown external organisation
Activity: Talks and presentations › Conference presentations

3rd International Workshop on Design in Civil and Environmental Engineering
Alfred Heller (Participant)
Department of Civil Engineering
Description
Presentation at conference

Related event
3rd International Workshop on Design in Civil and Environmental Engineering
21/08/2014 → 23/08/2014
Kgs. Lyngby, Denmark
Activity: Attending an event › Participating in or organising a conference

Smart City Network Denmark (External organisation)
Period: 1 Aug 2014 → …
Alfred Heller (Participant)
Department of Civil Engineering
Section for Building Physics and Services
Centre for IT-Intelligent Energy Systems in Cities

Description
Network in the field of Smart Cities in Denmark under the Ministry for housing, cities and rural areas.

Body type: Network

Related external organisation

Smart City Network Denmark
Activity: Membership › Membership of commitees, commissions, boards, councils, associations, organisations, or similar

CITIES Annual Conference
Period: 26 May 2014 → 28 May 2014
Alfred Heller (Organizer)
Department of Civil Engineering
Centre for IT-Intelligent Energy Systems in Cities

Description
Organisation of CITIES Annual Conference 2014.

Related event

Urbanisation and infrastructure in the Arctic – Challenges to sustainability
Period: 7 May 2014 → 9 May 2014
Alfred Heller (Participant)
Department of Civil Engineering
Section for Building Physics and Services
Centre for IT-Intelligent Energy Systems in Cities
Documents:
Paper_MRKO_Submission

Related event

Urbanisation and infrastructure in the Arctic – Challenges to sustainability
07/04/2014 → 09/04/2014
Introduction of flexible monitoring equipment into the Greenlandic building sector
Period: 8 Apr 2014
Alfred Heller (Lecturer)
Department of Civil Engineering
Section for Building Physics and Services
Centre for IT-Intelligent Energy Systems in Cities

Description
Greenlandic winters are long and cold so living inside a heated and properly ventilated space requires quite some energy. It is assumed that in mechanically ventilated buildings, significant amounts of energy for heating can be conserved by adjusting ventilation flow rates according to the actual demand of occupants. Traditional solutions available on a market consist of a controller and the sensors in a living space detecting occupancy and activity (movement sensors, CO2 sensors, Humidity sensors, etc.). The controller needs to be programmed and maintained by an expert and the sensors need to be hardwired to the controller. In Greenland where price of labor is very high and availability of experts is limited, installation of such control system becomes expensive. Particularly in case of renovation of existing buildings the costs of hardwiring the sensors can be very high. One possible solution to the above is to use wireless sensor network (WSN) technologies. A prototype wireless monitoring and control system is demonstrated on a renovation of a ventilation system in the new dormitory Apissesq in Sisimiut, Greenland. The existing mechanical ventilation was running at a constant air flow even during unoccupied hours which resulted in a very high heat demand. It was estimated that installing the WSN system will bring annual savings of 1,600 € at the investment of 8,000 €. This paper describes a setup of the system and discusses its advantages and drawbacks.
Documents:
Grønland Presentation WSN 08-04-2014_mrko

Related event
Artek Conference 2014
07/04/2014 → 09/04/2014
Sisimiut, Greenland
Activity: Talks and presentations › Conference presentations

European Workshop 2014 International Institute for Energy System Integration
Alfred Heller (Participant)
Department of Civil Engineering
Section for Building Physics and Services
Centre for IT-Intelligent Energy Systems in Cities

Related event
European Workshop 2014 International Institute for Energy System Integration
27/05/2014 → 28/05/2014
Copenhagen, Denmark
Activity: Attending an event › Participating in or organising a conference

Inno-SE Innovationsnæværk - Evaluator af Innovationsprojekter (External organisation)
Period: 2014 → …
Alfred Heller (Participant)
Department of Civil Engineering
Section for Building Energy
Centre for IT-Intelligent Energy Systems in Cities

Description
Body type: Evaluering
Related external organisation

Inno-SE Innovationsnæværk - Evaluator af Innovationsprojekter
Activity: Membership › Membership in review committee

Structural Frameworks for Open, Digital Research
Period: 11 Jun 2012 → 13 Jun 2012
Alfred Heller (Organizer)
Department of Civil Engineering
Section for Building Physics and Services
Description
Scientific advisor, member of scientific commitee

Related event

Structural Frameworks for Open, Digital Research
11/06/2012 → 13/06/2012
Copenhagen, Denmark
Activity: Attending an event › Participating in or organising a conference

Workshop on Sustainable Energies
Period: 14 Jan 2009 → 15 Jan 2009
Alfred Heller (Speaker)
Technical Information Center of Denmark

Related event

Workshop on Sustainable Energies
14/01/2009 → 15/01/2009
Lyngby, Denmark
Activity: Talks and presentations › Conference presentations

DataCite (External organisation)
Period: 2009 → 2011
Alfred Heller (Member)
Section for Building Physics and Services
Department of Civil Engineering
Description
10 years of DataCite - DOI registry infrastructure for research data.
Member of board
Body type: International Research Infrastructure Provider
Degree of recognition: International
Documents:
DataCite 10 year D-Lib Magazine
Links:
http://www.dlib.org/dlib/january15/brase/01brase.print.html (Article)

Related external organisation

DataCite
Activity: Membership › Membership of commitees, commissions, boards, councils, associations, organisations, or similar

Workshop on Open Access ( Nordbib)
Period: 23 Apr 2007 → 24 Apr 2007
Alfred Heller (Participant)
Technical Information Center of Denmark

Related event

Workshop on Open Access ( Nordbib)
Marienlyst, Helsingør
Activity: Attending an event › Participating in or organising workshops, courses, seminars etc.

Press clippings:

Hvad sker der når køleskabet går online?
Alfred Heller
04/04/2017

Description
Article in BYG Nyt - news letter of DTU Civil Engineering.

Subject
Internet of Things is relevant for the building industry. First trails in the City of Knowledge, Lyngby and DTU.
Department of Civil Engineering, Centre for IT-Intelligent Energy Systems in Cities, Section for Building Energy

Media contribution (1)

BYG Nyt
04/04/2017
DTU Civil Engineering, Denmark
Alfred Heller
Centre for IT-Intelligent Energy Systems in Cities
Press/Media: Press / Media

Fælles platform for smart city-løsninger lanceret på DTU: Smart City Hub
Alfred Heller
22/02/2017

Description
Innovation platform for the City of Knowledge, Lyngby.
Department of Civil Engineering

Media contribution (1)

Fælles platform for smart city-løsninger lanceret på DTU: Smart City Hub
22/02/2017
News letter, Web
DTU Byg
Alfred Heller
Department of Civil Engineering
Press/Media: Press / Media

Platform giver forskere datamanagement for projekter
Alfred Heller
12/01/2017

Description
Interview fra DEIC til deres hjemmeside og nyhedsbrev om udvikling af science cloud for cities - CITIES data management platform og Cloud løsning.
Department of Civil Engineering, Centre for IT-Intelligent Energy Systems in Cities

Media contribution (1)
Platform giver forskere datamanagement for projekter
12/01/2017
Nyhedsbrev, Web
Alfred Heller
Department of Civil Engineering, Centre for IT-Intelligent Energy Systems in Cities
Press/Media: Press / Media

Fremtiden byder på flere digitale services i byggebranchen
Alfred Heller
01/01/2017
Department of Civil Engineering, Centre for IT-Intelligent Energy Systems in Cities

Media contribution (1)

Fremtiden byder på flere digitale services i byggebranchen
01/01/2017
Nyhedsbrev, Web
DTU Byg
http://www.dtu.dk/nyheder/nyhed?id=d8406fe4-da56-4a92-a98a-2cb1e76e12a7
Alfred Heller
Department of Civil Engineering, Centre for IT-Intelligent Energy Systems in Cities
Press/Media: Press / Media