Final report

1.1 Project details

Project title	Flexible Retail Stores
Project identification (program abbrev. and file)	FlexReStore; 12413
Name of the programme which has funded the project	ForskEL
Project managing company/institution (name and address)	Center for Energy Informatics University of Southern Denmark Campusvej 55 5230 Odense M
Project partners	Aura Energi GreenTech Center Insero Business Services
CVR (central business register)	29283958
Date for submission	7/5 2019

1.2 Short description of project objective and results

The Danish retail sector can be a key player in the future smart grid by providing flexible energy consumption. The use of intelligent energy solutions in the retail sector is hampered by shortsighted economic thinking and low profit margins. The FlexReStore project has addressed these potentials and the motivation for the retail sector in general to be an active player in the smart grid. The outcomes of the project include detailed recommendations for activating stores focusing on the store owners, technology developers and decision makers, tools to energy screen retail stores for flexibility and a new ICT solution for operating flexibility.

Den danske detailbranche kan blive en nøglespiller i fremtidens smart grid ved at tilbyde fleksibelt energiforbrug. Udnyttelsen af intelligente energiløsninger i detailbranchen hæmmes dog af kortsigtet økonomisk tænkning og lave profit-marginer. Projektet har undersøgt potentialer og motivation for, at detailbranchen som helhed kan blive en aktiv smart grid aktør. FlexReStore projektet er kommet med konkrete anbefalinger til butiksejerne, teknologileverandørerne samt beslutningstagerne for at aktivere butikkerne, værktøjer til at forstå energifleksibilitets potentialer og en ny IT løsning til at styre fleksibelt forbrug med.

1.3 Executive summary

The main purpose of the FlexReStore project was to pave the way for the retail sector to provide flexible electricity consumption.

The project has established an energy guild of retail sector stakeholders with an outset in the project user group of major retail players in Denmark. The project has collected relevant energy datasets and developed methods to analyse the data to support energy screening activities in the project.

It is important to evolve retail store designs to include options for flexible consumption. The project has developed a tool to energy screening stores for flexibility options. The tool has been used in stores operated by the members of the energy guild. Project results document that the stores are relevant to consider in an energy flexibility perspective but also highlight a number of technical and organisational challenges. The challenges and opportunities were further unfolded with store stakeholders in a number of workshops. Building on the workshops a set of recommendations were distilled for how store owners, technical providers and decision makers can advance the smart grid readiness and participation of the retail sector. The recommendations have been published in booklets targeting the three groups of stakeholders.

An ICT-based solution to support the operation of retail store flexibility has been developed. The solution addresses cost issues when adopting technologies for operating flexibility. The solution has been developed and demonstrated in several test cases including a model of a real supermarket.

The project has addressed retail stakeholders' reaction to observable effects of flexible consumption and their energy relevant behavior in general. These areas have been studied to establish knowledge to inform store designs and gather design requirements for new technical solutions. The work has built on desk research, surveys and ethnographic work.

The project results will be utilized by the project participants in new activities and have been disseminated both to relevant national stakeholders and the scientific community

1.4 Project objectives

The main purpose of the FlexReStore project was to pave the way for the retail sector to provide flexible electricity consumption. From the outset this was defined by the following project objectives:

- Establishment of an energy guild of retail sector stakeholders with an outset in the project user group of major retail players in Denmark. The guild will facilitate data sharing and community innovation.
- Evolve retail store designs to include options for flexible consumption including lighting, ICT and plug-loads.
- Develop an ICT-based solution to support the operation of retail store flexibility including customer communication and demonstrate the solution for the proposed retail store designs.
- Studies of retail customers' reaction to observable effects of flexible consumption in relation to store owners' profitability and retail stakeholders' attitudes towards flexible consumption.

At project start, a startup meeting was completed, and a project group was established (milestone M1). At this stage, a collaboration agreement was signed among the partners (milestone M0). The project group did at the beginning of the project meet every month and later as needed for exchanging information and do status on plans, tasks and progression. In addition, each work package also had meetings with the relevant partners during the project.

The project has established an energy guild in the form of a user group of companies (milestone M2). Data has for all members of the user group been delivered by AURA (milestone M4). SDU has implemented data analytics and analyzed the data.

Screenings have been performed for five different store types. A tool for screening of flexibility have been developed. Several workshops with the owners/managers of the different stores have been completed (milestone M6). The lessons learned have been summarized (milestone M8) and published as three booklets to multiple interest groups.

Specification of ICT tools has been conducted (milestones M5 and RM2). Based on this specification, ICT tools have been developed to reduce the cost of making retail stores energy flexible. The ICT tools build on a concept that makes it easier to combine different services to make the consumption flexible (milestones M9 and RM5). Services have been evaluated with data from a demonstration retail store and a model of a real retail store (milestones CM2, RM6, M10).

A literature study about energy flexibility and customer behavior and stakeholders in retail stores has been completed. Interviews of experts on customer behavior and energy consumption have been carried out (milestone M3). Stakeholders have been surveyed (milestones RM1 and RM3), and the results have been analyzed (milestones RM 4 and CM 1) and published (milestone M7). An anthropologic study with observations and interviews in a retail store has mapped the workflow, and related customer flows in stores. The study has collected information about why the workflow is designed in this manner and linked this to energy usage. The study has been documented via video, notes, and tables (milestone M11).

Through the project we have collaborated with many retail stores and relevant stakeholders (milestone CM3) and finalized project results (milestone M12).

Most activities have been executed as planned. An adjustment was made in 2018 to align the project with lessons learned and changes in partner competences. The adjustment refocused the evaluation in stores on the employees rather than customers and to use a model rather than retrofitting a real store.

As many of the results of the project has been published as scientific papers the report has been kept concise. We refer the reader to the scientific papers for the in-depth details of studies and technical prototypes.

1.5 Project results and dissemination of results

1.5.1 WP1

The project has established an energy guild in the form of a user group of retail companies with representation of major store types in Denmark. The goal of the energy guild was to collect electricity consumption data and establish an innovation community to prepare the retail sector for providing flexible consumption. Data has for all members of the user group been delivered by AURA to achieve this goal. This includes total energy consumption for electricity and domestic heating and for specific stores submetering of specific areas and load types. The collected data from the different sources have been used as the basis for analyzing the present load types and their temporal consumption patterns to evaluate the flexibility potential in existing retail stores. SDU has implemented data analytics and analyzed the data (Mehanovic et al. 2016).

1.5.2 WP2

A guide to screening for flexibility has been developed by Aura and SDU in collaboration with the Danish Technological Institute. The guide is available here: http://www.teknologisk.dk/vaerktoej-til-screening-for-energifleksibilitet/37826 In collaboration with the retail stores and AURA, five retail stores were chosen and mapped from the perspectives of energy usage, hardware, compatibility with ICT tools, and finally demand response (DR) potentials existing in the stores. In the five stores there was a link between a building's age and the associated equipment within the building. E.g., because of several older buildings, many of the building controls had no external communication options. Therefore, stores were found to be severely lacking integration support for ICT tools and would require retrofitting of existing setups. Fortunately, retrofitting of retail stores are typically made at a faster pace than other building types. The results document that the stores are relevant to consider in an energy flexibility perspective, but a number of challenges exists. For instance, how do you secure that operation of flexibility does not influence the activities in the store? Regarding DR potentials, a surprising candidate was identified in the shape of ovens that could produce up to 60% of the demand response potential. Unfortunately, currently ovens seem challenging to integrate into DR endeavors. Another interesting load was ventilation, as it contributed 43%, and 17% of the DR potential in two of the three surveyed retail stores. The results from the interviews and the store inspections are documented in a published article by Hviid, J., & Kjærgaard, M. B. (2018b).

Workshops were held with four partners from the user group. These users covered different store types. The workshops covered both flexibility options, the practical limitations for operating this flexibility and the organizations' motivation and barriers to providing flexibility. Based on the screenings and workshops a catalog of recommendations where summarized under the following headlines. #1 – create value for the store owners, #2 – flexible electricity usage has a limited green image value, #3 – do not create risks for lost sales, #4 – create sales-ready solutions, #5 – Create technologies that increase the electricity flexibility in stores, #6 – Utilize digital store formats to introduce flexible control. A first version was presented to energinet.dk The recommendations have later been communicated to different relevant stakeholders using three booklets.

1.5.3 WP3

To obtain a better understanding of the retail store domain and the stakeholders involved, the FlexReStore project started by interviewing energy management stakeholders in a number of stores as part of WP4. The interviews identified that the stakeholders were not interested in communicating the green energy perspective to the customers and that the main driver for energy upgrades would be cost savings without impacting sales, and not marketing themselves as green. From their perspective, customers do not care enough about green energy to buy groceries at a competitor instead. This was an important consideration for specifying the requirements of the ICT solutions.

As the retail store stakeholders specifically mentioned sales and operations to be the most crucial factor in the building, and their concerns need to be addressed for a DR solution to be successful, the first ICT tool implementation was an activity tracking service built in the context of a building operating system (BOS) (Hviid, J., & Kjærgaard, M. B., 2018a). This service aims to help a DR system understand the current context of the building it is operating in, and its accompanying personnel. The state of the building is important, if DR operations are not to disturb the customers and employees in the building. Such an activity service was developed and demonstrated on real store data from a demonstration store in the Greentech center. Sensors for monitoring in-store actions (e.g., opening cabinets, placement of goods, …) was used to collect data. The machine-learning algorithms supporting the services showed to provide high accuracy in detecting the human activities in focus in the study.

While the setup worked as intended, it became apparent there was a monumental gap in the BOS architecture, in regard to making the DR applications and services portable between buildings. This gap means that an application would need to be re-written, or only have monolithic applications on top of the BOS, that included all algorithms needed. This is a major cost burden to scaling energy flexibility operation.

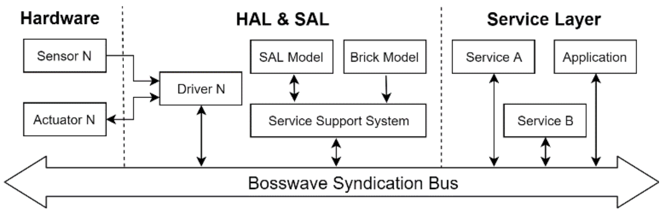

Figure 1 - Building Operating System Architecture Overview

A setup was created around existing research into BOSes, and multiple components were added. This new setup contains several new components, as described in Figure 1. The traditional BOS consists of a Hardware Layer (HL), a Hardware Abstraction Layer (HAL), and an Application Layer. In the case of the adapted version, that is described in Figure 1, a Software Abstraction Layer (SAL) was added, together with a new Service Support System (SSS) (for hosting the SAL, and a part of the HAL), and a new service layer. These new abstractions and contributions allow services and applications to query for information it needs from the building operating system, instead of having hardcoded dependencies. Essentially, the HAL does the same for the hardware, but with these changes, services and applications can now be moved independently between buildings, without requiring re-implementation for the specific building, or its service ecosystem. Also, the SSS not only enables the SAL but also further reduces the deployment cost of BOS based DR solutions, as it allows for autoconfiguration of a subset of service types that previously needed manual configuration. The SAL is described in the article Hviid, J., & Kjærgaard, M. B. (2018c). Also, another article based on the SAL is ready for publishing, and another article on this subject is planned. The SSS article has already been accepted at a conference (Hviid, J. et al. 2019).

From the experiences made with the SAL and the SSS, further deployment cost reductions are explored in the form of containerization and automatic dependency resolution and deployment of services in BOS'. This kind of system would allow services to dynamically be installed based on the needs of an application and allow these services to be easier for developers to create and maintain as separate packages. The changes that are enabled by the SAL, SSS, Containerization, and the automatic dependency resolution, essentially would allow a new subsector of software to be created. Most importantly, creating easy to deploy BOSes', support the goal of making BOS based ICT installations profitable, so that they can support DR operations. For the DR implementation, the project builds on the ideas behind OpenADR for DR, and how the iPower project has defined relevant DR services for a Danish context.

Building modeling and simulation can provide an effective method for evaluating flexibility opportunities in buildings. However, most building loads depend on the occupant presence and dynamic interactions between different building components. Therefore, occupant presence and different interactions must be considered when developing the energy performance model and when evaluating the simulation results for flexibility. This is key in the retail sector. Therefore, we have developed a detailed simulation model of a supermarket to evaluate the ICT solution and at the same time different flexibility scenarios. We also consider the flexibility results in light of an ethnographic study of the work processes and store operation (also part of WP4).

The methodology for making the model can be summarized in eight steps: 1) gather technical information for the retail store. 2) gather calibration and validation data. 3) do ethnographic studies of the retail store including observations and interviews to detail the work processes in the store. 4) develop an EnergyPlus model by first creating a 3D model in Google SketchUp and then importing the model into OpenStudio to define the building characteristics, such as physical envelope, occupancy, loads, HVAC systems and schedules. 5) define the demand response scenarios for the evaluation. 6) run simulations using the energy performance model. This includes model debugging to ensure that the model can simulate without any errors or warnings; conducting model calibration such that the electricity, heating and water consumption match with the data for the real retail store consumption; Validation with data for one month (as the yearly consumption was not available). 7) evaluate the energy flexibility of the retail store based on the simulation results, which in this instance entails shifting the majority of the electricity consumption from periods of high electricity price to periods of low electricity price. 8) interpret results with regards to the work processes of the store. A paper on the results of this study will be published at the Building Simulation 2019 conference (Jradi et al. 2019).

The ICT middleware tools described above in this section was demonstrated to run on the energy plus model described above. The setup is built on the setup described in Figure 1. It consists of a DR price signal prediction service, an occupancy prediction service, and a DR orchestrator application. The two first services publish their predictions into the SAL, while the DR orchestrator application queries for the information needed and adjusts the hardware in the Energy Plus model accordingly. The simulation shows that DR control is achievable by writing applications that have no direct dependency on a specific building or its service eco system, thereby effectively enabling portable services and applications.

1.5.4 WP4

The work package has from several perspectives studied customer and stakeholder behavior in relation to energy flexibility.

Regarding customer behavior a literature study was conducted to bring in existing knowledge to the project. Expert interviews were then carried out with questions informed by the literature study. The goal was to identify potentials and barriers for energy flexibility in the retail stores. The experts highlighted how the potentials are most significant for consumption types which can be adapted in time without affecting the service level of the customer areas. Ventilation, comfort cooling and goods cooling are mentioned as the services with the largest expected potential if comfort levels and security demands are not violated. The experts provided their knowledge on the stores' priorities, vulnerabilities to their main business and their views on the challenge of adding energy sustainability to the store branding.

The project has investigated the stakeholder involvement in energy flexibility by following the business ecosystem concept (including actors, relationships, value alliances, and influential factors), with the discussion of the stakeholders' roles and their interrelation in delivering energy flexibility with the influential factors to the actual implementation of energy flexible operation of their buildings. Based on literature analysis, the results cover for the energy flexibility in retail buildings stakeholder types and roles, perceptions (drivers, barriers, and benefits), energy management activities and technology adoptions, and the stakeholders' interaction. The results are published in a paper (Ma et al. 2017)

The project conducted a questionnaire with retail stores to investigate store managers' preferences for demand response programs and stakeholders' engagement. The questionnaire is designed and collected with store managers in Denmark (N=51) and the Philippines (N=36). The result shows that: 1) store managers in retail stores are more willing to participate in the implicit demand response by manual energy control compared to the utility control or building automation. Meanwhile, store managers have significant concerns about business activities and indoor lighting compared to other aspects; 2) the statistically significant influential factors for retail stores to participate in the demand response are related to whether demand response participation matches company goals, influences business operation, and whether retail stores lack knowledge; 3) store managers in retail stores believe that employees and customers should be informed about the demand response activities but not involved in these; 4) there are significant differences regarding energy control preferences and concerns between store managers in Denmark and the Philippines, but no significant difference regarding employees' and customers' engagement. The results are published in a paper (Ma et al. 2018)

To gather the insights for the supermarket model explained under WP3 an anthropological study was completed. The aim of the anthropological study was to develop descriptions and representations of work processes which could be used to 1) inform the design of the simulation model, 2) explore how work practices impact the store's energy consumption, and 3) identify opportunities and challenges for energy flexibility considering the work processes in the store. Questions guiding the design and planning of the study included: What does a week in the store look like? What happens in the store during each day of the week? What does the work of managers and employees involve and how is the work organized and carried out?

Our approach in this study of the retail store was inspired by ethnography (or ethnographic fieldwork) and, in particular the way ethnography (or ethnographic fieldwork) has been developed and applied to understand users and use contexts in the fields of Human-Computer interaction and design. Our research activities involved onsite interviews with the store managers and monitoring employees work, following them around the store as they went through their daily routines, observing their activities and having informal conversations with them about their work and tasks.

Observations of work focused on daily routines and activities such as reception and unpacking of goods (deliveries) and bringing the received goods to the shelves in the shop, production of food and ready-prepared dishes in the store's deli, production and sales in the store's baker shop, and the evening routines leading up to closing the shop.

Based on the conducted interviews and observations, a detailed schedule was created characterizing the deliveries of goods throughout the week. Bringing together the duty schedule and what we learned through interviews and observations, tables were developed showing the number of people at work during each day of the week and what routines and activities each group is involved in.

Some of the information collected was directly imported into the energy performance model, for example, an overview of the number of costumers and schedules in the store, while others demanded analysis and processing into new representations of the work due to its qualitative nature. The evaluation and analysis of the information was also included and imported in the energy model to characterize the work processes inside the store more accurately. The results of this study are also published at the Building Simulation 2019 conference (Jradi et al., 2019).

1.5.5 WP5 (Dissemination)

Dissemination activities have been ongoing continuously during the project to address public and business stakeholders and the scientific community as listed in the Annex. The publications to the scientific community have been introduced during the text when we reported on the different work packages. The publications have published in leading journals and conferences within smart grid systems and energy markets.

At project start, the project was publicly announced, and a webpage created as part of the Greentech center website. During the fall 2016, the project was in contact with Riis Retail concerning a possible co-operation on how a retail store design company can help prepare stores for energy flexibility. In March 2017, the project had a meeting with the Danish Chamber of Commerce to discuss a possible co-operation and how to get the message through to their members. The Danish Chamber of Commerce were very positive concerning a co-operation and they already had done a member survey on their approach to energy. Unfortunately, energy flexibility was only a minor part of the survey. In March 2016 and June 2017, the project was presented to Green Tech Center's advisory board to disseminate information on the project. In May 2017, we prepared a questionnaire survey for retail stakeholders. The purpose of the survey was to provide an insight into the retail level of energy flexibility. In November 2017, the project met with Energinet and Trefor to tell about the preliminary project results. Both organizations were, and still are, very interested in the project results, in terms of how to handle energy flexibility with their consumers. In April 2017, Green Tech Center published an article about FlexReStore on their website. The article led to interviews with Mikkel Baun Kjærgaard. In September 2017, AURA made an article "Hvordan udnytter detailhandlen grøn energi optimalt" that they published on AURAs homepage and LinkedIn. During the fall of 2017, the project initiated the work of preparing three leaflets on FlexReStore (they were revised in four steps) – one for retail, one for technology suppliers and one for decision makers. In January 2019, they were distributed to The Danish Chamber of Commerce, the employers' association Tekniq and Danish Energy.

1.6 Utilization of project results

The project consortium plan to utilize the project results in several directions.

SDU plan to utilize the technical results in new research and development activities. The developed tools enable new possibilities for improving the software stack in buildings. This will influence new projects at the Center for Energy Informatics. AURA and SDU are applying for a new project which includes the retail area and builds on the project outcomes together with new partners to realize market-ready offerings. The software will also influence the teaching activities in the Software Engineering program at SDU both for specific courses related to the topic and master thesis projects.

The Green Tech center plans to continue using the project results as part of promoting the green agenda in general. Whenever there is an opportunity, they will disseminate the leaflets. The Green Tech Center is a part of Dandy Business Park where they have a Food Innovation House with a demonstration supermarket where we will spread the word to retailers and suppliers of equipment to the retail sector. Further, Green Tech Center is often in contact with suppliers of technology whom they will inform of the importance of making technologies flexible. They will also host an Innovation Festival at the Green Tech Center on the August 28, 2019. The event will include a presentation of FlexReStore and its results. The Green Tech center expect 300 – 500 participants.

AURA plans to disseminate the project results to other energy companies using the EnergiViden center, which is a Danish network for energy consultants. The center's purpose is to promote educational activities to provide an effective and professional counseling with the purpose to realize energy savings. EnergiViden Center hosts 3-4 thematic meetings a year where the FlexReStore outcomes will be featured at the meeting on November 5, 2019.

Regarding energy policies the Danish parliament succeeded in 2012 in obtaining broad political commitment to an ambitious green transition that focuses on promoting sustainable energy in all sectors of society. The agreement requires substantial expansion of renewable energy. Wind power, which accounts for approximately 30% of our electricity consumption today, is expected to cover 50% by 2020. In essence the ambitious political goals emphasize the need for increased energy efficiency across all sectors coupled with a complete transition of the energy system to integrate fluctuating energy sources. The Energy Agreement focuses on smart grid technology as a mean to face these challenges and this project is one of many steps towards a green transition of the energy system in Denmark. Towards these goals the project has provided knowledge and methods to address the adoption of smart grid technologies in the retail sector.

1.7 Project conclusion and perspective

The main purpose of the FlexReStore project was to pave the way for the retail sector to provide flexible electricity consumption. The conclusions for the project objectives are as follows:

The project has established an energy guild of retail sector stakeholders with an outset in the project user group of major retail players in Denmark. The project has collected relevant energy datasets and developed methods to analyse the data which has supported store energy screening activities.

The project has worked on evolving retail store designs to include options for flexible consumption. The project has developed a tool to energy screen stores for flexibility options. The tool has been used on stores operated by the members of the energy guild. The results document that the stores are relevant to consider in an energy flexibility perspective but also highlight a number of technical and organisational challenges. The challenges and opportunities were unfolded with store stakeholders in a number of workshops. Building on the workshops a set of recommendations were distilled for how store owners, technical providers and decision makers can advance the smart grid readiness and participation of the retail sector. The recommendations have been published in booklets targeting the three groups.

An ICT-based solution to support the operation of retail store flexibility has been developed. The solution addresses cost problems when adopting technologies for operating flexibility. The solution has been developed and demonstrated with several test cases including a model of a real supermarket.

The project has studied retail stakeholders' reaction to observable effects of flexible consumption and their energy relevant behavior in general. These aspects have been studied to establish knowledge to inform store designs with flexibility options and gather design requirements for new solutions. The work has built on both desk research, surveys and ethnographic work.

The project results will be utilized by the project participants in new activities and have been disseminated both to relevant national stakeholders and the scientific community. In particular to use the established knowledge in terms of new energy management practices for energy flexibility and to further develop the ICT solutions towards market adoption in new project activities.

Annex

Publications for specific stakeholders and the general public:

- Sådan får supermarkeder fleksibelt elforbrug, Dansk Energi, 13/01/2019: https://www.danskenergi.dk/nyheder/sadan-far-supermarkeder-fleksibelt-elforbrug
- FlexReStore leaflet for decision makers (in Danish). https://www.greentechcenter.dk/projekter/flexrestore/flexrestore-folder-til-beslutningstagere
- FlexReStore leaflet for retail (in Danish). https://www.greentechcenter.dk/projekter/flexrestore/flexrestore-folder-til-detail
- FlexReStore leaflet for technology suppliers (in Danish) https://www.greentechcenter.dk/projekter/flexrestore/flexrestore-folder-til-teknologileverandorer
- Supersensorer fjerner energispild i detailhandel med IoT, ElektronikFOKUS,, 30/11/2018
- Dansk sensor har øjne på køledisken, Electronic Supply, 29/11/2018
- Supersensorer viser vejen væk fra energispild i danske supermarkeder, RetailNews, 28/11/2018
- Supersensor stopper spild af ressourcer, Automatik & Process, 27/11/2018
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- Hvordan udnytter detailhandlen grøn energi optimalt, AURA, 12/11/2017: https://www.aura.dk/om-aura/nyheder/alle-nyheder/hvordan-udnytter-detailhandlen-gron-energi-optimalt/
- Guide for Screening of flexibility, Danish Technological Institute, SDU and AURA: http://www.teknologisk.dk/vaerktoej-til-screening-for-energifleksibilitet/37826
- Danskerne skal købe ind i halv-mørke, Dansk Handelsblad, 06/05/2016
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- Hviid, J., & Kjærgaard, M. B. (2018a). Activity-Tracking Service for Building Operating Systems. 2018 IEEE International Conference on Pervasive Computing and Communications Workshops. http://doi.org/10.1109/PERCOMW.2018.8480362
- Hviid, J., & Kjærgaard, M. B. (2018b). The Retail Store as a Smart Grid Ready Building. Proceeding of the 2018 IEEE Power Energy Society Innovative Smart Grid Technologies Conference (ISGT), 1–5. http://doi.org/10.1109/ISGT.2018.8403354
- Hviid, J., & Kjærgaard, M. B. (2018c). Service Abstraction Layer for Building Operating Systems. Proceedings of the 2018 IEEE International Conference on Communications, Control, and Computing Technologies for Smart Grids (IEEE SmartGridComm'18). http://doi.org/10.1109/SmartGridComm.2018.8587543
- Mehanovic, A., Rømer, E. S., Hviid, J., & Kjærgaard, M. B. (2016). Clustering and Visualisation of Electricity Data to identify Demand Response Opportunities. Proceedings of the 3rd ACM International Conference on Systems for Energy-Efficient Built Environments. http://doi.org/10.1145/2993422.2996403
- Henrik Lange, Aslak Johansen, Mikkel Baun Kjærgaard: Evaluation of the opportunities and limitations of using IFC models as source of building metadata. BuildSys@SenSys 2018: 21-24
- Energy flexibility in retail buildings: From a business ecosystem perspective, Z, JD Billanes, MB Kjærgaard, 2017 14th International Conference on the European Energy Market (EEM), 1-6
- Demand Response Readiness in Retail Stores: DR Control Preferences, Stakeholder Engagement, and Cross-National Differences Z Ma, K Kuusinen, MB Kjærgaard, BN Jørgensen – 2018 (Preprint published)

- Jradi, Muhyiddine; Hviid, Jakob; Foldager, Henrik Engelbrecht; Jeppesen, Rasmus Camillus; Rasmussen, Mikkel Ask; Kjærgaard, Mikkel, Modeling and Performance Simulation of a Retail Store as a Smart Grid Ready Building, Building Simulation 2019. (accepted)
- Jakob Hviid, Aslak Johansen, Fisayo Caleb Sangogboye, and Mikkel Baun Kjærgaard, Enabling Auto-Configuring Building Services: The Road to Affordable Portable Applications for Smart Grid Integration, ACM e-Energy 2019 (accepted).