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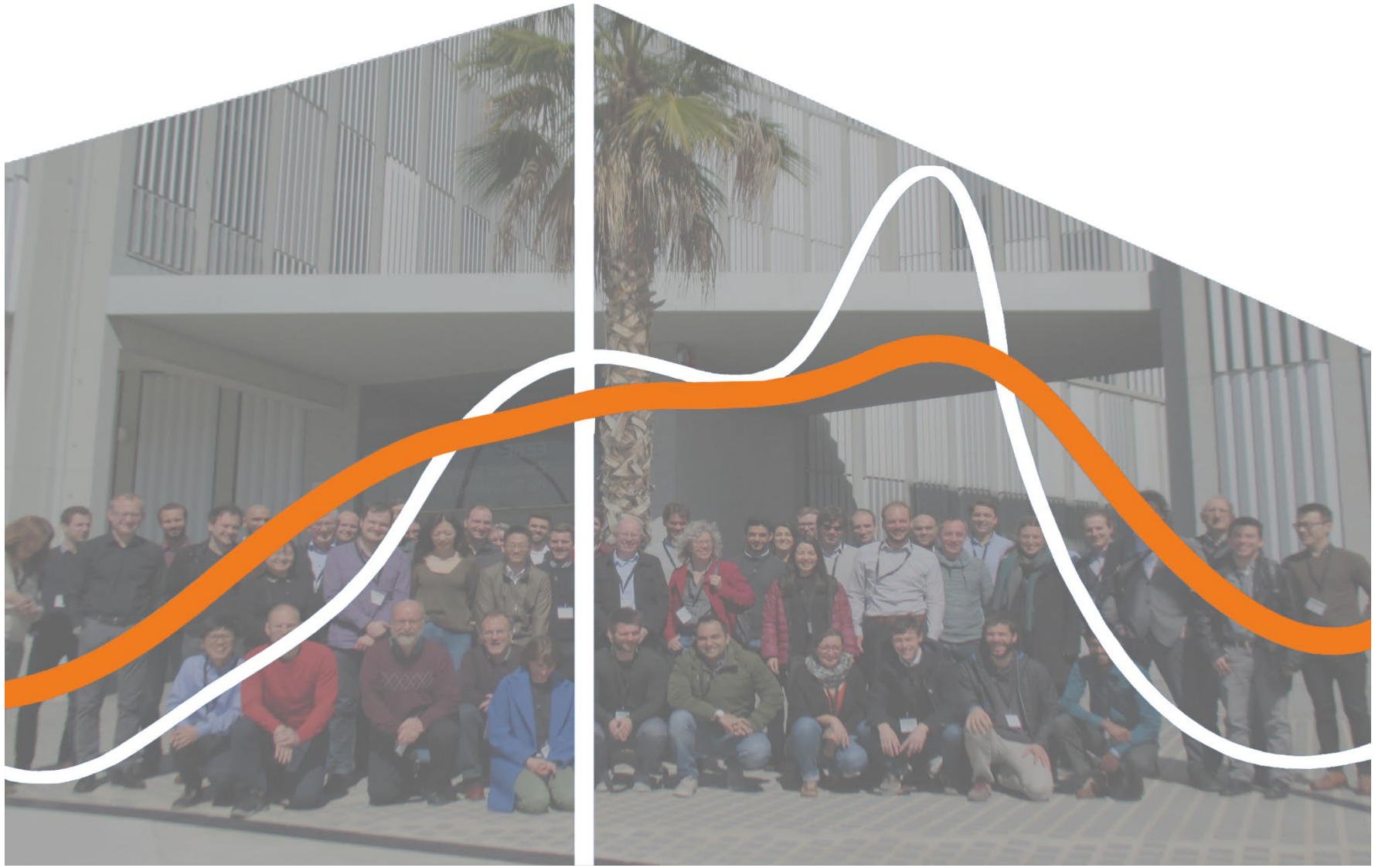
D4 Summary:

Stakeholders' perspectives on Energy Flexible Buildings



Editors:

Zheng Ma
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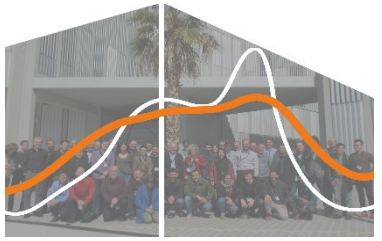

D4 – Chapter 1:

Building/Managers in Energy Flexible Buildings

Author: Zheng Ma

Campus Buildings: Case study DENMARK	▪ Building management system ▪ Energy consumption ▪ Energy purchasing strategy	**The main barriers for buildings to provide energy flexibility are:** **1) many buildings are too old and need to be refurbished,** **2) the benefit of providing energy flexibility to the grid is not sufficient,** **3) building management systems need to be either installed or upgraded to response to the demand from the grid.**
Retail Buildings: Questionnaire DENMARK PHILLIPINES	▪ Energy control ▪ Energy technology adoption ▪ Employees' participation in an energy program ▪ Customers' concern	▪ **Retail stores are much readier to participate in the implicit demand response by manual energy control compared to the utility control or building automation.** ▪ **Retail stores believe that stakeholders should be informed about the DR activities but not involved in these activities.** ▪ There are significant differences regarding the energy control preferences and concerns between retail stores in Denmark and the Philippines, but no significant difference regarding the stakeholder engagement.

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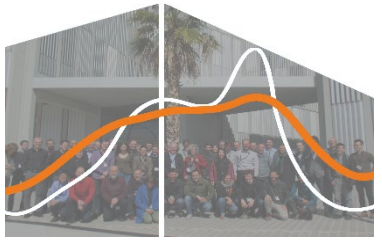

D4 – Chapter 2:

Occupants in Energy Flexibility in Buildings

Authors: Ronling Li / Roberta Pernetti, Ilaria Vigna / Zheng Ma

Campus Buildings: Questionnaire DENMARK	▪ Occupants' awareness ▪ Occupants' satisfaction with the energy performance in buildings ▪ Occupants' acceptance of energy flexible buildings	▪ Occupants cannot tolerate frequent changes of indoor comfort. ▪ Occupants think that only the indoor comfort of hallway and canteen can be adjusted frequently ▪ **However, occupants believe that university plans for green image and energy saving can improve occupants' acceptance of frequent changes of indoor comfort**
Office Buildings: Questionnaire ITALY	▪ Perception of renewable energy usage ▪ Perception and attitude towards smart grid, smart appliances, and smart meters ▪ Willingness to use smart appliances in offices ▪ Motivation to accept a flexible energy usage	▪ The use of renewable energy instead of fossil fuels to fuel HVAC systems in office buildings is recognized as a very important action; ▪ The smart grid concept is unfamiliar to almost half of the respondents; ▪ **The most suitable smart appliances accepted to be remotely controlled are the air conditioning and the heating system** ▪ **The main motivating factors to accept a flexible energy usage are the possibility to see how much the electricity usage is minimized and the amount of saved money**
Residential Buildings: Questionnaire NETHERLANDS	▪ Willingness of occupants to use smart technologies and change behaviour ▪ how well building users are prepared to contribute to the energy flexibility of their buildings	▪ Awareness of smart grids is the highest among respondents aged 20–29 years ▪ **Willingness to use smart technologies and change energy behaviour are interdependent** ▪ Potential flexible building users were found to be 11% of the respondents

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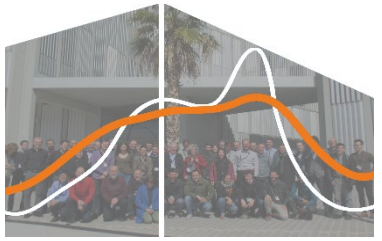

D4 – Chapter 3:

Energy suppliers in Energy Flexible Buildings

Authors: Tao Ma / Armin Knotzer / Steffen Petersen, Rasmus Elbæk Hedegaard / Anna Marszal-Pomianowska

District heating suppliers: Interviews, literature review & data analysis DENMARK	▪ Challenges in district heating operation ▪ Opportunities for DR initiatives	▪ **Energy flexible buildings compete with the less complex solution of centralized storage tanks.** ▪ There is currently no straightforward way of determining the economic incentive that could be provided to consumers.
District heating suppliers: Questionnaire AUSTRIA	▪ Smart operation of district heating grids ▪ Economic perspectives/ business and tariff models ▪ Drivers and barriers of using energy flexibility	▪ **District heating suppliers acknowledge the importance of energy flexibility, allowing for shifting heating peaks or for decentralized storage of heat from the grid, and of the control optimization for using the flexibility** ▪ There seems to be a relevant market for intelligent district heating concepts ▪ Renewable energy use for district heating grids is of high importance
Grid management & RES: Residential: Questionnaire DENMARK	▪ Know the customers ▪ Customers motivations to be energy flexible ▪ Which control options will they allow? ▪ Find how many customers are flexible now	▪ **Economic incentives are what motivates customers most.** ▪ **The customers prefer automatic control or grid remote control when they know that it increases their savings.** ▪ 11 % of the customers in Denmark were estimated to be potential flexible building users in 2017
Grid management & RES: Residential: Case study/model DENMARK	▪ Create 1-min resolution load prediction data for domestic appliances for investigation of flexibility potential and grid simulation.	▪ There is a 7.7% difference between the model and the experiments, which is seen as acceptable. ▪ **The model captures the characteristics of domestic electricity load profiles on a daily, as well as seasonal, basis.** ▪ **The model under-predicts the need for lighting.**

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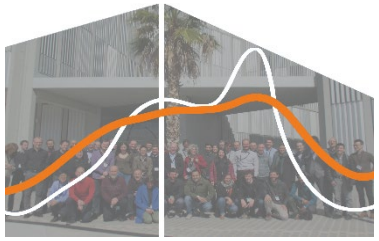

D4 – Chapter 4:

Aggregators for Energy Flexible Buildings

Author: Mette Jessen Schultz

Aggregators' activities and opinions: Case study

DENMARK & AUSTRIA

- Aggregators
- Aggregator models
- Business opportunities

- Market stakeholders as TSOs and BR's believe that aggregators will play a major role in the utilization of building flexibility and DR
- The role of aggregators can be undertaken by suppliers, BRP's and third party.
- The aggregation potential can be in industry, buildings, and smaller units with a battery or storage facility as electric vehicles and heat pumps.
- **The main influential factors for aggregators to enter the building flexibility are:**

1) **A clear definition and standardization of the aggregators' role in the market structure,**
2) **The technological development of DR equipment,**
3) **Energy price reflects the market price and distribution conditions.**

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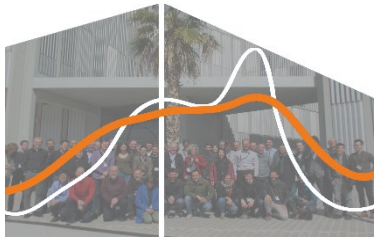

D4 – Chapter 5:

Technology Providers for Energy Flexible Buildings

Authors: Theis Heidmann Pedersen, Steffen Petersen, Rasmus Elbæk Hedegaard

Technology providers, objectives and challenges: Residential & Commercial: Experimental study

DENMARK

- A prototype implementation of MPC schemes that enable flexible consumption

- **The results indicate that technology providers already have the hardware needed for MPC.**
- **More efforts should be put into the development of robust and reliable MPC algorithms.**
- **Cost-efficient building automation hardware for non-commercial buildings (homes) should be developed.**

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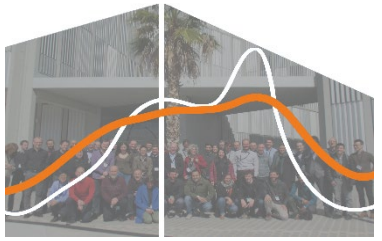

D4 – Chapter 6:

Energy consulting and analytics in energy flexible buildings

Author: Mette Jessen Schultz

Energy consultants' opinions : Interviews DENMARK	▪ Regulation and policies ▪ Tariffs and taxes ▪ Market condition and microgrids ▪ Stakeholders' collaboration	▪ **The complexity of the energy system regulation makes the energy system very difficult to be more flexible.** ▪ The requirement for providing energy flexibility to the grid is high and complicated. ▪ One large barrier to energy flexibility is the tariffs and taxes associated with power production. ▪ **Smart meters with two-way communication and hourly electricity pricing must be implemented to create an incitement for energy flexible buildings.**
Roles of energy analytics: Interviews DENMARK & AUSTRIA	▪ Regulation and policies ▪ Tariffs and taxes ▪ Market conditions and aggregators ▪ Stakeholders' collaboration	▪ **The implementation of flex settlement needs to be a reality for all, also consumers with a supply unit like photovoltaics (PV), to promote energy flexibility in buildings.** ▪ The access to data from the consumers is complicated. ▪ Greater fluctuation of the electricity spot price will create an incentive to move consumption and save money. ▪ **The electricity price should reflect the grid and market condition instead of a price with fixed tariffs and taxes.**

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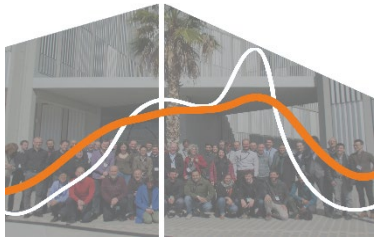

D4 – Chapter 7:

The National Regulatory Authority

Author: Mette Jessen Schultz

The National Regulatory Authority: Interviews

DENMARK & AUSTRIA

- Opportunities
- Tariffs
- Market condition
- The potential for energy flexibility

- Consider the energy sources used in the grid to analyses the potential and need for energy flexibility.
- Even when it is possible to control the energy sources and the need for energy flexibility is small, it still will create more competition in the market – which is good.
- **Blockchain can be used for energy flexibility instead of aggregators.**
- **The rollout of smart meters can make real-time pricing possible.**
- **Different tariffs due to the time of use create prices reflecting the grid condition and create an incentive to move consumption.**
- Easy access for smaller loads to be used as ancillary services is necessary.
- Private customers need a service provider to control and perform energy flexibility for them. It needs to be easy.

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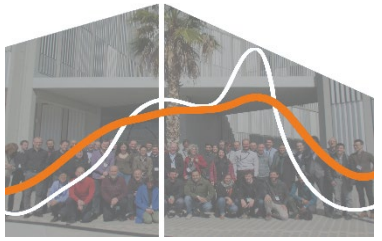

D4 – Chapter 8:

Industrial consumers in Energy Flexible Buildings

Author: Jonas Korsgaard

Building-to-Grid participation: Interview DENMARK	▪ Regulation and policies ▪ Market conditions ▪ Energy prices ▪ Smart grid solutions	▪ **Subsidies are cancelled by the end of 2018, making energy flexibility more attractive.** ▪ Self-producing in heat and some electricity, making them sensitive to changing electricity prices if flexibility cannot be achieved. ▪ Not familiar to smart grid solutions, but positive towards net-based services if profit is maintained.
Acceptance of smart solutions: Interview DENMARK	▪ Energy transformation ▪ Shared support interaction ▪ Energy flexibility ▪ Smart grid solutions	▪ Electricity prices may vary in the future, making it crucial to have access to Nord Pool spot prices. ▪ Heat from the cooling process is utilized to cover own heat consumption. ▪ Do not proactively seek involvement in smart grid activities. ▪ **The desire to brand the company as "green". It impacts the inscription stage but interconnects customer focus.**

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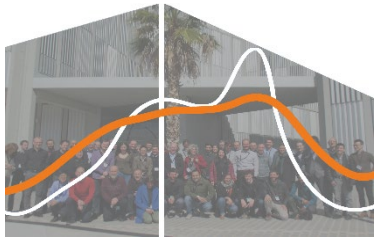

D4 – Chapter 9:

Recommendations

Authors: Zheng Ma, Jim Parker, Erwin Mlecnik

Demand Response / Virtual Power Plants	1. Building owners participate in the implicit DR program via retailers **2. Building owners (small energy consumers) participate in the explicit DR via aggregators** 3. Building owners (large energy consumers) directly access the explicit DR program 4. Building owners access the energy market via VPP aggregators by providing DERs	1. Retailers / All buildings **2. Independent aggregator / Buildings with small energy consumption** 3. Buildings with large energy consumption 4. VPP aggregators / DER owners (buildings are equipped with DER)
Policy makers	▪ **Identify specific financial incentives (sticks and carrots)** ▪ **Provide an easy solution for upfront investment (for example loan or mortgage)** ▪ **Lower cost of solutions and equipment, for example by standardising and determining larger quantities for application**	▪ Develop clear monetary benefits and incentives ▪ Encourage incentives from regulators, TSOs/ DSOs ▪ Strengthen ROI perspectives, for example by communicating a clear time path for deployment of energy flexibility ▪ **Financially support the (collaboration for developing) equipment control system (e.g. loans, renting, innovation funding) during an innovation phase**