



ENERGY FLEXIBILITY IN BUILDINGS

A main driver in the future energy systems

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FUTURE ENERGY GRIDS AND FLUCTUATING RENEWABLES

02

FLEXIBILITY POTENTIAL OF BUILDINGS

03

ASSESSMENT OF FLEXIBILITY

04

CHARACTERIZATION

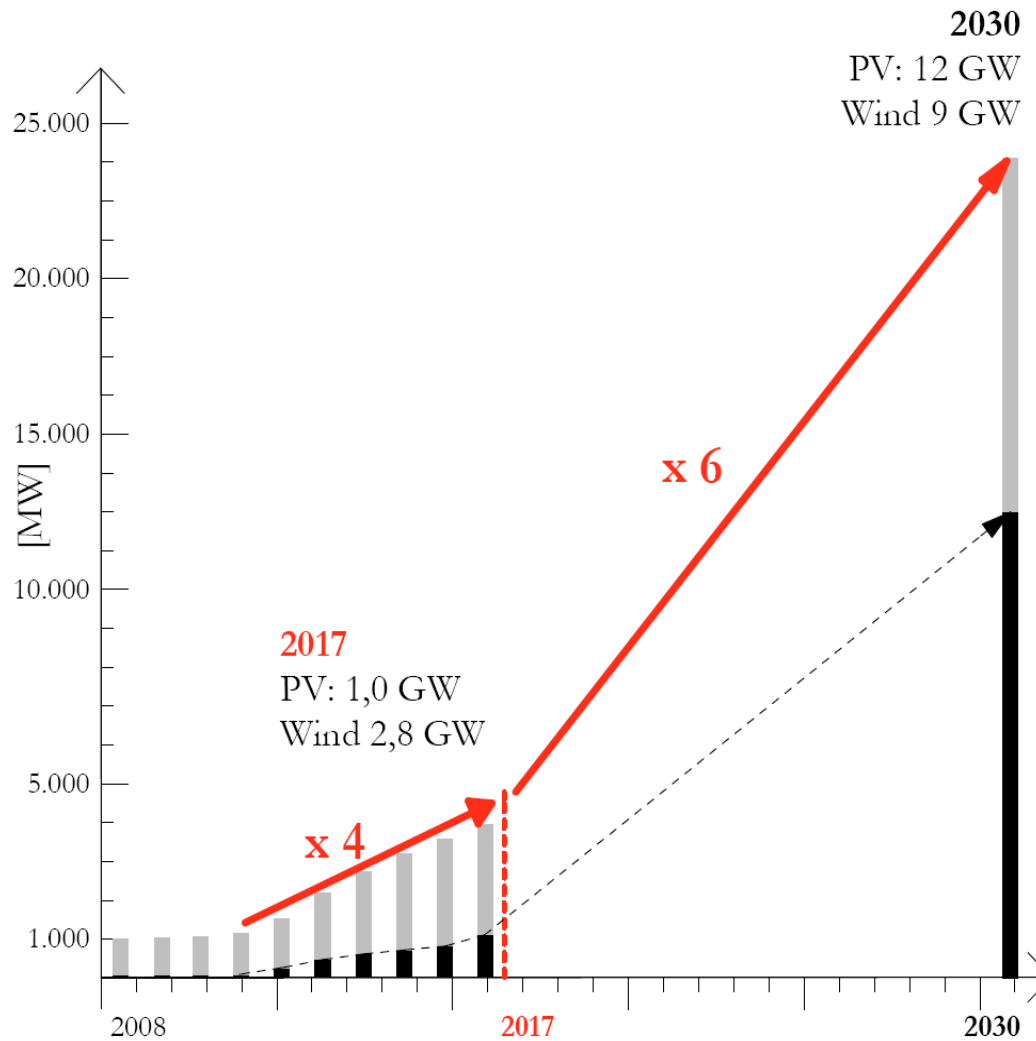
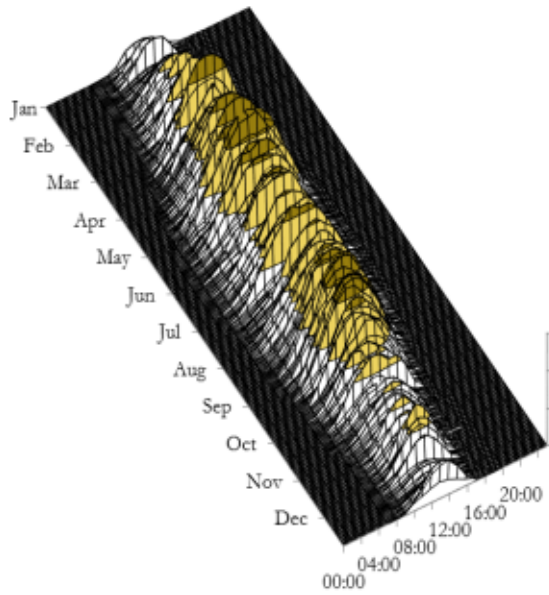


Figure : Stromzukunft Österreich 2030- Analyse der Erfordernisse und Konsequenzen eines ambitionierten Ausbaus erneuerbarer Energien (Haas, 2017)

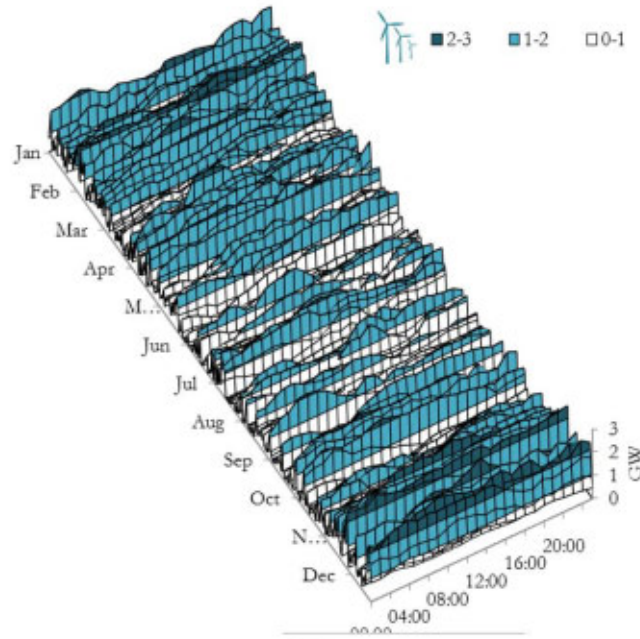
SOLAR

☀️ ■ 1-1,5 ■ 0,5-1 □ 0-0,5



WIND

🌬️ ■ 2-3 ■ 1-2 □ 0-1



CONVENTIONAL

🏭 ■ 5-6 ■ 4-5 ■ 3-4
■ 2-3 □ 1-2 □ 0-1

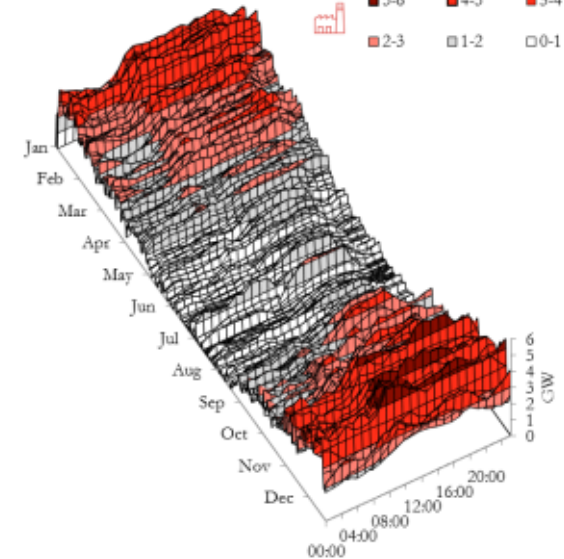
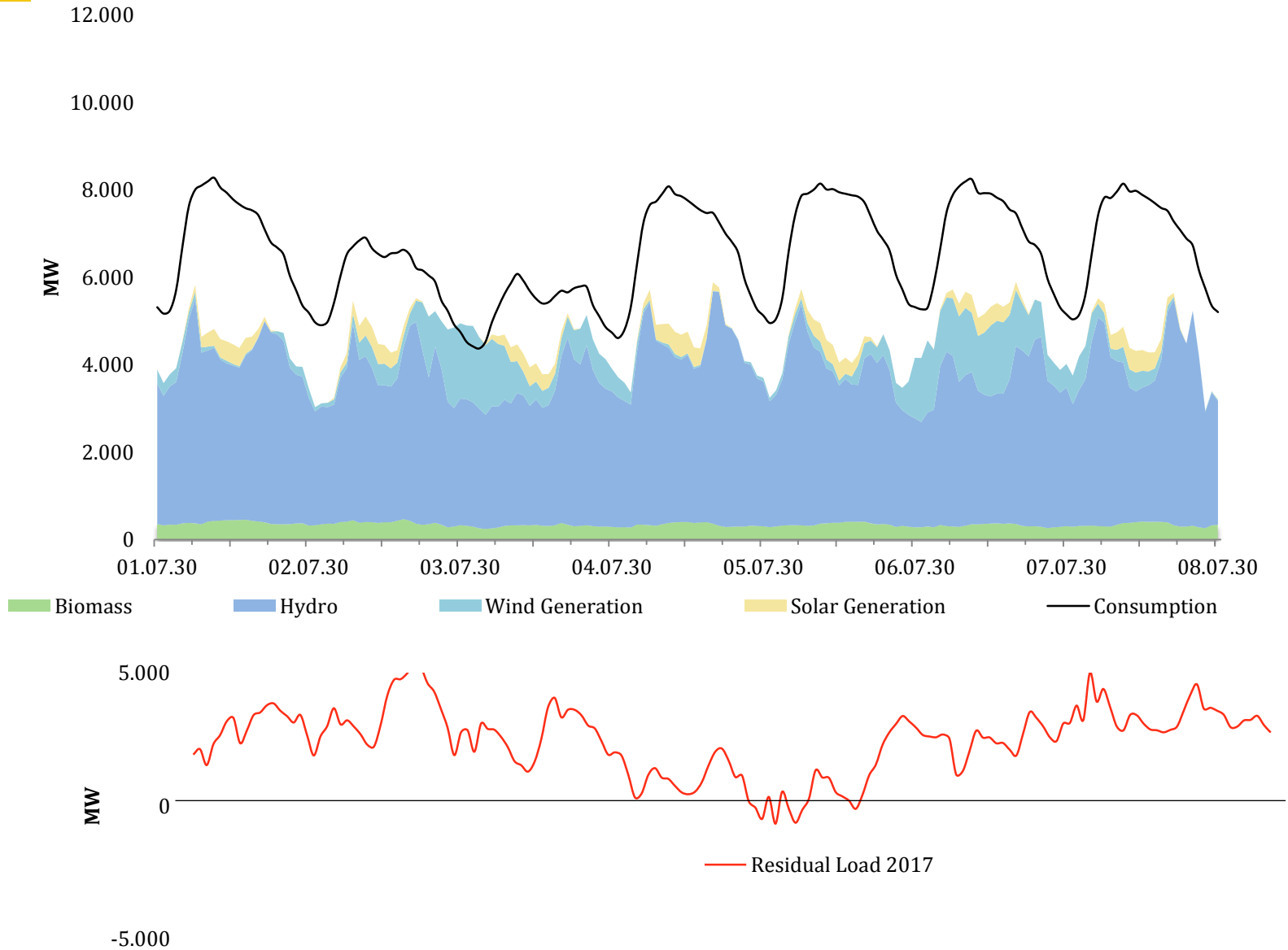


Figure: Power Consumption Breakdown – Austria 2016 - Datasource: European Network of Transmission System Operators for Electricity, Electricitymap.org – Illustrated by Tobias Weiß (AEE INTEC)

ELECTRICITY GENERATION AUSTRIA

MARCH 2017 + Renewables Wind & PV

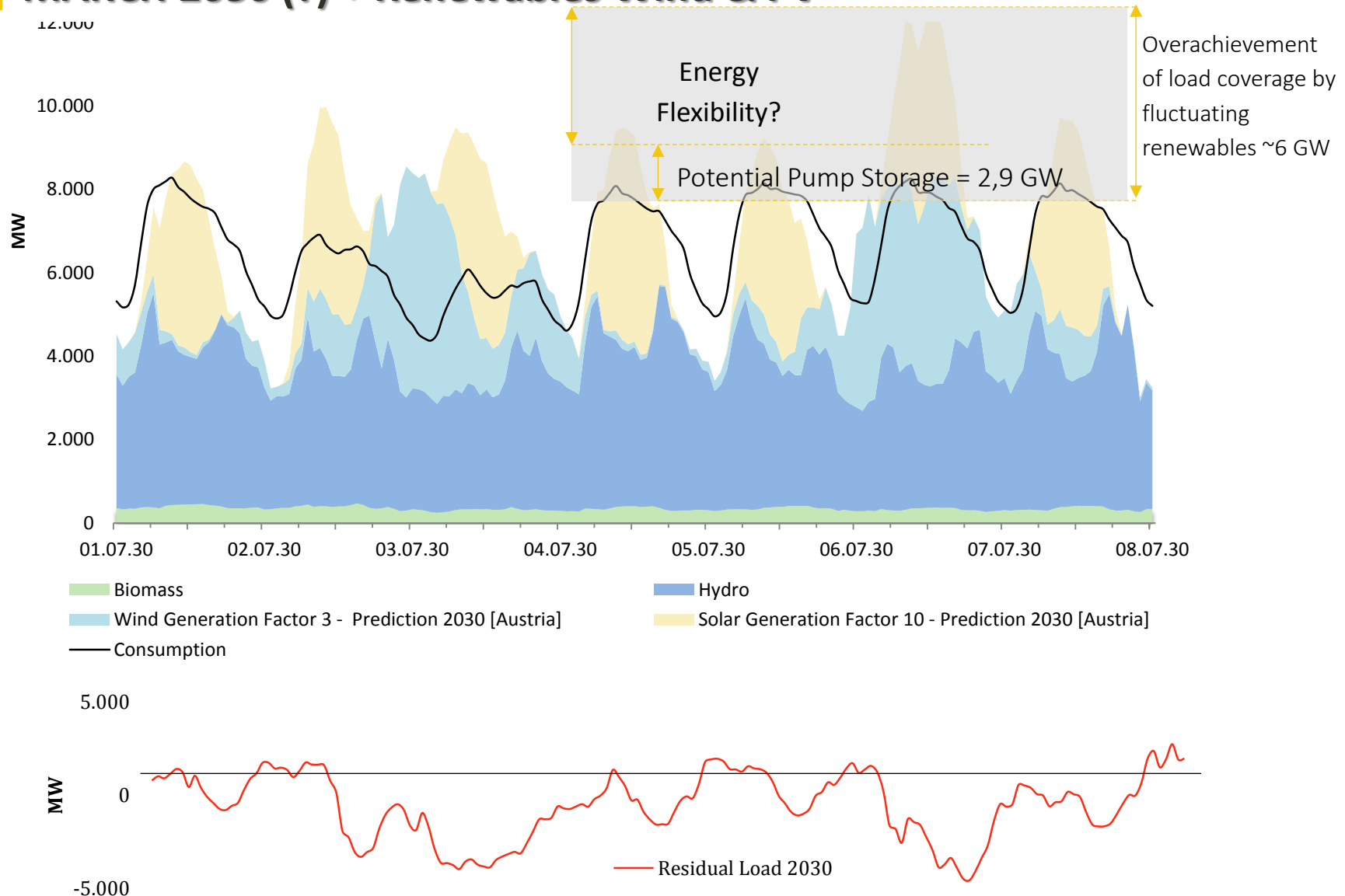
AUSTRIA JULY 2017



ELECTRICITY GENERATION AUSTRIA

MARCH 2030 (?) + Renewables Wind & PV

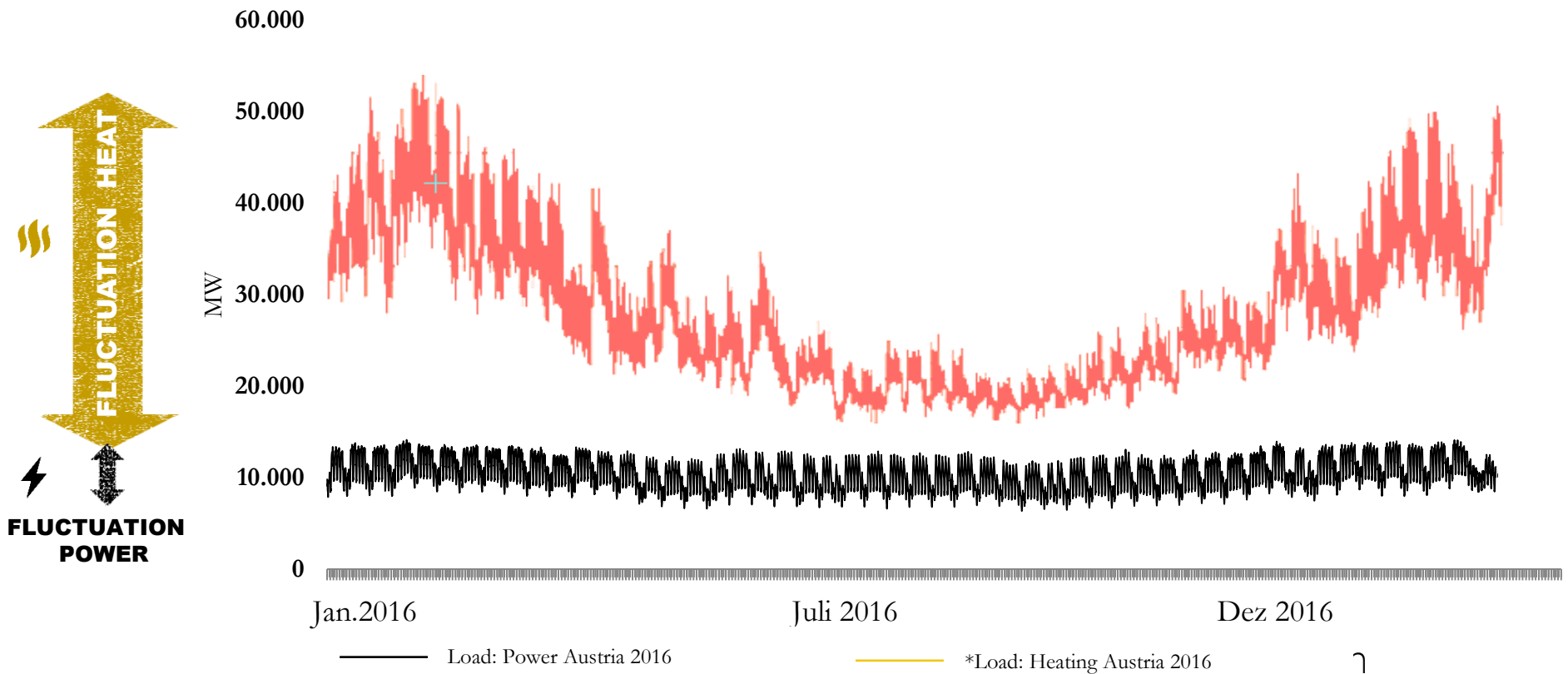
AUSTRIA JULY 2030

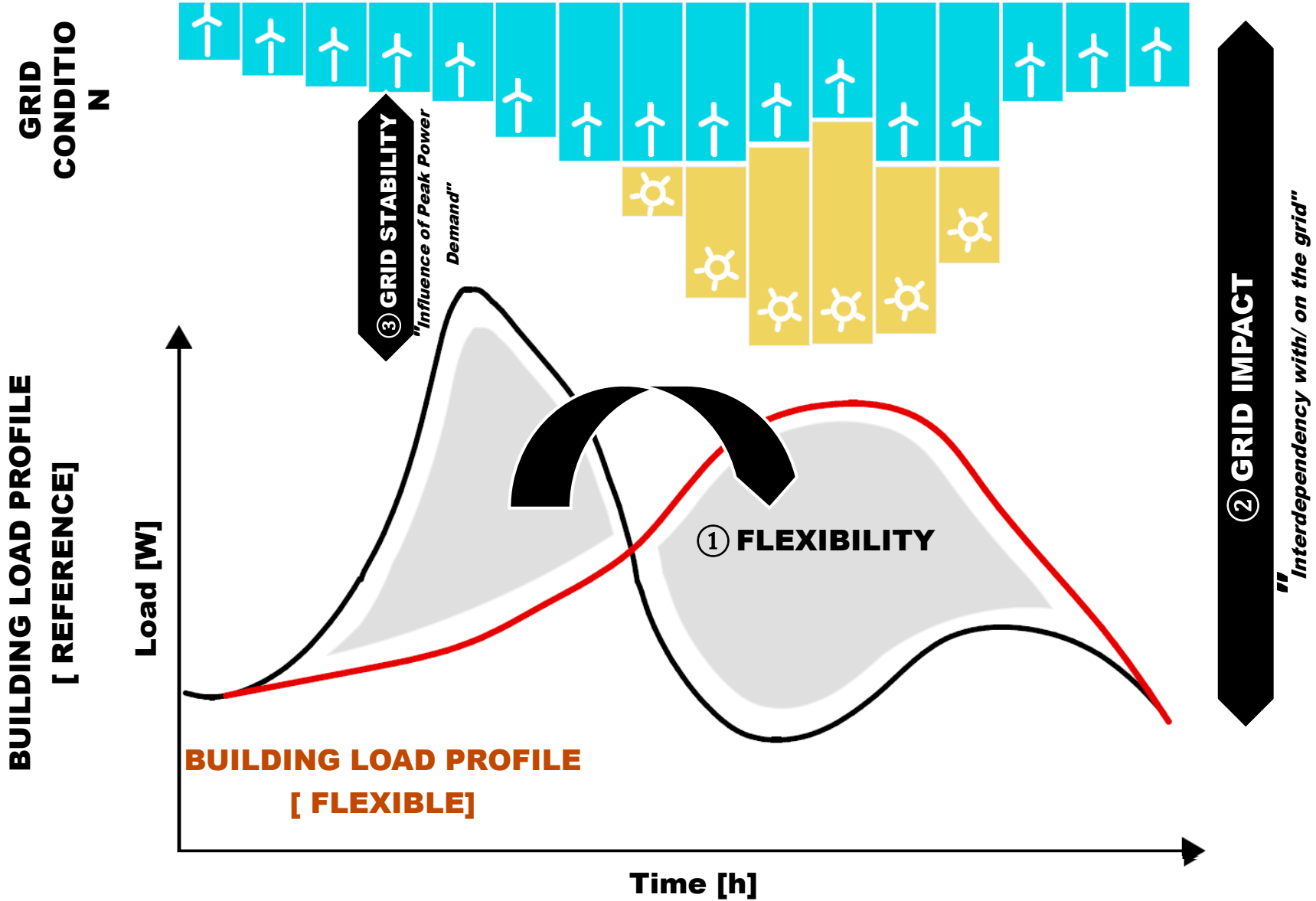


THERMAL AND POWER FLUCTUATIONS AUSTRIA 2016

**grobe Abschätzung des Lastgangs der Wärme auf Basis der Statistik Austria / ENTSO-E / BMWFV/AGGM Report 2044) (Tobias Weiß – AEE INTEC)*

Figure: Power Consumption Breakdown – Austria 2016 - Datasource: Statistik Austria / ENTSO-E / BMWFV/AGGM Report 2044 – Illustrated by Tobias Weiß (AEE INTEC)





FLEXIBLE HEATING SYSTEM OPERATION AUSTRIAN BUILDING STOCK

Source: TABULA/EPISCOPE

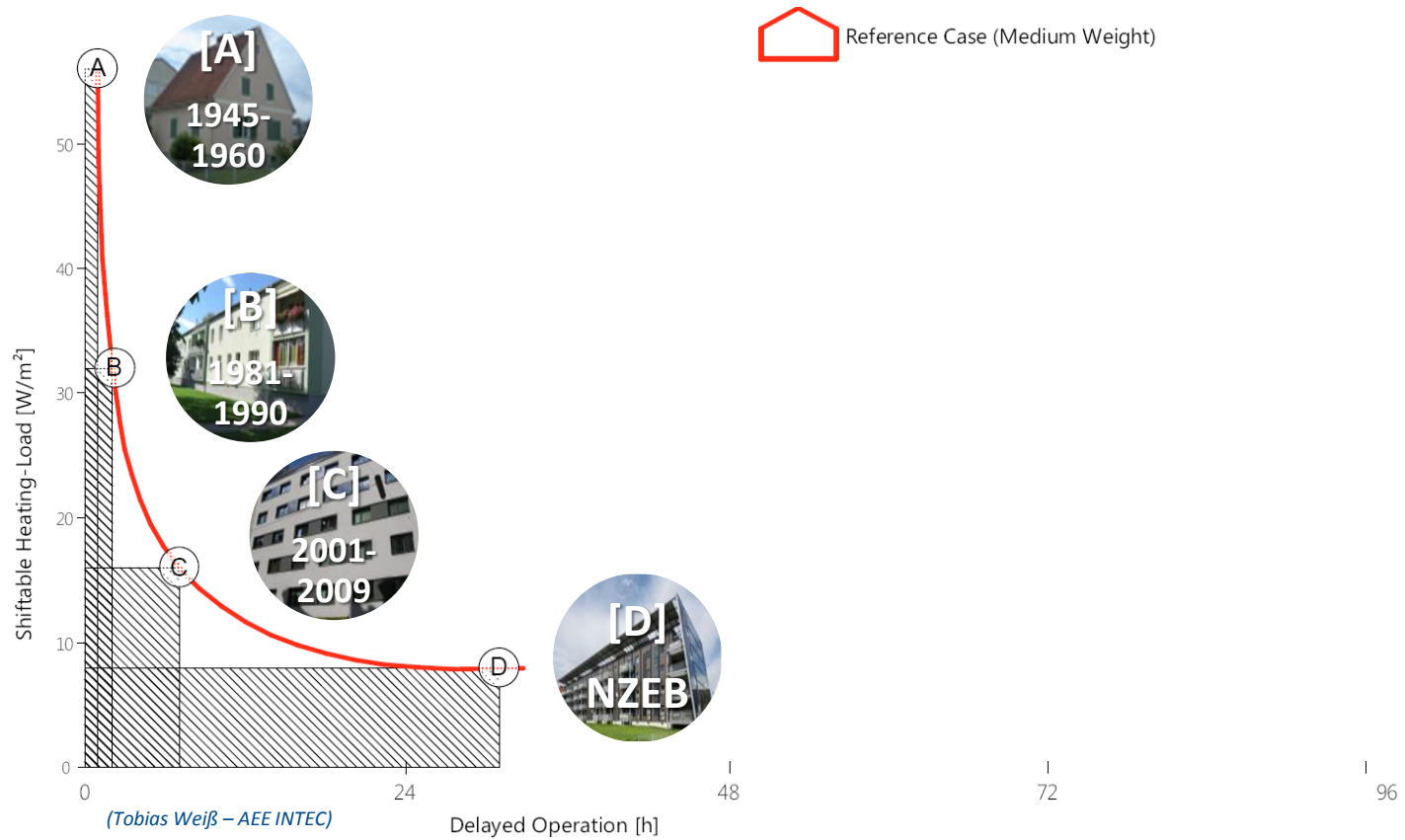
Region	Construction Year Class	Additional Classification	MUT			
			Single-family House	Terraced House	Multi-family House	Apartment block
1 national (Gesamt-Österreich)	... 1919	generic (Standard / allgemein typisch)				
	1919-1945	generic (Standard / allgemein typisch)				
	1946 ... 1960	generic (Standard / allgemein typisch)				
	1961 ... 1980	generic (Standard / allgemein typisch)				
5 national (Gesamt-Österreich)	1981 ... 1990	generic (Standard / allgemein typisch)				
	1991 ... 2000	generic (Standard / allgemein typisch)				
7 national (Gesamt-Österreich)	2001 ... 2009	generic (Standard / allgemein typisch)				
	NZEB – Passivhouse (?) > Cases ?					

Source: Tobias Weiß AEE INTEC – Industriennahe Dissertation Projekt FLEX NZEB 856025

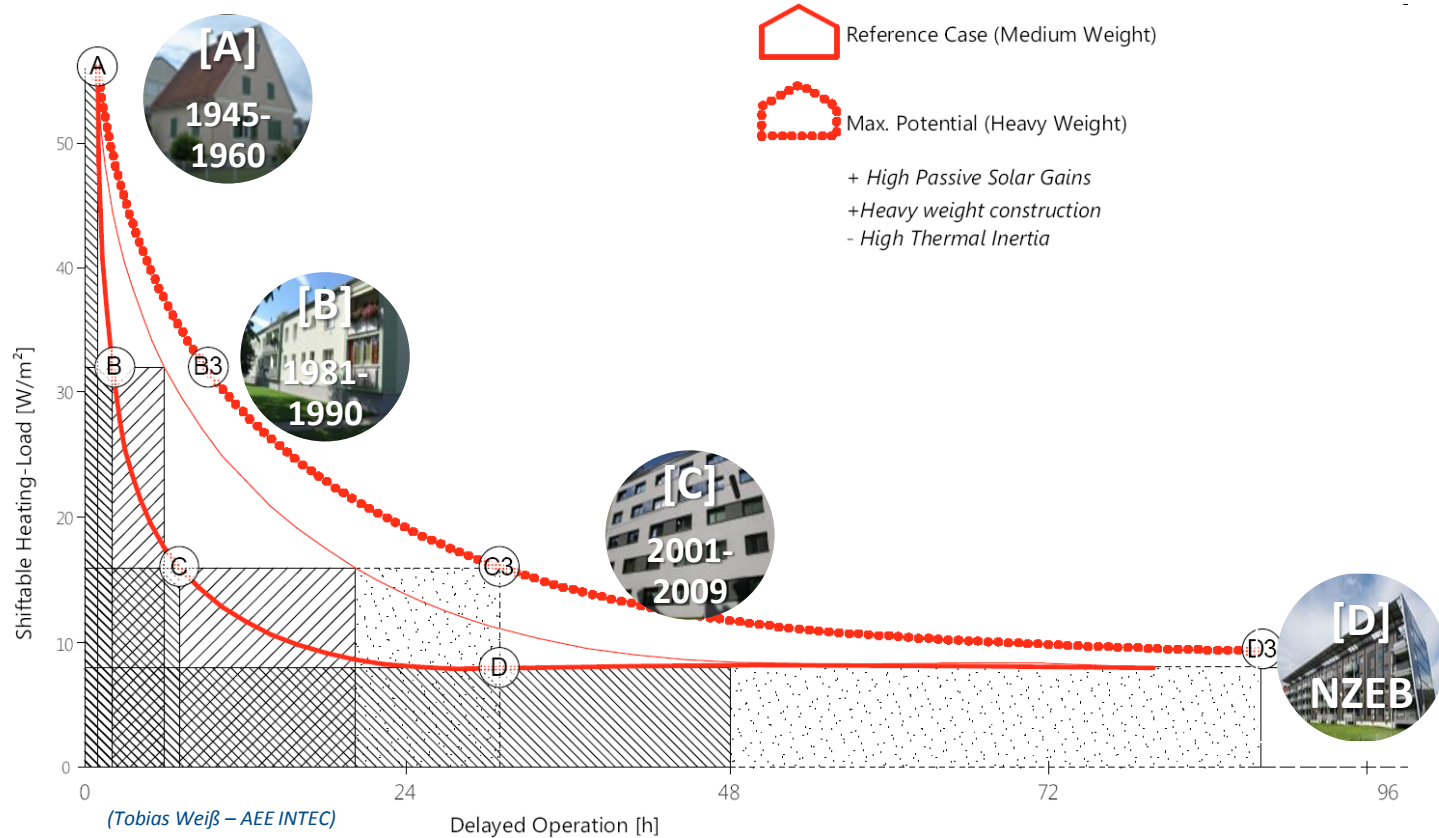
FLEXIBLE HEATING SYSTEM OPERATION AUSTRIAN BUILDING STOCK

LOAD DURATION CURVES OF CASE STUDIES

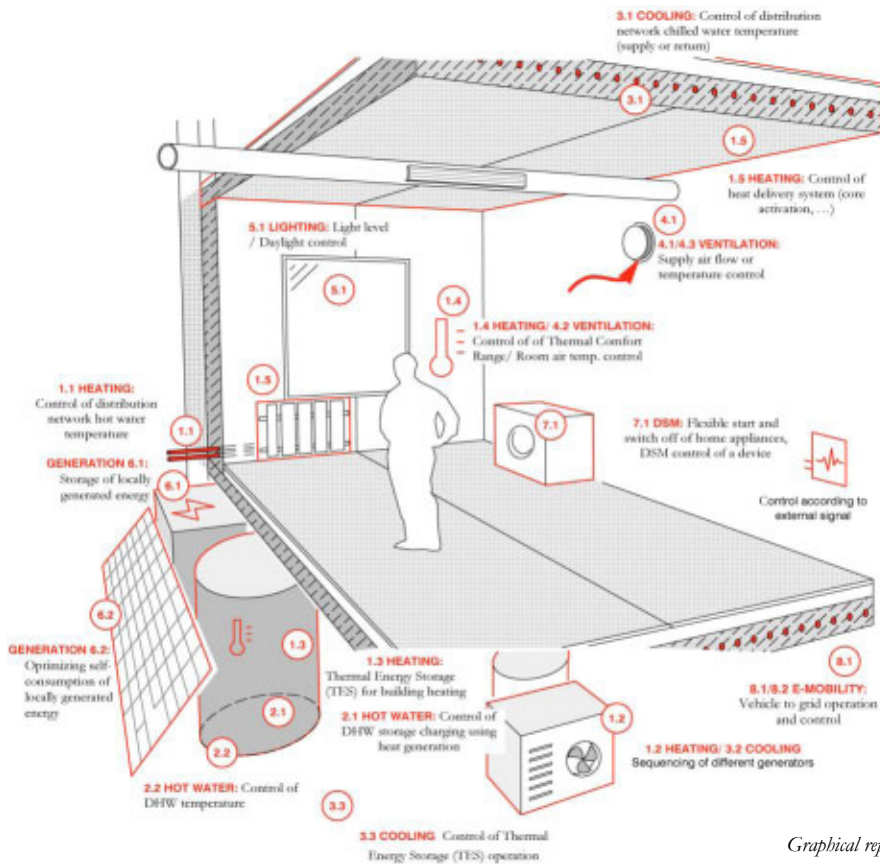
MIN. POTENTIAL OF SHIFTABLE DOMESTIC HEATING LOAD over time (Δt_1)



FLEXIBLE HEATING SYSTEM OPERATION AUSTRIAN BUILDING STOCK



Source: Tobias Weiß AEE INTEC – Industriennahe Dissertation Projekt FLEX NZEB 856025



Graphical representation of selected energy flexible components – DISSERTATION EFLEX NZEB Tobias Weiß – AEE INTEC

ENERGY FLEXIBILITY OPTIONS (BUILDING):

A) STORAGE

- Batteries
- Thermal Storage

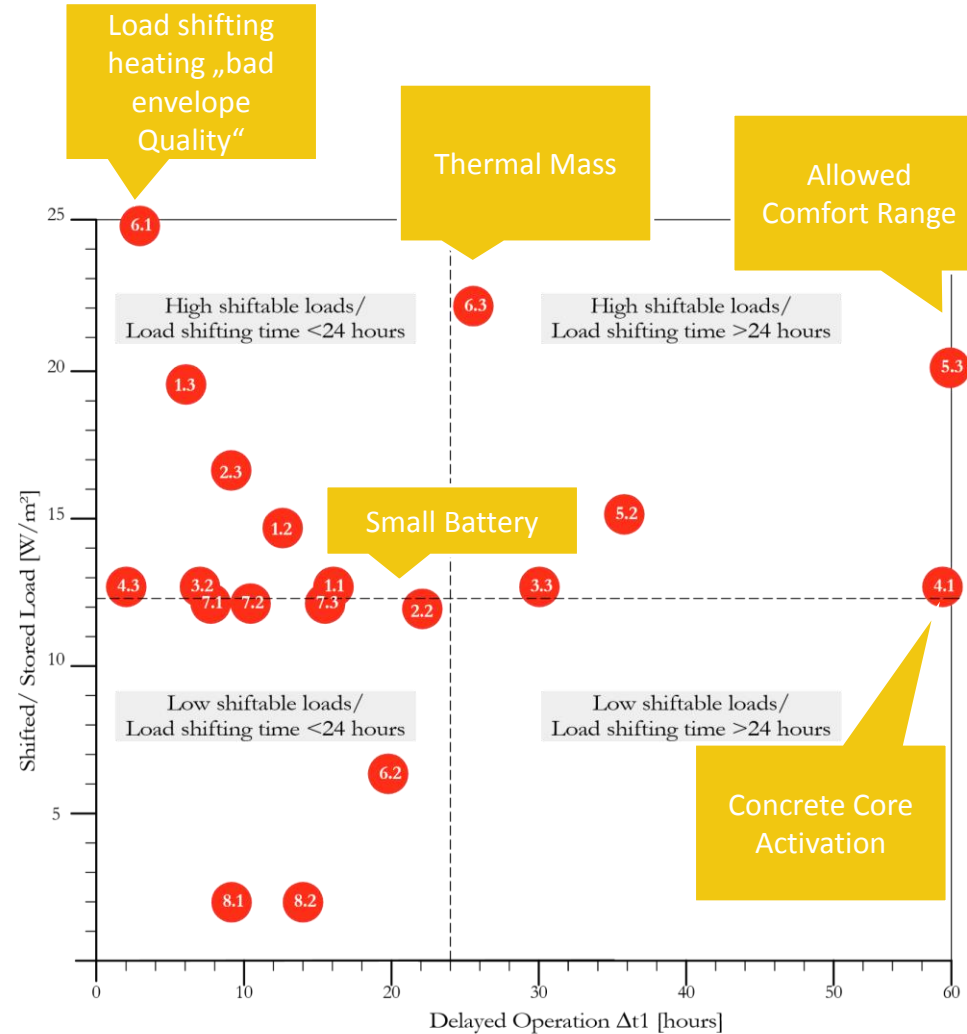
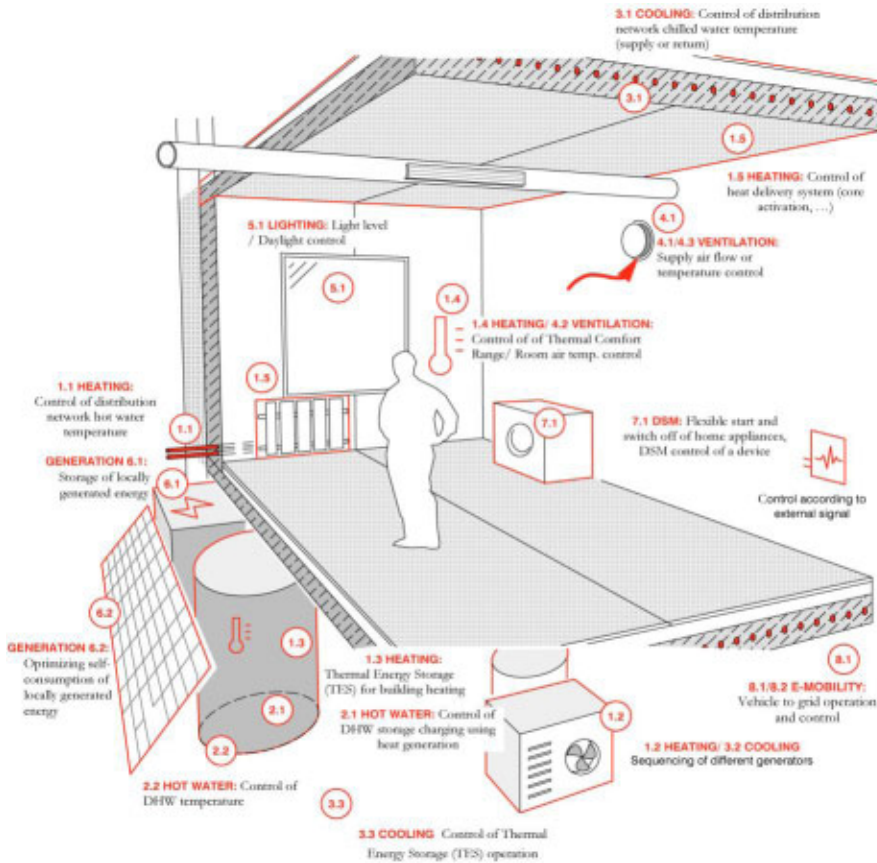
B) THERMAL LOAD MANAGEMENT

- Thermal Mass
- Core Activation
- Comfort Temperature Deviation
- HVAC Modulation Heating/ Hot Water

C) ELECTRIC LOAD MANAGEMENT

D) FUEL SWITCHING

FLEXIBILITY POTENTIALS – SINGLE TECHNOLOGIES



Source: Tobias Weiß AEE INTEC – Industriennahe Dissertation Projekt FLEX NZEB 856025



*“The introduction of a smartness indicator rating the readiness of the building to **adapt its operation to the needs of the occupant and the grid, and to improve its performance [...] measure buildings’ capacity [...] to optimise operation and interact with the grid” ****

* Source: Proposal for a DIRECTIVE OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL amending Directive 2010/31/EU on the energy performance of buildings

MOTIVATION - SMART BUILDINGS

Smart Building



Figure 1: Illustration of a smart building

Measure the technological readiness of your building



Source: Verbeke S., Waide P., Bettgenhäuser K., Usslar M., Bogaert S. et al.: Support for setting up a Smart Readiness Indicator for buildings and related impact assessment - final report executive summary. August 2018; Brussels

The total SRI score is based on the average of total scores on 8 impact-criteria
= 1 value in percent!

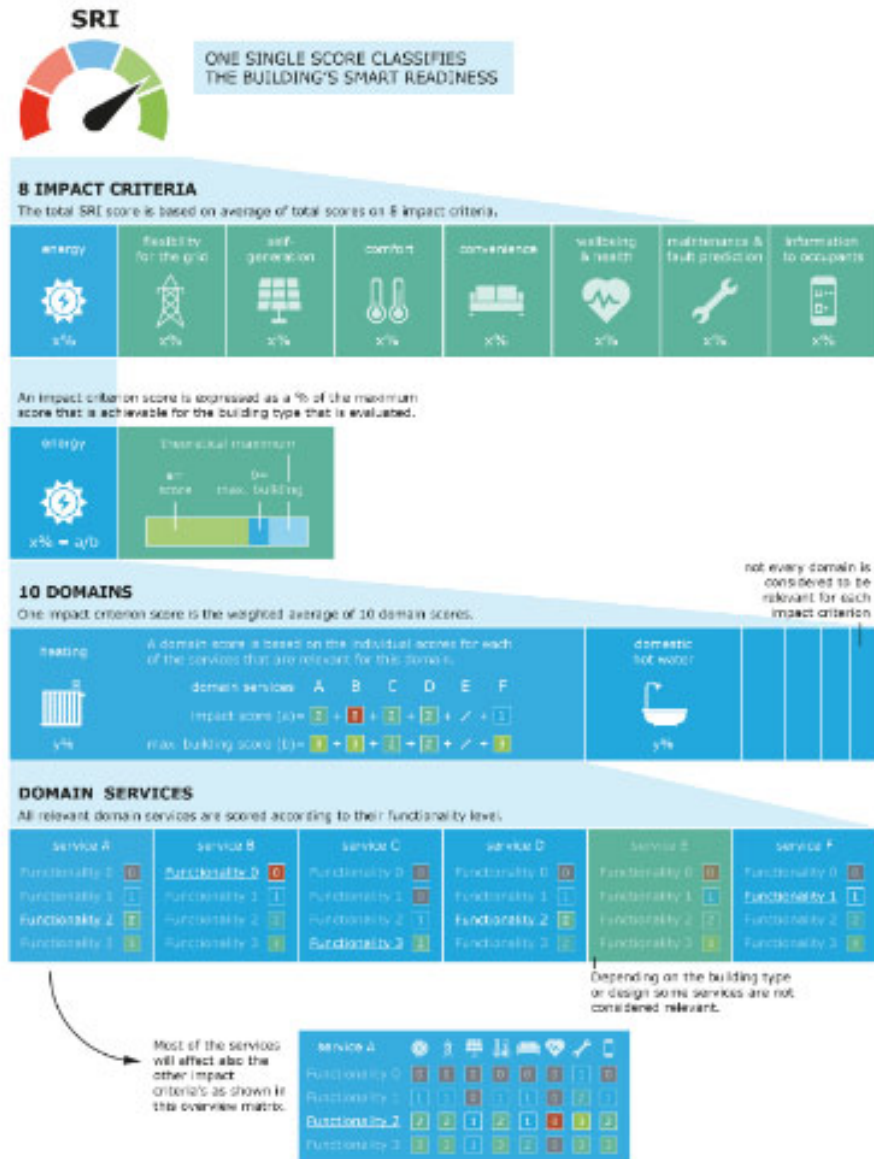


Figure 3 - Overview of the SRI methodological framework

Source: Verbeke S., Waide P., Bettgenhäuser K., Usklar M., Bogaert S. et al.: Support for setting up a Smart Readiness Indicator for buildings and related impact assessment - final report executive summary. August 2018; Brussels

Smart Readiness?

Real Data
Assessment

Technology- und
Servicerating

User-adaptive
Smartness

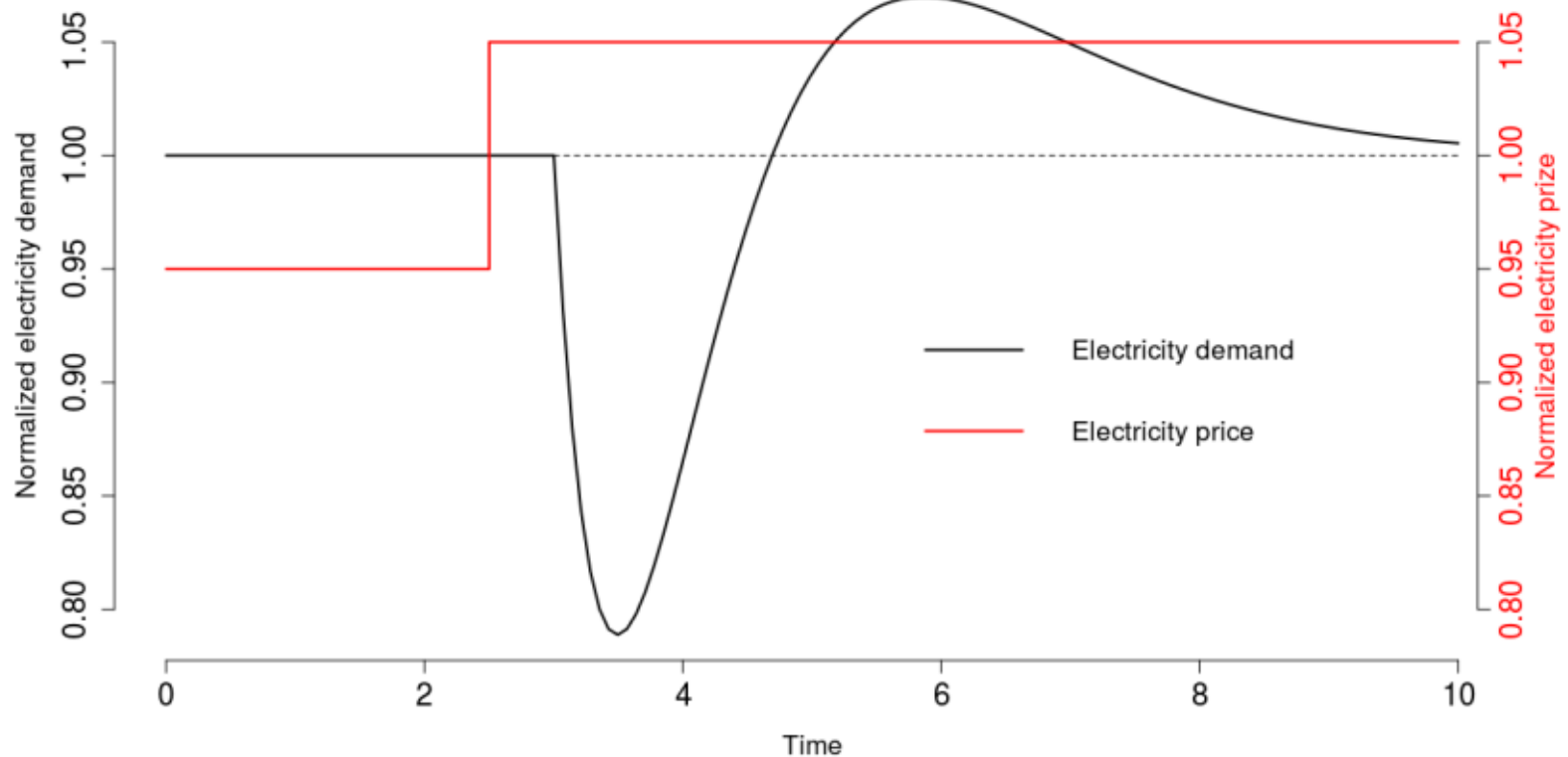
Interfaces with energy generation / grid operator / overall energy system

Peak load characteristics,
duration of the response,
(p)rebound-effects
→ Interest of CO₂- und
resource-reduction

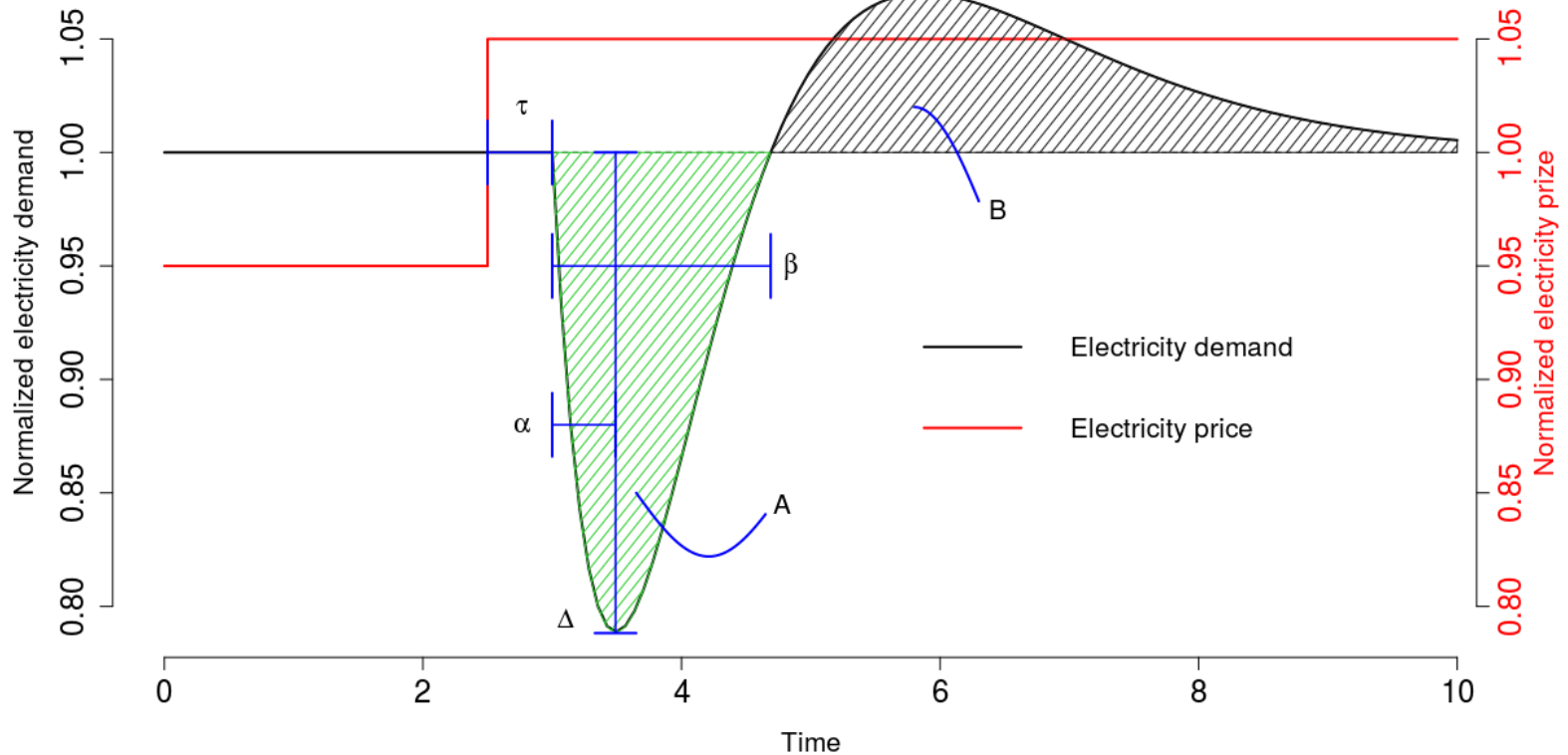
Rating of existing
technologies and service,
maybe incl. business models
→ Economic interests

Smart operating control,
user-friendly displays; data
privacy, resilient solutions
→ Interest of the user

“The Energy Flexibility of a building is the ability to manage its demand and generation according to local climate conditions, user needs and grid requirements...”

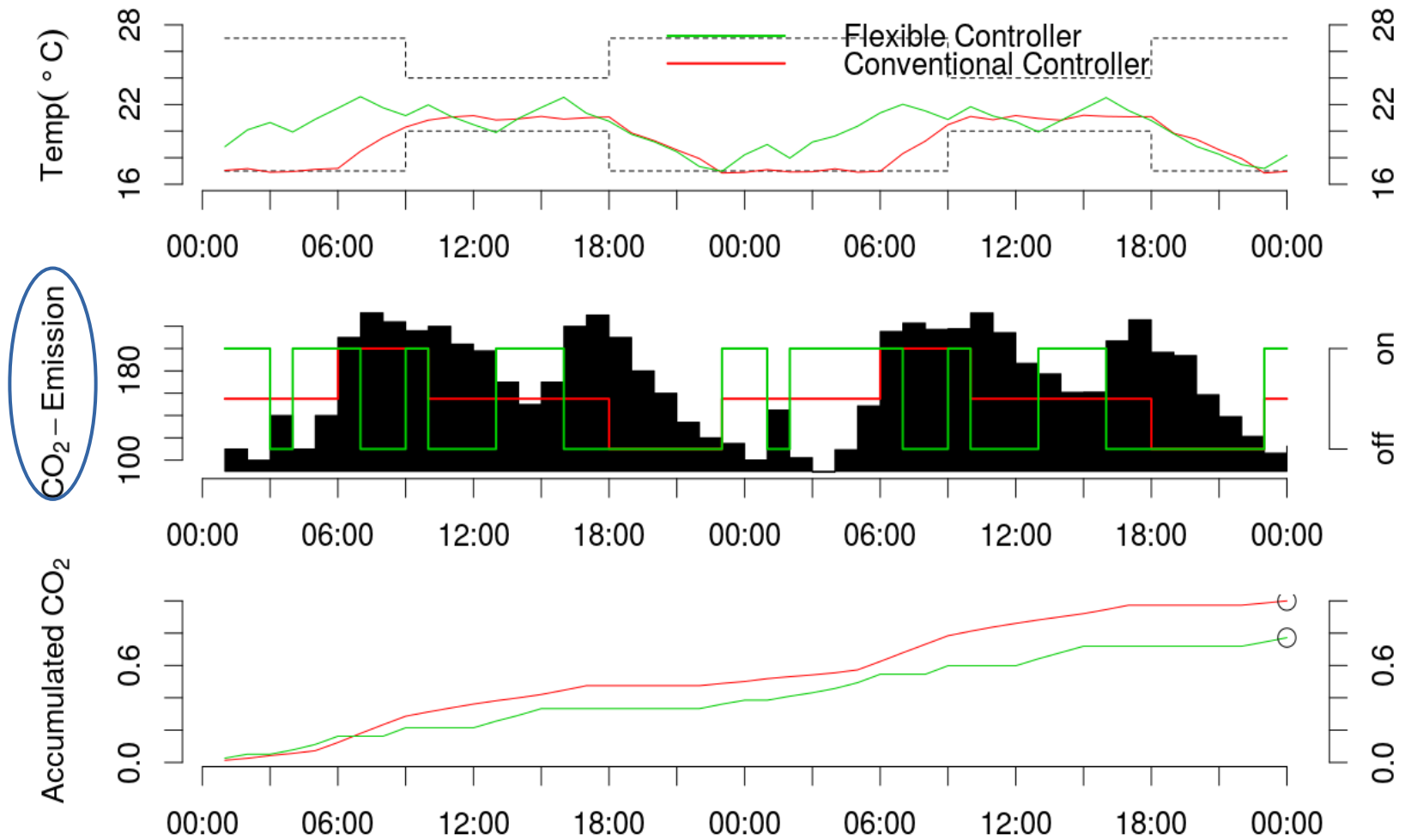


Source: Technical University of Denmark DTU and Faculdade de Ciências e Tecnologia, Universidade Nova de Lisboa



Source: Technical University of Denmark DTU and Faculdade de Ciências e Tecnologia, Universidade Nova de Lisboa


HOW TO UTILIZE AND LABEL ENERGY FLEXIBILITY




Source: Technical University of Denmark DTU and Faculdade de Ciências e Tecnologia, Universidade Nova de Lisboa

HOW TO UTILIZE AND LABEL ENERGY FLEXIBILITY

Energy Flexibility KPIs

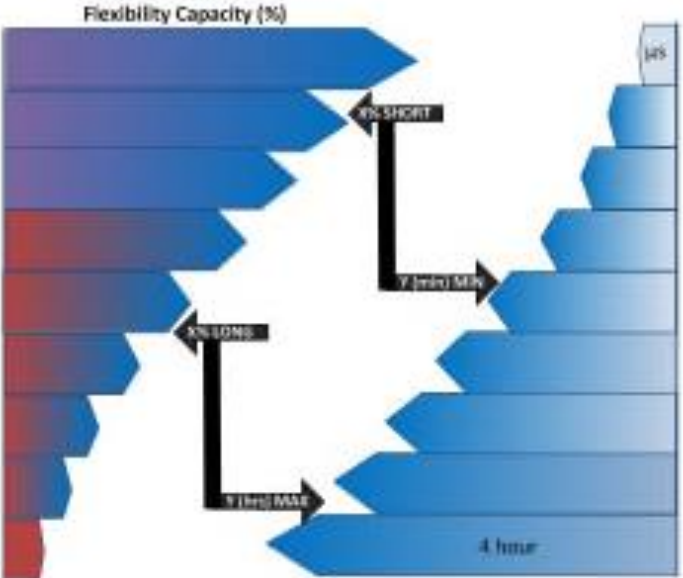




Building / Site Details

Name: _____

Address: _____



KPIs

Building / Site Type: _____

Peak Load: _____ kW/MW

Base Load: _____ kW/MW

Response timescale: μ s/ms/s/10 min/30min/h

Market Suitability: Day Ahead / Intra-Day

Flexible/Shed Capacity:

Short Event Max: _____ kW/MW, Avg: _____ kW

Long Event Max: _____ kW/MW, Avg: _____ kW

TIA Notification: _____ s/min/h

Shiftable / Curtailable / Combination

Pre-load: Y/N

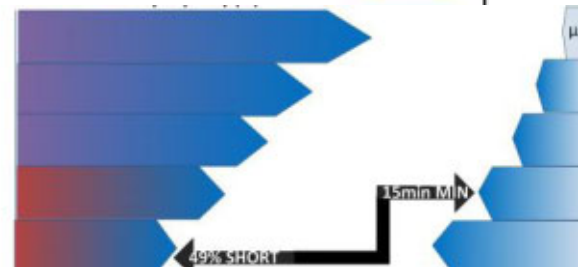
Rebound: Y/N

This project: Energy Local Storage Advanced system (ELSA) receives funding from the European Union's Horizon 2020

Short Event Max: 68 kW, Avg: 57 kW
 Long Event Max: 32 kW, Avg: 19 kW

TIA Notification: 10-15 min

Combination
 Pre-load: Y
 Rebound: Y



KPIs

Building Type: Educational Training Centre

Peak Load: 140 kW/MW

Base Load: 20 kW/MW

Response timescale: 10 - 15 min

Market Suitability: Day Ahead & Intra-Day

Flexible/Shed Capacity:

Source: Sarah O'Connell and Stefano Rivero, 'Flexibility Analysis for Smart Grid Demand Response', arXiv:1704.01308 [cs.SY], April 2017, United Technologies Research Centre Ireland, Cork, ROI

- *There is potential to use energy flexibility of buildings but the business case is missing for grid friendly building operation*
- *A methodology to characterize this flexibility is available although there are some open questions*
- *A national agreed penalty-signal as reference for renewable supplied future grids would be helpful*
- *In comparison to power, heat is under-represented*
- *The “smart readiness indicator” promoted by the EU refers to the importance of energy flexible buildings*

Operating Agent: Søren Østergaard Jensen, Danish Technological Institute, Denmark
assisted by Anna Joanna Marszal-Pomianowska, Aalborg Universitet, DK
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Co-subtask leader: Daniel Aelenei, Universidade Nove de Lisboa, Portugal
Subtask B leader: Peter Engelmann, Fraunhofer ISE, Germany
Co-subtask leaders: Bart Bleys, BBRI, BE, and Igor Sartori, SINTEF / NTNU, NO
Subtask C leader: James Parker, Leeds Beckett University, UK
Co-subtask leader: Wim Zeiler, Technische Universiteit Eindhoven, The Netherlands

16 participating countries:

Austria, Belgium, Canada,
China, Denmark, Finland,
France, Germany, Ireland,
Italy, The Netherlands,
Norway, Portugal, Spain,
Switzerland, UK



Further information: <http://annex67.org>

An aerial photograph of a modern, multi-story building with a prominent facade of large, blue solar panels. The building is situated in a landscaped area with a paved courtyard and some greenery. The sky is clear and blue. In the background, other buildings and trees are visible under a bright sky.

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IDEA TO ACTION

Thank you for your attention!