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Comfort demand leading the optimization of energy supply from the Smart Grid

Wim Zeiler, Tom Thomassen, Gert Boxem, Kennedy Aduda

Faculty of the Built Environment - Unit Building Physics and Systems

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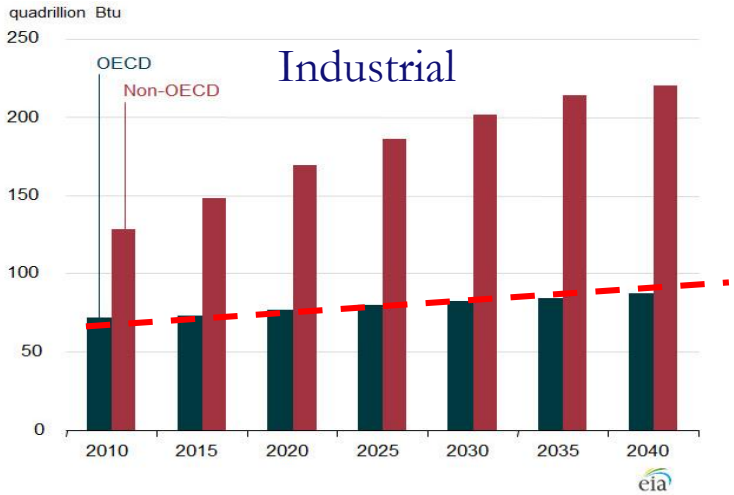
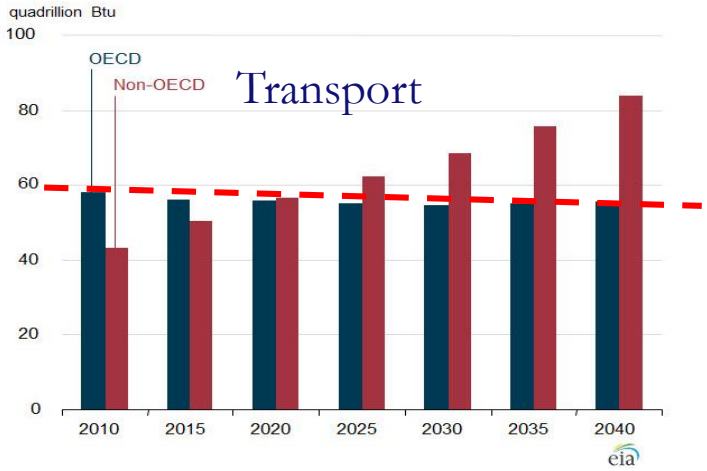
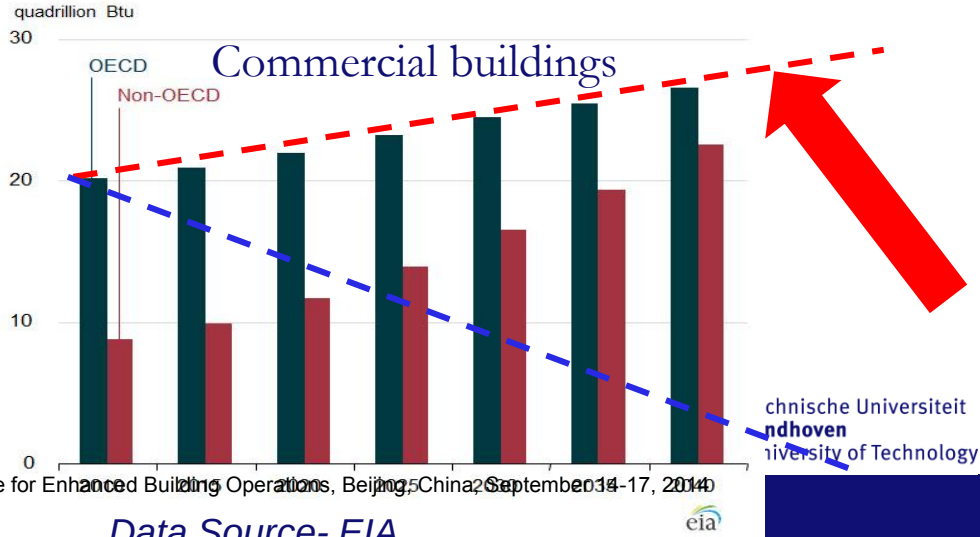
Delivered energy consumption (2010-2040) by Sector: EB in 2020 & nZBE in 2050????







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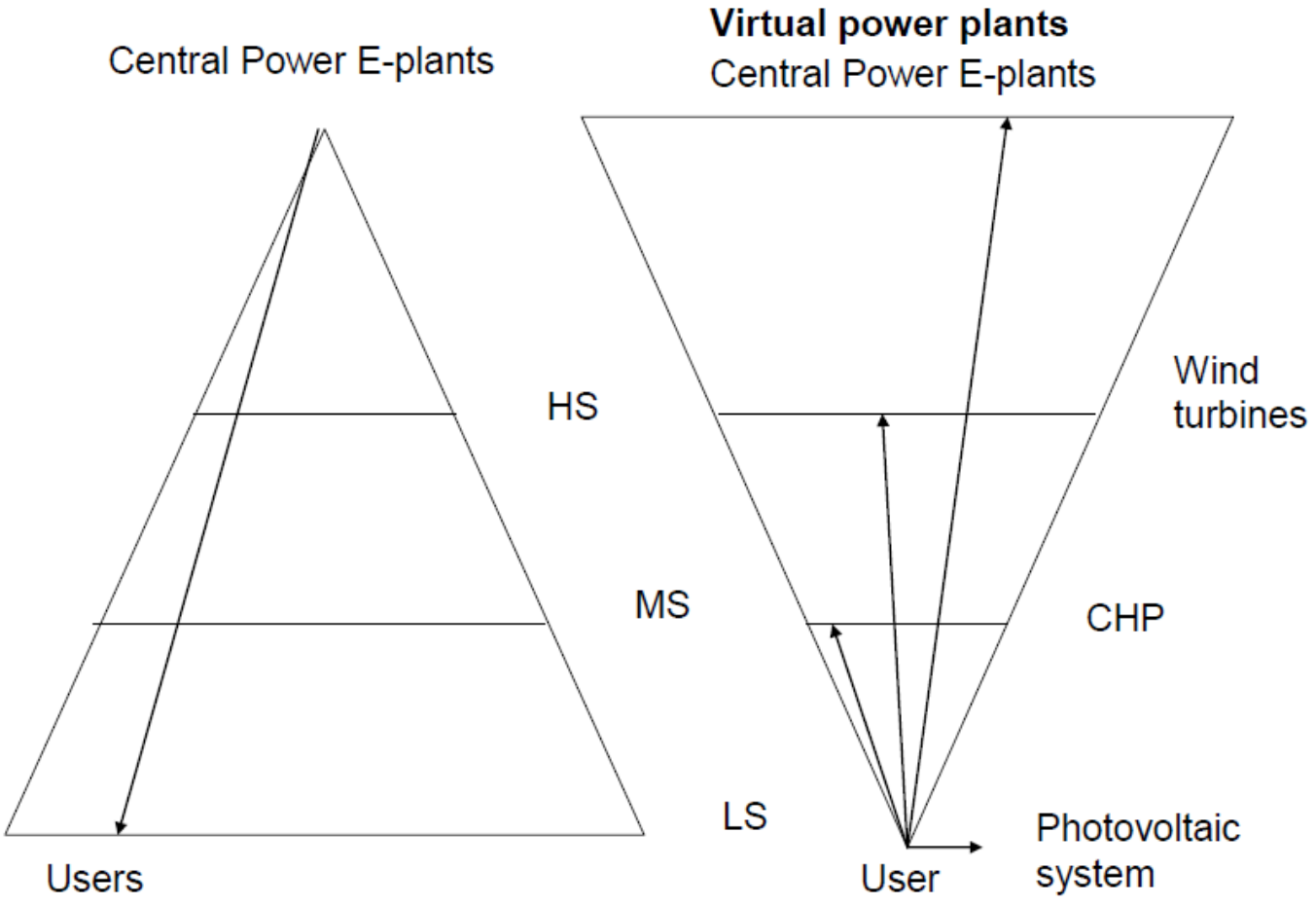
Proof of principle

Data Source- EIA

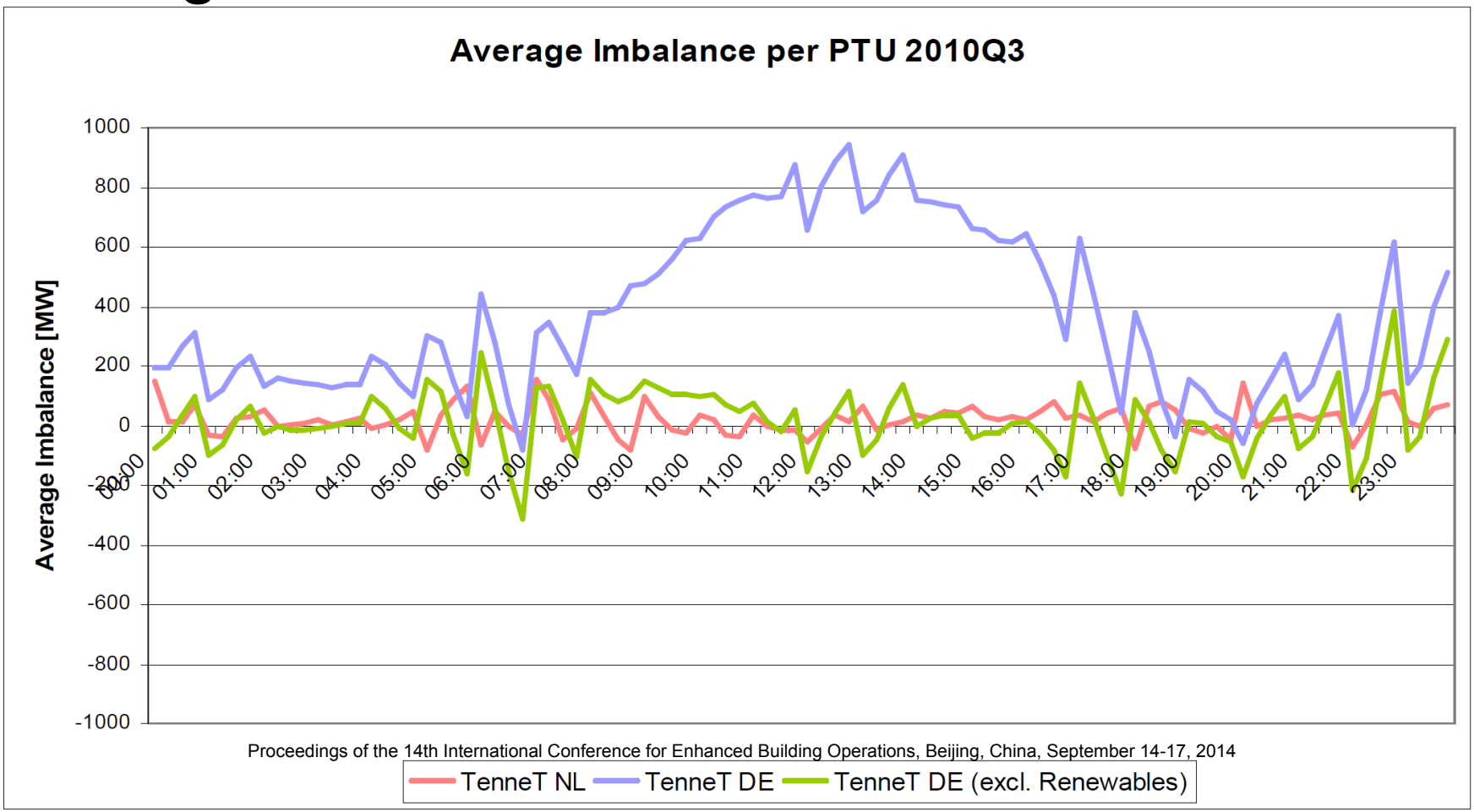
Change from a top-down electricity supply to bottom-up supply



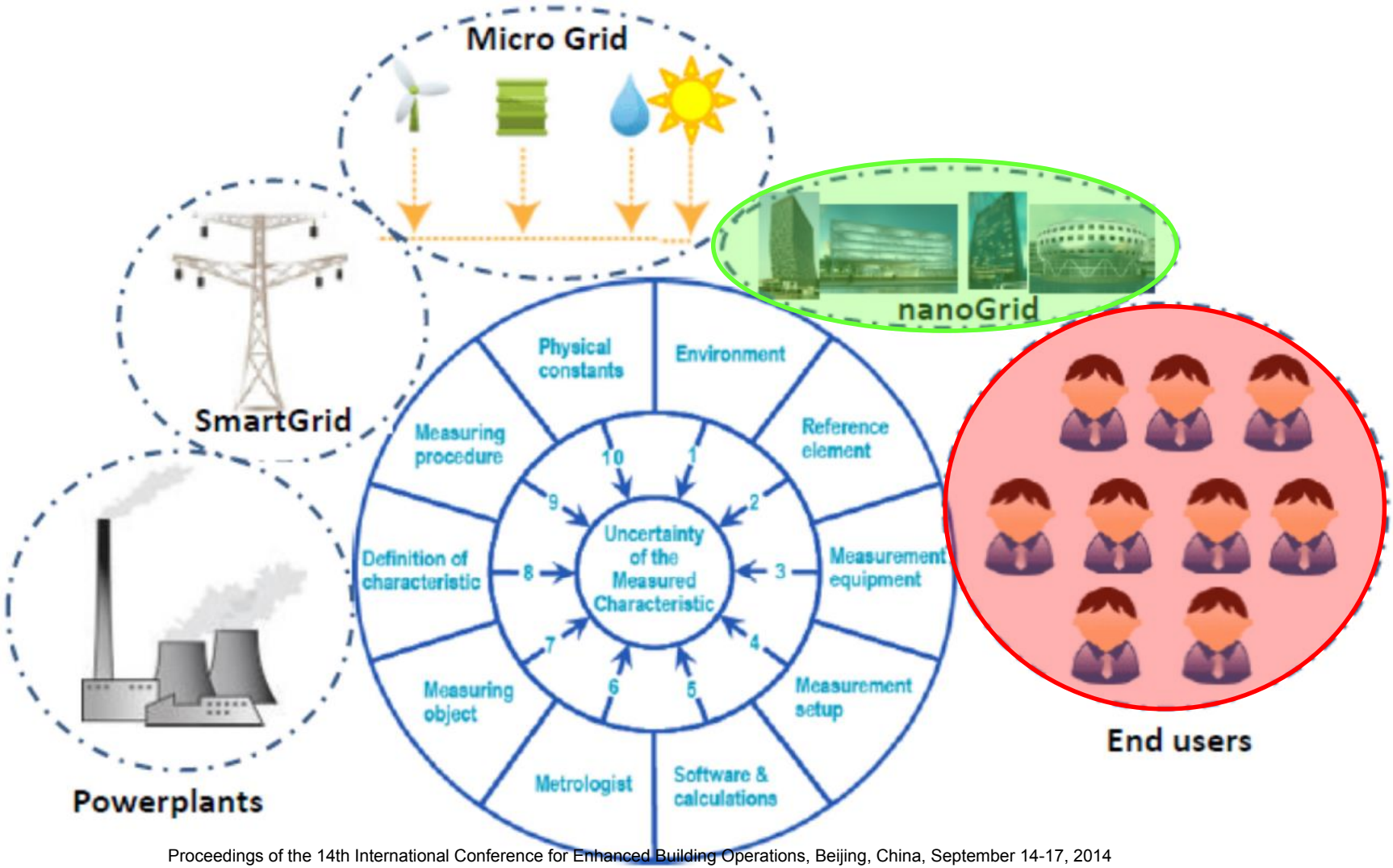
HS= High current electricity distribution network
MS= Medium current electricity distribution network
LS = Low current electricity distribution network
CHP=Combined Heat Power genaration

Clearly a need for renewable energy to reach net Zero energy targets

Impact of renewable production on the average imbalance [TenneT 2011].



Overall approach to uncertainty reduction based on ASME 89.7.3.2 for Smart Grid.



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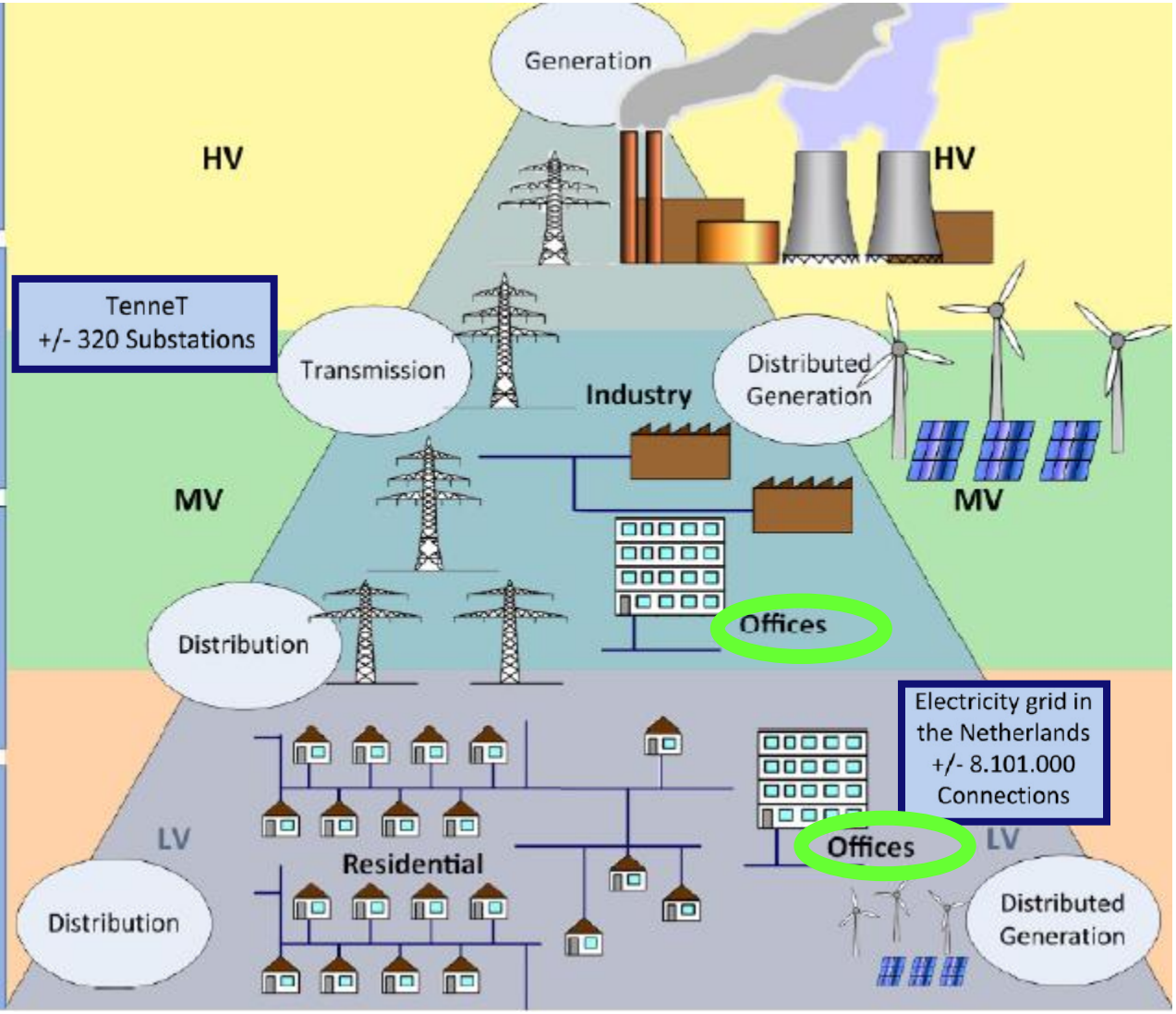
TenneT
220 / 380 [kV]
2.685 [km] Cable

TenneT >= 110 [kV],
Cogas Infra en Beheer, DELTA Netwerkbedrijf,
Endinet Groep B.V. Enexis, Liander, RENDO
Netwerken, Stedin, Westland Infra <=50 [kV]
50 / 110 / 150 [kV]
9.836 [km] Cable

Cogas Infra en Beheer, DELTA Netwerkbedrijf,
Endinet Groep B.V. Enexis, Liander, RENDO
Netwerken, Stedin, Westland Infra.
3 - 25 [kV]
101.275 [km] Cable

Cogas Infra en Beheer, DELTA Netwerkbedrijf,
Endinet Groep B.V. Enexis, Liander, RENDO
Netwerken, Stedin, Westland Infra.
0,4 [kV]
195.706 [km] Cable

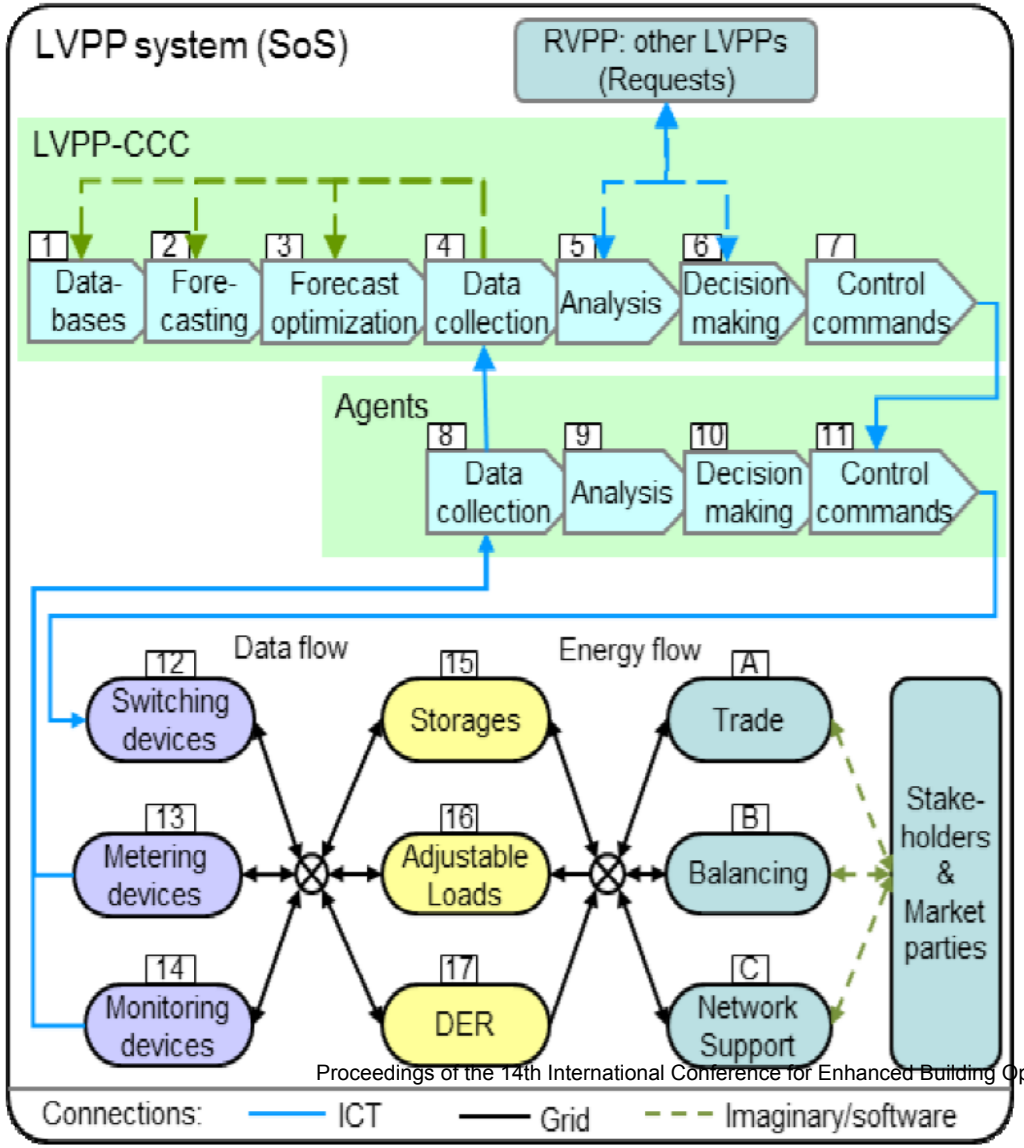


Electricity grid in the Netherlands
380 - 0,4 [kV]
309.502 [km] Cable

Liander	Enexis	Stedin
+/- 2.978.000	+/- 2.662.000	+/- 2.003.000

DELTA Netwerkbedrijf	Endinet Groep B.V.	Cogas Infra en Beheer	Westland Infra.	RENDO Netwerken
+/- 212.000	+/- 108.000	+/- 53.000	+/- 53.000	+/- 32.000

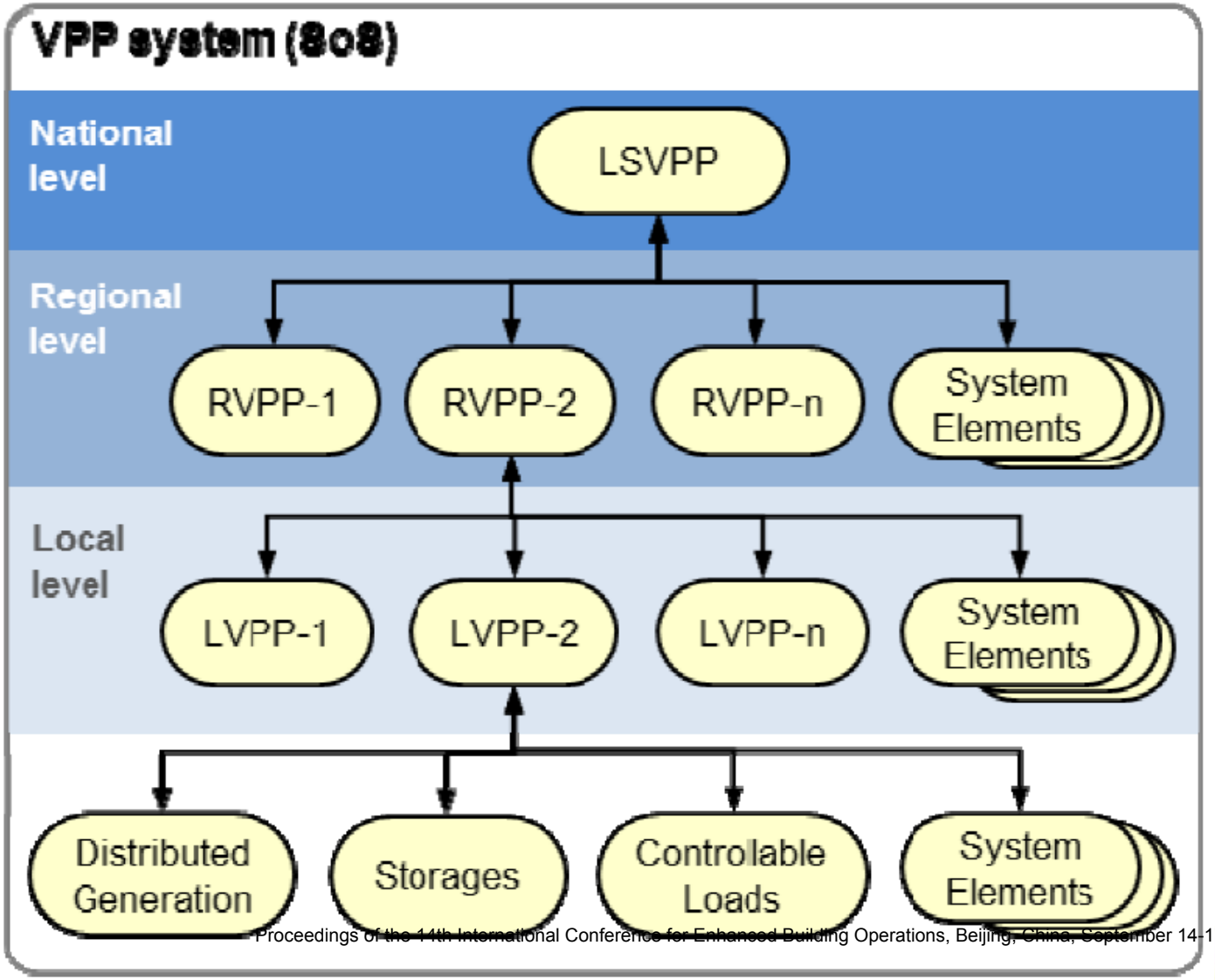
Modular LVPP system [El Bakari and Kling 2010].



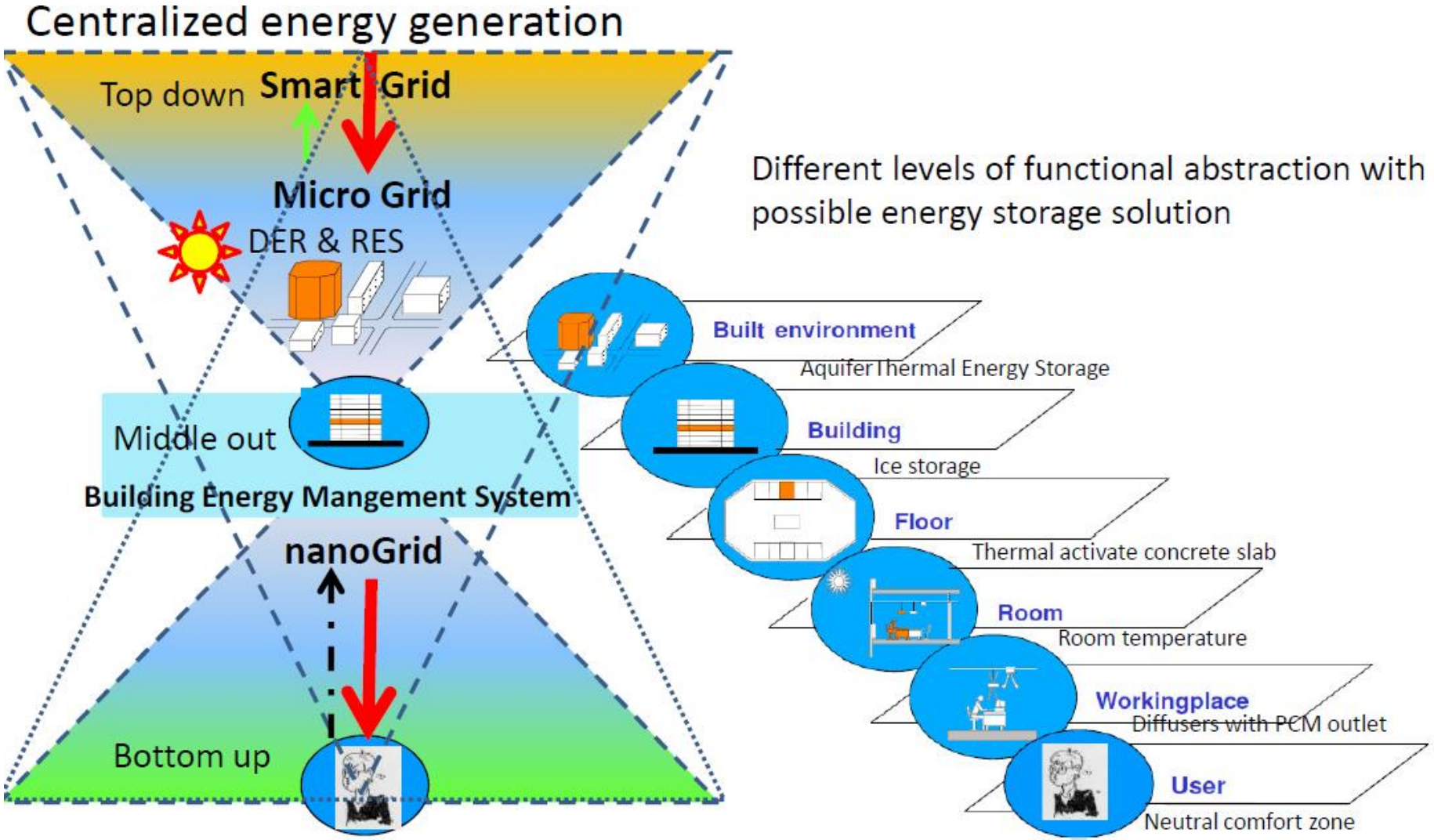
Offices as **L**ocal **V**irtual **P**ower **P**lants

Scalable design of LVPP system

[El Bakari and Kling 2012].

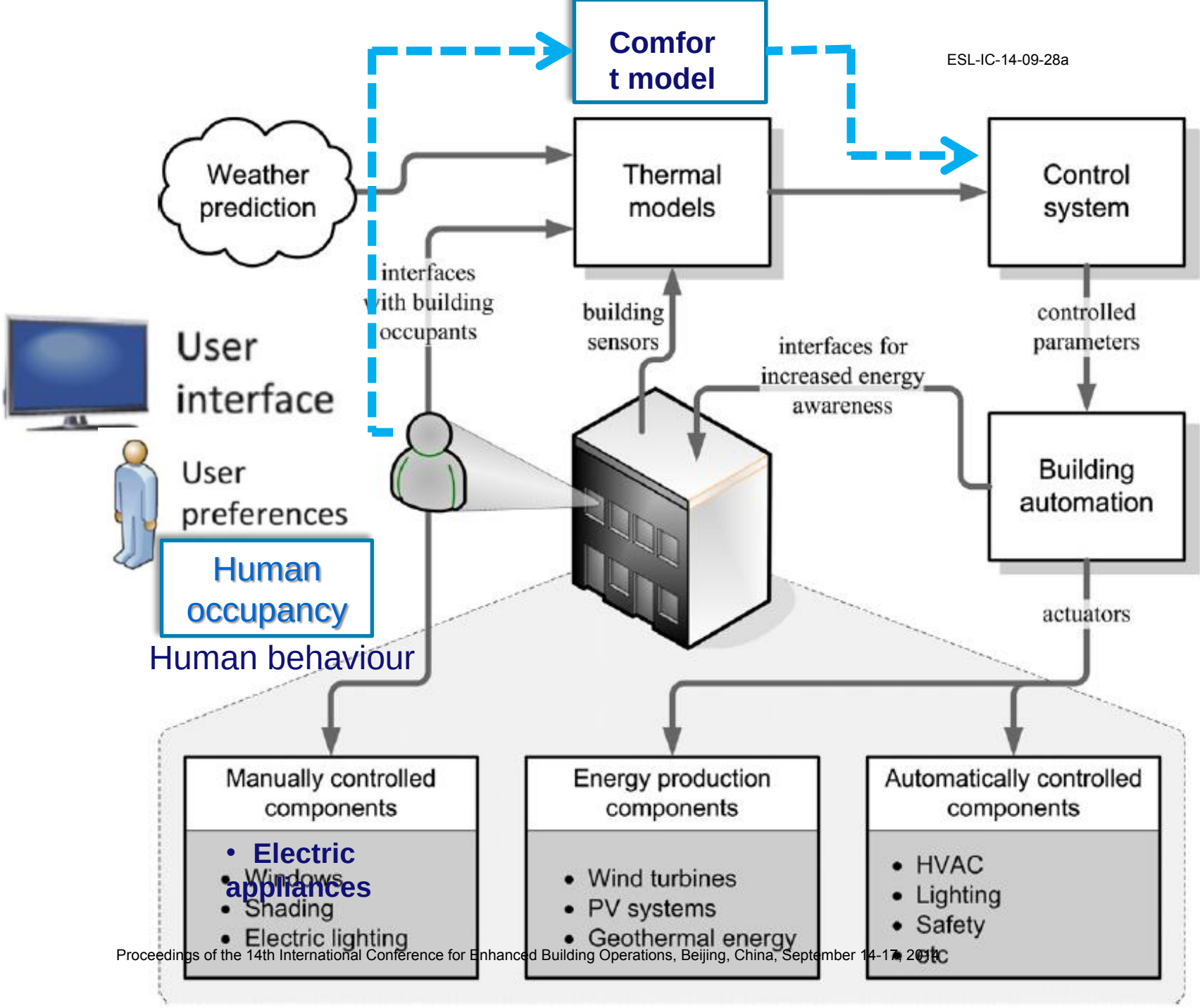


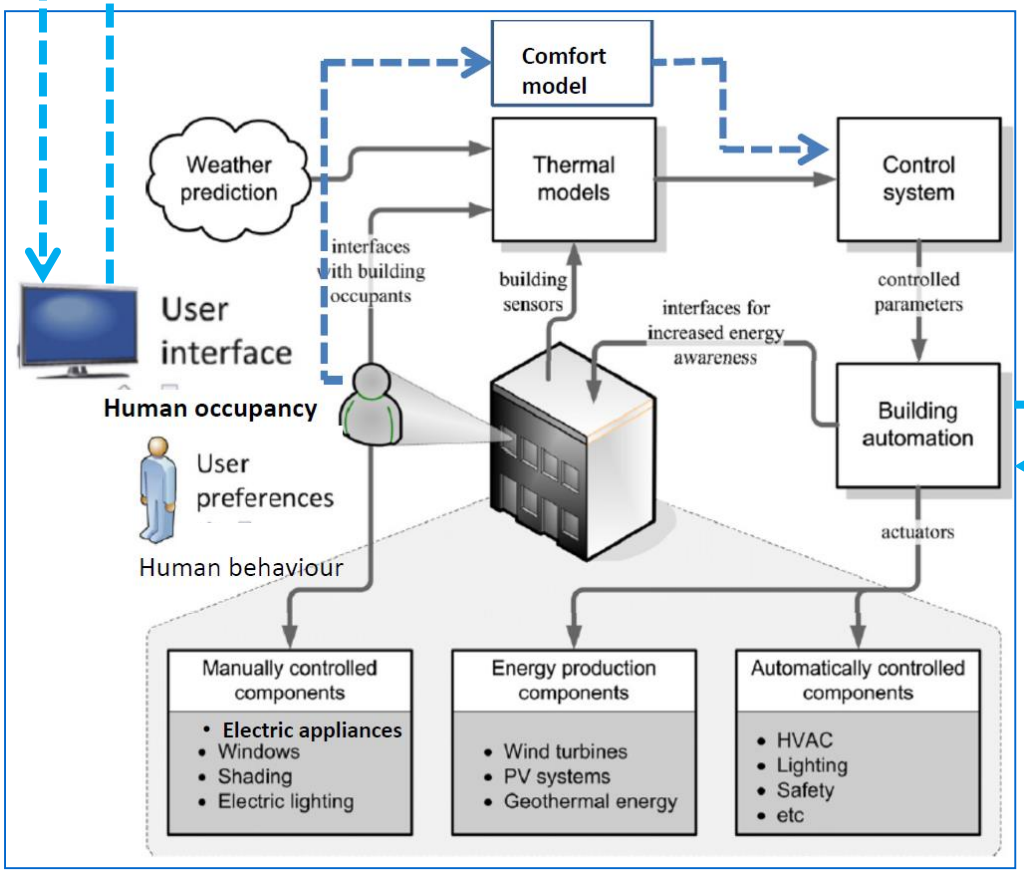
Representation intended approache to optimize building interaction with the Smart Grid.

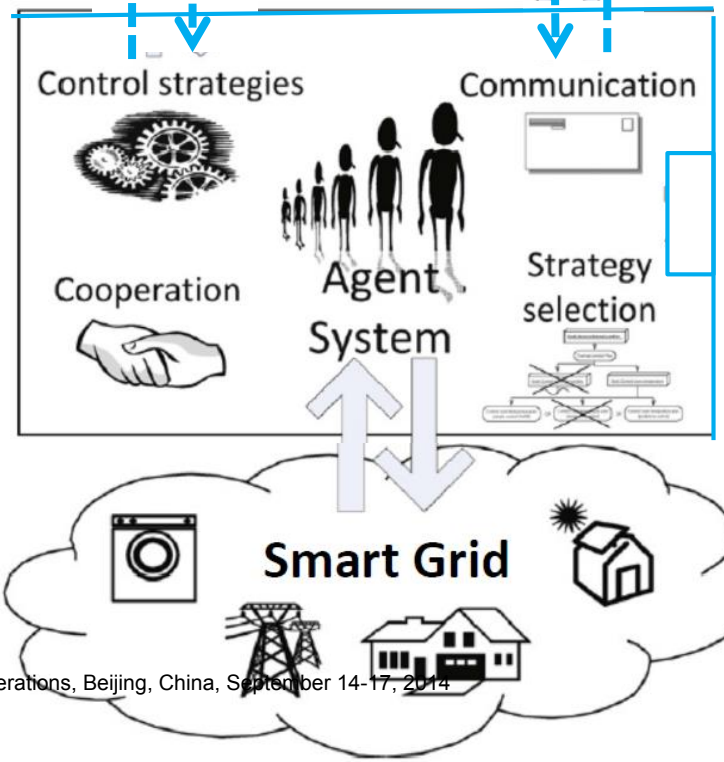


Mean functional orientation

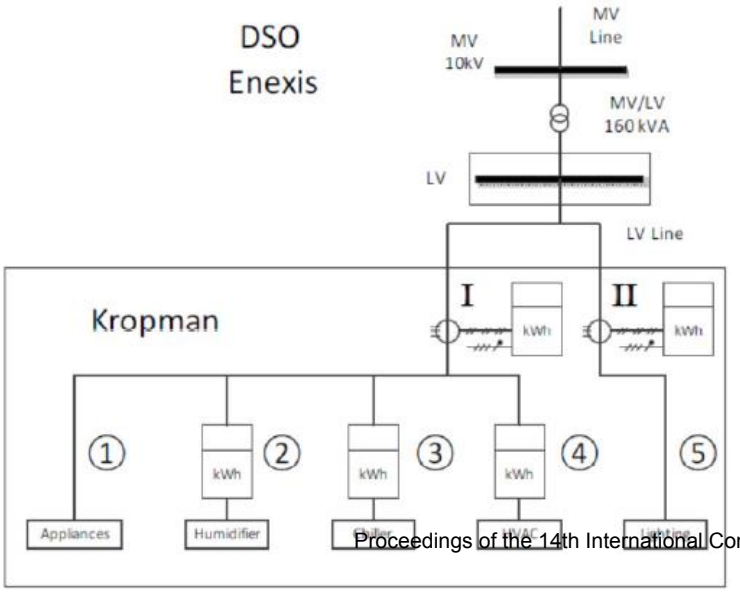
(based on Kolokotsa et al. 2011 and Kofler et al. 2012)

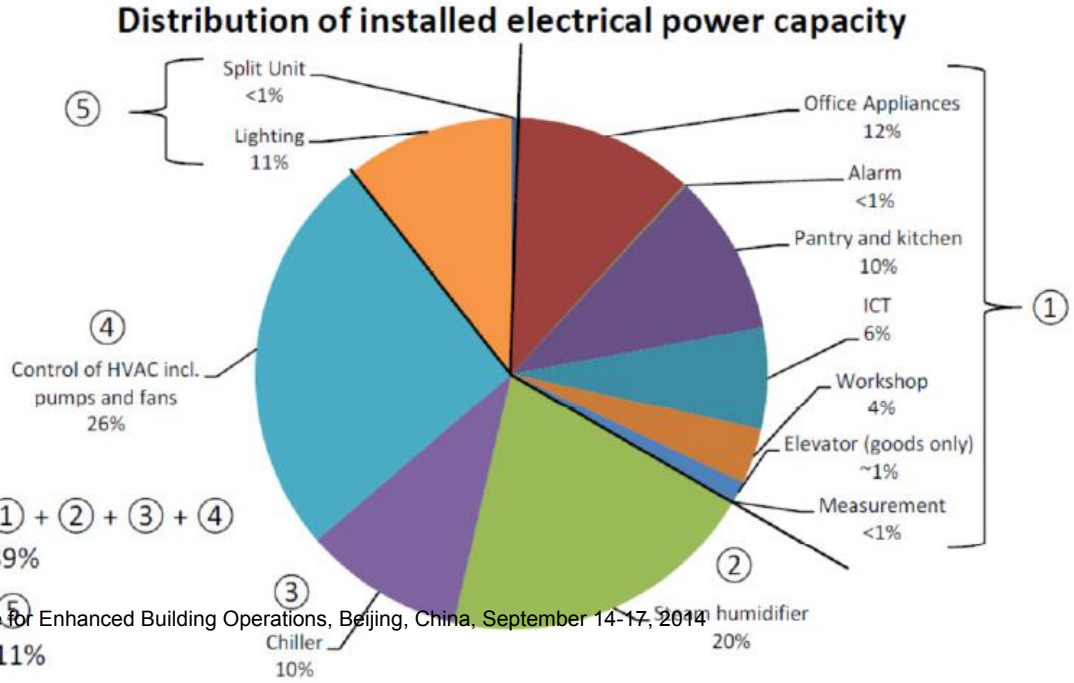



Comfort model
Weather prediction
Thermal models
Control system
interfaces with building occupants
building sensors
controlled parameters
interfaces for increased energy awareness
User interface
Human occupancy
Building automation
User preferences
Human behaviour
actuators
Manually controlled components
Electric appliances
Windows
Shading
Electric lighting
Energy production components
Wind turbines
PV systems
Geothermal energy
Automatically controlled components
HVAC
Lighting
Safety
etc


Control strategies
Communication
Cooperation
Agent System
Strategy selection
Smart Grid

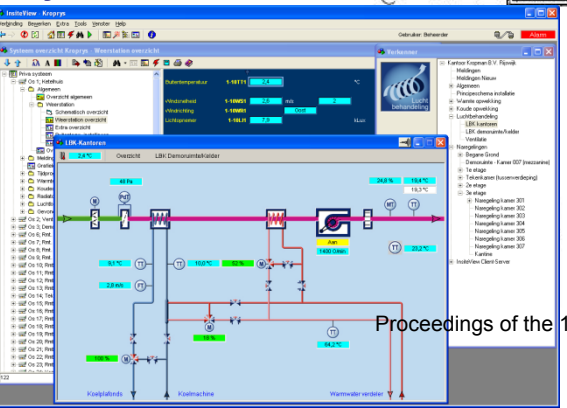
Measurements in a real office building

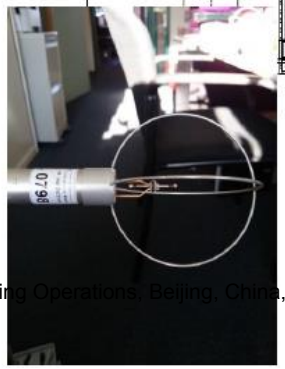




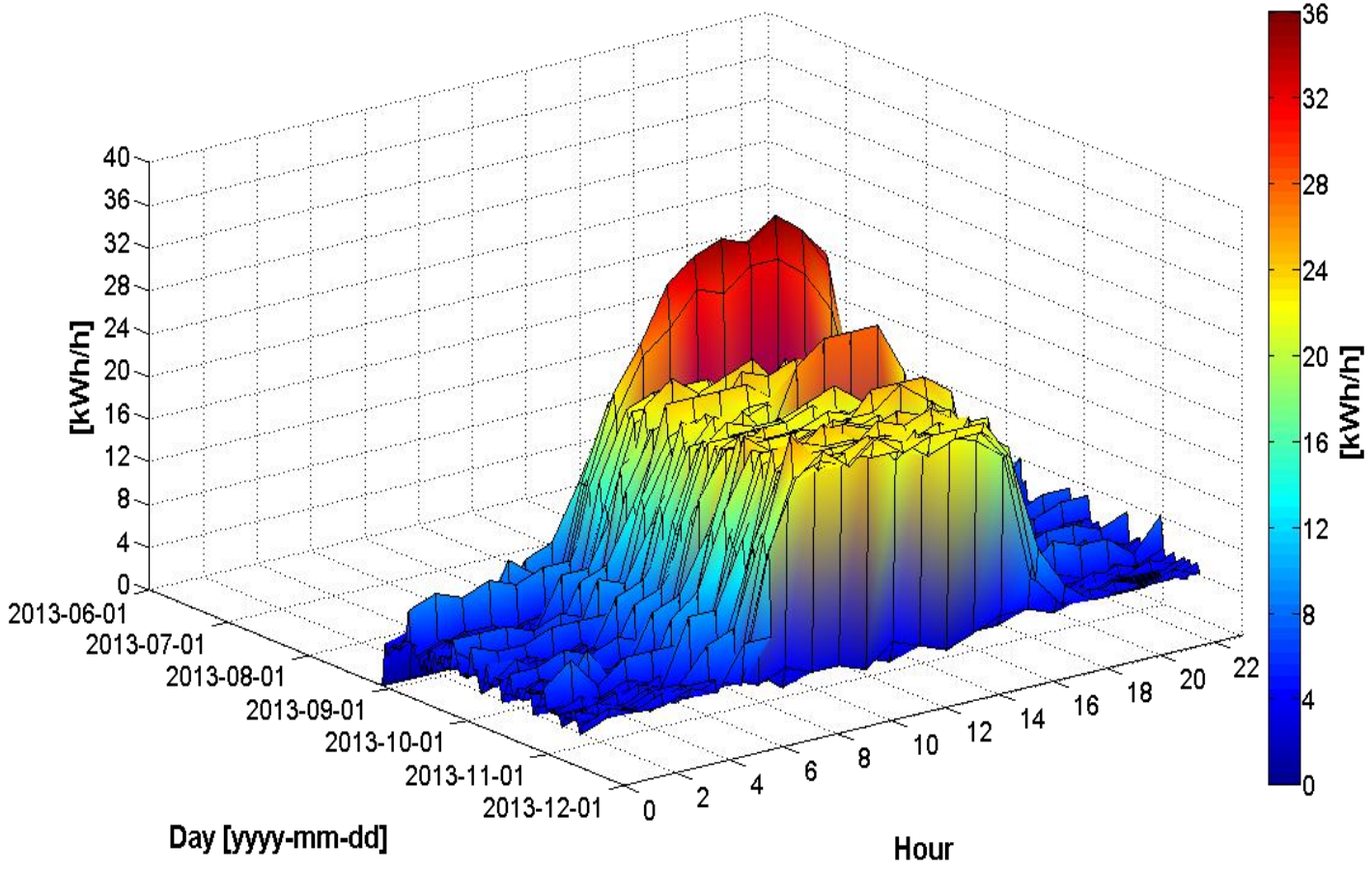
Kropman Breda Living lab

InsiteView Gebouwbeheer systeem





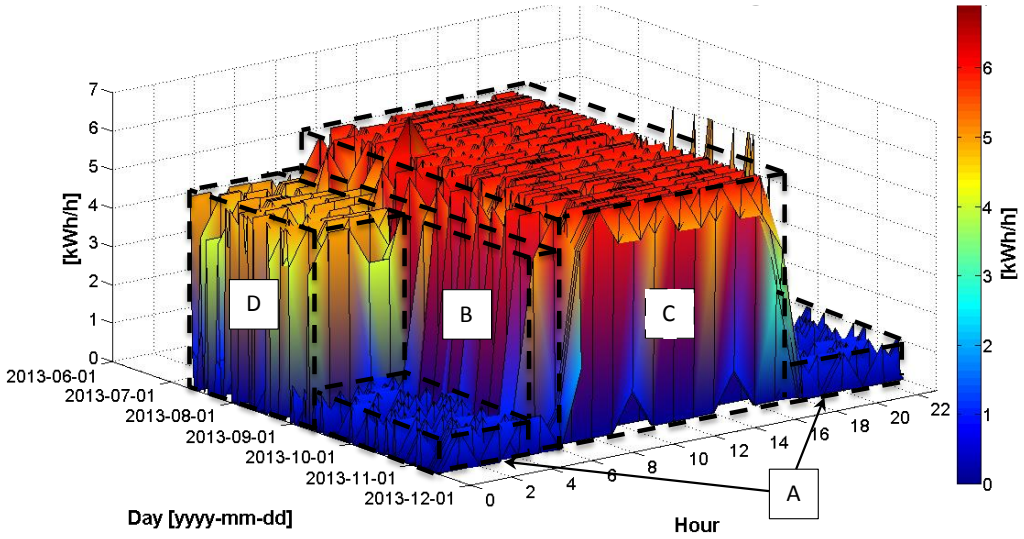
Initial experiment-Total Energy Profile (1)



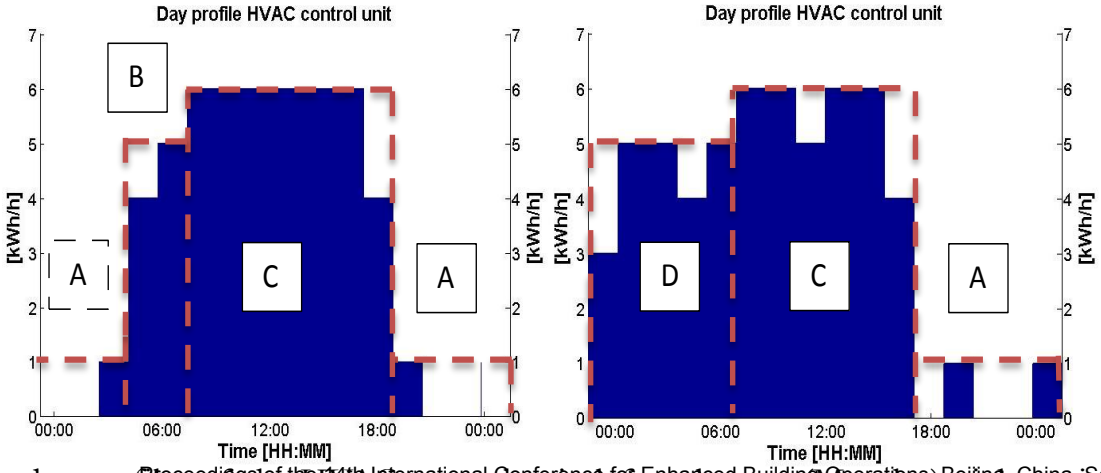
3D representation of total energy use profiles stacked by date.

Results from Thomassen's experiments at Breda, 2013

Results from Initial experiment -Ventilation & Cooling System



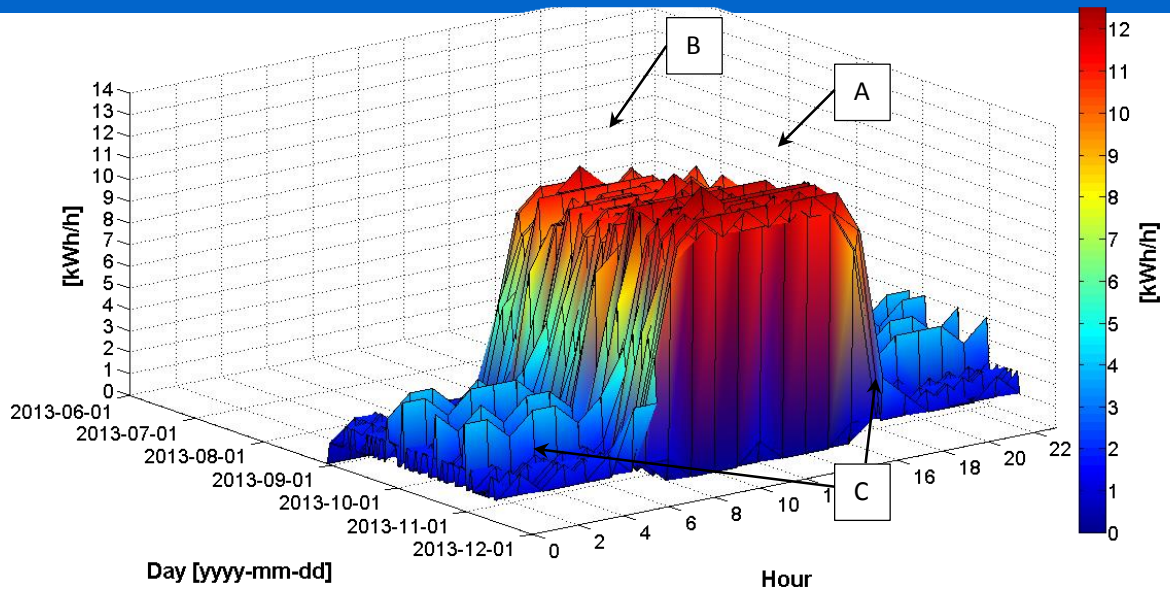
3D representation of ventilation system energy use profiles stacked by date.



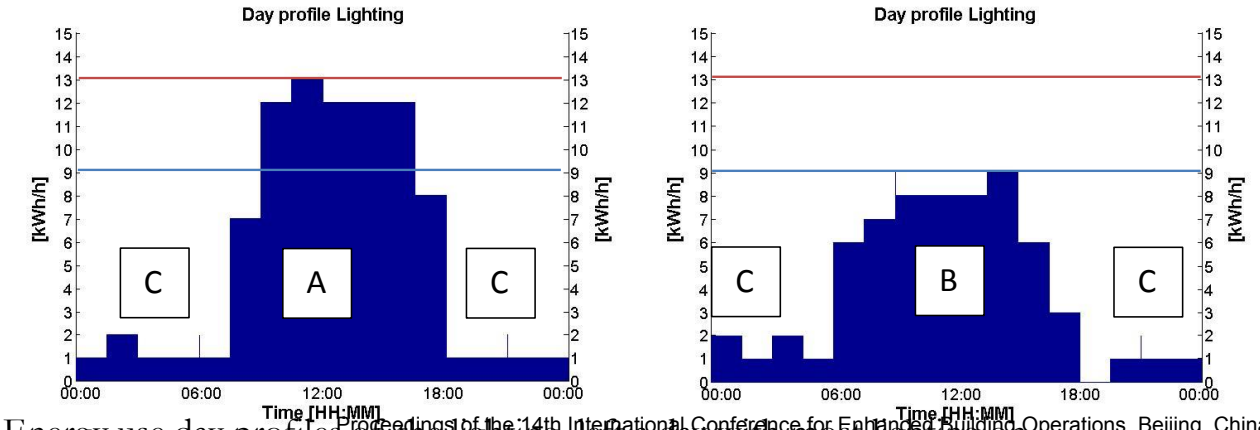
Energy use day profiles of the HVAC control unit, left early start (Monday), right active night ventilation

Results from Thomassen' s experiments at Breda, 2013

Results from Initial experiment- Lighting System



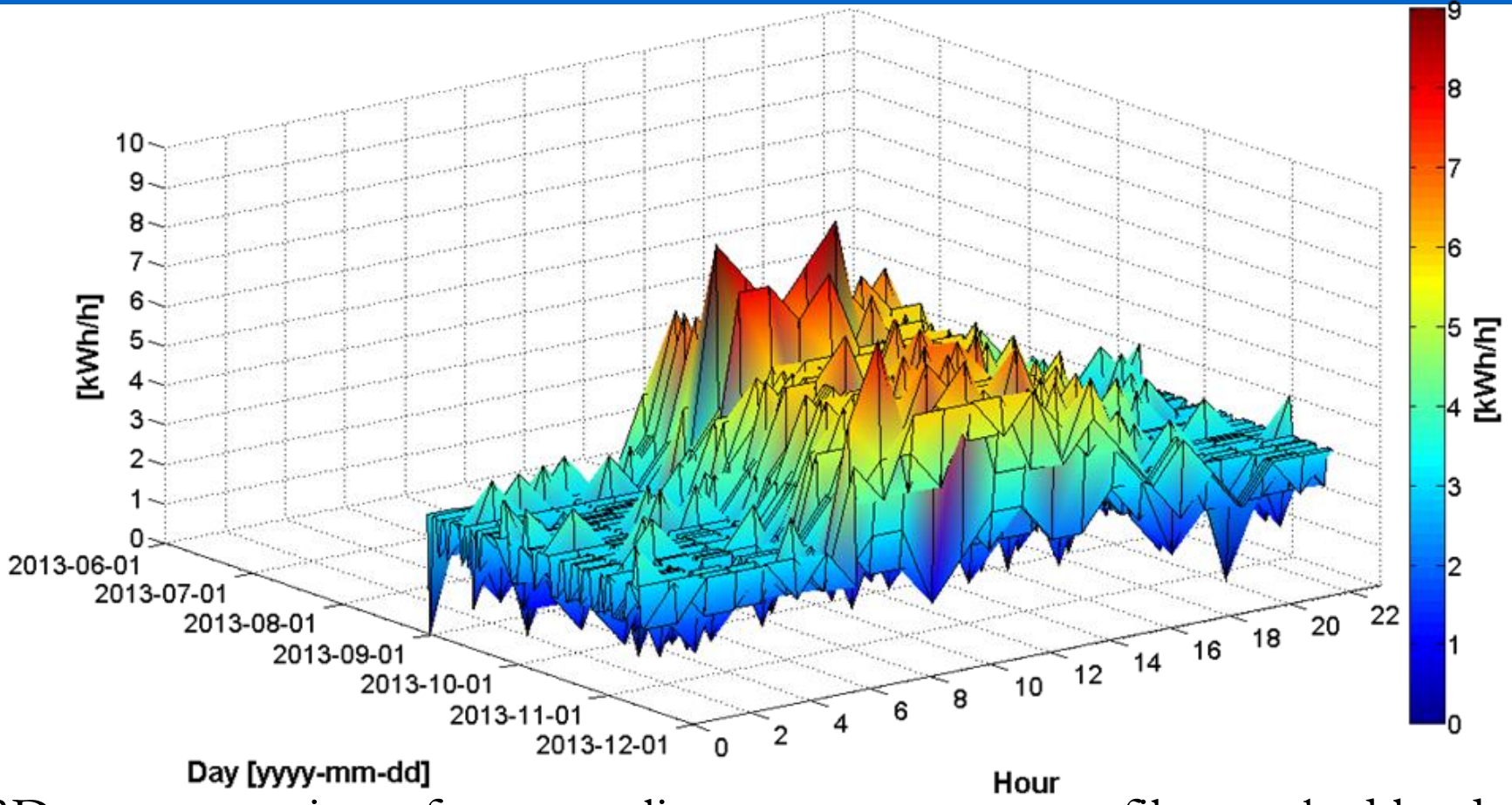
3D representation of lighting system energy use profiles stacked by date.



Energy use day profiles of the lighting, left a day with most lighting on, right only limited lighting on

Results from Thomassen' s experiments at Breda, 2013

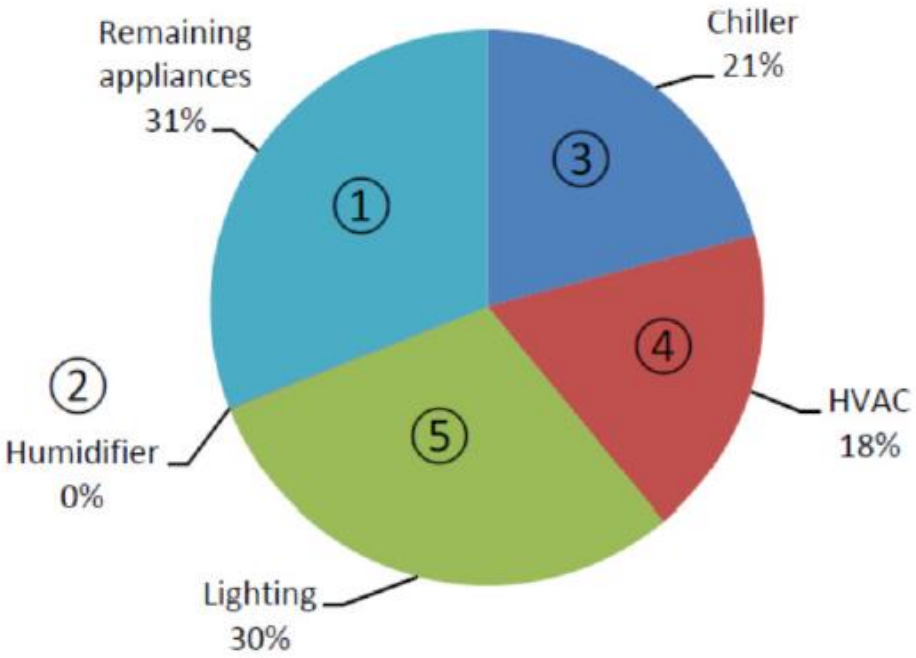
Initial experiment- User Appliances



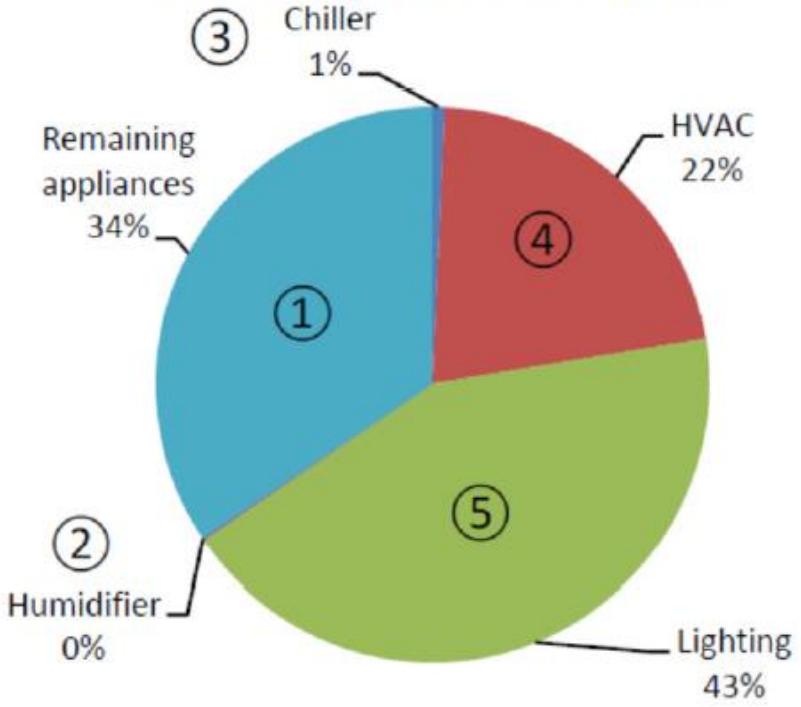
3D representation of user appliances energy use profiles stacked by date.

Results from Thomassen' s experiments at Breda, 2013

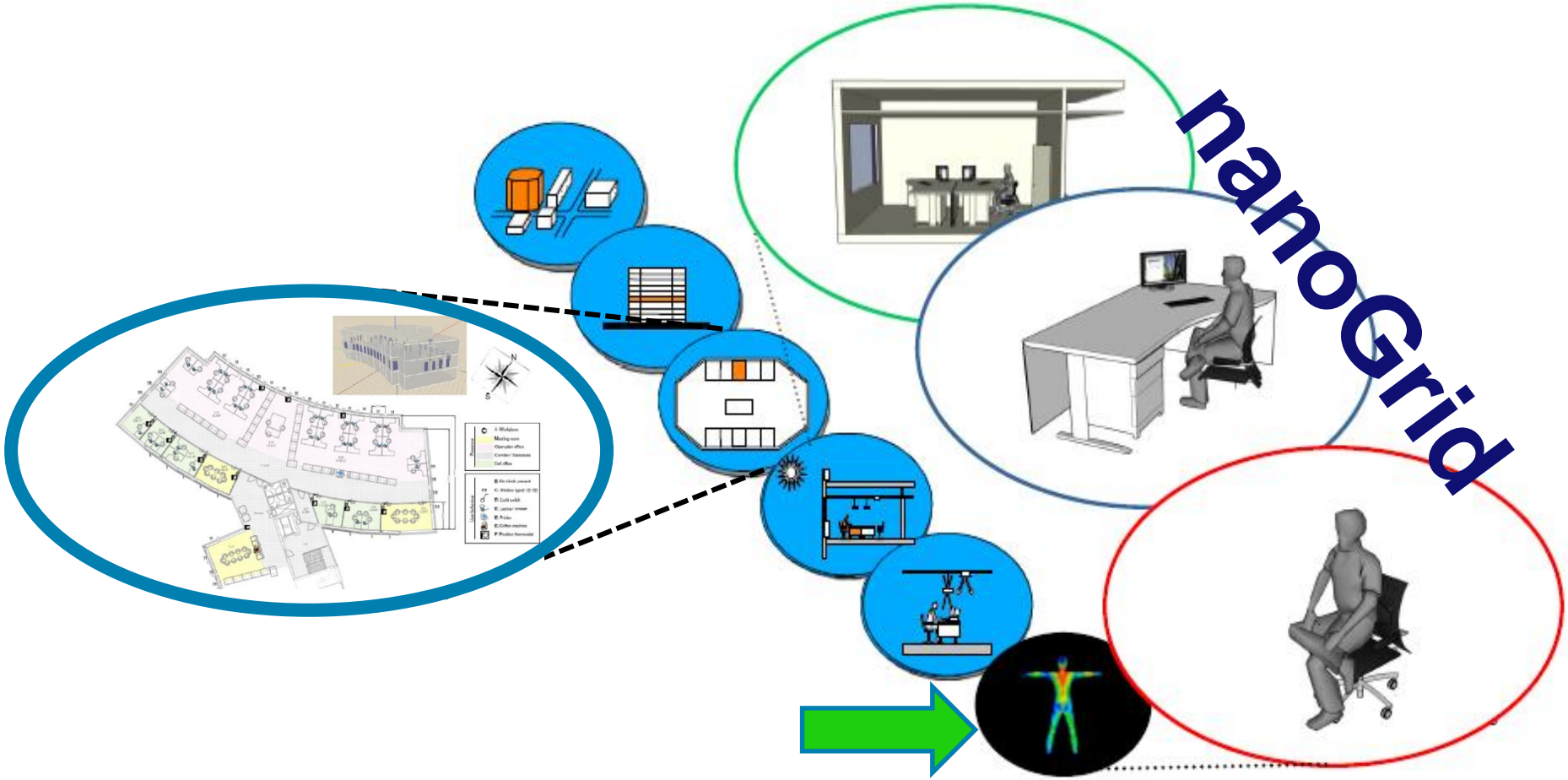
Distribution of energy consumption Week 36



Distribution of energy consumption Week 42



Human in the loop approach



Conclusions

- Reduction of uncertainty within Smart Energy Systems by applying offices as LVPP with different types of energy storage on different systems levels, connecting energy demand and supply within offices (nano Grid) with micro Grid (field or street) and public Smart Grid
- The user behaviour is a key issue to be included te be able to predict the energy use of a building
- Offices can only act as a virtual power plant to reduce the uncertainty within the Smart Grid if we know enough of the building and its occupants

Thank you for your attention!

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