ÓBUDA UNIVERSITY
KANDÓ KÁLMÁN FACULTY OF ELECTRICAL ENGINEERING

Power System Department

Harnessing digital technology for energy efficiency

Balance manager and Remote energy management service

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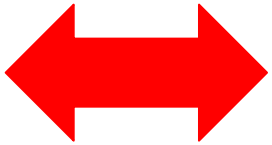
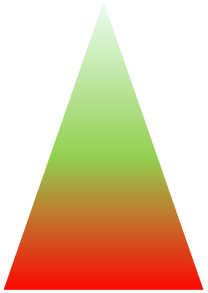
Bulk system vs. Small local solution

- Unlimited sources
- No need for storage



- Limited renewable sources (in island, in microgrid or in energy community)
- Dynamic availability – forecast
- Dynamic load – forecast
- Scheduling – DSM (Demand Side Management)
- Storage is the second option

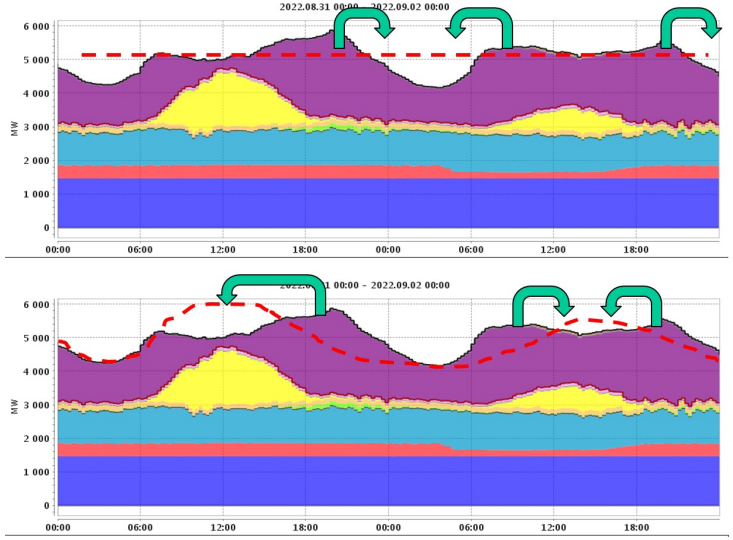
Paradigm change



The GOOD energy:

- Not used – not consumed
- Used in time of generation
- Stored

Traditional DSM



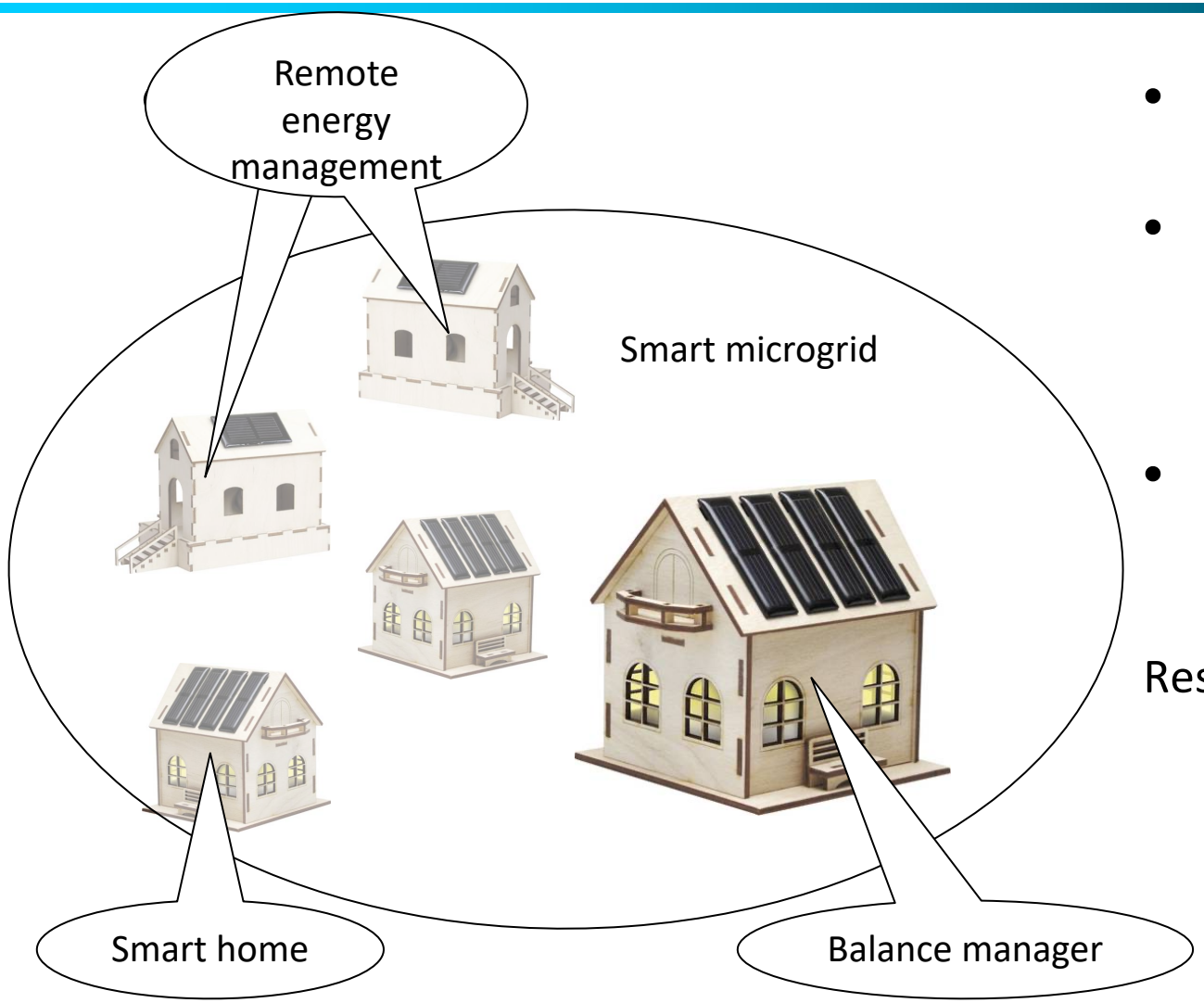
New paradigm

- The renewable production isn't flexible
- The previous paradigm, i.e. *"Use more electricity at night!„*
- Instead it is more appropriate to implement the

"Consume more energy in case of excess production!" **principle**

(e.g. PV production).

Energy management on different level



- To decrease the **amount** of energy used
- To decrease the purchasing **cost** by knowing the energy usage schedule
- To raise the **efficiency** of the applications

Result: decrease of the total energy costs

All the solutions are based on ICT!

Small scale balance manager for household energy systems – „Energy control box”

- The balance manager unit is responsible for also the **intelligent control of the loads and sources** and also through its power electronic makes the necessary switches:
- controls the **load situation** – analyze the required minimum and maximum load
- make **balance** between the load and generation – in island mode the equilibrium can be reached by tuning the generation and/or controlling the load (“Demand Side Management” – DSM, Demand Response – DR)
- controls the state of the **storage device** – checks the charge level of the battery
- makes continuous **data logging** for later analysis
- makes decision about the **island operation** – in case of external alarm signal, or low input voltage or in case of disappeared input voltage it turns into island operation mode
- controls the **derogated functionality** - in case of lack of cheap utility supply only the necessary loads are supplied from internally stored energy or from the recently generated PV electricity
- **optimize** the load and generation – the highest security level is provided if the storage device is fully load, and the energy wasting devices (e.g. tumble drier) are supplied by external utility source
- **controls** the air conditioning system – active power control and/or control of passive elements, as shadowing curtains

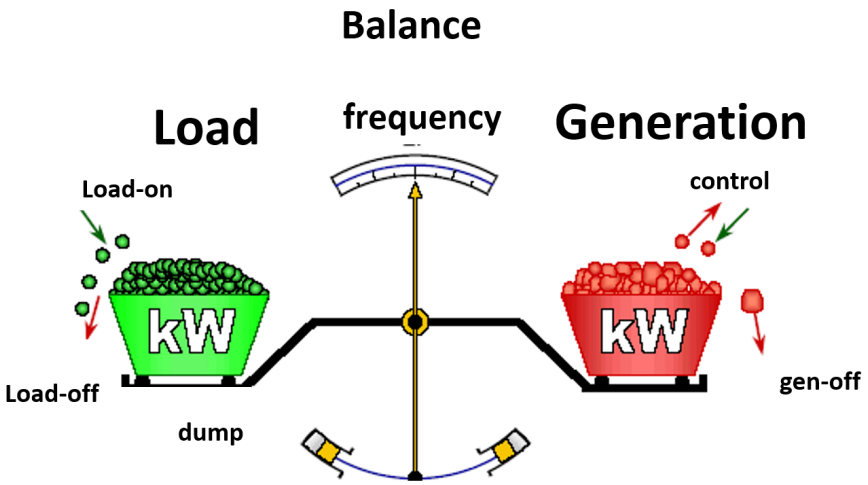
The Balancing and Scheduling problems

Islanded power system

- Limited sources
- Priority of the renewables
- How to satisfy the demand?

Net connected operation

- We generate renewable energy
- We buy cheap energy for storing
- We sell it in peak time

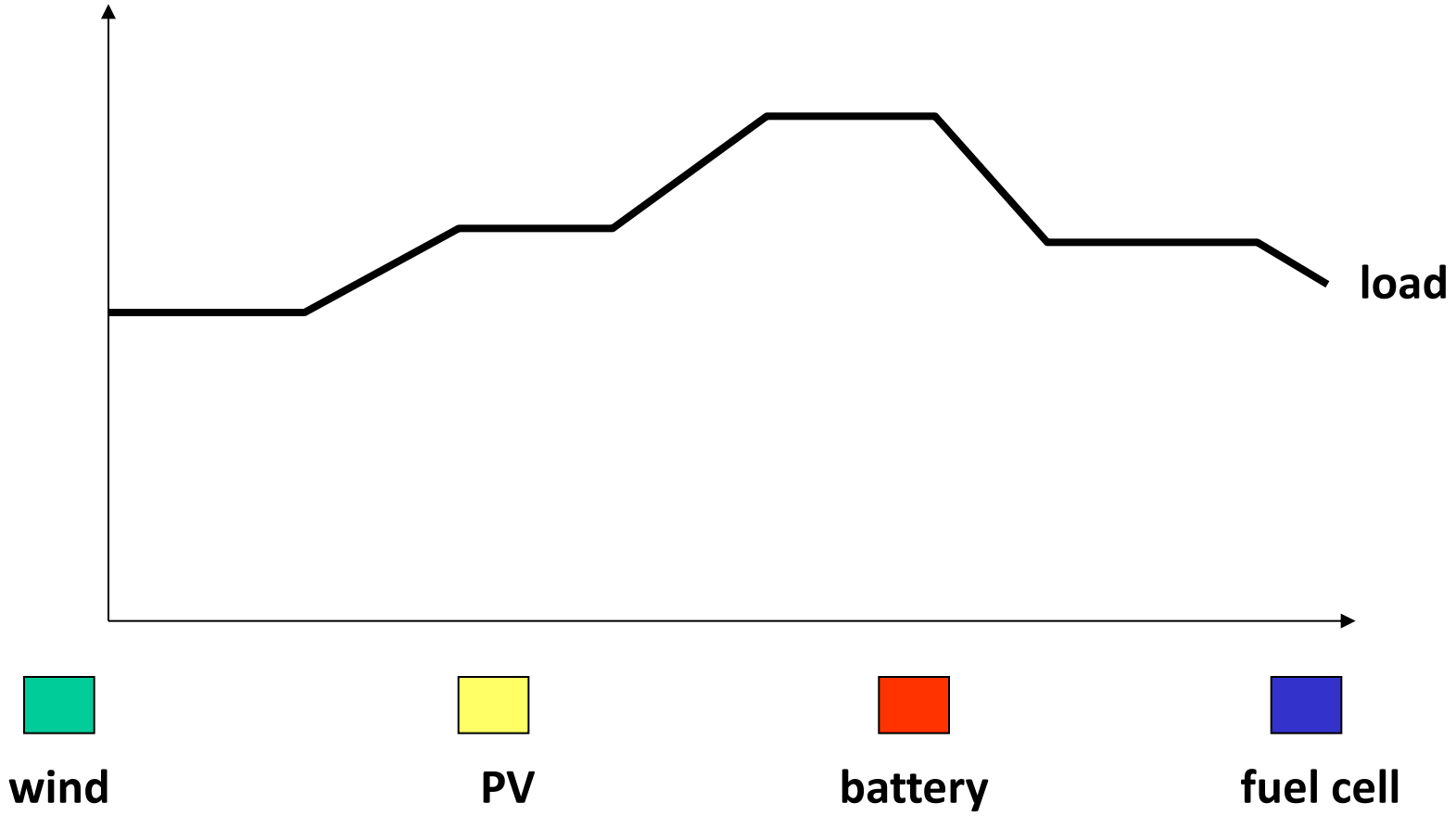


Economic storage is hardly possible

Original base from Alajos Strobl

Intelligent optimalisation solutions

The Tetris problem

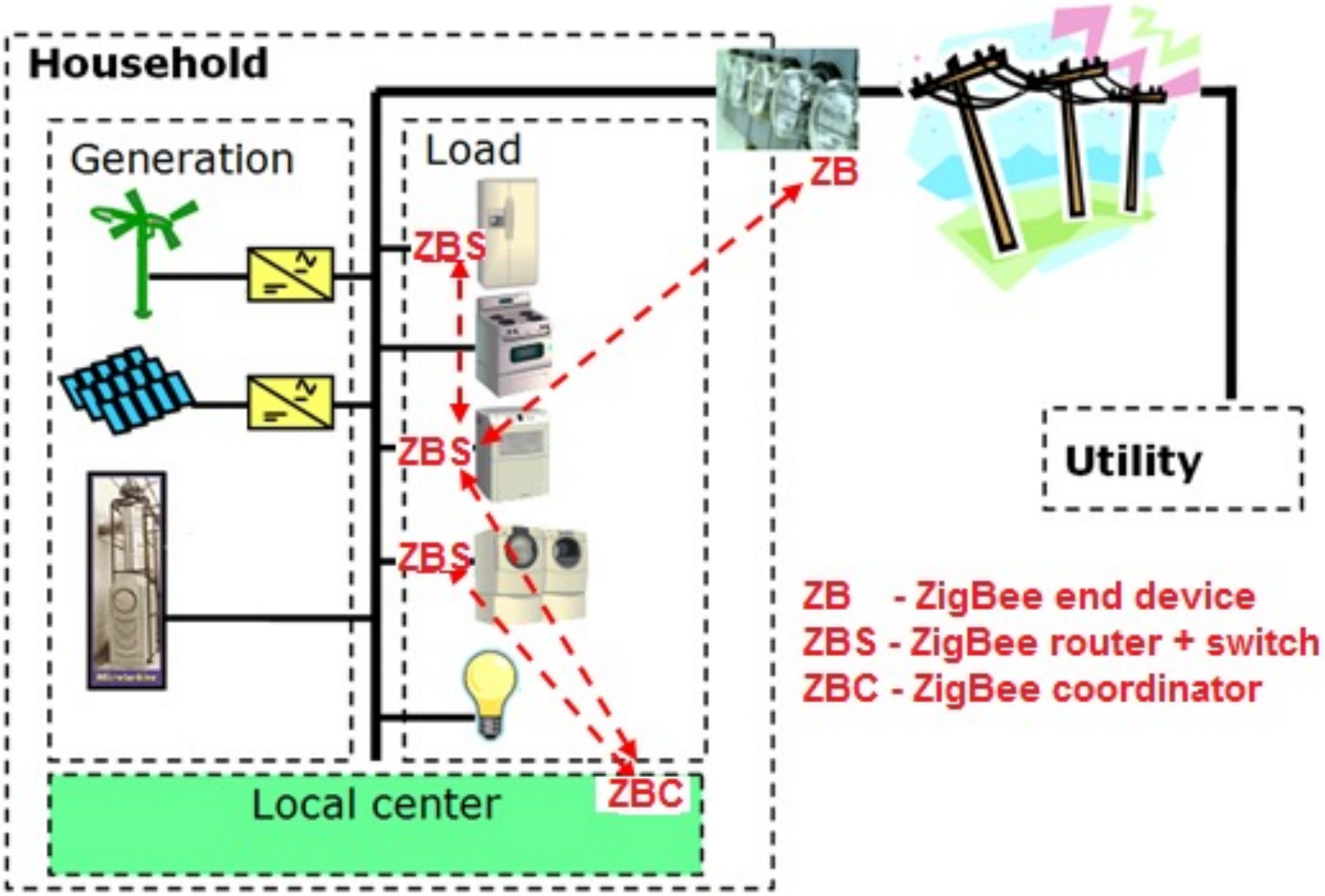


„Household" DSM example

Devices and operational modes	P act in W	Q react in var	S in VA
notebook normal op.	46,42	0	46,42
CRT standby	15,47	27,16	31,26
Cathode Ray Tube Screen	190,84	146,63	240,67
scanner	10,32	5,68	11,78
modem	8,25	6,63	10,59
microwave 500 W	1413,26	572,95	1524,99
microwave 900 W	1547,37	678,21	1689,47
microwave 100 W	515,79	320,32	607,16
*washing machine heat up	1472,1	42	1472,70
*washing machine operation	865,3	234,2	896,43
*bread baking machine heat up	1181,3	27,2	1181,61
*refrigerator low	2,84	0,26	2,85
*refrigerator running mode	115,54	111,89	160,84

Can be locally rescheduled

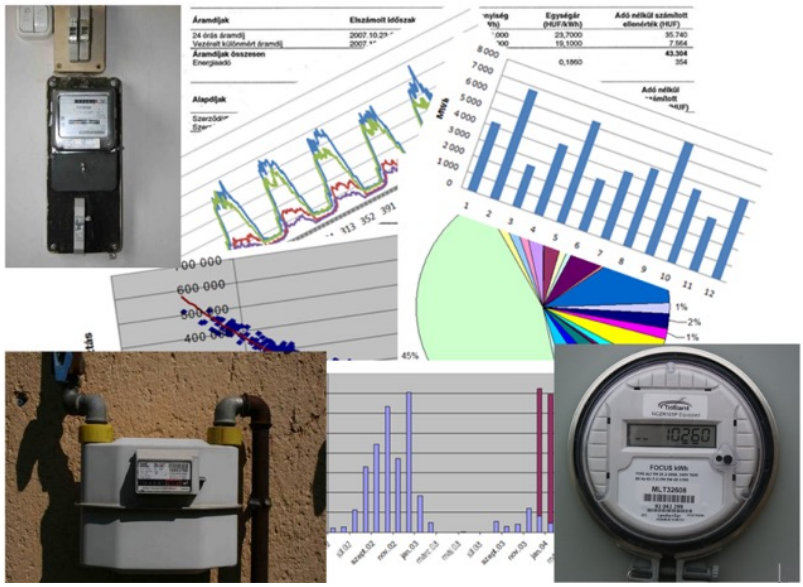
Local power surveillance



Data sources of the energy management

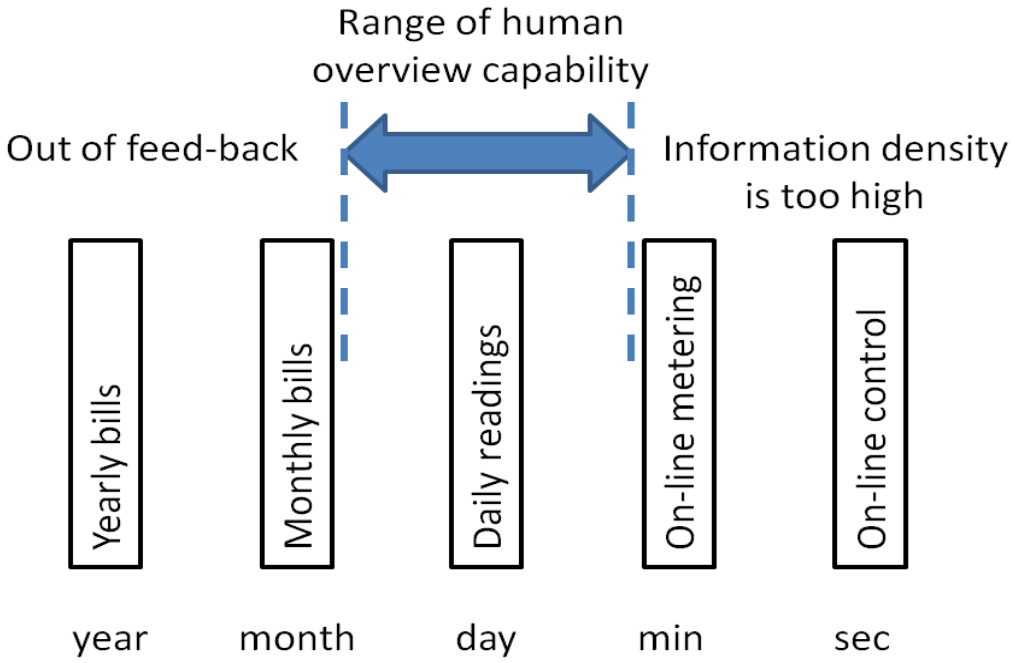
We can get information about our consumption, about our behavior from the following data sources

- yearly bills
- monthly bills
- meters – counters
- on-line meters
- building management systems
- closed loop metering systems and …
- … from the smart meters



The data density and the human interaction

- In case of a yearly frequency of information flow there is no chance to influence, to tune our consumption: Who knows what happened a year ago…?
- The monthly information is not enough to the closed loop, feed-back thinking.
- On the other side if we have daily or minute data, we have no time and capacity to evaluate that continuously.



Focus on the public and home consumption

- **Residential area**
- **Flats**
- **Housing estates**
- **Hospital**
- **Library**
- **Local government office**
- **School**
- **Caretaking home for old people**
- **Kindergarten**
- Industrial buildings
- Office towers
- Malls
- Agricultural buildings

The proposed energy management process

- daily, weekly, monthly amount check and valuation of the consumption (normal, low, extraordinary, etc.)
- daily, weekly, monthly specific values
- limit violation alarm
- schedule and trend monitoring
- recommendation for better scheduling
- cost forecast
- saving potential calculation
- seasonal effects

Smart meters are available

- Electronic (digital) operation based smart meter is planned to replace the currently used power meters.
- Transfer data in both directions.
- Remote controller.
- Continuous control of the tariffs and tariff zones.
- Utility companies like gas, electricity and district heating systems can join the smart metering system.

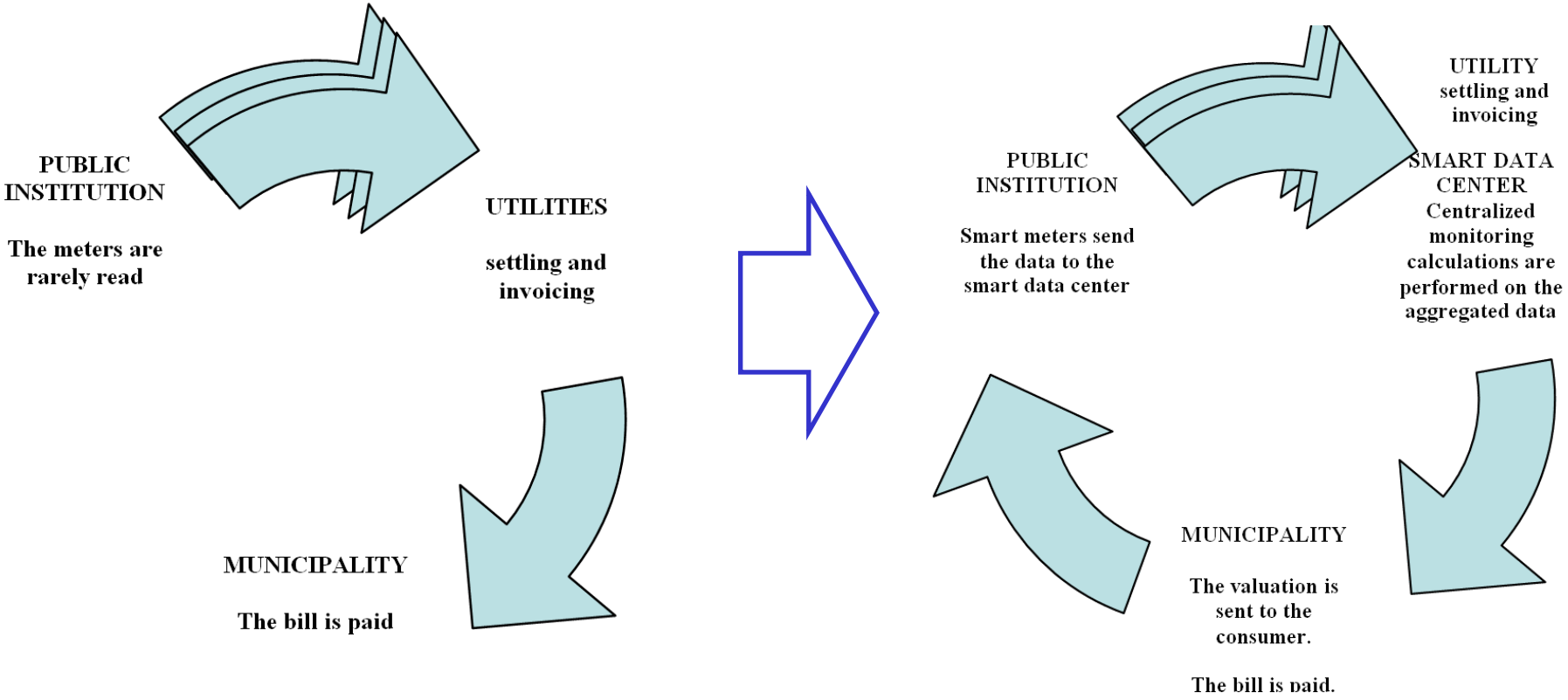
Electricity

Gas

Water

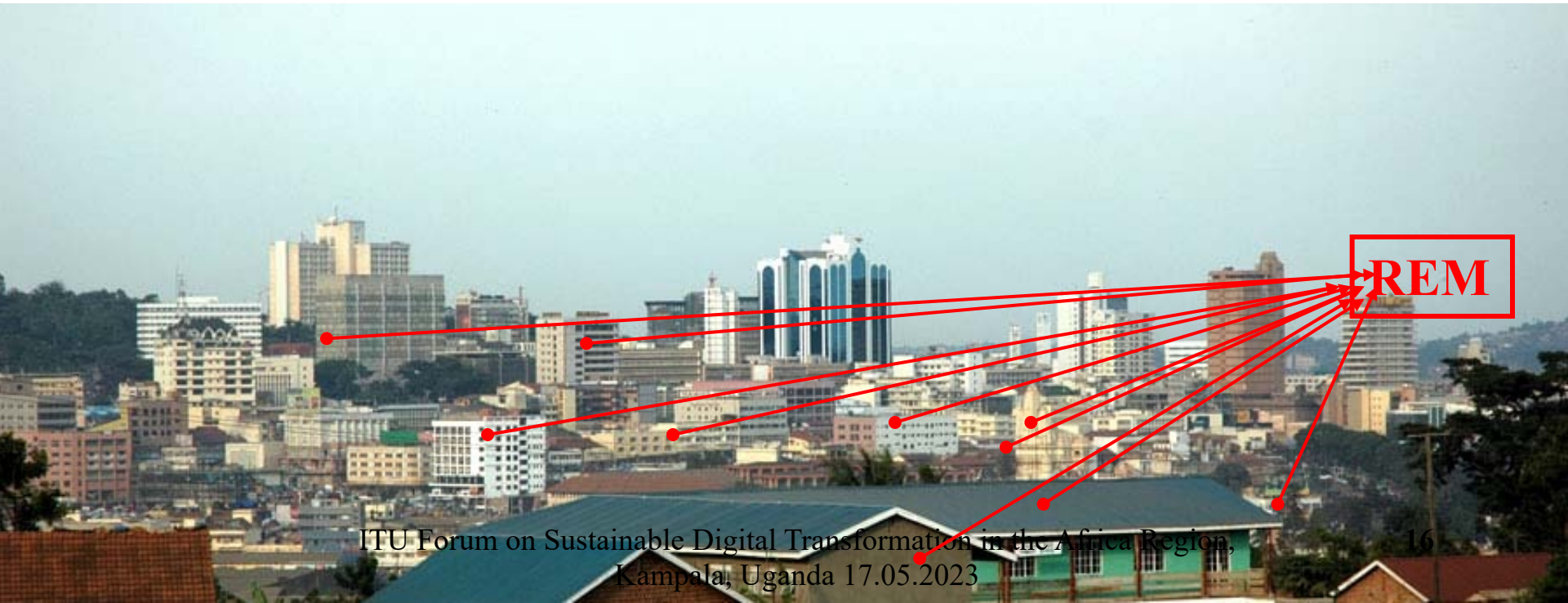
Heat

Close the loop of the energy management process!



The solution

- The customer is not energy specialist
- It is no worth to putting „**on-the-site**” energy management hardware devices
- Smart phone application
- Centralized **Remote Energy Management**



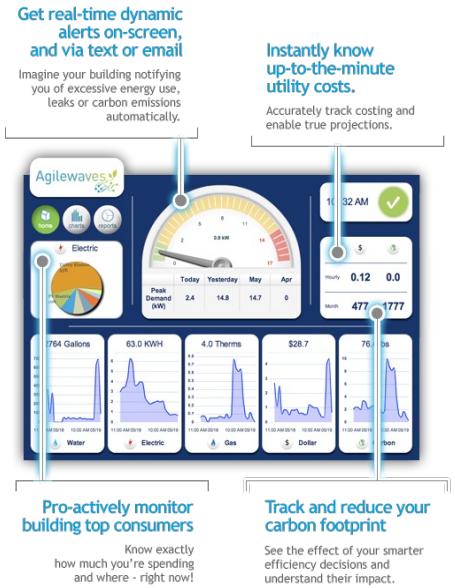
Remote Energy Monitoring applications

GOOGLE POWERMETER

AGILEWAVES

ENERGYHUB

ZigBEE Smart Energy



Possible remote advices for the end-user

- *„The peak temperature tomorrow will be 39 °C. Please do not use your airconditioner at full power. Please make an air change in the early morning time. You can precool your flat.”*
- *„Use your washing machine only after 10 pm. You can save 0,32 EUR. It makes 15,36 EUR per year!”*
- *„Your night consumption was flat, but twice as high as one day ago. Did you turn off all the unnecessary lights during the night?”*
- *„The load neared 10% the contracted current values. In case of overstepping the fuse break the supply. Higher contracted values are recommended.”*
- *Etc.*

Conclusion

- A smart **Balance Manager** Box can be developed for automatic DSM for households
- This HW provides balance between the **load and source**
- The DSM part **adjust** the actual load

- The key to sustainable energy usage is the appropriate **energy management.**
- With **smart meters** and remote energy management system the closed loop intensive energy management can be introduced for such wide but “poor in energy wisdom” areas like the public building or the household sector.
- A high level **application** possibility has been proposed, which makes these meters useful not only for the utility, but for the consumers too
- Through this system the **energy saving** is encouraged on local level makes advantages for national economy too

Thanks for the attention!