NIALM for Smart Buildings

LoReMA

Load Recognition Monitoring and Acting

1st International Workshop on
Non-Intrusive Load Monitoring

Carnegie Mellon University, Pittsburgh, PA
May 7th, 2012

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iHomeLab Research Center
Lucerne University, Switzerland

Agenda

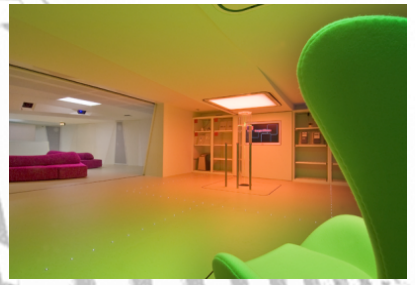
- iHomeLab
- LoReMA
  - Data acquisition
  - Data analysis
  - Data transmission
- Learnings / Outlook

Intelligent living begins here!

i|Home|Lab
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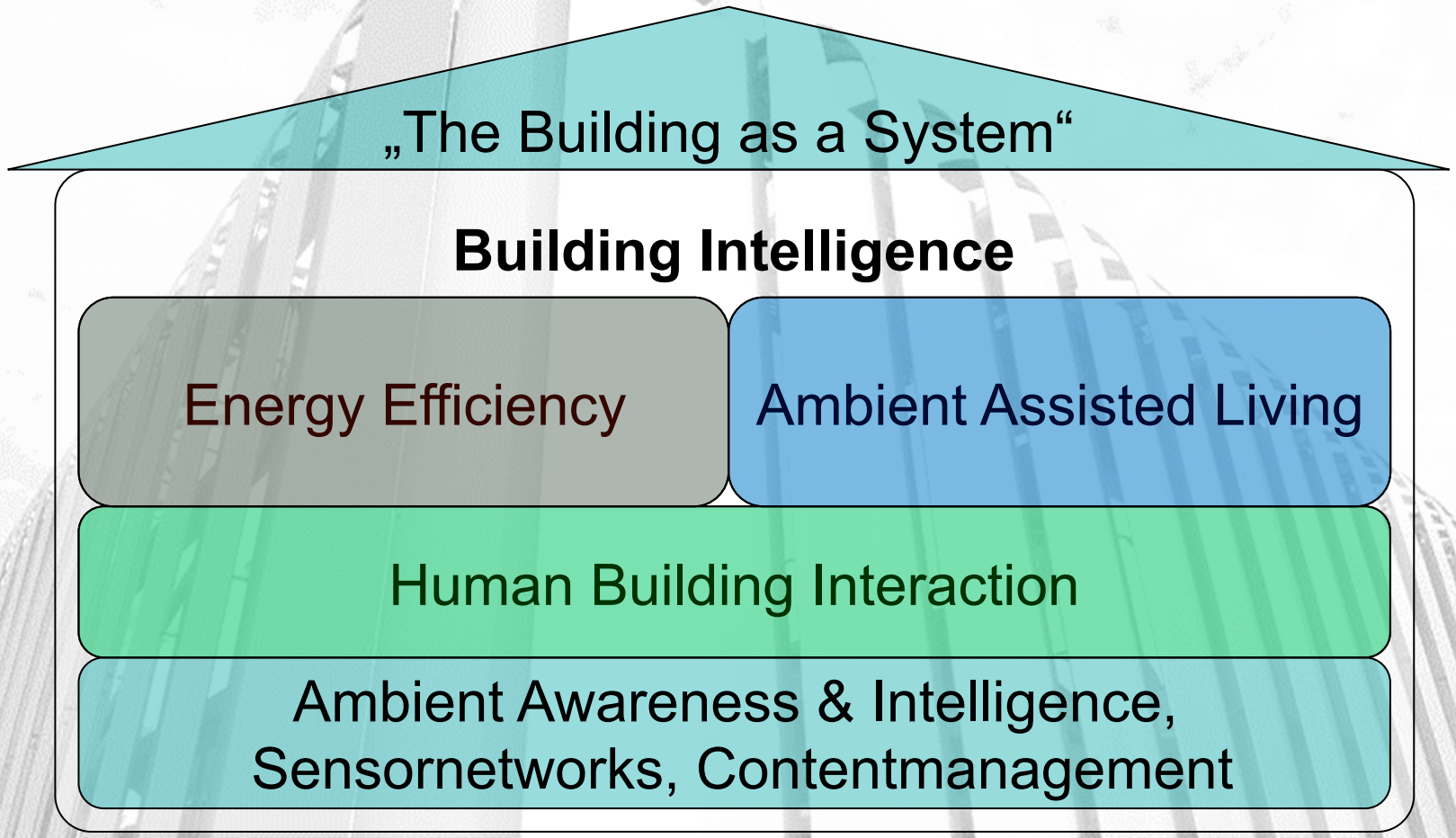








Research Areas



The iHomeLab Research Team

18 Engineers

- Software and firmware development
- Embedded system and PCB design
- Simulation and modeling
- Fast prototyping and testing

Domain knowledge

- **Low power wireless sensor networks**
- **Networking and routing mechanisms**
- **Sensor fusion and context processing**
- **Building intelligence and machine learning**
- **Building automation**

LoReMA: Research project

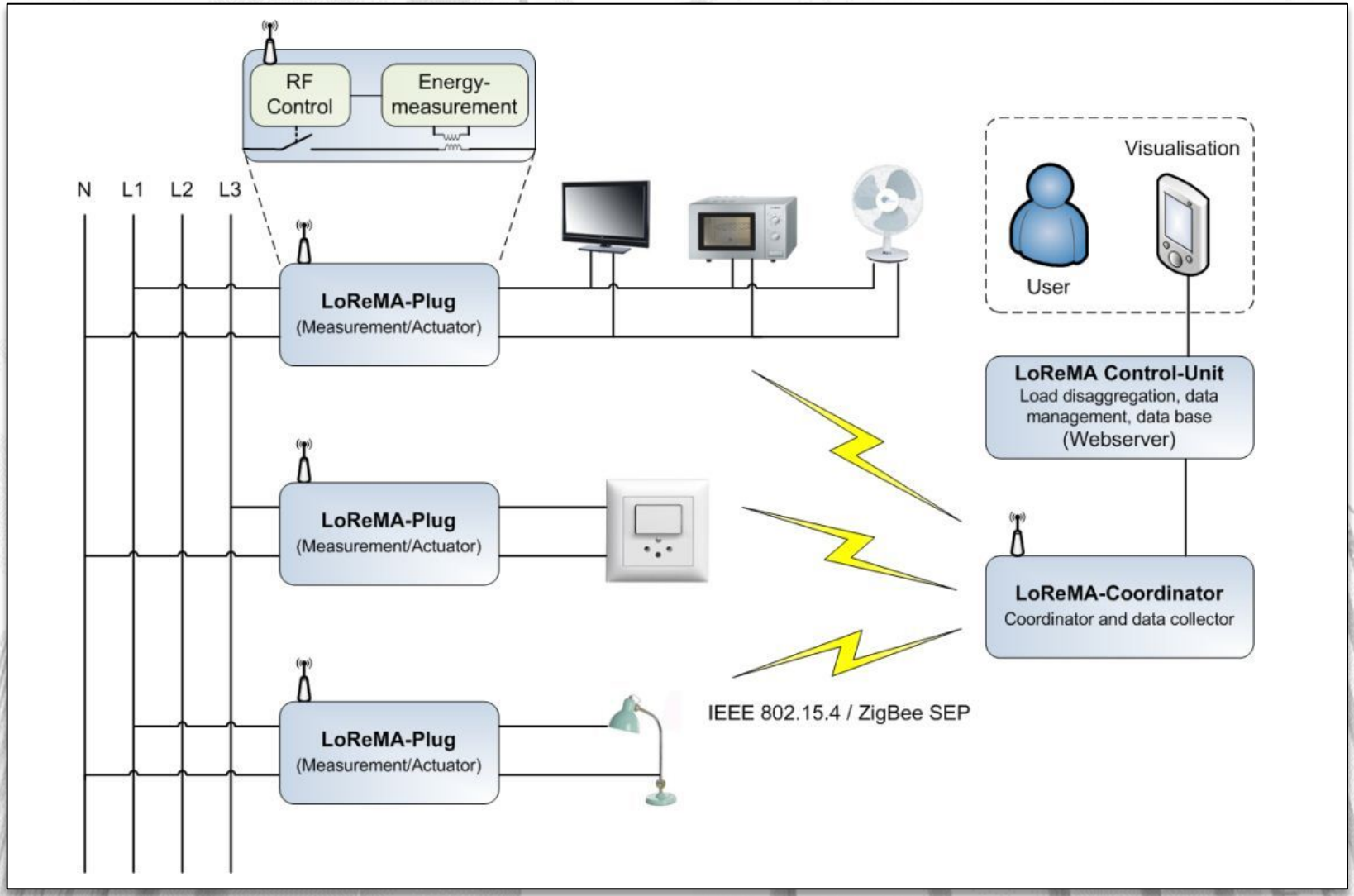
Requirements

- Identify all appliances in households and offices using NIALM for load-disaggregation and increase of energy efficiency
- Decentralized wireless measurement nodes
- Actuating of appliances from the node
- Low power design
- Retrofit and zero installation

Goals

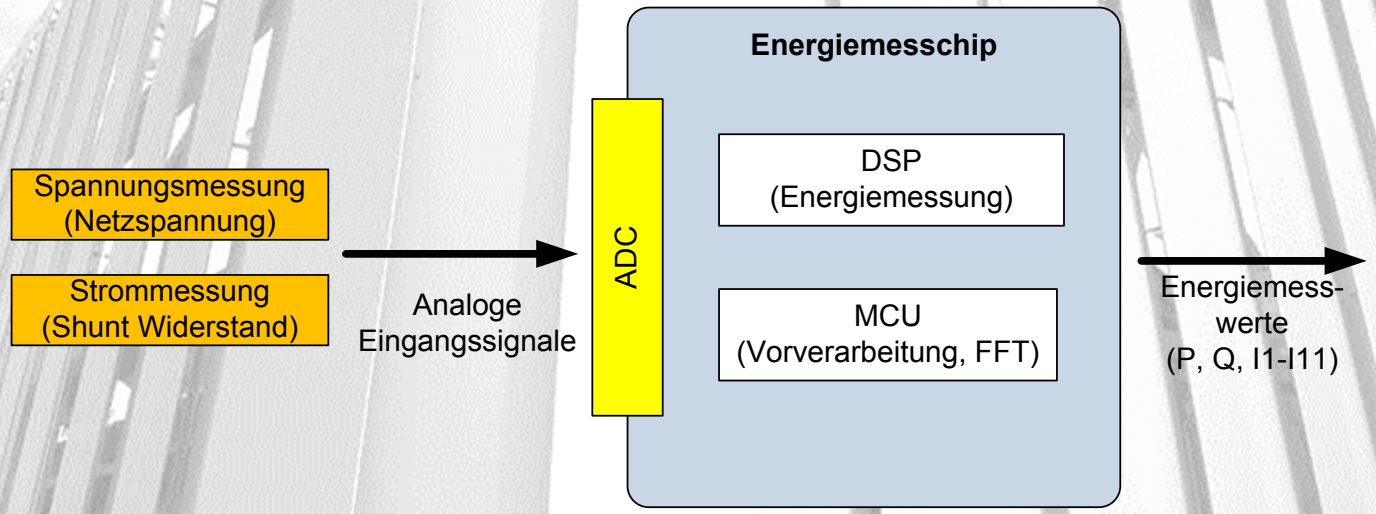
- Proof of the technical concept
- Increase transparency of energy usage
- Development of energy efficiency strategy
- Increase energy efficiency

LoReMA: System overview

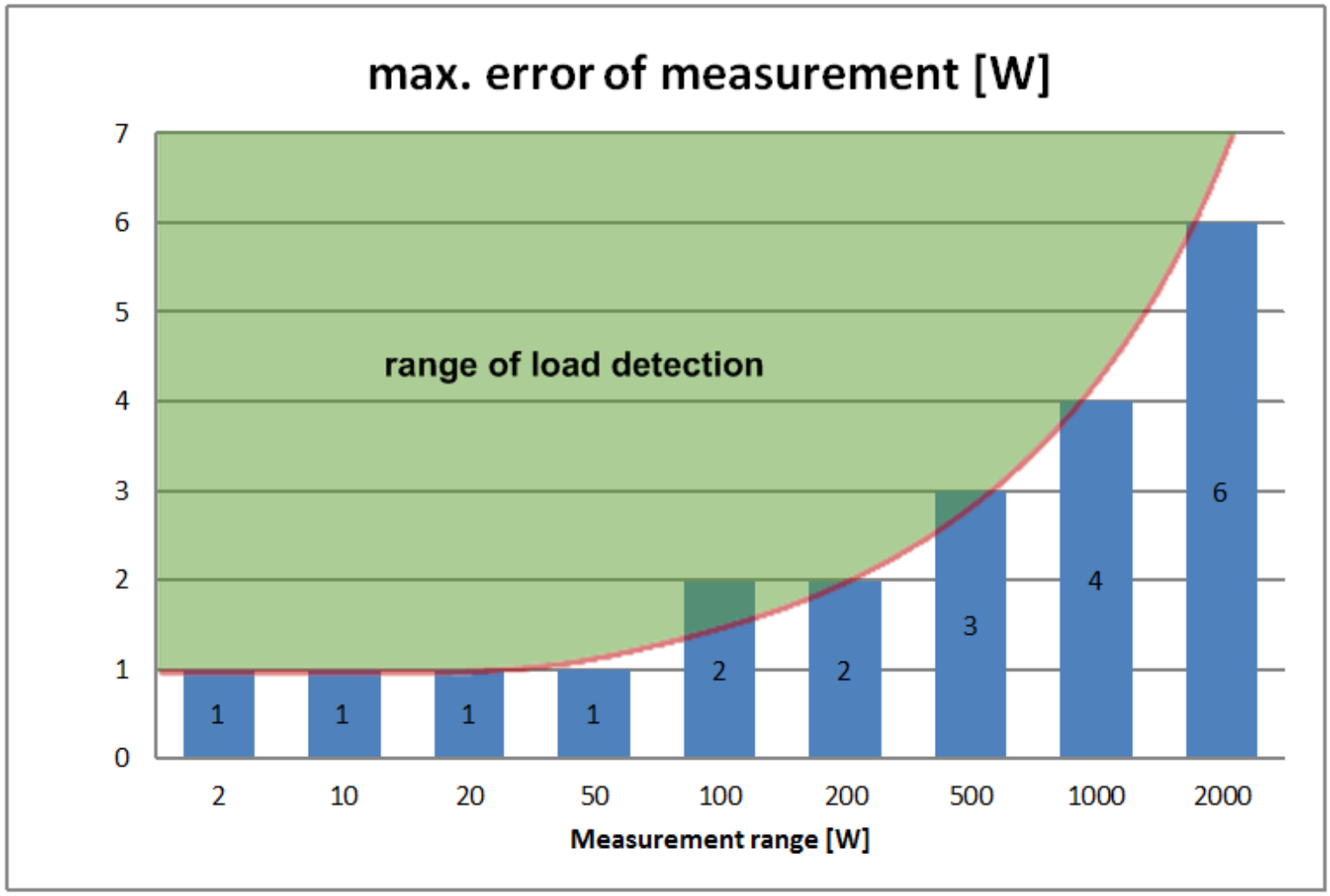


Measurement concept

- Standard components for the measurement unit
- Active power / Reactive power / I RMS and Individual waveform samples on chip
- Sampling rate of 3.2 kHz, 64 measurement at 50 Hz
- **Data Set: active power, reactive power, RMS value of the current and a FFT calculation of: I1, I3, I5, I7, I9, I11**

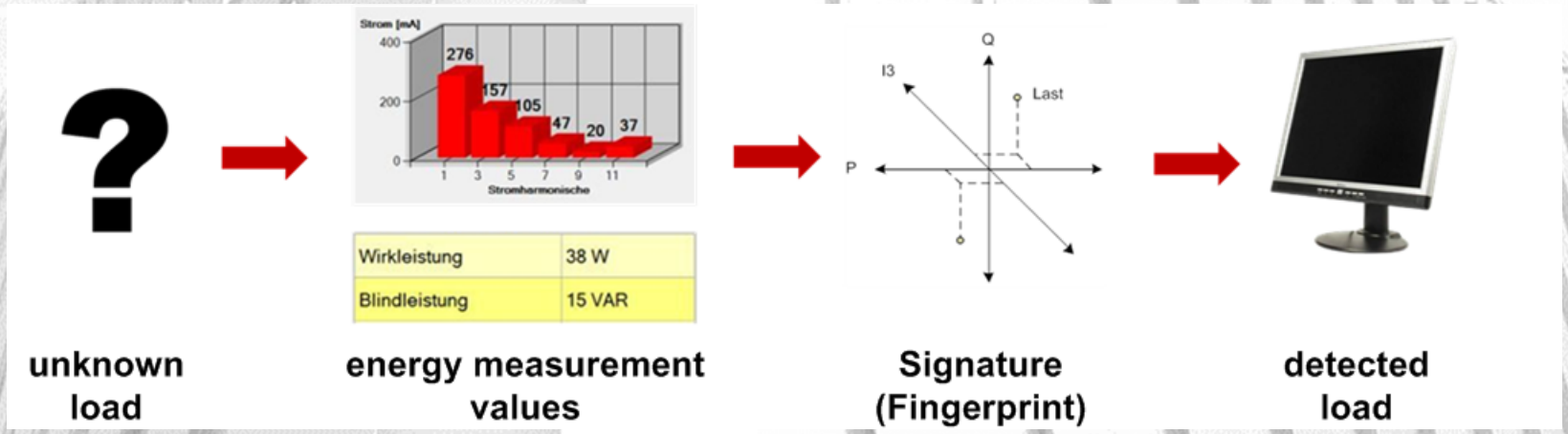


Measurement range



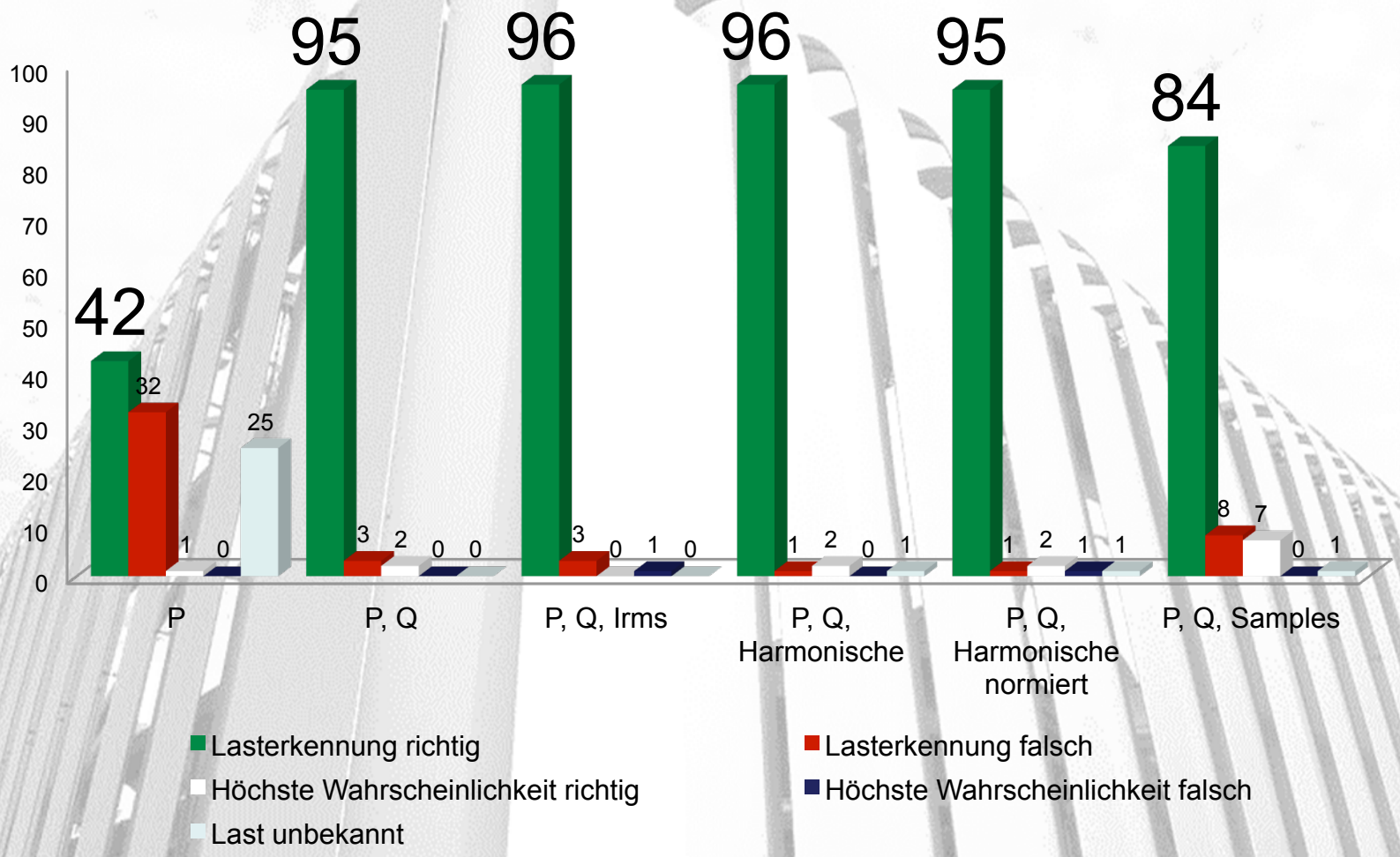
Runtime behavior

1. Load change triggers (P, Q)
2. Wait for steady state
3. Waveform sampling
4. FFT analysis
5. Data set transfer to the central unit for post processing

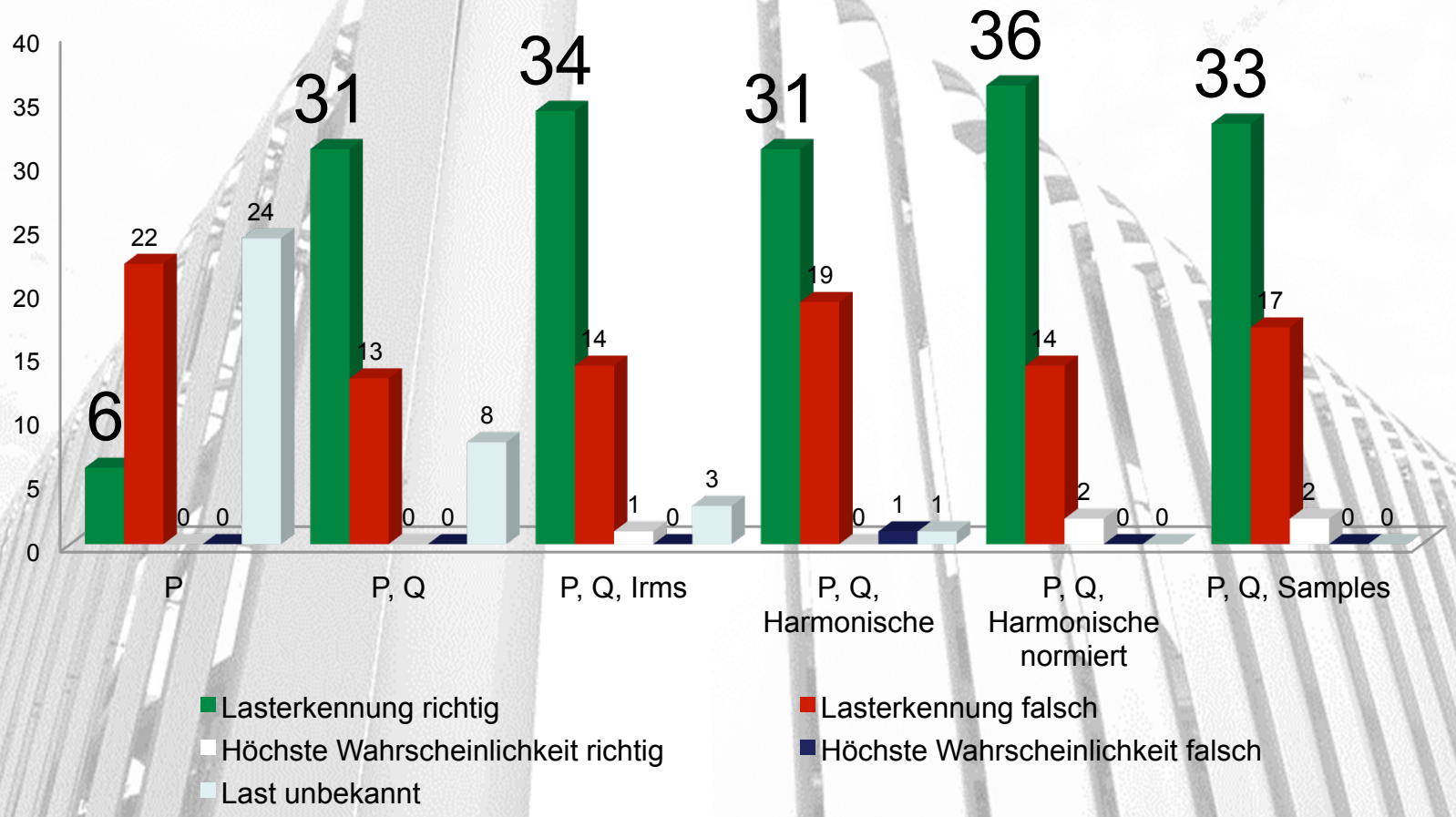


Data set comparison with best matching algorithm

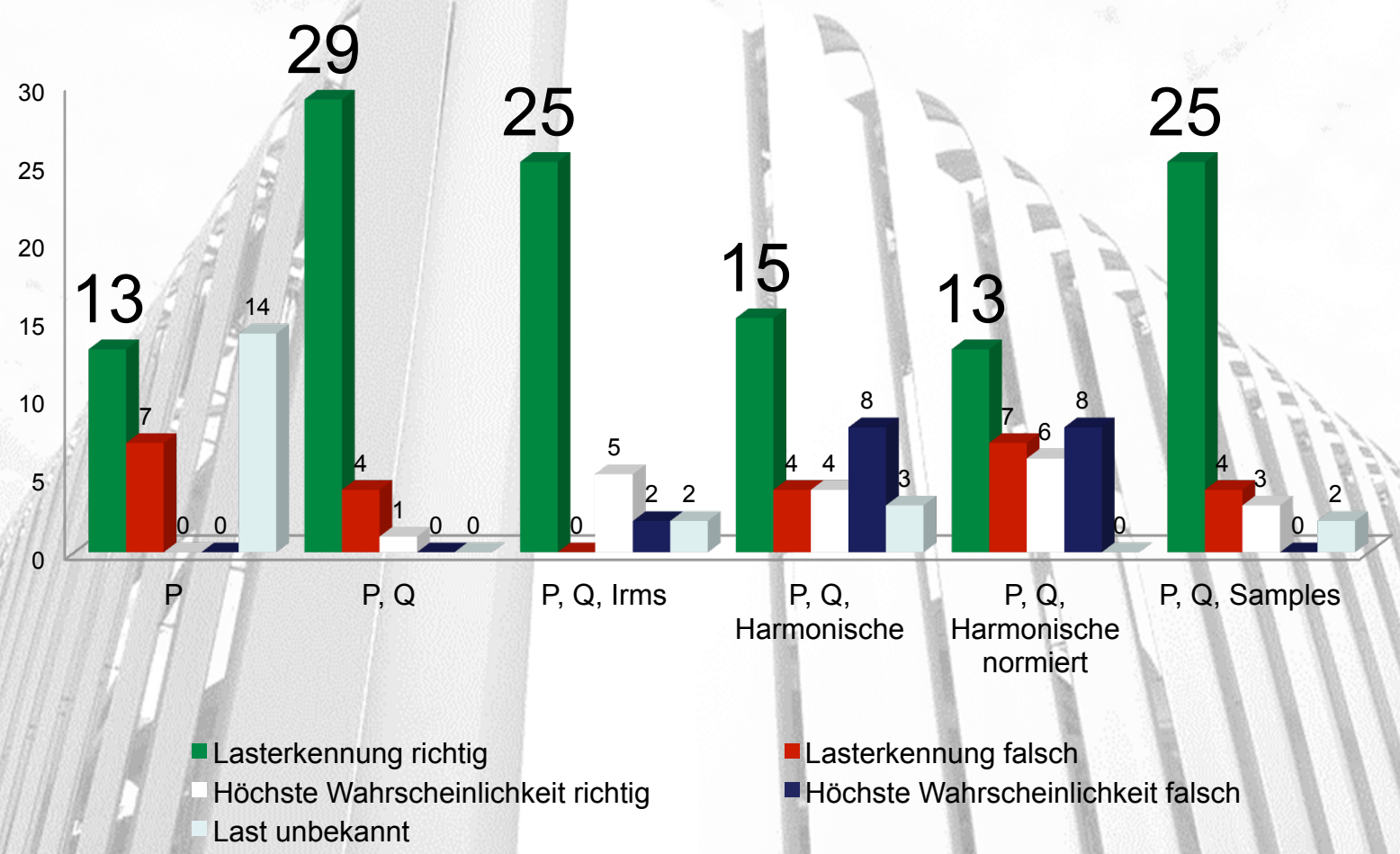
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Best matching algorithm with switched power supplies



Robustness of algorithms when injecting noise according EN50160



ZigBee Network

ZigBee Profile: Smart Energy Profile (SEP)

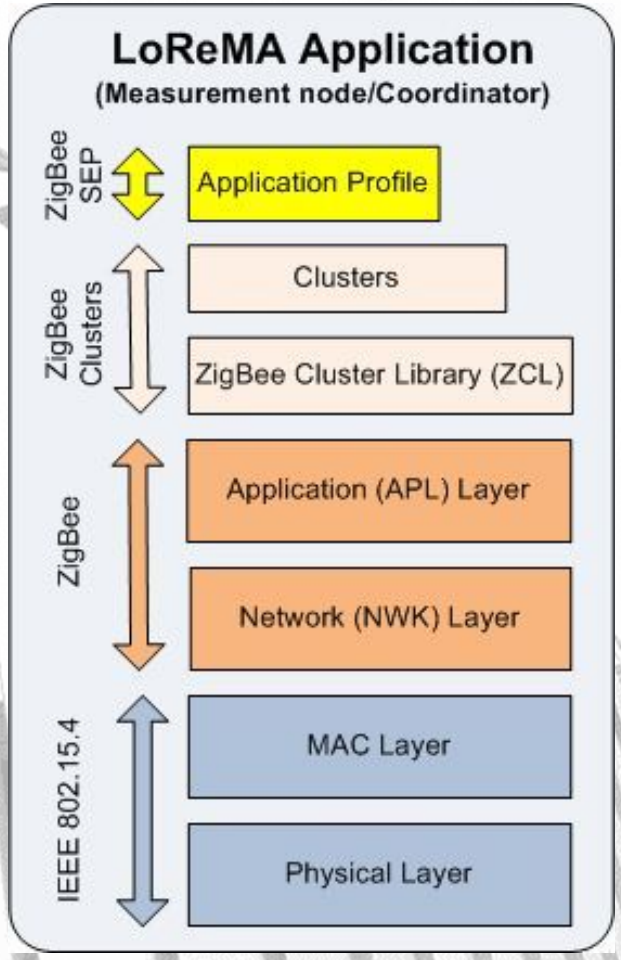
Network topology: Mesh-Network

Smart Energy Devices:

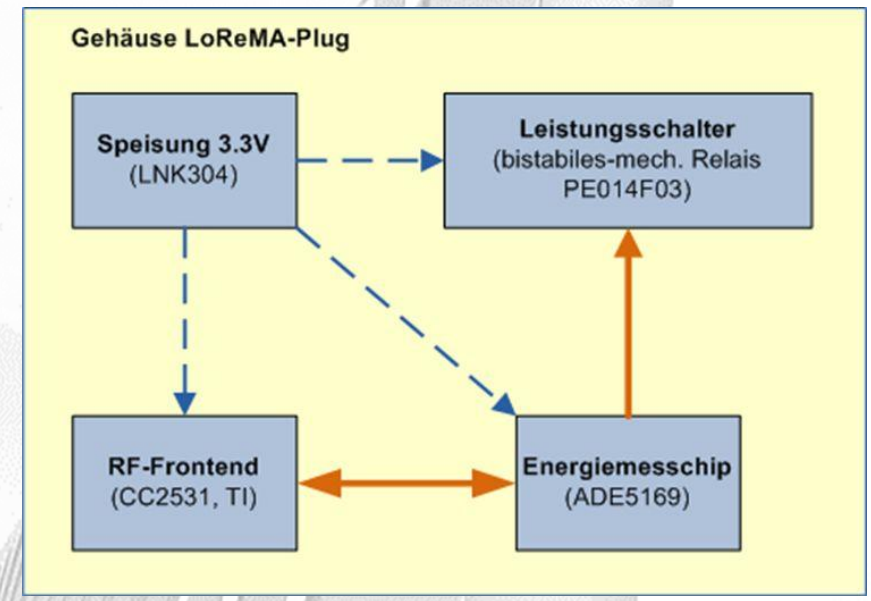
- Metering Device
- Load-Control Device
- Energy Service Portal (ESP)

Coordinator (ESP) as Cluster Head

- Network configuration
- Channel selection
- Assignment of the node ID's (short address)



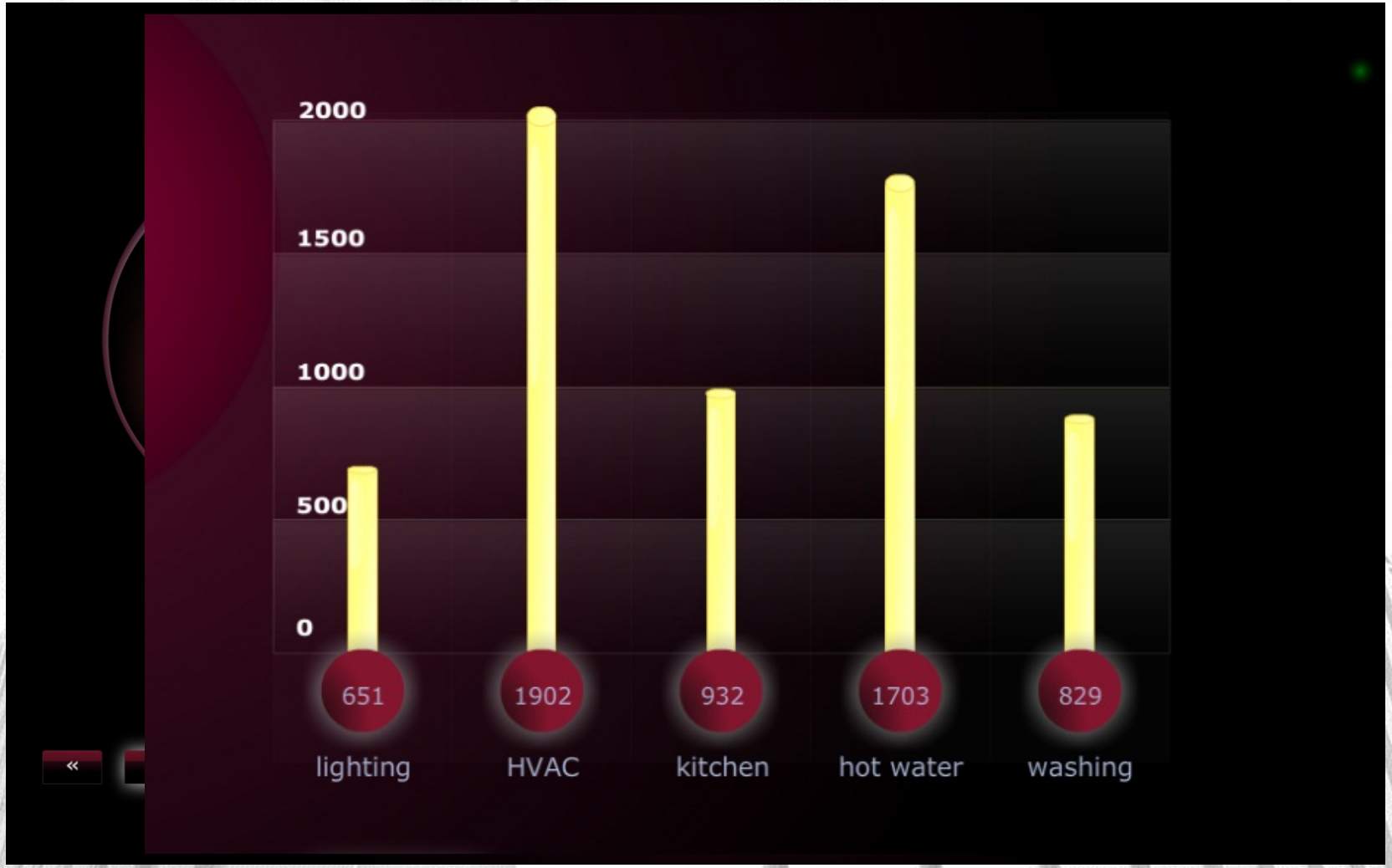
Miniaturization





4.5*5*3 [cm]

End-user information, Load-Disaggregation



End-user information, Energy efficiency tips



End-user information, on the SmartPhone

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Lessons learned

- The various NIALM algorithms have their strengths and weaknesses
- Choosing the correct algorithm depends on the application
- NIALM combined with ambient information can lead to 100 % identification of the appliances
- There is no standard data set definition for energy fingerprints available
- Norming bodies didn’t picked up NIALM until now

Conclusion / Outlook

- We don't have a technology issue with NIALM
- The issues are missing standards and norms which will make it hard for NIALM products to reach the public
- NIALM offers new business and can become a gold mine for system developers, the danger is proprietary standards
- The IEA is interested to explore NIALM in more details in order to understand the necessary next steps required

NIALM can bring transparency to the end-users and increase energy efficiency with out big investment.

Thank you for your attention

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