2016 IERE – CLP-RI Hong Kong Workshop
Smart Cities
A Convergence of People, Technologies and Big Data

Non Intrusive Load Monitoring

innogy SE · Friedrich Schulte · 23 November 2016

Agenda

Big Data in urban environments

Non Intrusive Load Monitoring (NILM[1])

innogy's approach to NILM

[1] also known as NIALM (Non Intrusive Appliance Load Monitoring)

„Big Data" in energy supply is quickly gaining momentum

innogy

Volume, velocity and variety are key characteristics of Big Data

VOLUME
1. GByte
2. TByte
3. PByte
   …

VELOCITY
1. Weekly
2. Daily
3. Seconds
   …

VARIETY
1. Weather data
2. Production Data
3. …

Why Big Data is currently undergoing such a growth in energy business

Trend towards data collection due to
- Smart Meter infrastructure
- Decentralisation of power production
- Market integration of fluctuating RES
- Integration of technological development such as E-mobility, storages

   …

Development is intensified by:
- Low price for data storage / processing power
- Interconnection of components ("Internet-of-things")

   …

**Big Data is on the rise especially in urban environments**

Big cities generate „Big Data" originating from diverse sources

High "data" density due to growing number of

- **Loads**
- **Consumers/ prosumers**
- **Decentralised generation**
- **Grid assets**
- **IT equipment**
- **Data links**
- **Supply systems**
- **Public and individual transport systems**

❶ **Ideal environment to implement data driven energy applications**

❷ **High complexity but still limited availability of data**

❸ **Considerable potential for new business models providing value streams for energy companies and other players**

For many applications gaining access to the data is a key challenge

innogy

Amount of publically accessible data
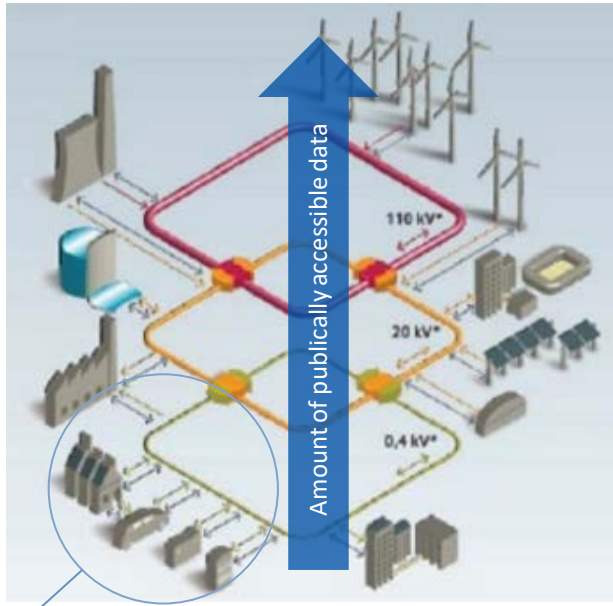
Example[1]
Even though local production or consumption data is already generated, access to it is highly limited. Less constraints, e.g. transparency of neighbouring profiles, could be a boost for decentralised market places.

How can data be

- acquired
- aggregated
- stored and
- transferred

so it can be used in appropriate applications/services also operated by 3rd parties?
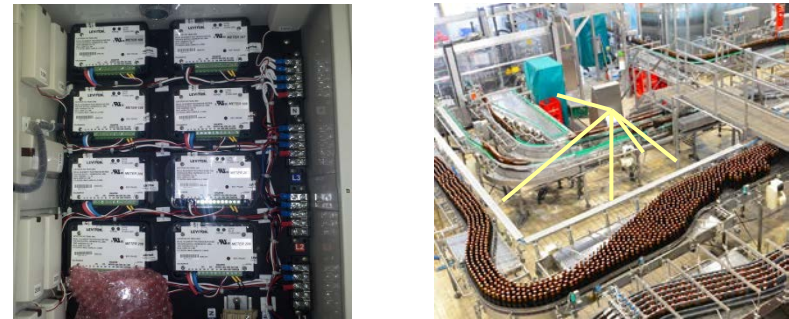
[1] Source of picture: http://www.energienachrichten.net/energiespeicher-sind-fuer-die-energiewende-unerlaesslich/

Technological evolution is obvious in many areas e.g. metering

Ferraris ➡ Smart Meter

Submetering ➡ NILM

+
- Proven long-life hardware

-
- Not appropriate for more sophisticated tariffs (e.g. load dependent)
- Need for on-site measurements

+
- Small and light weighted
- Electronic data interface (incl. remote access)
- Modularity

-
- Security concerns by customers

+
- Commercial off-the-shelf hardware

-
- High installation effort
- Need for synch. of multiple source measurements

+
- One metering point only
- Easy retrofit possible

-
- Feasibility within industrial environment still to be proven
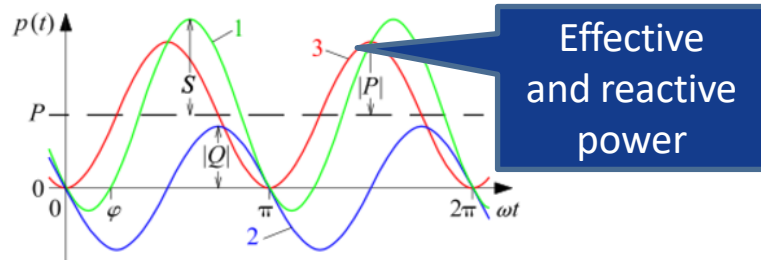
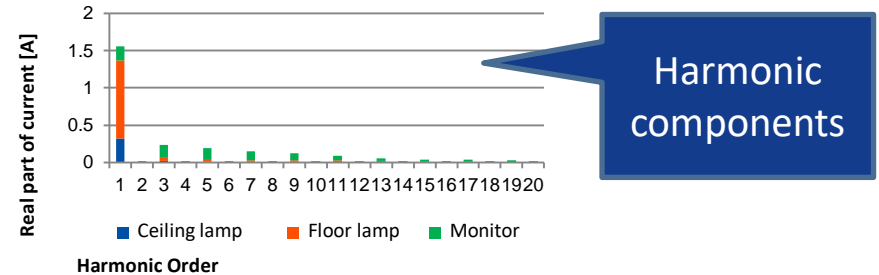# Non Intrusive Load Monitoring is already existent – all solutions share the concept of central metering

innogy

Primary difference is the way technical parameters are processed in order to perform "device fingerprinting"
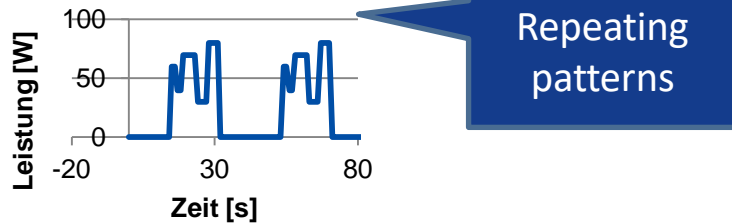
Electric consumption

Effective and reactive power

(Source: Wikipedia)

Harmonic Signature

Harmonic components

(Source: Fraunhofer IMS)

Macroscopic variation in time

Repeating patterns

(Source: Fraunhofer IMS)
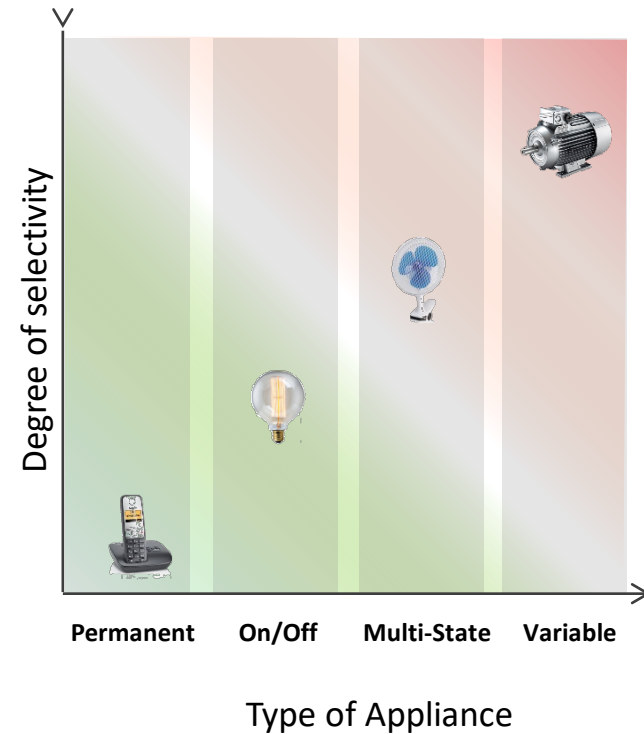
Emitted interference

Disturbances at high frequencies
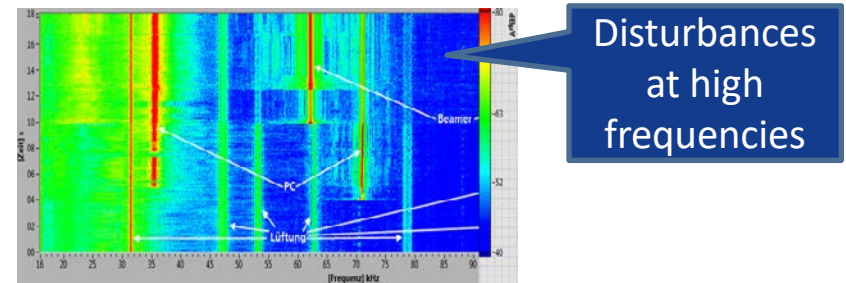
(Source: Fraunhofer IMS)

Commercial products primarily target private households and still deal with major limitations

NILM Market Players
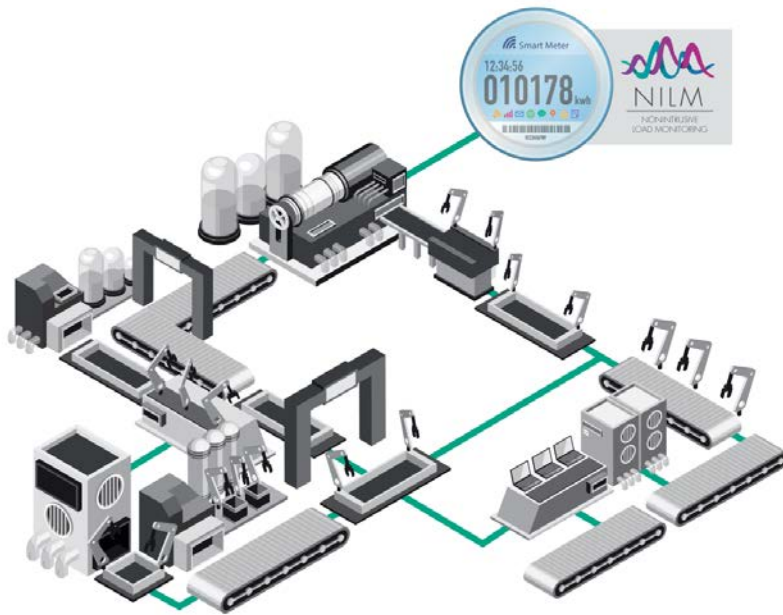
smappee

bidgely

neurio

plotwatt®
Save your energy™

Detection rate strongly varies according to type of appliance

Degree of selectivity

Permanent   On/Off   Multi-State   Variable

Type of Appliance

Future NILM systems will be characterised by highly improved accuracy and plug&play capability

To get the max out of NILM it can be complemented by energy consulting

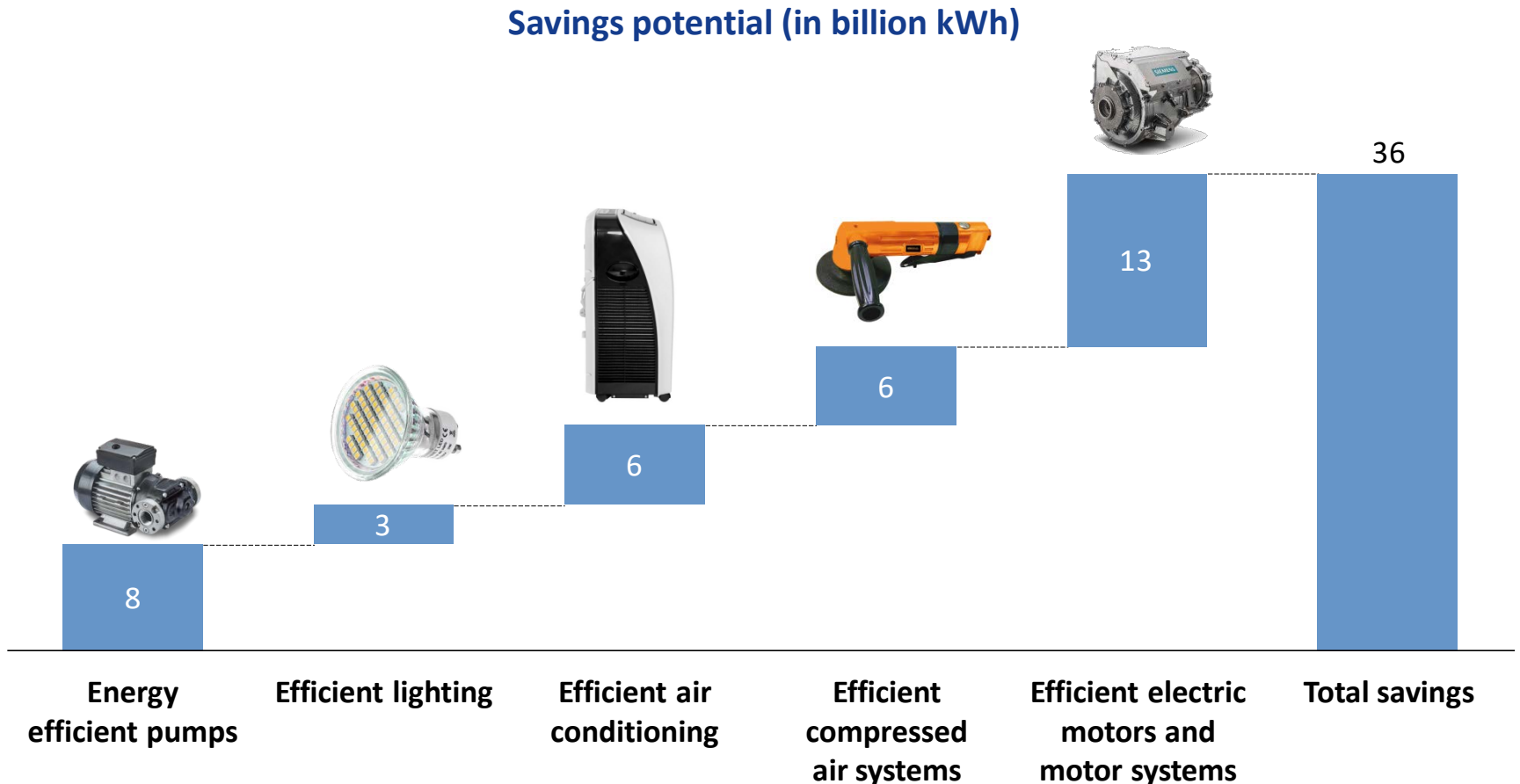Major characteristics of an ideal NILM system

- Easy to integrate into electrical installation or already part of Smart Meter
- High accuracy for all types of devices
- Operation in industrial environment possible
- Accessible from local/remote work places (also by 3rd parties)
- Affordable

NILM has the potential to become a key component for the purpose of energy measurement and efficiency

Just within industry there is a significant potential to save electricity

Within the 5 most promising areas, savings amount to 36 billion kWh

Savings potential (in billion kWh)

Energy efficient pumps	Efficient lighting	Efficient air conditioning	Efficient compressed air systems	Efficient electric motors and motor systems	Total savings
8	3	6	6	13	36

[1] According to study „Energieeffizienz: Potenziale, volkswirtschaftliche Effekte und innovative Handlungs- und Förderfelder für die Nationale Klimaschutzinitiative" (ifeu, Fraunhofer ISI et al.; scope Germany)

A NILM project has been launched to exploit the full potential of this technology
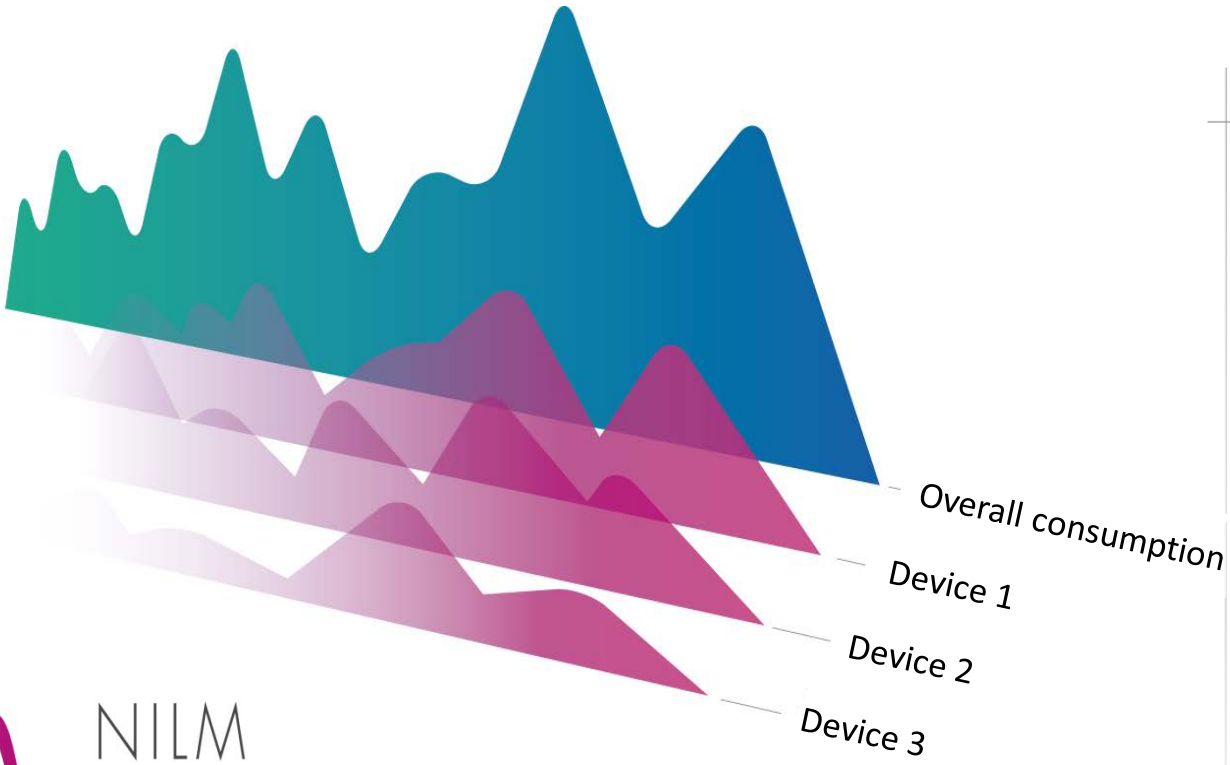
Project duration

2 years
(Oct. 2015 – Oct. 2017)

Project-executing agency

Supported by:

Federal Ministry of Economics and Technology

on the basis of a decision by the German Bundestag

A NILM project has been launched to exploit the full potential of this technology

Objective

- Identify appropriate machinery within **SME** and **industry** for the purpose of energy efficiency

- Based on practical experience develop a **highly reliable NILM** system

- Further **improve accuracy** in comparison to already existing NILM solutions

- Create **intuitive user interface** that can be accessed from remote destinations

Competences of other partners

- **Discovergy GmbH -** Supplier of intelligent Smart Meter solutions and country wide metering-point operator

- **EasyMeter GmbH -** Development and production of future-oriented modular metering solutions

- **Fraunhofer IMS (Leitung) -** Research, development and pilot manufacturing of microelectronic solutions

- **GreenPocket GmbH -** Software specialist for IoT and Smart Energy solutions

Role of innogy

- **Interface** to SME and industrial customers

- Develop comprehensive **requirements analyses**

- Coordinate **measurement campaign** involving up to 15 customers

- Assist in **energy consulting** to exploit full savings potential

Involving Customers at an early stage provides valuable insights to define desired product features

innogy

Field tests are also vital to practically validate NILM in industrial environments[1]

Bakery

Metal Processing

Champignons farm

Recycling

[1] A practical challenge could be to cope with multiple devices of the same type, electromagnetic interference, high currents etc.

Involving Customers at an early stage provides valuable insights to define desired product features

Field tests are also vital to practically validate NILM in industrial environments[1]

Bakery

- Agitator
- Kneading machine
- Ovens
- Lighting

Metal Processing

- CNC machines
- Cargo cranes
- Lighting

Champignons farm

- Heating and air conditioning
- Conveyor belts
- Lighting

Recycling

- Conveyor belts
- Squeezing machines
- Lighting

[1] A practical challenge could be to cope with multiple devices of the same type, electromagnetic interference, high currents etc.

Accuracy of Non Intrusive Load Monitoring can be further increased by technical measures

Subject of a recent patent application is signal coupling which allows for device identification even in the case of variability[1] or similarity[2]
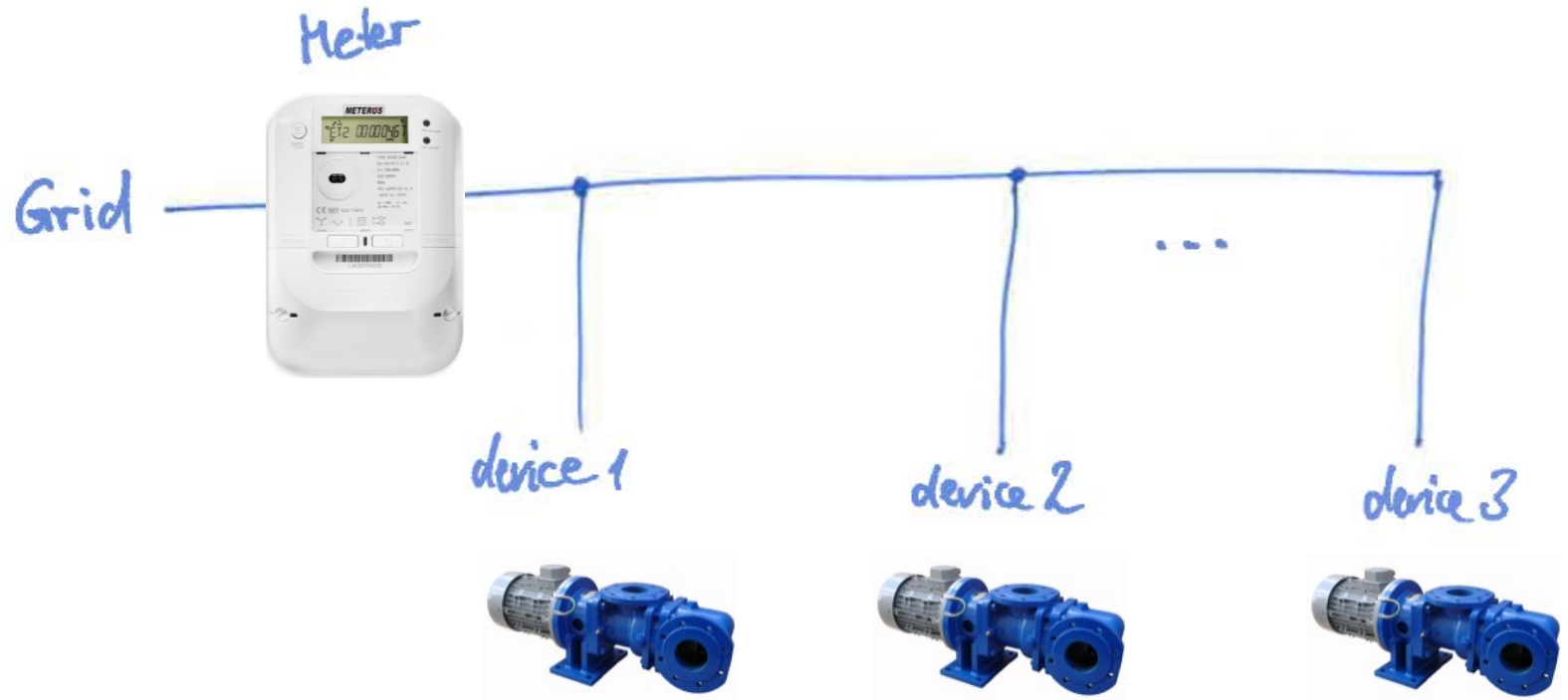
[1] variable loads such as motors are operated

[2] devices with similar fingerprints (e.g. devices of the same type) are operated

Accuracy of Non Intrusive Load Monitoring can be further increased by technical measures

Subject of a recent patent application is signal coupling which allows for device identification even in the case of variability[1] or similarity[2]
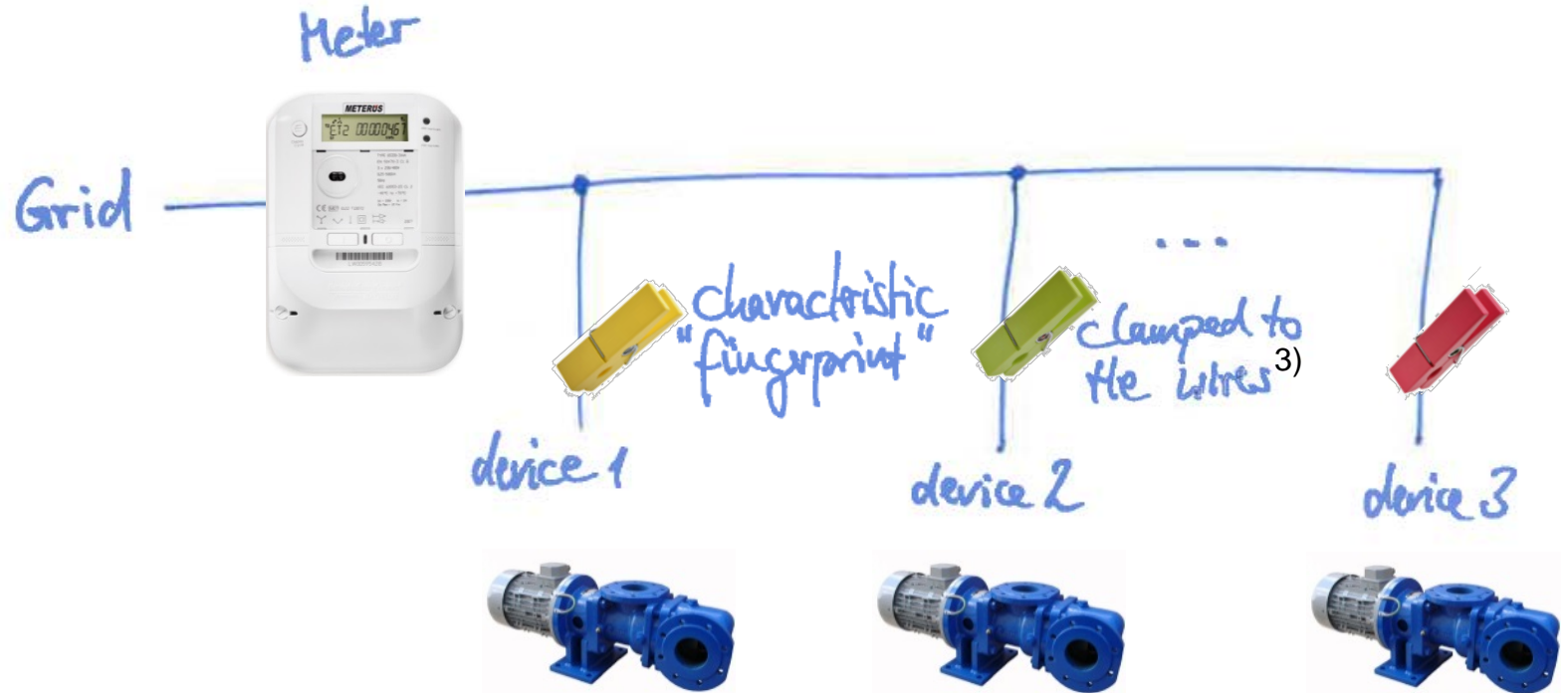

[1] variable loads such as motors are operated

[2] devices with similar fingerprints (e.g. devices of the same type) are operated

[3] both active and passive realisation possible (e.g. composed of electromagnetic field affecting coil combined with characteristic load)

Thank you for your attention

Gunnar Hoffmann
Project Lead NILM

T +49 201 12-15464
Gunnar.Hoffmann@innogy.com

Friedrich Schulte
Head of Technology/ R&D Strategy

T +49 201 12-15460
Friedrich.Schulte@innogy.com

Jens Klein

T +49 201 12-44827
Jens.Klein@innogy.com

Munib Amin

T +49 201 12-44826
Munib.Amin@innogy.com

Denise Wilms

T +49 201 12-44635
Denise.Wilms@innogy.com

Thorsten Miltkau

T +49 201 12-15466
Thorsten.Miltkau@innogy.com

Max Voss

T +49 201 12-15469
Max.Voss@innogy.com

innogy