ADAPTRICITY
Planning Smarter Grids

Results of SoloGrid pilot project

Decentralized load management to increase the efficiency of local energy communities

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Spinoff ETH zürich

Adaptricity Partner for digitizing grid operators

March 2014	Founding Vision – Digital & Efficient Power Grids
Since 2014	Strong Growth in DACH Area
February 2017	Majority Acquisition by LEONI Group
Since 2018	Market Expansion: Europe & Asia & Australia
Today	Strong Innovation Partner for Grid Planning, Asset Management and Digitization

bayernwerk

Netze Mittelbaden

NETZOÖ Ein Unternehmen der Energie AG

IWB

STADTWERK WINTERTHUR

Adaptricity Platform

Our Solutions

Input Data

- Grid topology (GIS, …)
- Generation data (PV, Wind, …)
- Customer data (yearly consumption, structural information)
- Meter data (smart meters, metered large-scale consumers)

ADAPTRICITY

Data integration and conversion	Cloud management	Multi-platform visualization
Data cleaning and completion	Time-series simulation engine	Analytics engine
Data enrichment	Load flow model	Decision support

Interfaces (Grid simulation tools, GIS, MATLAB / Python / R, CSV, SXM, …)

- **Usage of time-series data, physical models and artificial intelligence**
- **Grid simulations using all available utility-scale grid data (grid models and measurements)**
- **Cloud-based parallelized grid simulations (what-if)**
- **Big data analytics & process automation**

Applications

- Grid planning
- Prosumer simulation
- Data analytics
- Monitoring
- Asset management

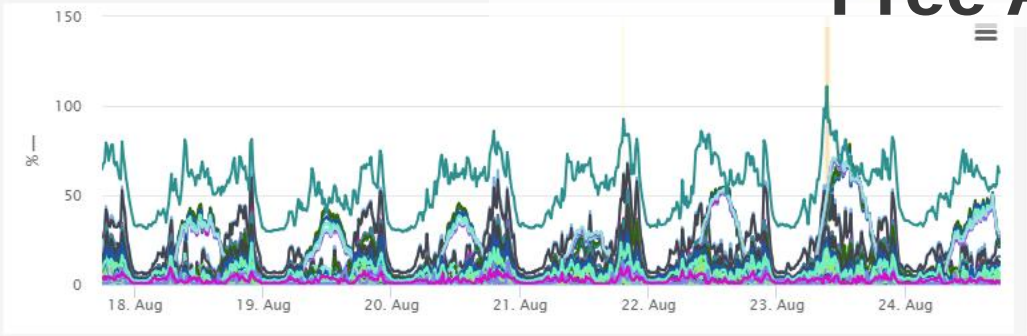
Adaptricity Platform

Our Solutions

ADAPTRICITY.PLAN	ADAPTRICITY.SIM	ADAPTRICITY.MON
.Efficient	.Smart	.Live
Streamlined engineering processes for grid planning	Intelligent, data-driven grid analytics	Real-time LV & MV monitoring

Adaptricity.Plan Launch in September 2018
Licenses for 1'000 DSOs in DACH

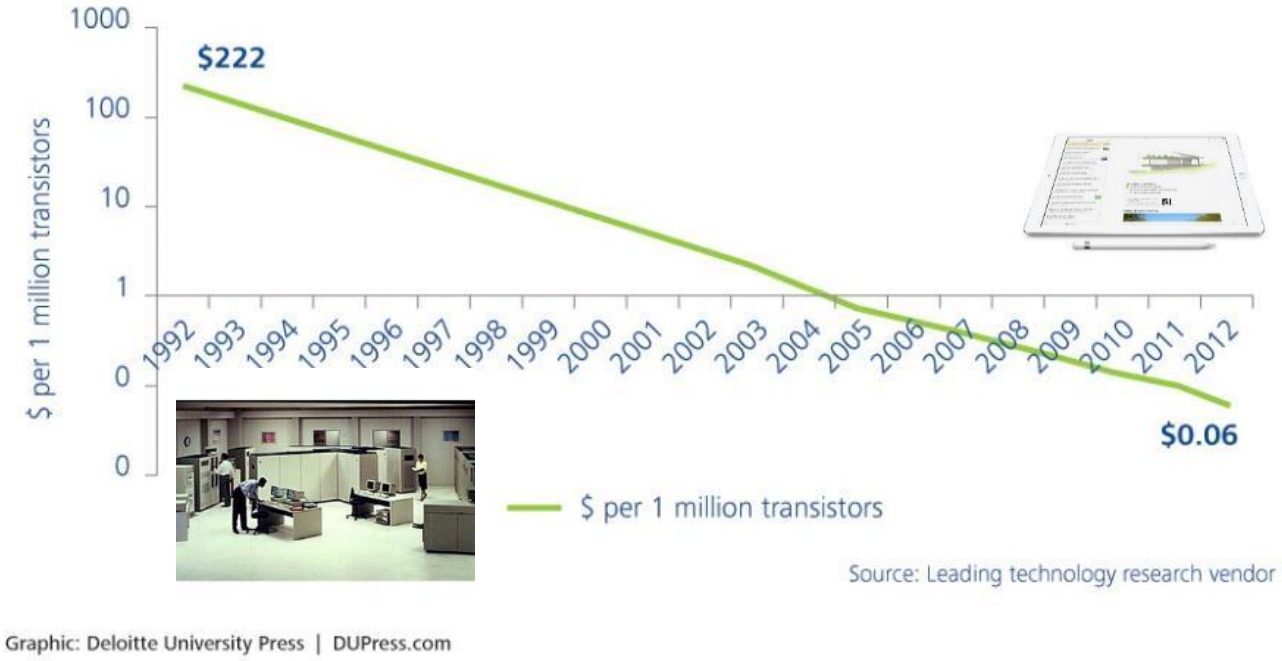
Free Academic Licenses!



Digitization trend in the electricity grid

Cost developments as driver for change

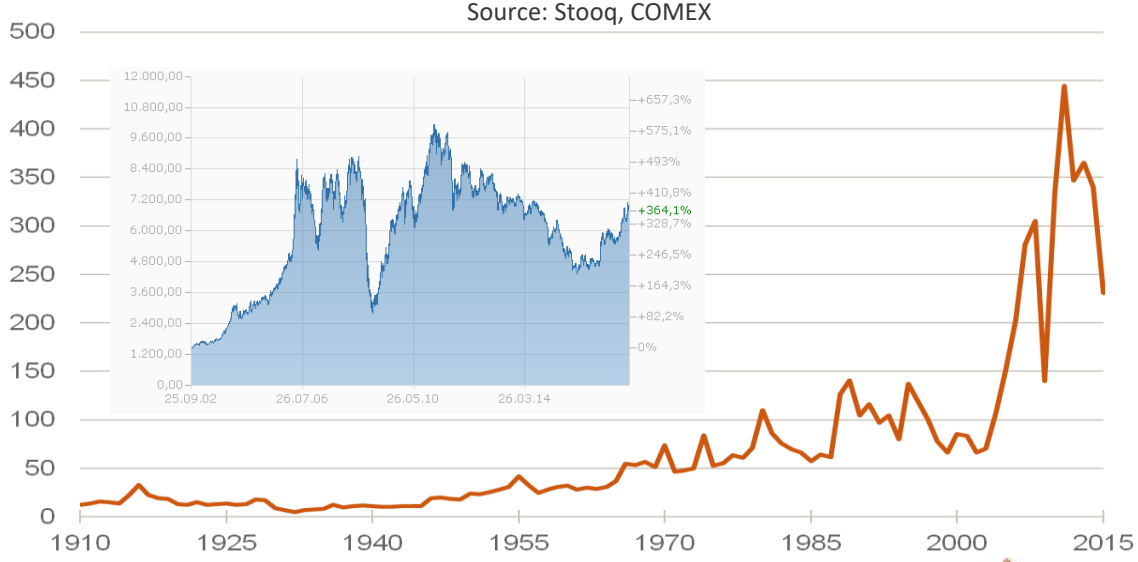
Comparison – Computation Power and Computation Cost (1992-2012)

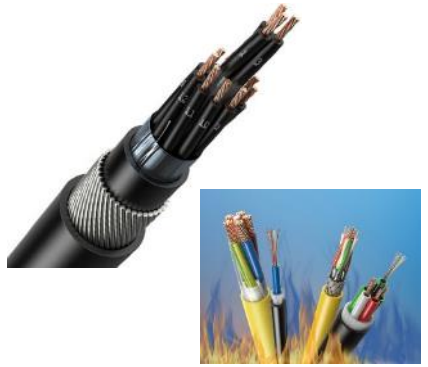


Graphic: Deloitte University Press | DUPress.com

Copper Prices over last 100 years

Source: Stooq, COMEX





Digitization trend in the electricity grid

SmartGrid = sensors & actuators + sensible usage

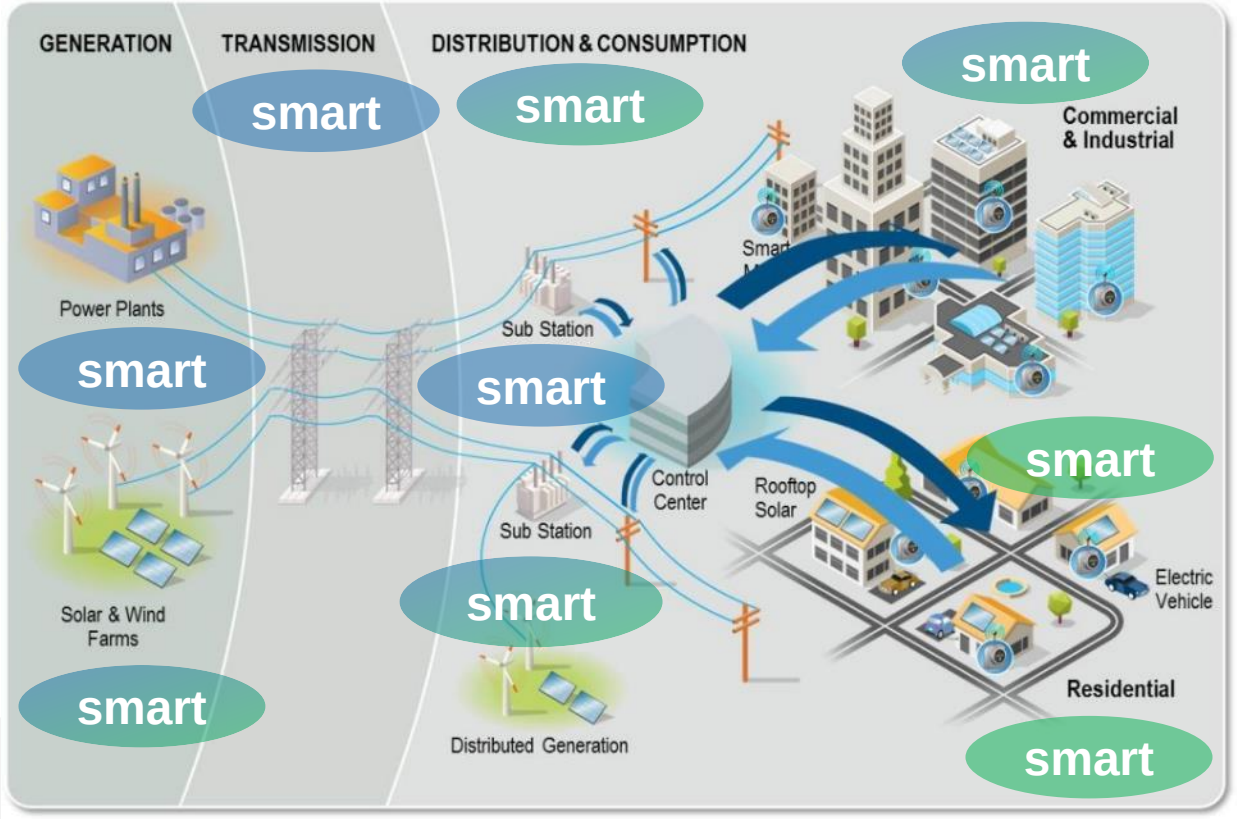
Transition Passive grid operation (more cables) → Active grid operation (ICT, energy management)

Costs Grid Maintenance 1.4 billion CHF per year (Swiss Federal Office of Energy)

Grid expansion 18 billion CHF **+** ICT: ca. 1.3 billion CHF

Status Quo

Trend

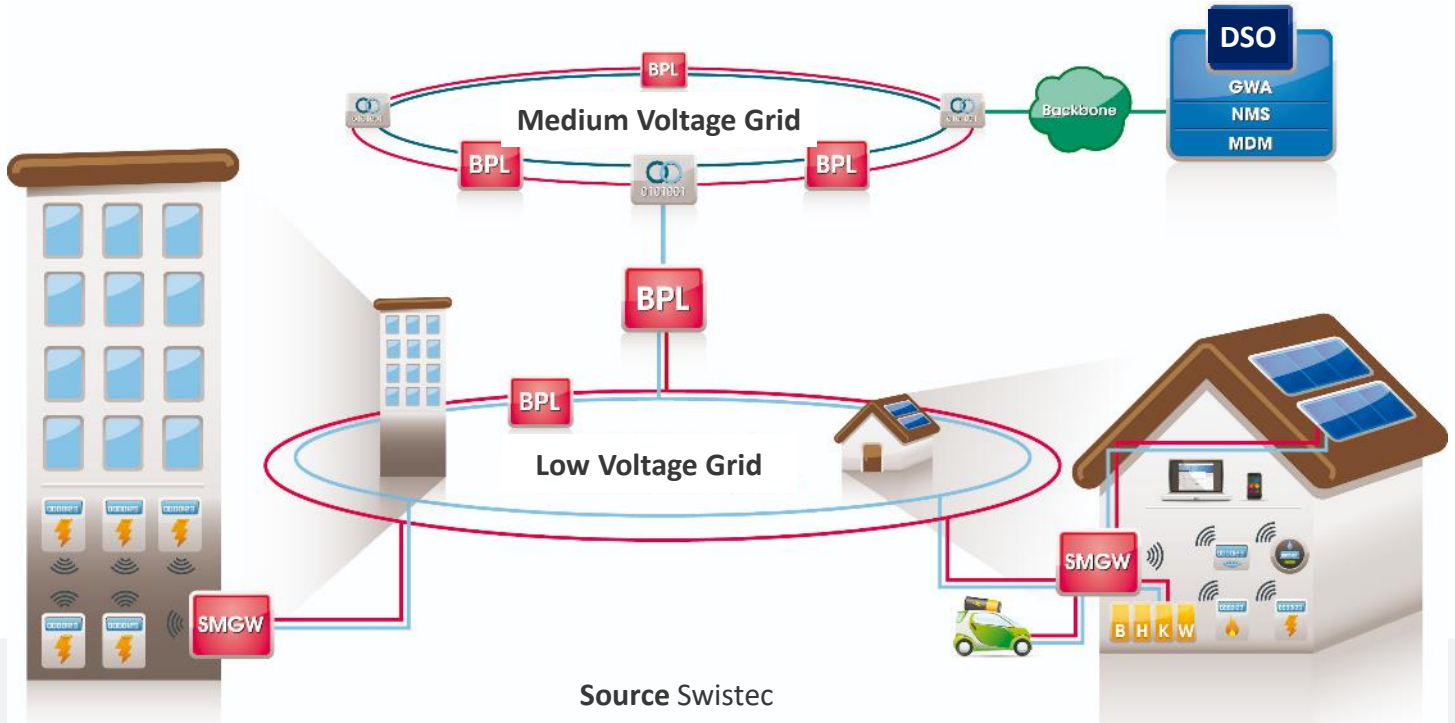


Digitization trend in the electricity grid

Better ICT opens up new opportunities – BPL (Broadband over Powerline) versus classic Ripple Control

- **Classic ripple control**
  - feed-forward control, i.e. switching of **large appliance groups** in few distribution grid areas, **high latency** (min.)
  - Example: larger city (~200'000 households), 40 MW flexible loads, ~12 control groups, no direct monitoring possible

- **BPL-based ripple control**
  - feedback control, i.e. monitoring and control of **individual household applicances**, **low latency** (sec.)
  - IEEE Standard 1901-2010 (Dec. 2010) for high speed communication devices (up to 500 Mbit/s at physical layer)



Source Swistec

SoloGrid
Leuchtturmprojekt für die Energiezukunft

SFOE Lighthouse project SoloGrid (2015–2017)

Data analytics of large data sets of distribution grid and prosumer measurements

Project Scope & Grid Analytics

- Analysis of future grid challenges (PV, EVs, HPs) using *real* distribution grid data in Solothurn (Riedholz)
- Validation of AI-based GridSense load management technology
- Integration of 2 GB grid data / month (real data = faulty, incomplete data)
- Quantitative analysis and visualization of grid dynamics
- **Publication at CIRED Workshop 2018**

Electric boilers

Grid Operator

Photovoltaic

Heat pumps

EV chargers

Electric boilers

Grid Operator

Photovoltaic

House batteries

Heat pumps

EV chargers

Heat pumps

Grid Operator

Electric boilers

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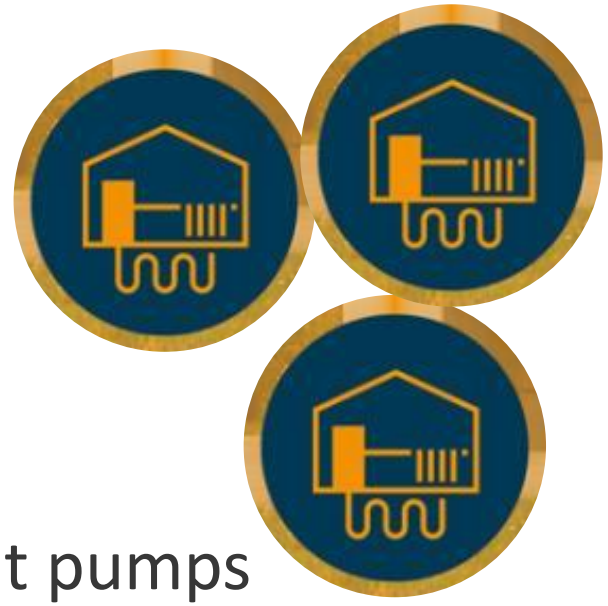
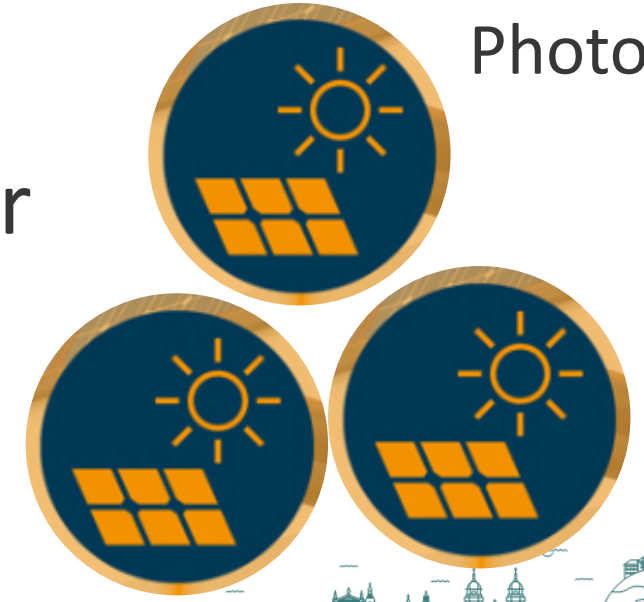


Heat pumps

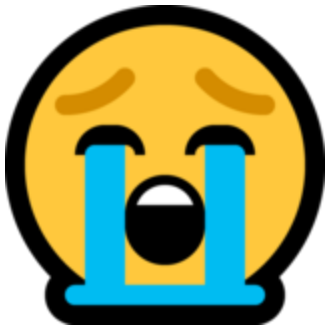
Photovoltaic



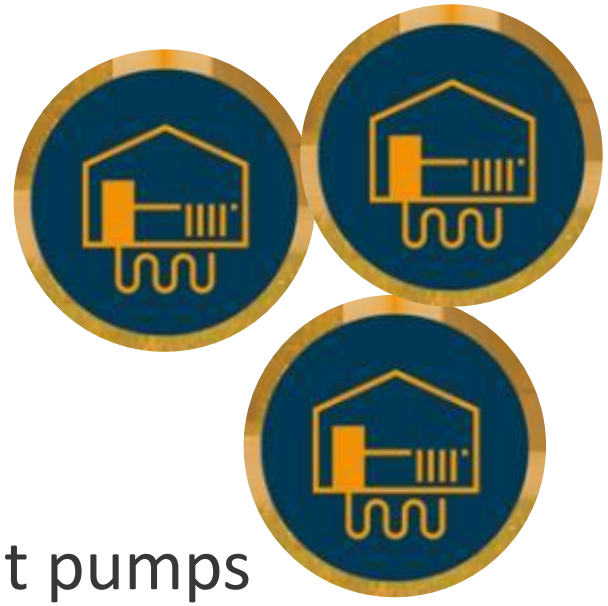
House batteries

EV chargers

Electric boilers



Grid Operator



Heat pumps

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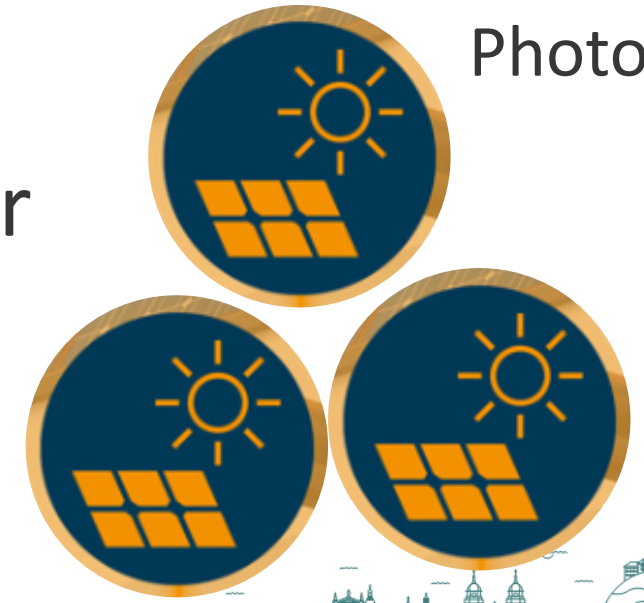


House batteries

GridSense for Load Management

What is it?

- Decentralized system for LV grid optimization (device swarm)
- Communication-less coordination of energy-hungry appliances

What does it do?

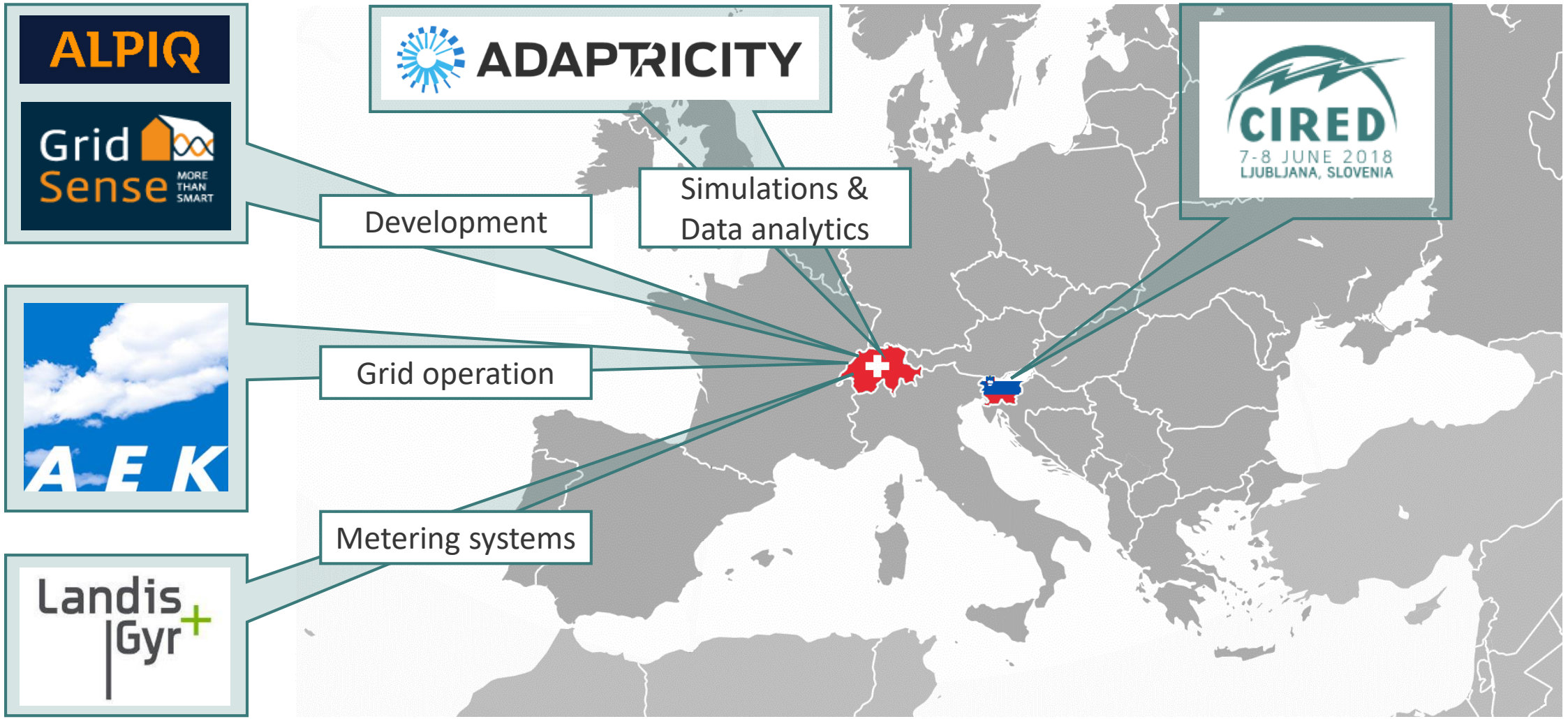
- Smooth aggregated consumption within LV grids
- Lower voltage fluctuations

How does it achieve that?

- Self-learning of occurring load patterns
- Self-learning of available load flexibility
- Application of neural networks

PROJECT FRAMEWORK

Project Partners



Why Adaptricity here at CIRED?

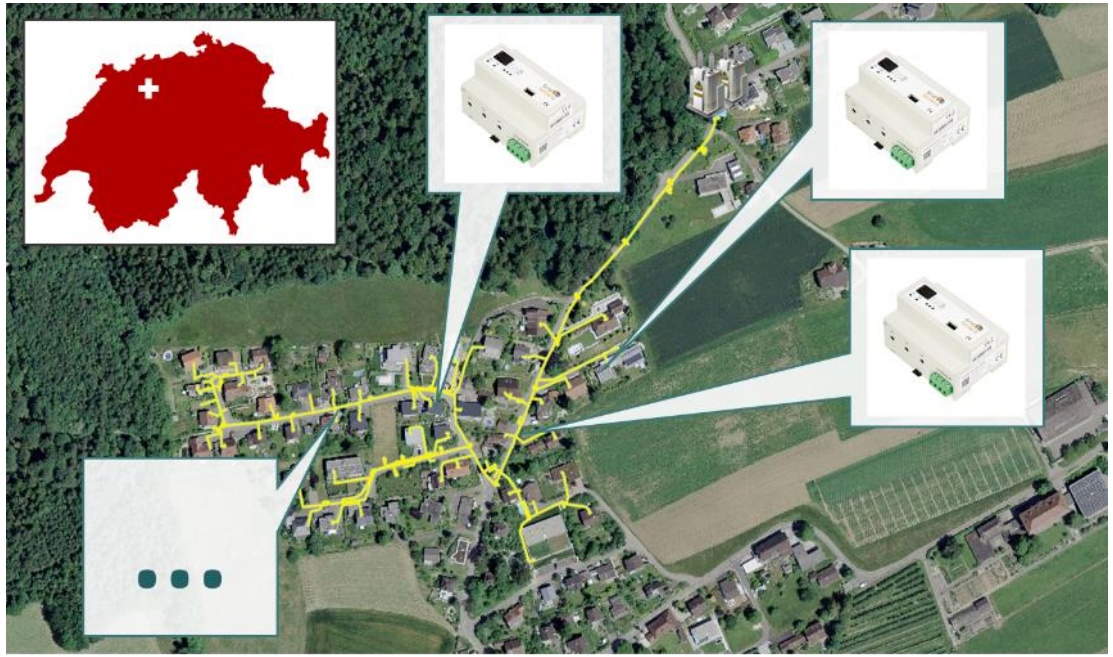
- Validate the system

- Virtual environment for simulating:
  - Dynamical load models
  - Human behaviour
  - Weather and temperature
  - **External controllers via plugins**

- We specialize in:
  - Scenario simulation
  - Data analytics

SETUP OF TEST AREA

GridSense Fleet



56	Households (total)
62%	Household participation

35	Households
7	PV units
34	Electric boilers
21	Heat pumps
3	House batteries
5	EV chargers

Validation Setup

Three operation modes for benchmarking:

GridSense

GridSense controls the devices

Observation Mode

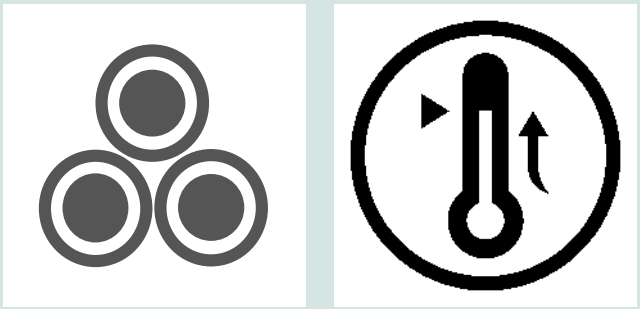
No control

Ripple Control

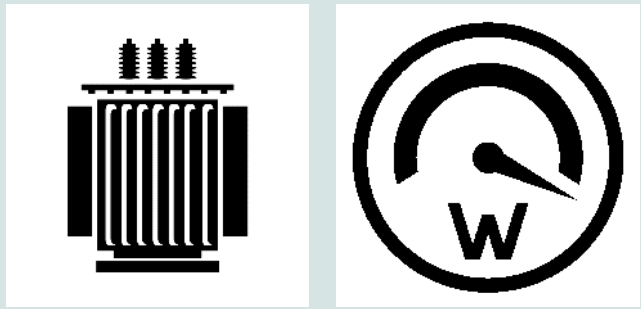
Device loading over night time

Variables of Interest

Line loading

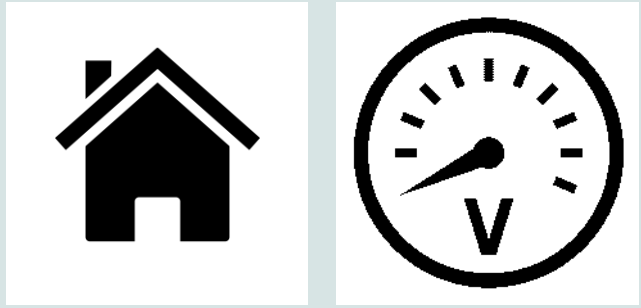


Transformer loading



Voltage daily range

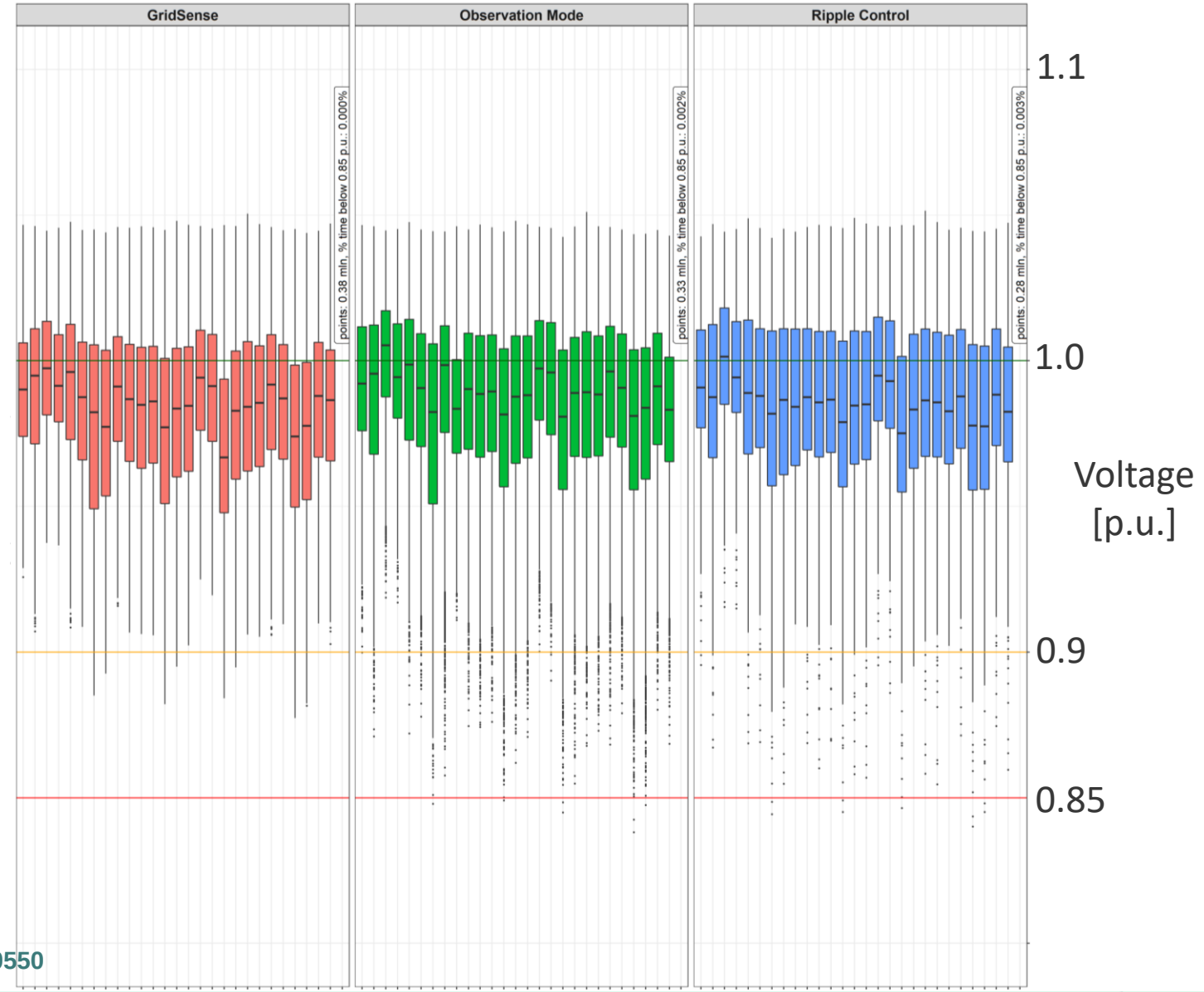
Under-voltage violations



PERFORMANCE ASSESSMENT

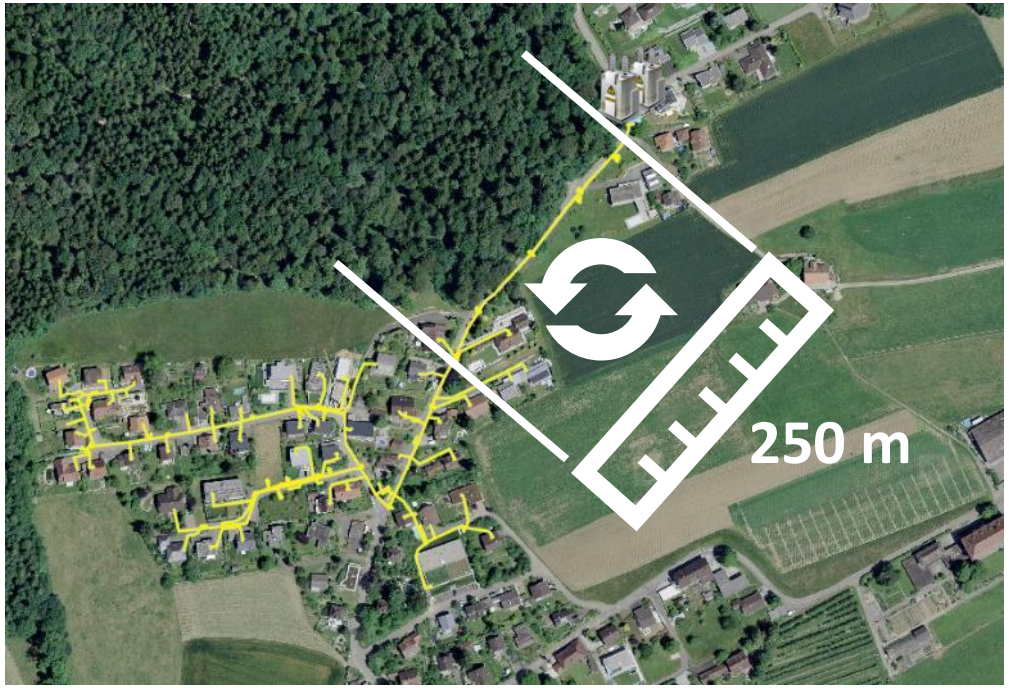
Voltage Measurements

- Measurement period: 01.10.16 – 30.09.2017, 10-minute-resolution
- One boxplot per household in each mode
- Low voltage limits according European norm EN50160
- Less severe undervoltage events with GridSense
- *Observation mode* and *ripple control* feature similar voltage levels



Comparison Grid Reinforcement

- Comparison of current grid with reinforced grid
- Identical simulation scenarios except for underlying grid model



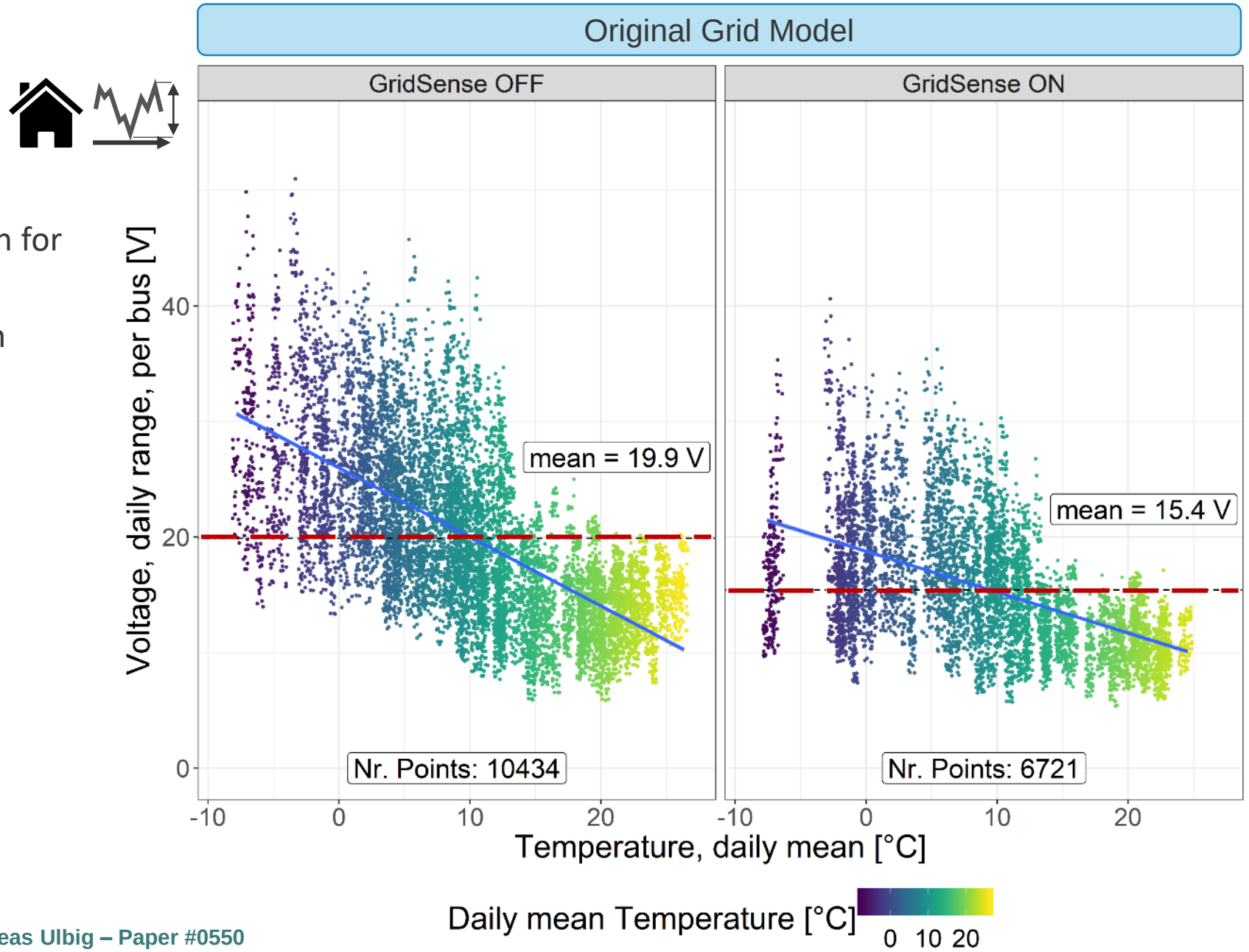
Inputs

Measured and synthesized power time series

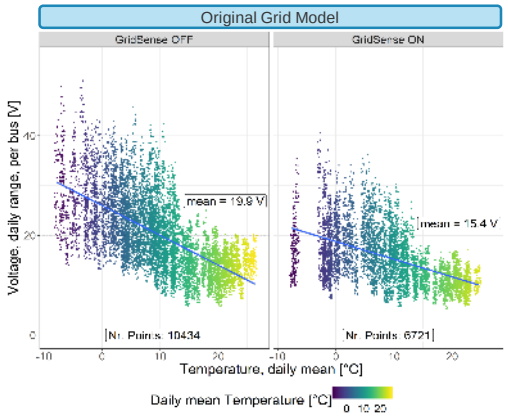
	Actual grid	Reinforced grid
Simulations		
Results	Grid connection voltages (while GS is on/off)	Grid connection voltages (while GS is on/off)

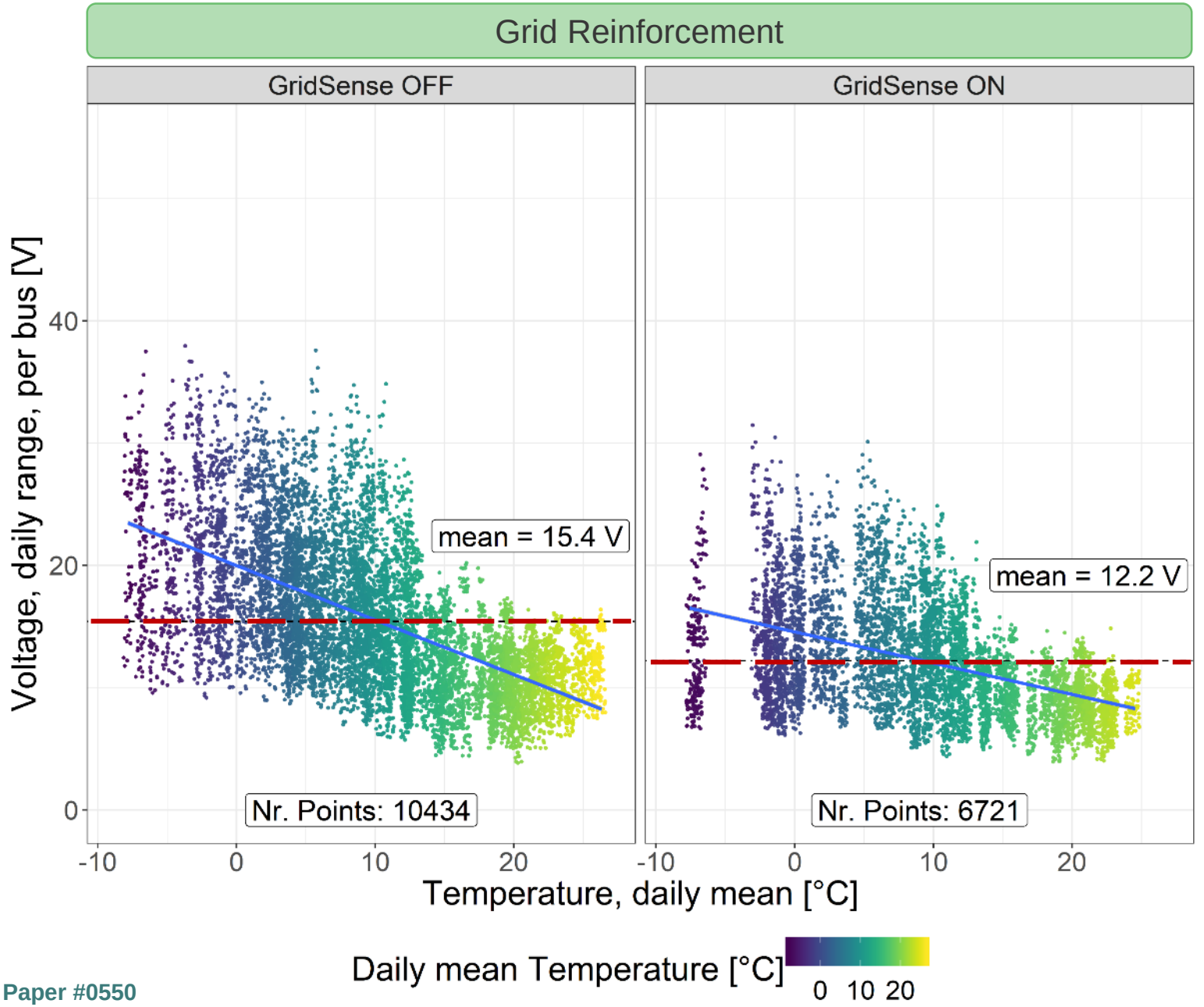
- Grid model as in reality
- Big daily voltage range: indication for voltage-related problems
- Reduced daily voltage range with GridSense*

*highly significant coefficient in multivariate linear regression

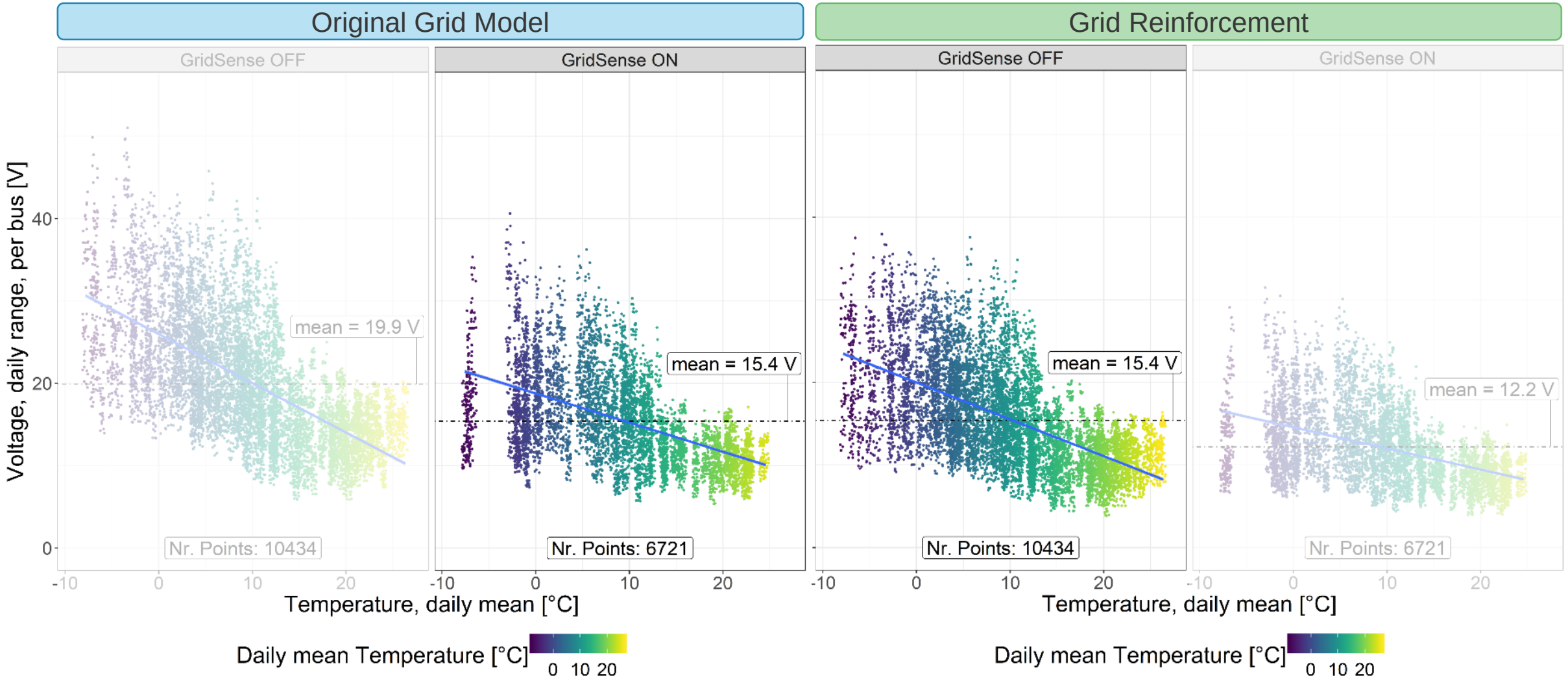


- Grid reinforced (cable with doubled cross-section)
- GridSense OFF: state with just cable replacement
- GridSense ON: state with cable replacement and GridSense





Results Grid Reinforcement



CONCLUSIONS

Conclusions

GridSense Performance

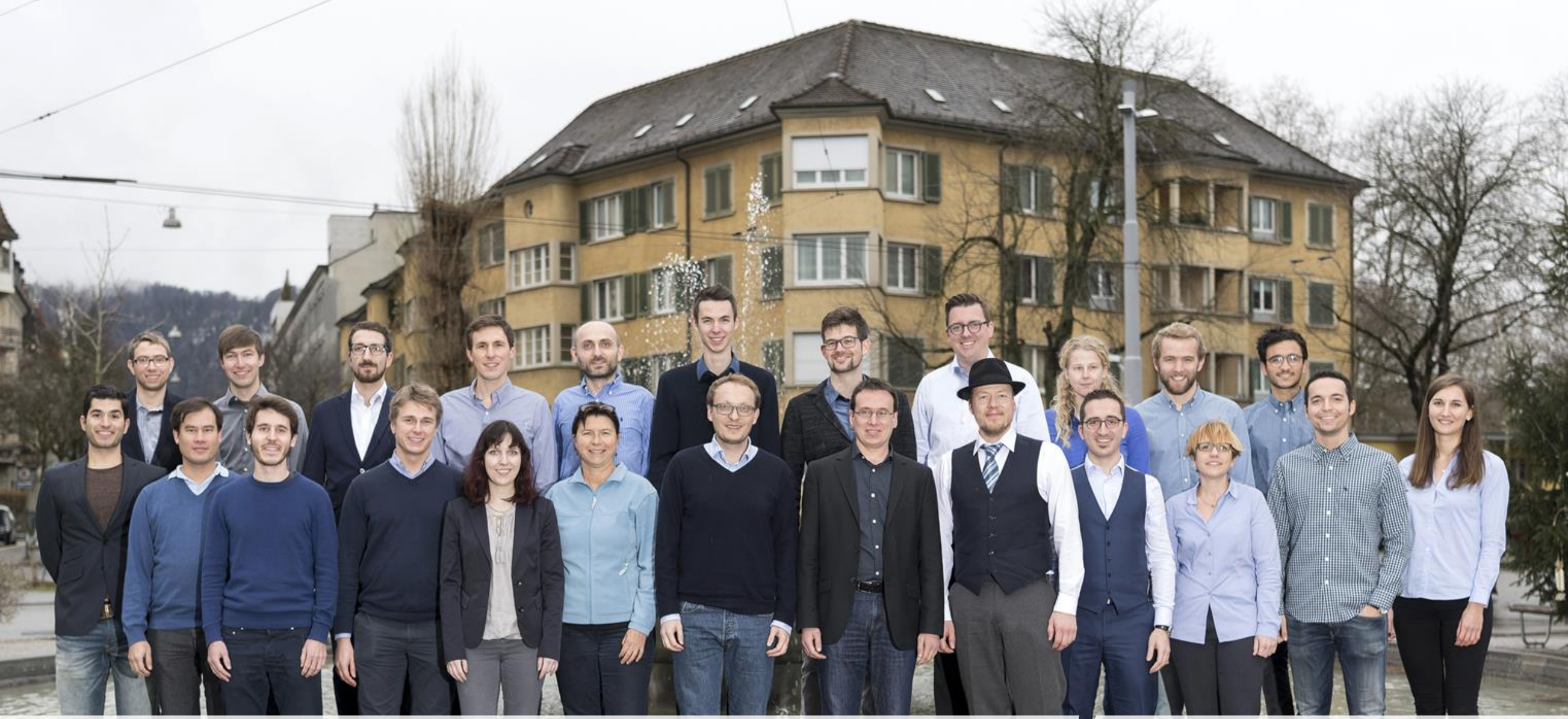
- Local voltage-based load control supports efficient and safe operation of distribution grid
- **Additional benefits** adjustable, detailed measurements provided
- Increasing potential with ongoing electrification

Innovative Analyses

- **Simulation platform to combine the advantages of different analyses**
- Combination of grid measurements, synthesized data, appliance models and local controllers
- Analyses limitations as reason for different plot types

Energy Management Effects

- **Potential for infrastructure savings** (specific comparison: replacement of main electric supply cable)
- **Tradeoff** Load management at local level vs. regional level
- In this project, ripple control shows detrimental impact on voltage



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ADAPTRICITY
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