Results of SoloGrid pilot project
Decentralized load management to increase the efficiency of local energy communities

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Adaptricity Partner for digitizing grid operators

- 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
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)

**Applications**

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

**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**

Your Future Distribution Grid: Digital, Efficient, Automated
Adaptricity Platform

Our Solutions

<table>
<thead>
<tr>
<th>ADAPTRICITY.PLAN</th>
<th>ADAPTRICITY.SIM</th>
<th>ADAPTRICITY.MON</th>
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<tbody>
<tr>
<td>Efficient</td>
<td>Smart</td>
<td>Live</td>
</tr>
<tr>
<td>Streamlined engineering processes for grid planning</td>
<td>Intelligent, data-driven grid analytics</td>
<td>Real-time LV &amp; MV monitoring</td>
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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

Copper Prices over last 100 years

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
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 appliances**, **low latency** (sec.)
  - IEEE Standard 1901-2010 (Dec. 2010) for high speed communication devices (up to 500 Mbit/s at physical layer)
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
Grid Operator

- Electric boilers
- Photovoltaic
- Heat pumps
Grid Operator

- EV chargers
- Electric boilers
- Photovoltaic
- House batteries
- Heat pumps

Stocker Nicolas, Toffanin Damiano, Andreas Ulbig – Paper #0550
Grid Operator

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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

- Alpiq
- Grid Sense
- AEK
- Landis+Gyr
- Adaptricity

Development
Grid operation
Metering systems
Simulations & Data analytics

Stocker Nicolas, Toffanin Damiano, Andreas Ulbig – Paper #0550
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

<table>
<thead>
<tr>
<th>56</th>
<th>Households (total)</th>
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</thead>
<tbody>
<tr>
<td>62%</td>
<td>Household participation</td>
</tr>
</tbody>
</table>

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

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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

Stocker Nicolas, Toffanin Damiano, Andreas Ulbig – Paper #0550
Comparison Grid Reinforcement

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

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<tr>
<th>Inputs</th>
<th>Simulations</th>
<th>Results</th>
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<tr>
<td>Measured and synthesized power time series</td>
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- Actual grid
- Reinforced grid

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

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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
Design the energy future with us!

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