

## List of Abbreviations

BEA	Building Energy Agent
CEMS	Customer Energy Management System
DER	Distributed Energy Resources
DG	Distributed Generation
DSO	Distribution System Operator
EV	Electric Vehicle
ICT	Information and Communications Technology
PV	Photovoltaics
SGAM	Smart Grid Architecture Model
SLVGC	Smart Low Voltage Grid Controller

## Abstract

### a) Five-line summary (**synopsis**) in **English**

**SYNOPSIS:** *Leafs* evaluates the effects of increased customer and energy market driven utilization of energy storages and load flexibility on power distribution grids. Technologies and operation strategies are developed that enable optimal use of distribution grid infrastructure by activating flexibilities using direct or indirect control also by the local grid operator or even incentives. The consumer benefits from more flexible integration of distributed energy resources at minimum network reinforcement costs as well as achieving a higher self-consumption level for customers operating their own DG-unit.

### b) Summary in **English**

Significant changes can be expected in the way end customers will behave from a power distribution grid perspective. Today, layout and dimensioning of distribution grid infrastructure is based on statistical assumptions and historic data for load and generation behavior over time. New technologies, especially small-scale home storage systems and aggregation of demand flexibility by virtual power plant operators, can result in market-driven load profiles based on price signals with potentially high synchronous behavior in a given distribution segment. Without consideration of the local distribution system limits this might cause thermal overload or voltage band violations. In return a grid relieving operation has the potential to relieve power grids.

The project *Leafs* proactively tackles this challenge by developing technologies and operation strategies that minimize network reinforcements required from the integration of renewable energy sources and dynamics resulting from the market. Approaches in the project for activation and control of flexibility include both active control of home storage systems and flexible loads also by the grid operator (technical solution) and evaluation of monetary incentives and motivation (organizational solution). The end customer benefits in a long term from

minimized network reinforcement costs and even higher self-consumption levels in case of operating their own DG-unit. To reach this aim, *Leafs* combines three central activities:

1. Impact Assessment – Simulation with representative sets of model networks to determine the potential effects of increased energy market driven utilization of energy storages and load flexibility on power distribution grids. Surveys among relevant end customer groups assess the willingness to participate in flexibility provision schemes.
2. Technology Development – Solutions for flexibility activation by the local grid operator for better grid integration of renewables and market service provision will be developed and evaluated with extensive simulations and laboratory trials. All relevant control solutions are analysed in three generic use cases including
  - a. direct control of central components (e.g. central storage) where components belong to the system operators (first use case)
  - b. direct access of decentralized components (decentralized storage, heat pumps, second use case)
  - c. indirect access of decentralized components through a customer energy management system (CEMS), where component belongs to the customer (third use case).
3. Field Validation – The developed solutions and operation strategies are implemented and evaluated in different field trials. Each use case is validated in a separate field trial carried out in Eberstalzell (Netz Oberösterreich), Köstendorf (Salzburg Netz) and Heimschuh (Energienetze Steiermark). In the municipal area of Eberstalzell an additional field trial with monetary incentives, depending on the local actual power from PV is carried out for the determination of user based flexibility activation. R&D infrastructure as well as research results of previous projects can partly be re-used in these areas, reducing costs and engineering effort required for the *Leafs* project.

Legal, economic and regulatory analyses are performed for all solutions and will give additional inputs for the final simulation based investigation of replicability and scalability of the solutions.

Based on this three-fold approach, the project will give answers to the question of the effect of market-driven flexibility activation on distribution grids, which is essential for grid operators on one hand. On the other hand the project will prepare recommendations and solutions so that public subsidies for electrical storage devices make sense compared to solutions activating load flexibility in a system beneficial manner (market and grid related). Crucial experiences for efficient network use with storages and flexible loads are gathered that are the basis for defining future procedures. The project is going to develop and validate concepts for the related system architecture, system solutions and technologies for flexibility provision from and for low voltage networks. Technologies are developed that give a head start to the industry partners in the consortium and support the future commercialization of these technologies and the realization of sustainable electrical energy systems using them.