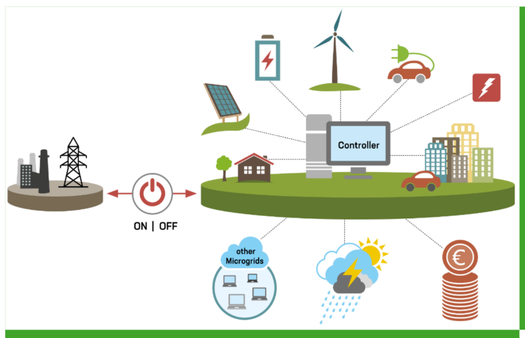
Optimized Planning of Distributed Multi-Energy-Systems



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Area 2.3 – Microgrids and Smart Energy Communities

Microgrids and Smart Energy Communities

Microgrids generate and store energy for self-consumption (electricity, heating, cooling, mobility, etc.) locally. Distributed renewable generation and storage increase efficiency, resiliency, grid stability, import independence, sustainability and climate neutrality. A microgrid is displayed in Fig 1.

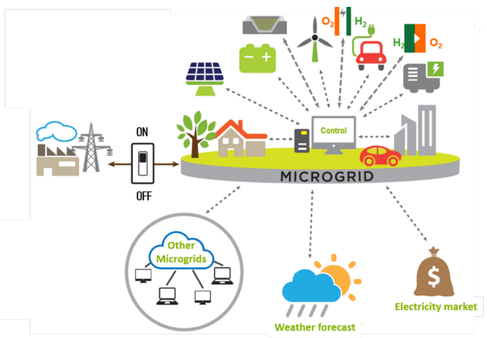

Fig. 1: Microgrid / Smart Energy Community Concept

Design Requirements and Challenges

The design of local energy systems requires the consideration of a wide range of factors that can be categorized into methodology, technology and usability, as illustrated in Fig. 2.

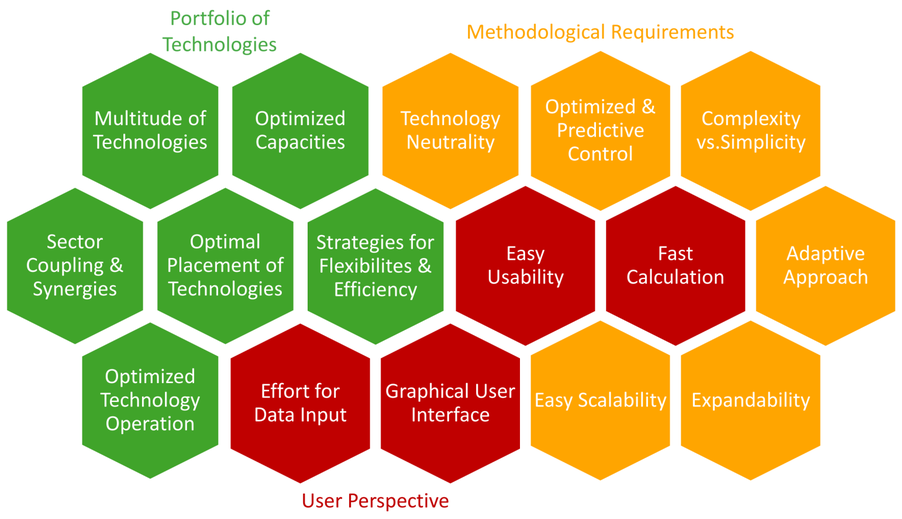

Fig. 2: Essential aspects for planning Microgrids

The Planning Tool OptEnGrid

An **standardized methodology** is required for a cost-effective and rapid planning. The tool *OptEnGrid* (developed by BEST) meets these requirements, which have been proven in numerous reference projects. Following aspects are addressed:

- Combined consideration of technology planning and a holistic operation of technologies and consumers - for grid-connected or islanding energy grids
- Objectives: Optimization of total costs or $CO_{2\text{-eq.}}$ emissions

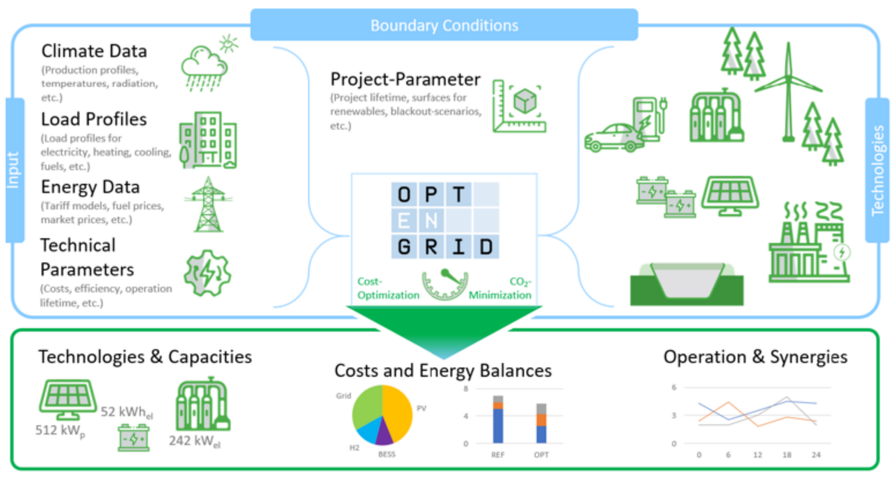

Fig. 3: OptEnGrid framework including Input/Output

Future Development of OptEnGrid

- **Optimized energy system design and control in a holistic platform** integrating innovative technologies (e.g. H_2) and flexible and controllable loads
- **Multisectoral energy systems** (networking LECs)
- **Co-simulations** for improved usability and validation
- Extended web-based and **graphical user interface** for easy usability for broad application
- **Automated data acquisition** for facilitated planning processes.

Reference Optimization Use Cases

4-Star Hotel Resort Complex

Optimized planning has been performed in order to retrofit existing technologies and to increase the **share of renewable technologies** as well as local **self-sufficiency.**

The challenge of this use case is the high variety of loads and technologies with the following energy demands:

- Space heating & domestic hot water (1.119 MWh/a)
- Space cooling & refrigeration (37 MWh/a)
- Electrical energy ~ 998 MWh/a (Electricity & E-Mobility)

Following main steps have been completed: 1) Data collection (existing technologies, energy & mobility demand, economic parameters, etc.). 2) Calculation of a reference case (business as usual). 3) Optimization of minimum cost and CO_2 scenarios.

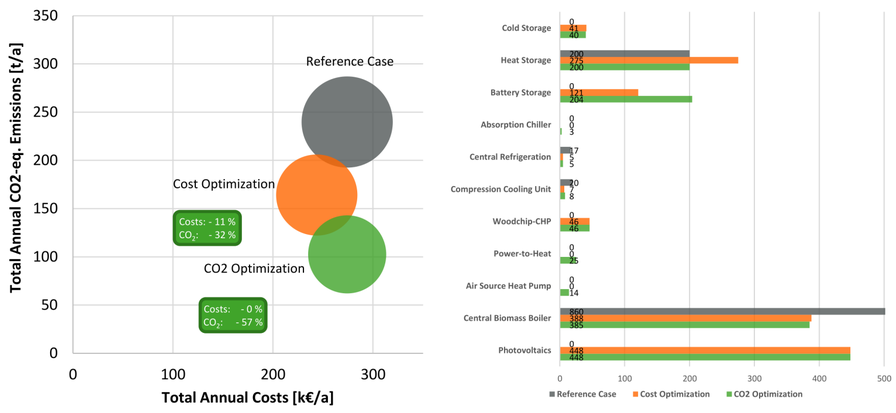

Fig. 4: Optimized Cost & CO_2 reduction (left) and rated capacities of storage [kWh] & generation [kW] (right)

Results: Optimal technology mix and capacities, holistic control strategies for technologies, cost & CO_2 savings, share of local self-sufficiency.

Local Energy Communities (LECs)

Optimal design and in-depth analysis of economic and energy operations were performed for two municipal LECs during their planning and start-up phases. The feasibility of integrating centralized battery storage, electric vehicle charging stations, and the use of load flexibility were also analyzed. In addition, an in-depth economic analysis of the LEC operation was conducted in three scenarios.

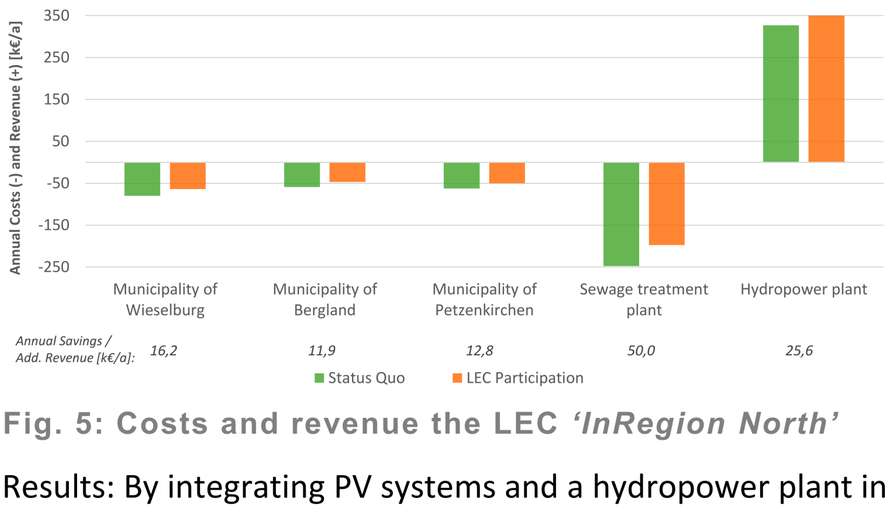

Fig. 5: Costs and revenue the LEC *'InRegion North'*

Results: By integrating PV systems and a hydropower plant in each LEC, costs (20-30%) and emissions (up to 100%) can be significantly reduced. Flexible loads increase on-site utilization of PV plants, energy surplus enables integration of charging stations, centralized storage is not suitable in this use case due to the implemented tariff system.

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