

Planning of Digitalization and Smartness for Industrial Infrastructure

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The current energy system is moving quickly from centralized energy production using fossil resources to more decentralized and renewable generation. The 3D transformation (Decarbonization, Decentralization and Digitalization) heavily changes the current energy world and turns it into a prosumer-centric one. Based on the ongoing electrification and automation, the digitalization of the power sector is a key enabler to unlock tremendous increases in productivity and boost new business models.

From traditional industrial energy supply to a digital microgrid

In an integrated microgrid design study delivered by Siemens PTI, an industrial campus in China was planned and simulated with distributed energy resources supplying electricity. The industrial campus is transformed from the traditional energy supply system into a microgrid using digital technologies.

The industrial campus is divided into the northern district and the southern district. The northern district is where the headquarter of the corporate group is sited, while all industrial applications are located in the southern district. The industry includes solar power and pharmaceutical productions. In comparison with the industry loads, the load in the northern district is negligible. Consequently, the microgrid planning focuses on the southern district. The electricity for the southern district comes from 10 kV grids, combined heat and power (CHP) and several photovoltaic (PV) plants.

The right generation mix: analysis of cost and revenue streams

After investigating the current system state, the generation portfolio was simulated and evaluated. The maximum potential capacity for solar power of around 4.8 MW was identified with reference data from existing buildings. Based on the wind resource assessment, 2 MW wind power can be installed in the southeast part of the southern district. A battery storage system with the capacity of 2 MWh with a maximum power output of 1 MW was applied for the simulation. Additionally, ten electric bus chargers with an individual charging power of 60 kW were integrated into the electric load.

As there were no load profiles for the whole year available, an artificial load profile was generated using specific load characteristic of certain periods, measured data as well as various growth factors (see Figure 1, top picture). This load profile was then used to perform several dispatch simulations of solar power, wind power, CHP, battery storage and energy withdrawal from the grid in PSS[®]DE to calculate cost and revenue streams of the different components (see Figure 1, bottom picture).

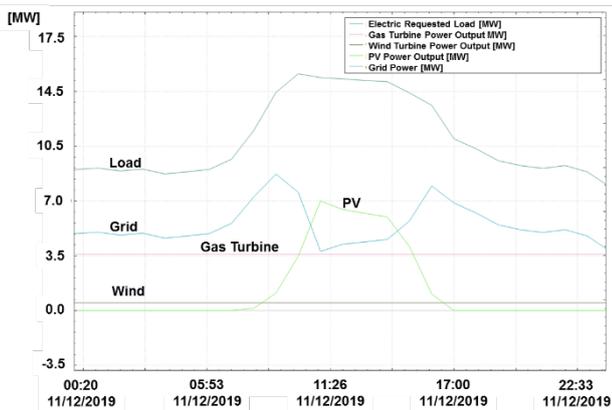
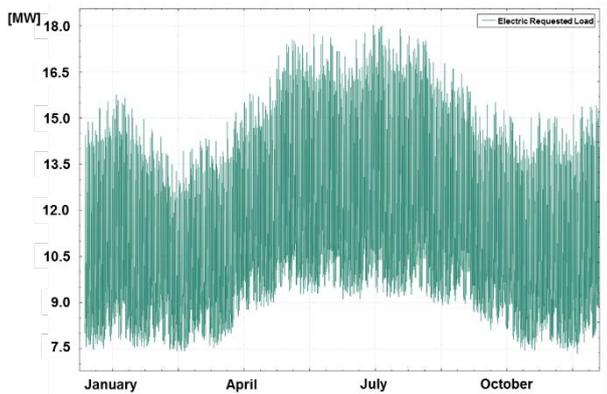


Figure 1 - Electric load profile over one year (top) and simulation of one-day in PSS®DE (bottom)

The simulation showed a reduction of electricity cost for the industrial campus as well as the opportunity to annually earn ~5 million ¥ from solar power and ~3 million ¥ from wind power with the local subsidiary and feed-in tariff. In addition, the battery storage system that was simulated could arbitrage from the price difference in the time of use electricity tariff. The arbitrage achieves an economic benefit of ~0.2 million ¥ per year. From an environmental point of view, emissions can be reduced, and the carbon footprint can be improved.

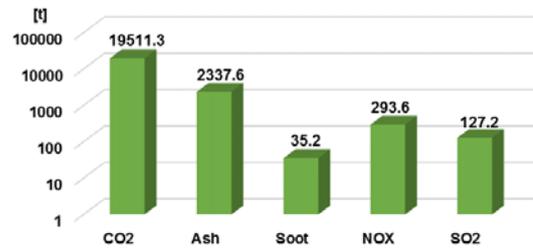
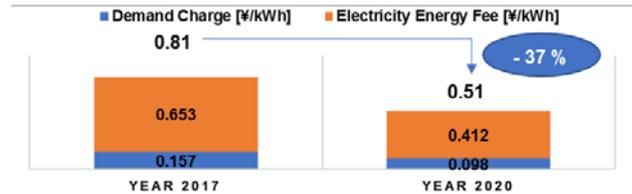


Figure 2 - Exemplary results of a dispatch simulation

Effects on grid components: evaluating the need for re-investment

Subsequently, based on the available data and requirement of the customer, the power flows in the grids were investigated. Different system states were simulated for each period described in the generation analysis. Based on the system model, the busbar voltages and the loading of branch elements such as transformers and overhead lines, were calculated with the power flow calculation in PSS®SINCAL. The simulation results showed that the grids can operate without exceeding their limits in different situations. There is no requirement to upgrade either distribution lines or transformers. However, it will be necessary to build a 10 kV switching station near the substation, because it is officially required that a microgrid has a sole point of connection to the public grid. The industrial campus is currently connected to the public grid via three feeders. The additional switching station will integrate these three feeders as well as the individual feeder for the CHP.

The result: significant savings and a structured implementation roadmap

Based on the calculation results from the performed generation and network analyses, the application of a microgrid concept can directly achieve an economic benefit of 2.6 million ¥ per year through the savings in the

electricity price described in the network analysis. PV and wind power could generate an additional income of ~7.5 million ¥ per year but would require significant investments.

Considering the high amount of investment and the economic benefits in the system analysis, the construction of a microgrid was recommended to be divided into two phases. The first phase focuses on the establishment of microgrid. The introduction of digitalization and smartness enables the existing industrial campus to supply their process loads with reliable, economic and safe power. The switching station, microgrid control and energy management system as well as part of the battery storage system will be installed in the next months.

In a second step, the share of renewable generation will be expanded. The additional capacity to be installed will have to be adjusted to the expected load growth and market prices. Depending on the market, enlarging the size of the battery storage will also be considered.

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