Smart Prognosis of Energy with Allocation of Resources – Successful completion

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Figure 1: SPEAR use case provided by FFT Production System in Fulda

The energy consumption of a component in a production plant depends strongly on its control. For example, if an industrial robot is moved at maximum speed, significantly more energy is consumed than in a slower movement with smoother acceleration curves. In principle, this effect applies to all actuators used. While high acceleration is important and unavoidable in some processes, most processes have a certain flexibility in terms of available process time and execution time. Often, robots are moved at maximum speed just to then hold their position while waiting e.g. for another robot to finish its movement before being able to continue. With the goal of using this flexibility to optimize energy consumption, the international research project SPEAR was started in 2017 (www.spear-project.eu, funded by BMBF). The goal was to expand a production system with the lowest possible costs in such a way that the determination and simulation of energy consumption is possible.

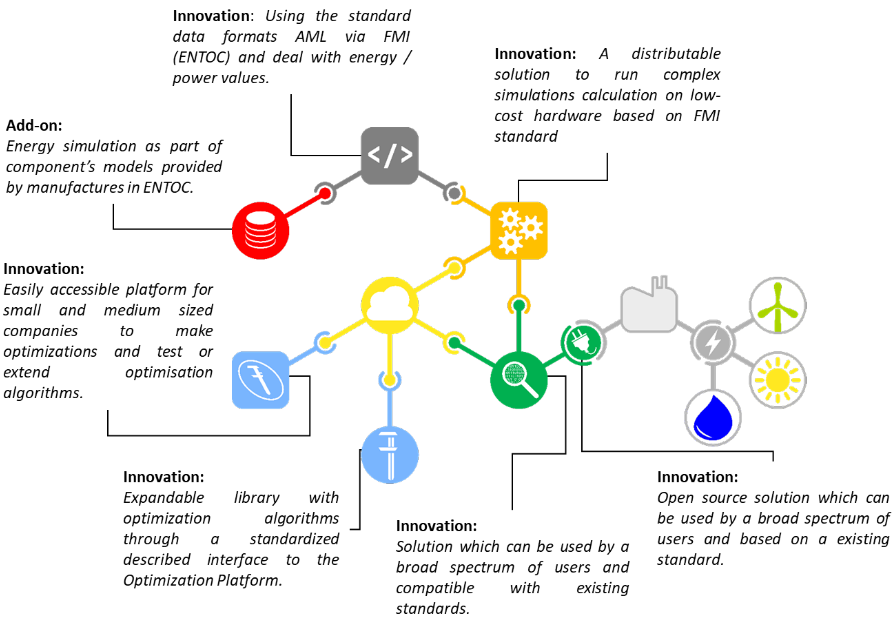

Figure 2: Overall architecture of SPEAR (see teaser video of SPEAR https://youtu.be/0F_KHY19x-0)

The basis are system-neutral simulation models according to the FMI (Functional Mockup Interface) standard. Since the provision is to take place via the respective component manufacturers, a corresponding implementation was discussed in the project with different manufacturers and various models were created as examples. The simulation is performed over a distributed infrastructure. For this purpose, modules for ROS (Robot Operating System) were implemented, which allows a simulation of the models. In addition, a connection to the real production system was implemented so that both simulation and real data can be used for later optimization.

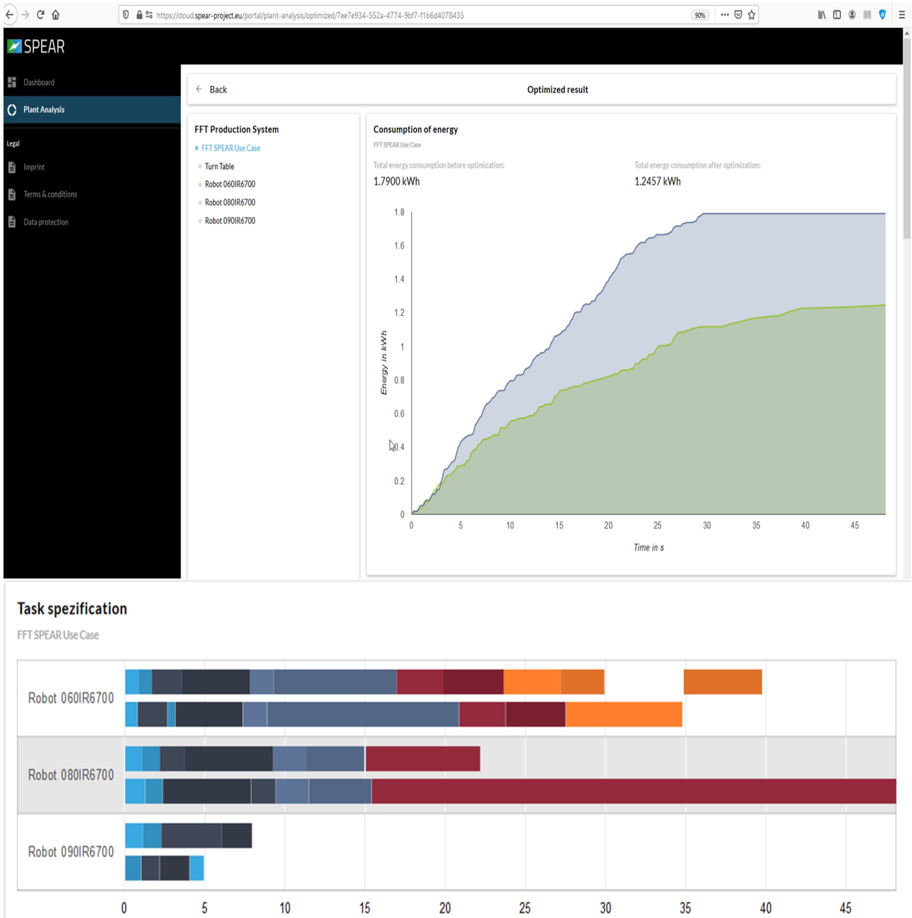

Figure 3: Cloud based optimization platform from SPEAR

To support the creation of the simulation, an online configurator has been developed in SPEAR (see https://as3850.lps.ruhr-uni-bochum.de/spear). The simulation models can be connected via an intuitive interface. The complete configuration including all models can be exported in the AutomationML standard and is used in a co-simulation to calculate necessary input data for energy optimization. A cloud platform was implemented for the optimization (see https://cloud.spear-project.eu/). The platform can use different optimization algorithms, which are integrated via a uniform interface (see SPEAR API description http://spear.aot.tu-berlin.de:8080). This allows the processes within the production plant to be adapted according to selectable boundary conditions. An important element for this is the inclusion of energy production (see Figure 4). This way, energy-intensive processes can be shifted to times when a large amount of energy are available due to high solar radiation, and energy peaks can be avoided in order to implement uniform consumption.

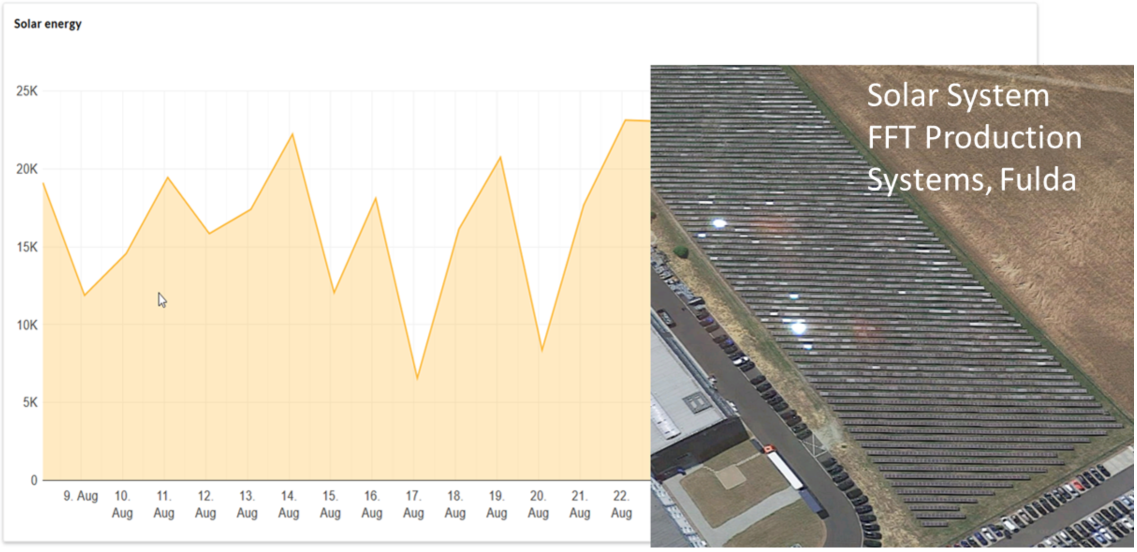

Figure 4: Solar energy based on forecasts generated values using an AI energy model of SPEAR

An application example from the automotive sector was chosen to demonstrate the results. The example plant is equipped with several robots, welding unit and gluing unit and is used for the production of B-pillars. Energy data were measured, simulated and optimized in elaborate tests. In addition to the functionality of the developments, the structure shows the potential of the results implemented in SPEAR.

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