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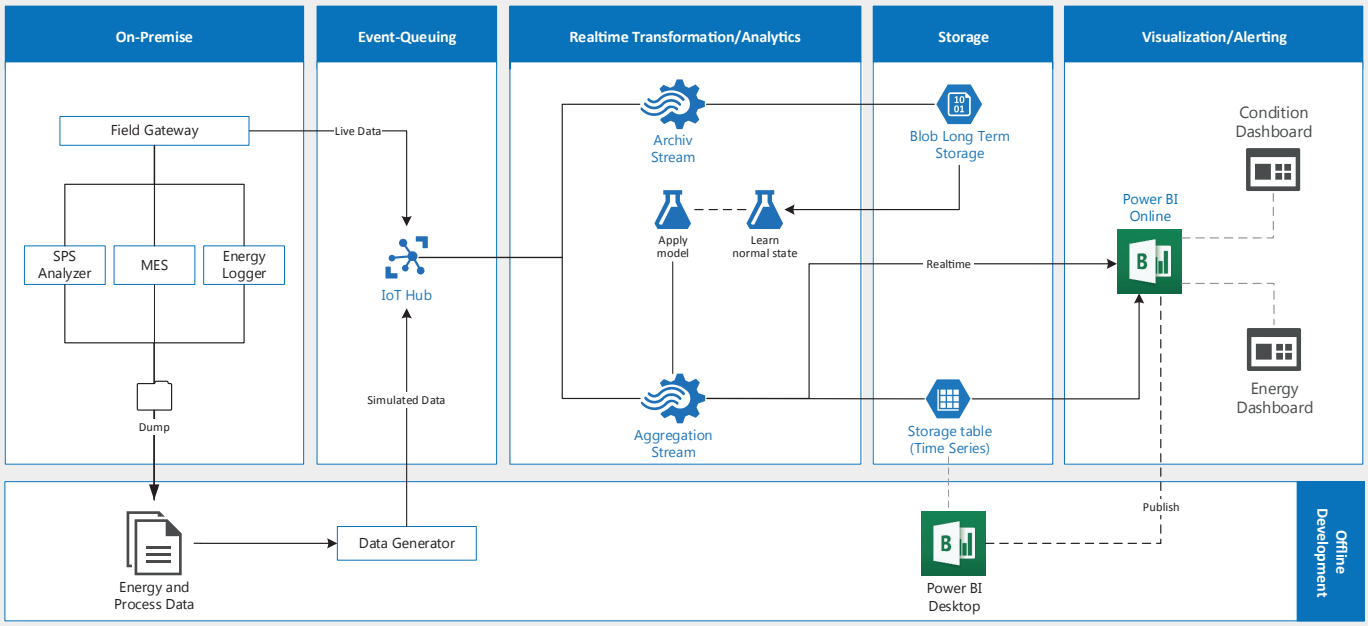
Advanced Energy Analytics with Azure IoT

Success story for a cloud based energy efficiency analysis and condition monitoring

Our automotive industry customer was looking for a simple method to evaluate production process and energy efficiency on shop floor level. The customer had data available for such detailed analysis, however, failed to analyze production process weaknesses. Energy data were recorded, but saved only as 15 minutes aggregates and evaluated completely separated from the production process data. Consequently, using this interval, it was not possible to analyze in detail the energy data to use it for optimization purposes. In individual cases, available data were manually merged for analysis with a lot of effort, but an automated approach for data integration and data analysis was missing completely. Thus, transparency for an energetic optimization at shop floor level did not exist.

The Challenge

A complete production process transparency can only be achieved if both SCADA data and system control data (PLC) are correlated with energy data. Only by using production process information and their states, an energy efficiency evaluation for an equipment is feasible. In this way, it is possible to evaluate whether the energy consumption is value-adding or non-value-adding for the time period under review. Using this knowledge the system can then be assessed and optimized. For this we established an indicator, the so-called Energy Efficiency of Equipment (EEE). Similar to the Overall Equipment Effectiveness (OEE), this figure can be calculated at different time scales and can thus be used to identify time periods with optimization potential quickly. Starting with the results for the EEE a simple detailed analysis should be possible for the respective time period visualizing the correlated data graphically. In this way, newly implemented optimization measures can be validated and monitored continuously. At the same time, a platform should be established to share these findings with the equipment manufacturer. Hence, the aim of the implemented solution was the reduction of the energy base load and thus the improvement of sustainability of the production processes as well as the consequent reduction of costs.



Software with concept.

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The Platform Based Solution

We build a holistic solution covering all requirements for our customer by using the Azure IoT stack. The three data streams (energy, SCADA and PLC data) were integrated using a software-based Field Gateway (***robotron*SwitchingServer***) sending the incoming data every second to an Azure IoT hub. Afterwards, an Azure Stream Analytics Job archives all data streams into Azure Blob Storage. A second Stream Analytics Job correlates and aggregates the data streams with complex queries and enriches them with reference metadata. Outputs are stored into an Azure Table, which is the base for subsequent processing and visualization of that data with Power BI, as well as sent directly to Power BI for real time visualizations. The Power BI reports resulted in a multi-stage approach: from the system overview using the mentioned EEE down to the detailed analysis of the states of the equipment components. With this platform, our customer can now share insights directly with the equipment manufacturer. Analysis can show exactly at what point during the production process which components consume an excessive amount of energy without adding value. By using Azure cloud services in order to connect equipment manufacturers with producers, we were able to cover an essential concept of the widely recommended Industry 4.0 (IoT) strategies. Already in the course of the project, we could leverage the correlation of data streams to identify very energy-consuming equipment and provide these findings to the equipment manufacturer.

Another advantage of the implemented solution is that after system updates has been provided by equipment manufacturers these can be verified and monitored continuously.

Used Azure IoT components

- IoT Hub
- Stream Analytics and ML functions
- Blob and Table Storage
- ARM based provisioning
- Azure ML
- Power BI desktop and online

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Solution Benefits

Cost savings due to energetic optimization would not legitimate the significant expenses for data collection on a second based level as well as a historical storage of all data. For that reason, a second objective of the solution was to develop an approach to use the energy data also for a condition based maintenance with Azure ML in order to increase ROI. The advantage of this type of condition monitoring is that no additional sensors were needed. This approach especially can be applied for mechanical systems. As energy is a so-called rapid impact factor it is suitable to detect the degeneration of such an equipment. We use Azure ML to learn the normal states of the energy signatures for all types of equipment and the particular process states. With Azure Stream Analytics the Azure ML model gets applied as a function and annotates the real time sensor stream with the deviation from the normal state. In case that the values exceed the learned thresholds an alert in form of an e-mail or SMS is triggered directly.

This approach is currently expanding to a method for predictive maintenance. Here, we are going to implement a method to save the change of the energy signature over time in order to extrapolate the process steps by when the process will exceed the normal state. In this way, our customer is able to adapt the maintenance plans to a dynamic model and reduce cost intensive system downtimes.

With the two implemented approaches we provided our customer with a platform based on Azure IoT stack to evaluate energy efficiency at shop floor level and condition based monitoring. This solution helps our customer to improve and stabilize its production process in a sustainable manner. Currently, it is implemented only for one factory and selected assembly lines. However, as the solution is independent from the equipment manufacturers, it can be adapted to any other line and site easily. In preparation for this, the entire solution has already been transferred to Azure Resource Manager templates for the provisioning process.

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