Energy machines verification (EMV)

Energy Machines ApS

ENERGY MACHINES

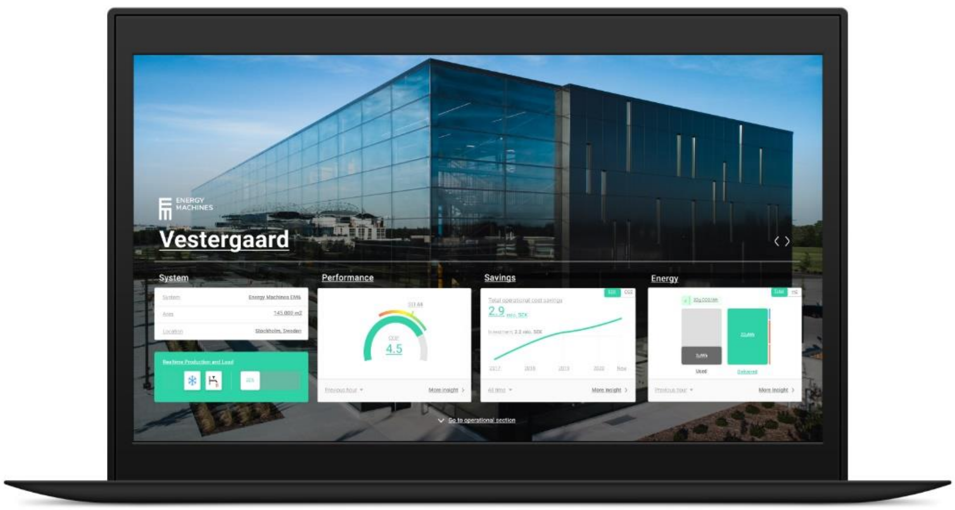

Figure 1: The energy machines dashboard including the EMV with a quick overview of current performance.

Summary of IoT case

Energy Machines™ is a leader in the design, implementation, and operation of integrated energy systems for buildings. Buildings are a growing climate problem, accounting for over 28 % of global CO_2 emissions. We are working to transform them into climate solutions.

The Energy Machines Verification tool (EMV) is a combined hardware/software solution based on physical measurements, a service REST API (REpresentational State Transfer Application Programming Interface) and thermodynamic models of the heatpumps, in order to provide online/live transparent performance monitoring of these, as well as to provide early warning systems for predictive maintenance (to-be-implemented).

The tool is based on measurements of temperature and pressure, and enthalpy data for the refrigerant(s). It provides an alternative measurement to energy meters, but also extends beyond the limitations of these, as even more information can be extracted from the thermodynamic cycles.

Using a reliable and scalable cloud backend (Google Kubernetes Engine), it can be extended to any number of systems.

Data security is taken very seriously, and all services use encrypted protocols (TLS/HTTPS) when exchanging data from client to server. Endpoints require authentication with user permission granularity to access.

Figure 2: An Energy Machines installation. Heat pumps are located on the right. Sensors are placed inside the boxes.

The tool is functioning on most Energy Machines systems, with paying external customers in the portfolio. It is currently implemented through the ControlMachines SCADA service (https://control machines.cloud/), but the API allows flexibility in external access.

Results

Live monitoring of heat pump performance provides total transparency between supplier and customer.

A typical use-case would be if customer has been promised a heat-pump that can deliver a COP (Coefficient of performance) of 5, they can live monitor the COP and see if they are getting what they are promised. This can potentially lead to better performing heat-pumps, as suppliers can be held accountable.

As monitoring also includes the compressor efficiency, there's a potential to include early warning systems for predictive maintenance, when for example the compressor efficiencies rise above 100 %, indicating liquid refrigerants cooling the compressor outlet, which can cause breakdown and failure. Combining EMV with data-driven machine learning models, which run as digital twins, may even reveal early signs of deterioration.

FACTS ABOUT THE IOT CASE

IoT category: Online service with analysis of functionality and performance from live measurements of the heat pump COP, energy production and cycle efficiency. In addition to this, service with early warning system for predictive maintenance.

Heat supply capacity: Any.

Heat source: Air and ground.

Analysis method: Sensor measurements of pressures and temperatures are sent to a REST API. Energy balances calculate COP, compressor efficiency, and heating/cooling production, etc. The calculations are uniquely timestamped, and results are made available on demand. To reduce noise from raw measurements, know-how of the system is applied (typical time constants).

Modelling requirements: Measurements and knowledge of refrigerant and cycle.

Data required: Temperature, pressure, and compressor power.

Data interface: No specific requirements.

Transmission protocol for data: REST API

Quality-of-Service: Data measured every minute and results provided every minute (real-time).

Technology Readiness Level: TRL 9.

Link to webpage: www.energymachines.com

The latter models, can also be trained using the output from the EMV as input, when the drift over time is interesting to monitor (e.g. refrigerant loss through leakages, fouling of heat exchangers etc.). EMV is not a predictive tool and relies on sensor measurements, nevertheless EMV can also be applied on modelled sensors, and may be interesting to apply for simulations of heat production in system simulations, where multiple heat pumps are connected through a thermal grid. EMV may find usage even in optimization of heat production with respect to balancing electricity prices, demand and thermal reservoir capacity.

Contact information

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