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Simantics for industrial simulation-based Digital Twin development: Case Siemens WebTurbine

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Digital twins

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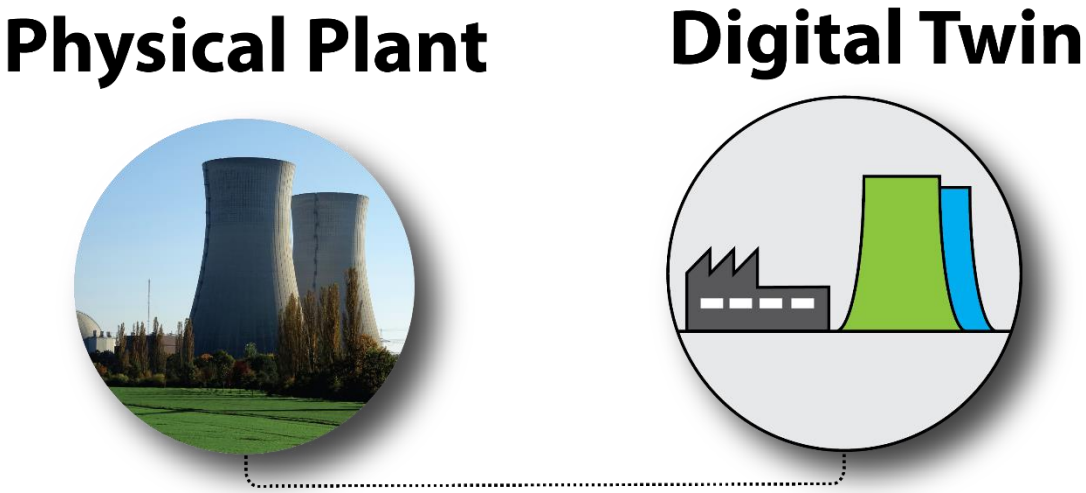
Digital Twin

A digital replica of a plant, which contains information of the:

- Structure
- Dynamics of how the devices or processes operate



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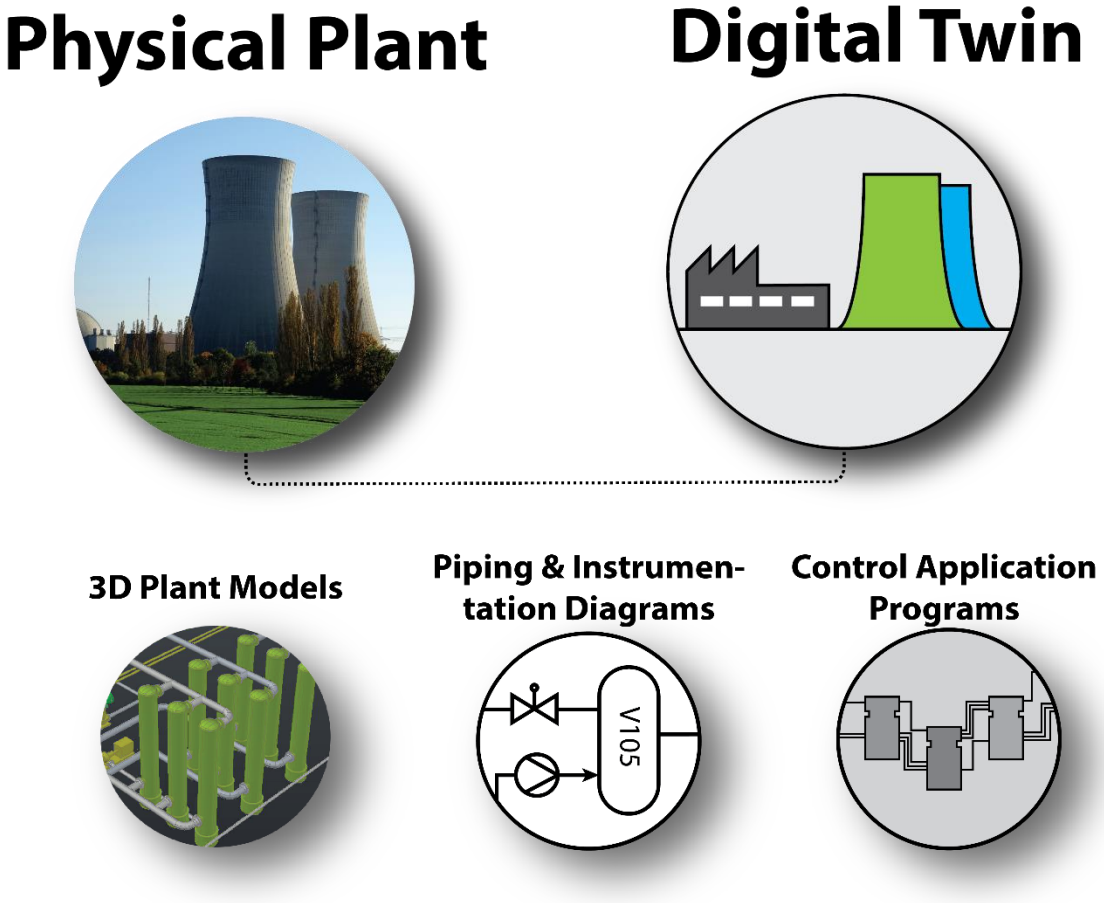
Digital Twin: Structure information

A digital replica of a plant, which contains information of the:

- Structure, which can be obtained from plant design material



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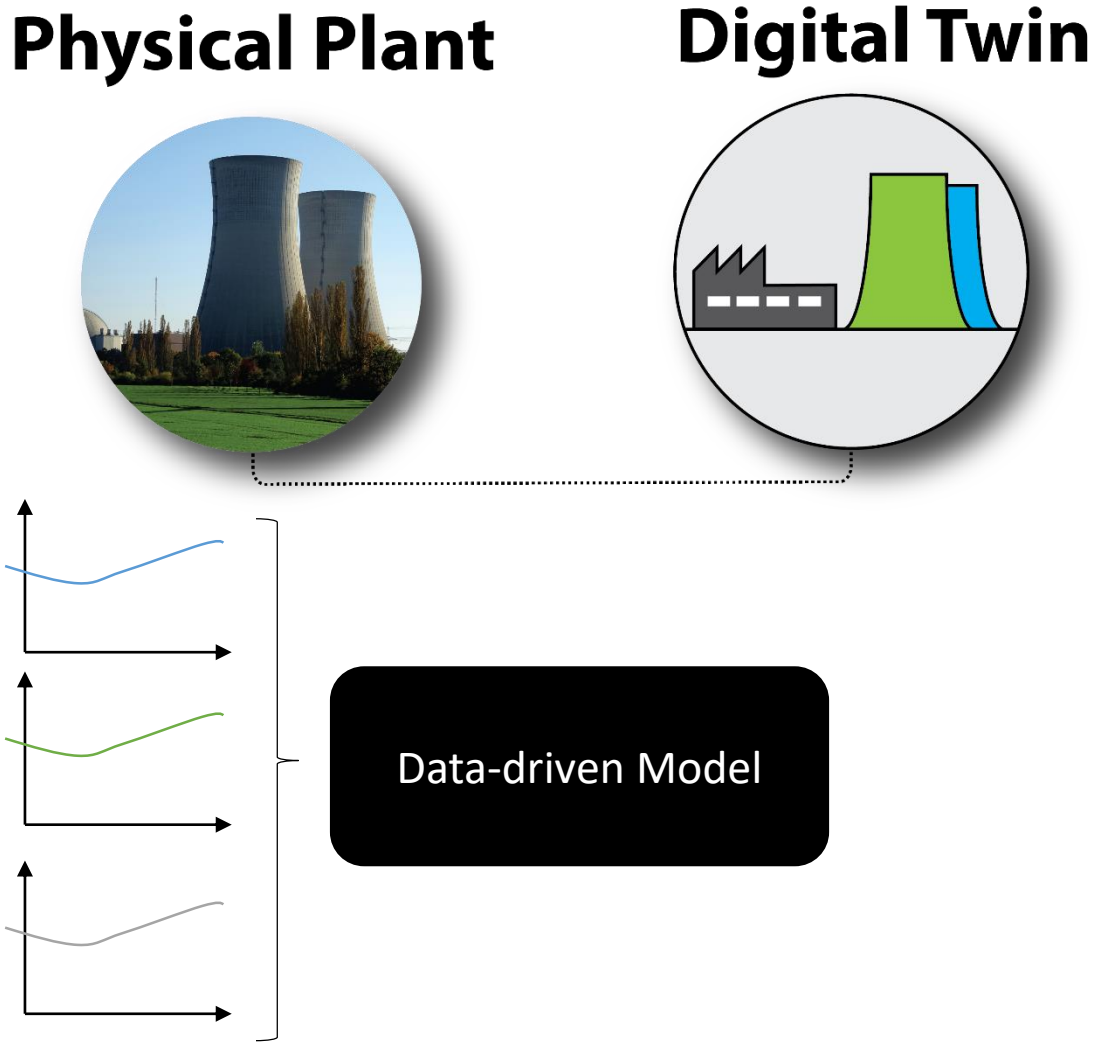
Digital Twin: Dynamics of the plant

A digital replica of a plant, which contains information of the:

- Dynamics, which can be **partially** obtained from data-driven methods



Simulation-based Digital twin

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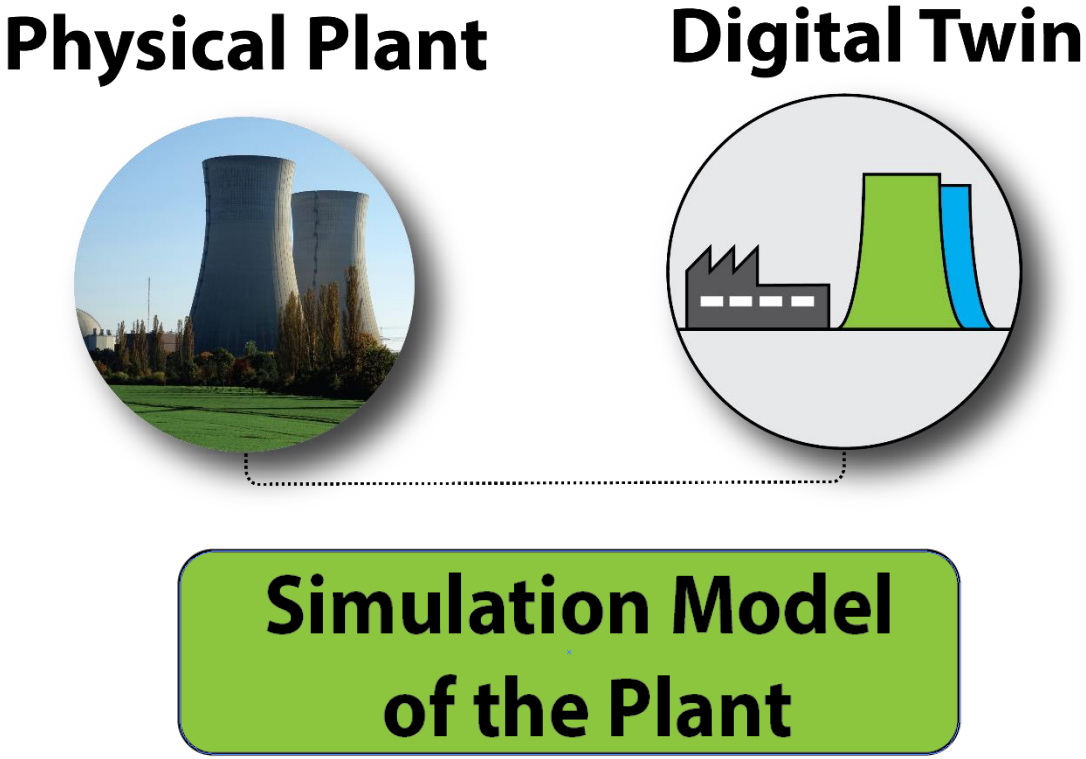
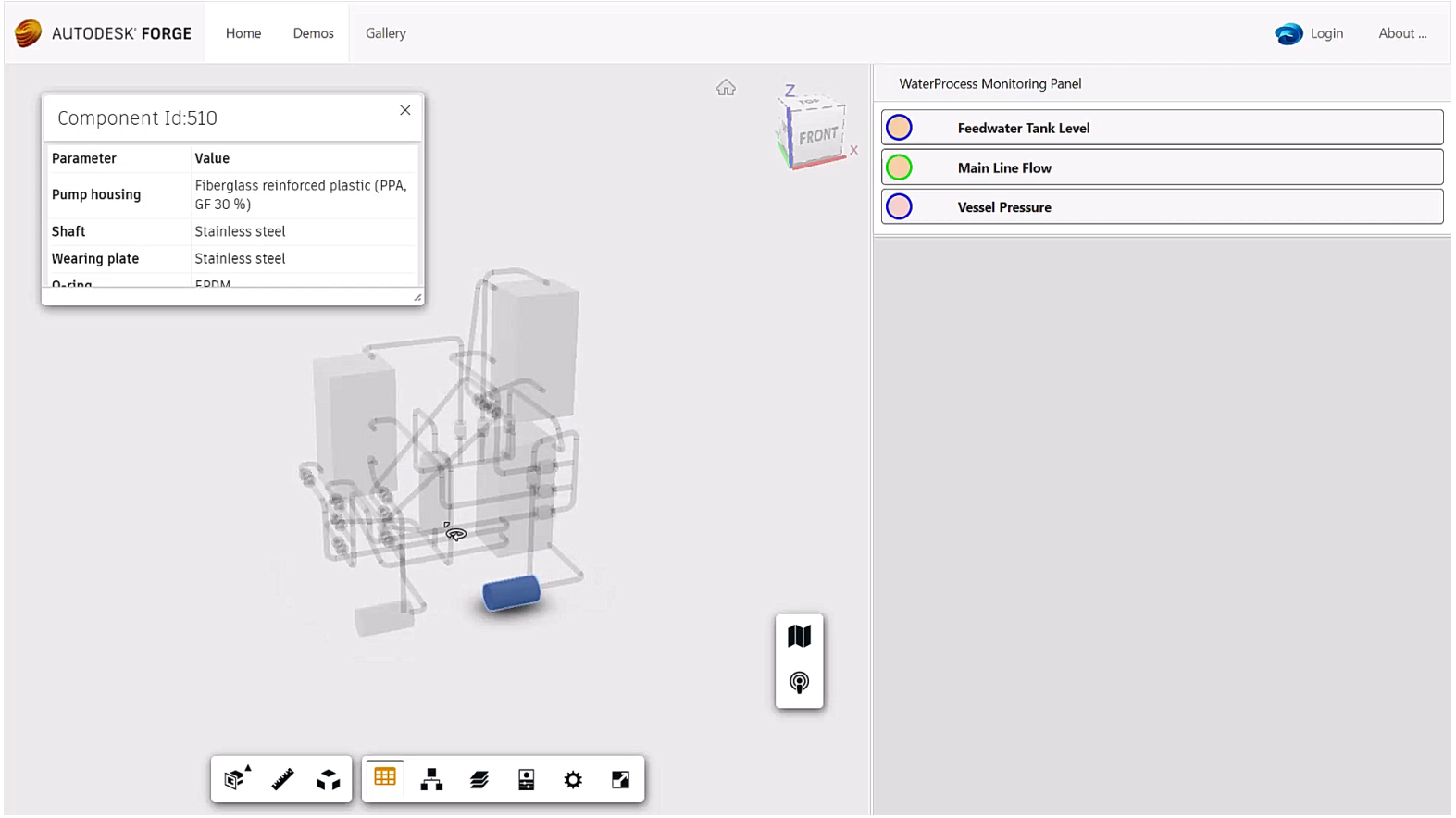
Digital Twin: Dynamics of the plant

A digital replica of a plant, which contains information of the:

- Dynamics, which can be simulated using first-principles simulation models of the plant



Technical Data Sheet information



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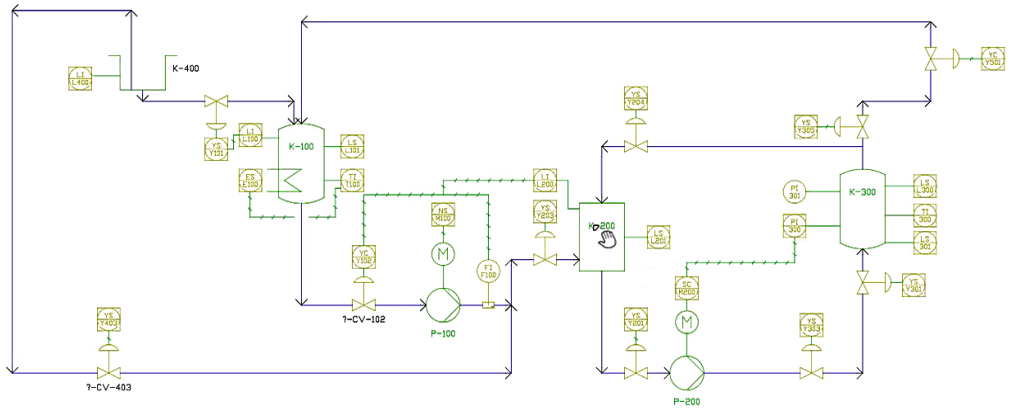
P&ID visualization



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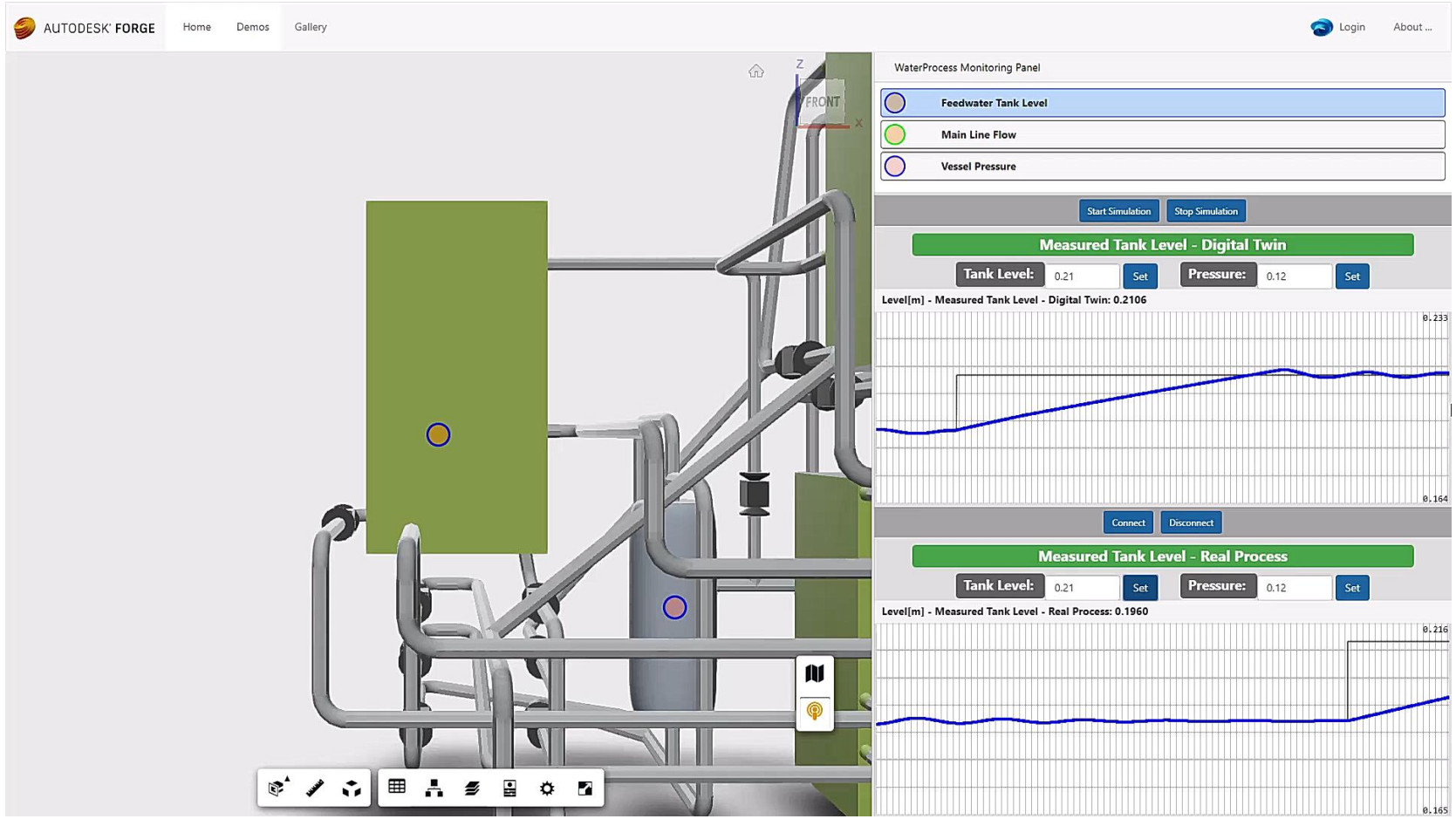
Transient prediction with Digital Twin



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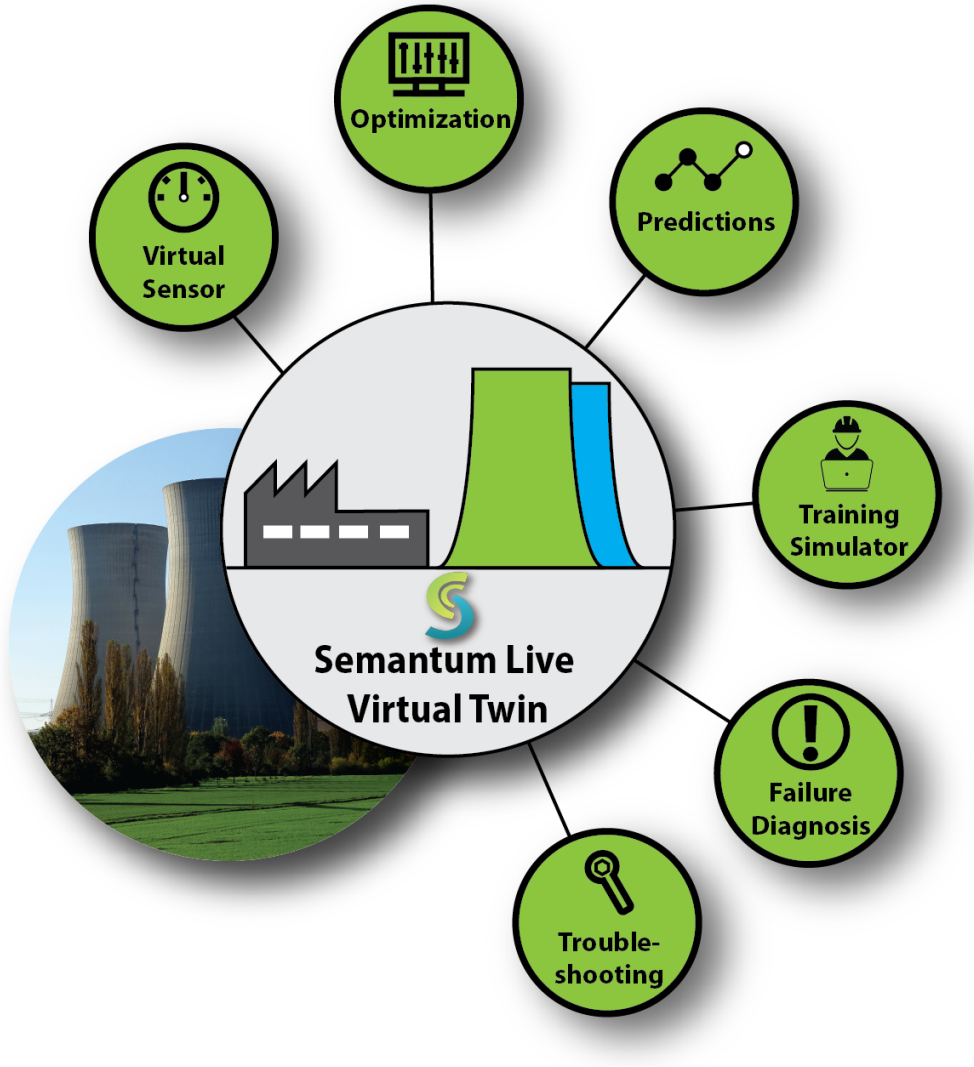
Simulation-based Digital Twin: Applications



FMI Simulation-based Digital Twin:
Enabling Technologies

- **Functional Mock-up Interface (FMI)**
- **Simupedia**
- **Simupedia FMI Studio**

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Functional Mock-up Interface (FMI)

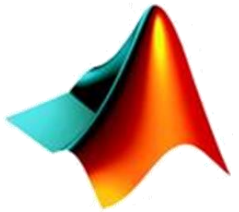
- Standard interface for co-simulation and model exchange of heterogeneous simulation models
  - Executable code packages can be executed as Functional Mock-up Units (FMUs)
- FMI Addresses the need to integrate models of subsystems of different vendors for system-wide simulation
- Maintained by FMI-Consortium, a non-for-profit industry group

(https://fmi-standard.org/)

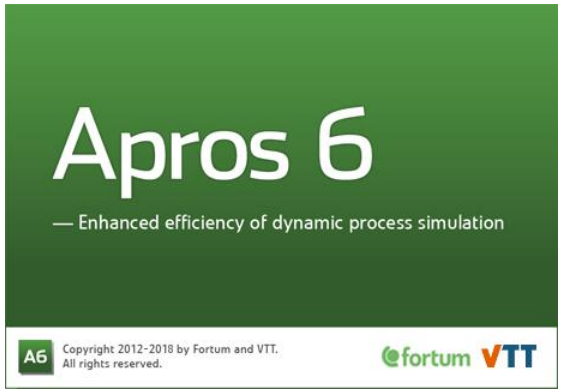
FMI: Supported tools

- Different Ansys tools
- Dymola
- Matlab Simulink
- JModelica
- NI LabVIEW
- OpenModelica
- **Sulca**
- SystemModeler
- **Apros***
- Many others…

https://fmi-standard.org/tools/



MATLAB



FMI Simulation-based Digital Twin:
Enabling Technologies

- Functional Mock-up Interface (FMI)
- **Simupedia**
- Simupedia FMI Studio

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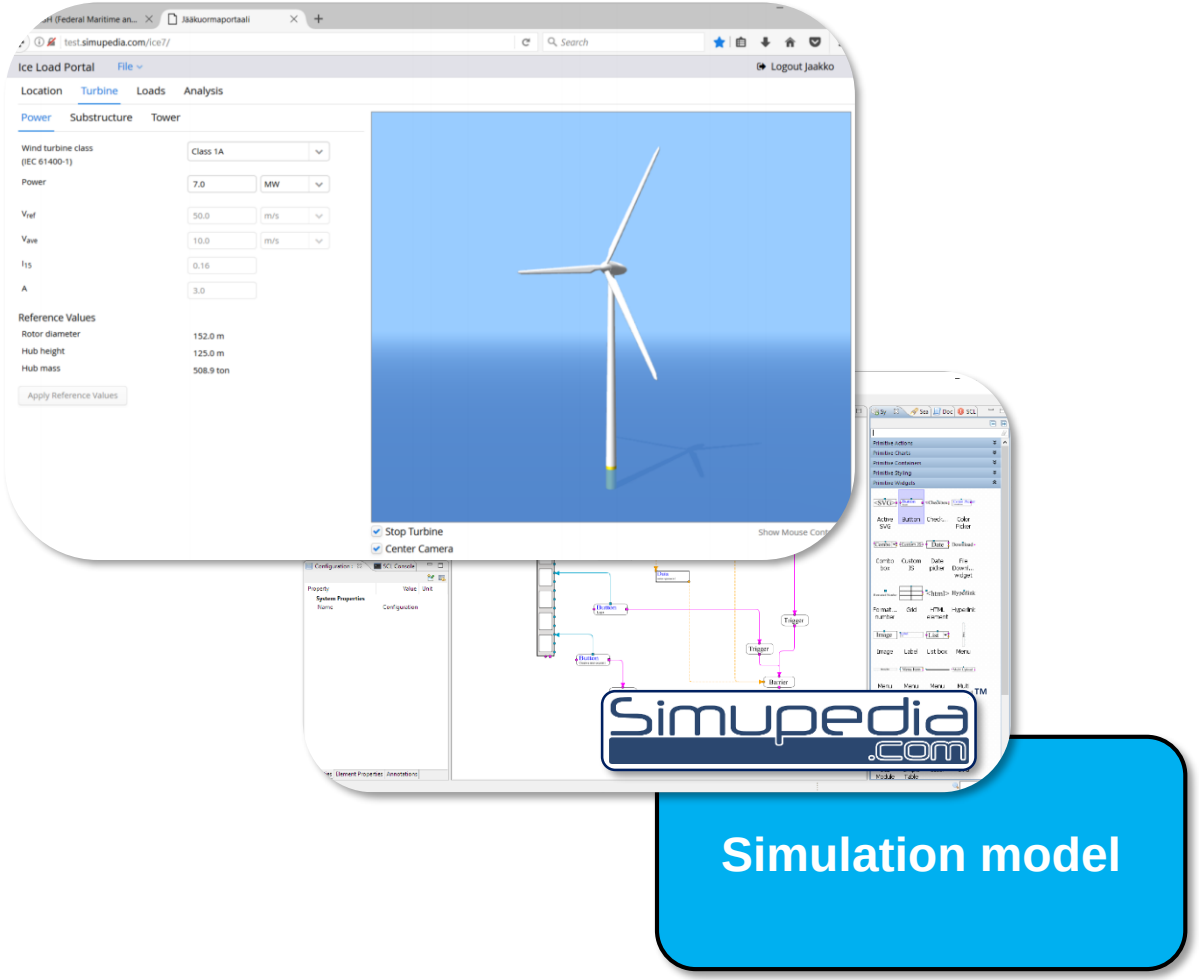
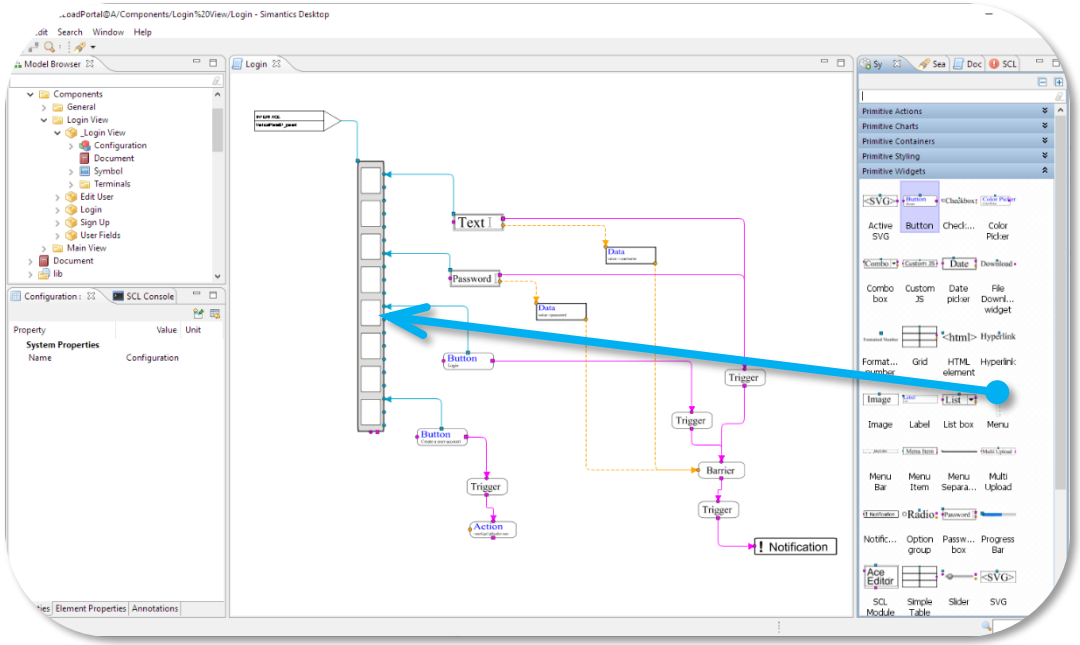
Simupedia™

- Simupedia is a platform for rapid and efficient development of web-based modelling and simulation applications.
- Targeted to enable cloud-based Simulation-as-a-Service (SaaS).
- Based on Simantics platform.



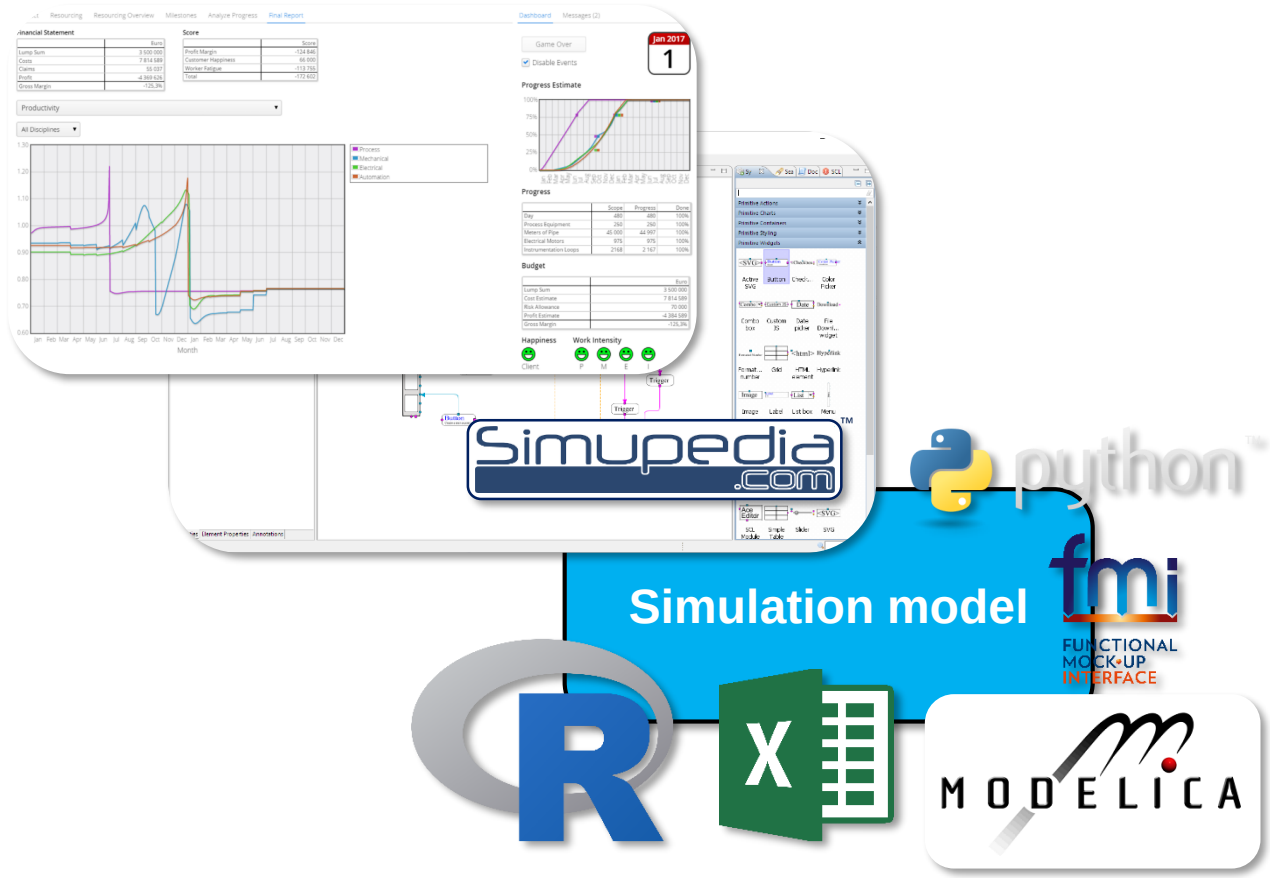
Rapid and efficient application development

- Simupedia™ applications are configured graphically using primitive widgets such as buttons, text boxes, images, labels and charts, as well as re-usable components defined by the user.
- Simupedia™ applications can be run on any modern web browser with no additional plugins required.



Simupedia™

- Simupedia™ supports integration with several popular languages for implementing the underlying simulation model and result data analytics, such as:
  - R
  - Modelica
  - Python
  - Excel
  - FMI
  - More!



Example Applications

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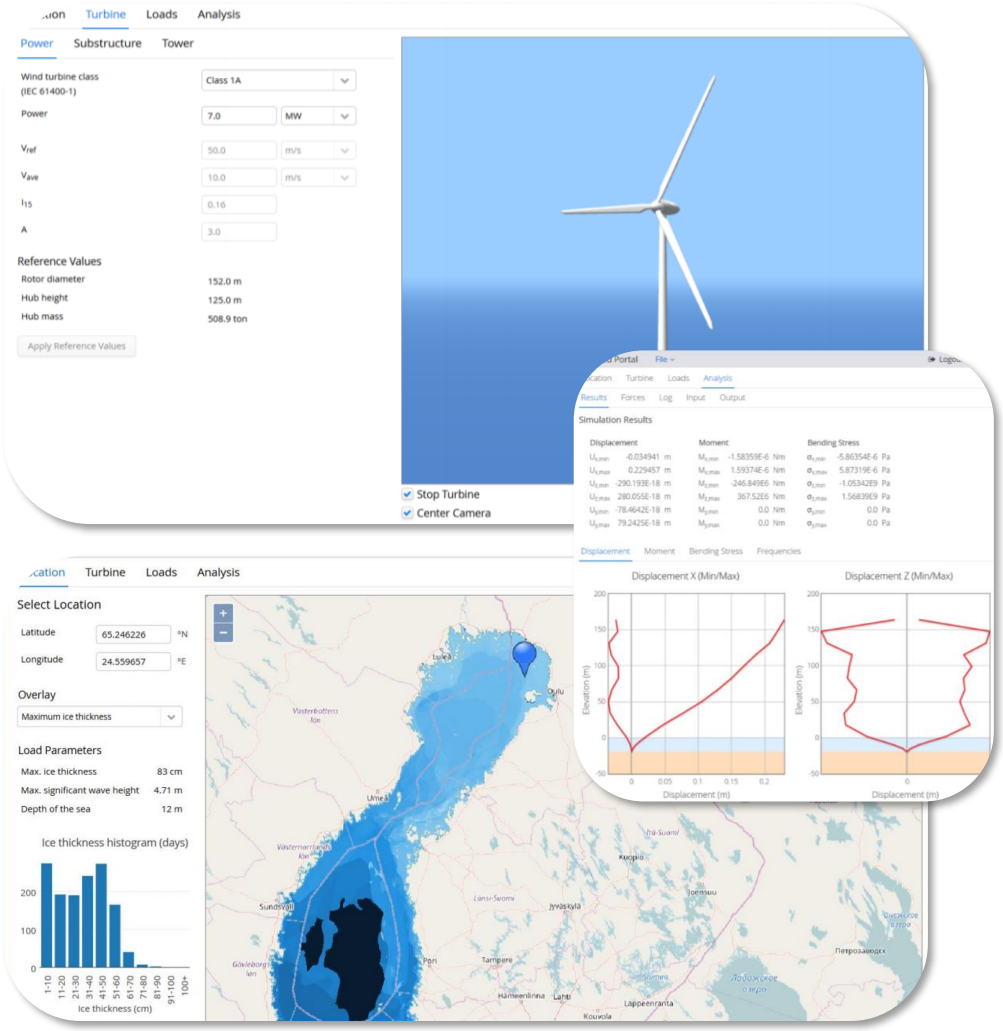
Ice load portal

For rapid preliminary design of offshore wind turbines in the Gulf of Bothnia

- Cloud-based, modular and script-based design tool
- Calculation modules for structural and dynamic analyses are combined with weather historical data on an interactive design portal.
- Results are used to assess construction viability of offshore wind farms in certain coastal regions.



Heinonen, J., Tikanmäki, M., Kurkela, J., Klinge, P., Hekkala, T., Koskela, J., ... Eriksson, P. (2017). *Ice load portal for preliminary design of offshore wind turbines in ice-covered sea areas*. Poster session presented at Wind Europe Conference & Exhibition, Amsterdam, Netherlands.

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BALAS

Steady state simulation tool for chemical processes.

- Widely used in Finnish Pulp & Paper industry for preliminary plant design.
- Flowsheet-based simulation tool with unit operations and model libraries that can be used to create models of the whole paper mill.
- Web-based model configuration interface enabled by Simantics and Simupedia™ .
  - Process Simulation as a Service

http://balas.vtt.fi/

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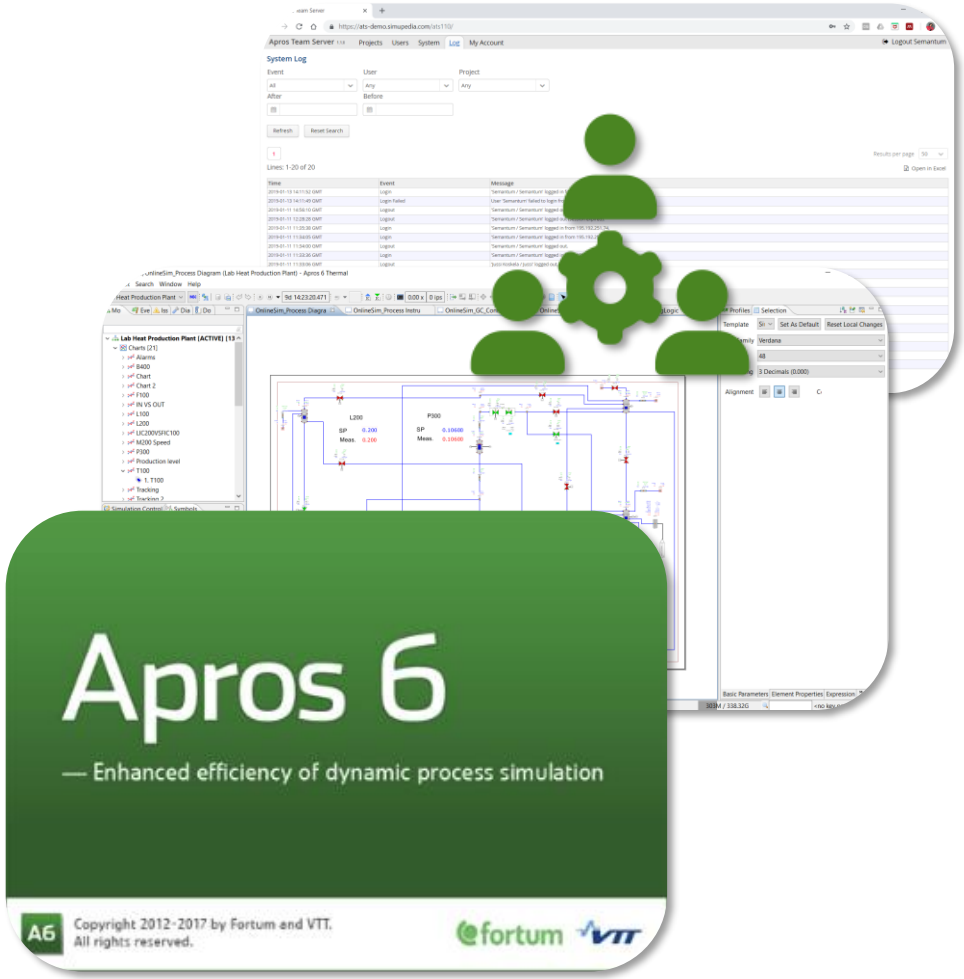
Apros® Team Server (ATS)

Model version control for Apros® simulator

- Apros ® is a widely-used dynamic simulation system for thermal-hydraulic processes.
- Simupedia™ has been used to developed ATS.
- ATS helps to effectively automate modelling project tasks. It provides:
  - Version management
  - Change control
  - Report and tracking
  - Ticket system
  - More!



http://www.apros.fi/en/

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FMI Simulation-based Digital Twin:
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- Simupedia
- **Simupedia FMI Studio**

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Simupedia FMI Studio

FMI support for Simantics is provided by FMI Studio.

- A set of plugins that provide basic FMU import and manipulation support for the Simantics workbench.
- FMI studio can be used for
  - Importing FMU files into the workbench
  - Run simulations
  - Plot simulation results
- The product also exposes the structure of the FMU model for the rest of the Simantics platform
  - The model can also be accessed and manipulated by other Simantics products through SCL.

WebTurbine

Simulation-based Digital Twin of Siemens SGT 700-800 gas turbines

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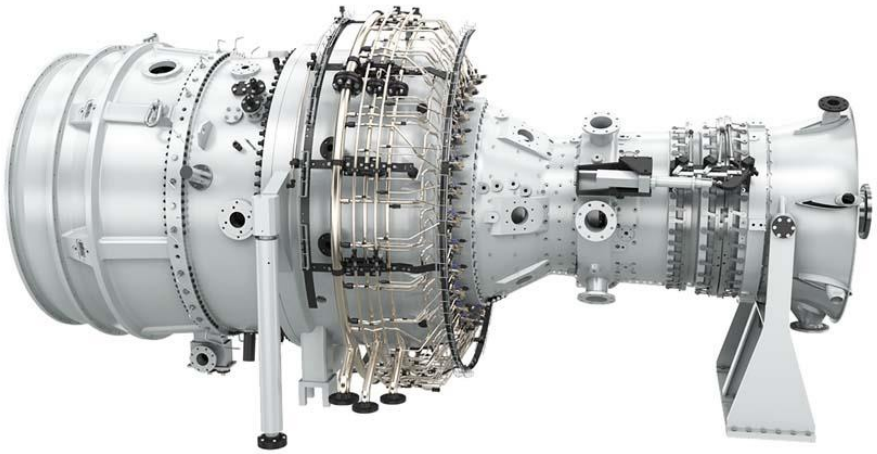
WebTurbine

- Gas turbine models were developed
- Utilizing the model requires knowledge about implementation details of the model
  - Model initialization parameters
  - Simulation variables
- This hinders wider utilization of the simulation model for other applications



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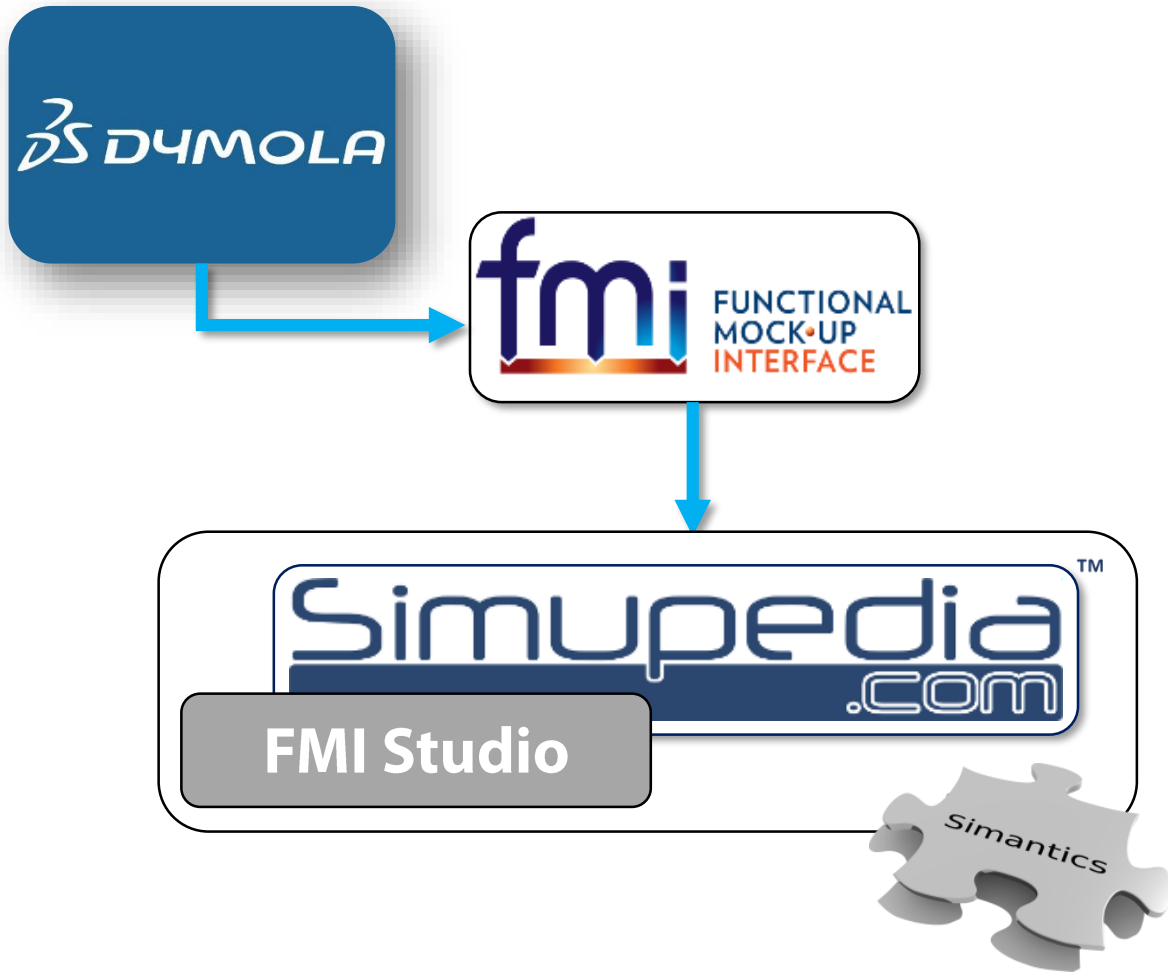
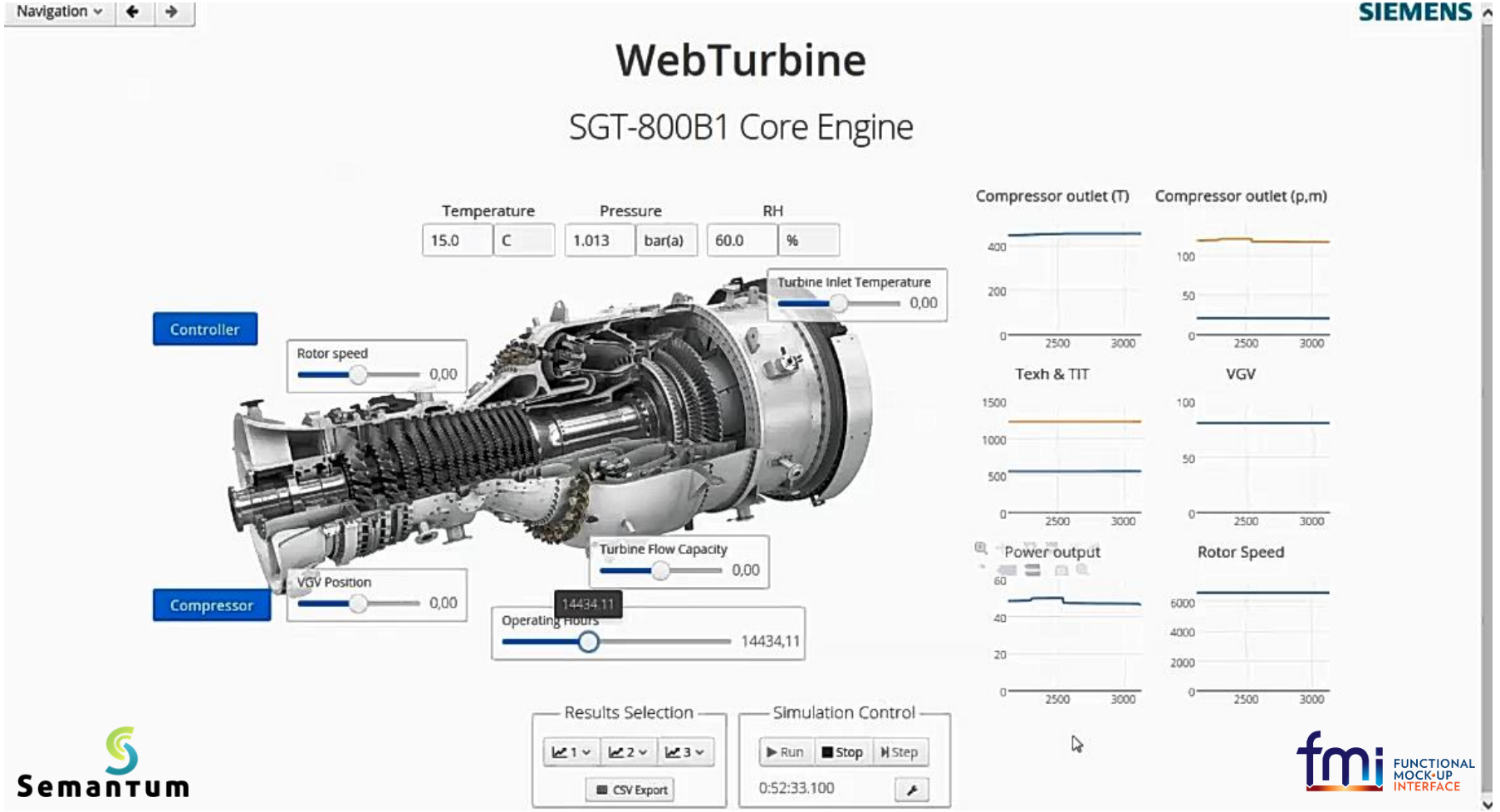
WebTurbine

- Simulation model developed in Dymola
  - Modelica-based simulation tool
  - Developed by Siemens TU
  - Different models covering different turbine models
- Simulation models exported as FMUs
- Simupedia was used to create the document that defines the user interface



Digital Twin of the Siemens SGT 800 Turbine



Benefits

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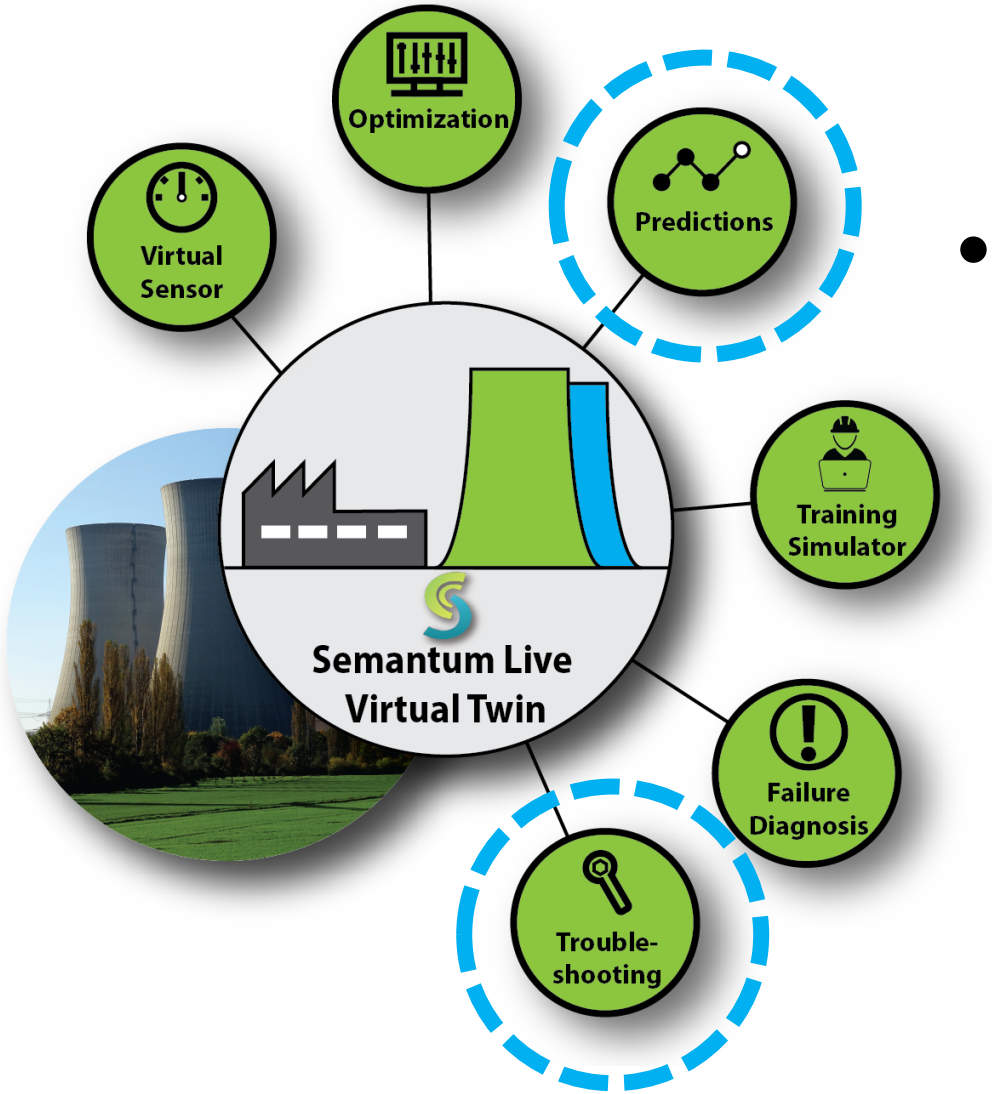
Simulation-based Digital Twin: Applications



- Sales support

Thank you!

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