INTELAB | Interactive Energy Lab

RTSoft Group of Companies

Modeling Intelligent Control Systems based on a Digital Platform for the Management of Distributed Energy Systems

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Company profile

INTELAB LLC - Interactive energy lab of the RTSoft Group of Companies. The company's goal is to develop and implement intelligent software services and solutions for Distributed Energy Resources (DERs).

INTELAB's activities are focused on solving the following tasks:

- ❑ Improving the efficiency of energy management through optimization and forecasting algorithms
- ❑ Improving the efficiency of energy modernization projects using modern technologies for storage and generation of electricity
- ❑ Modeling and creating digital twins
- ❑ Development of the Russian digital platform for digital energy resources - "∀Platform"

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Project description

Platform approach for developing applied control systems for distributed energy resources

The development of intelligent DESs is accomplished by all kinds of “growing pains”:

- problems of DERs owners with development and configuration of control systems
- threats to the stability of the global energy system
- inconsistencies in information exchange and workflow
- insufficiently developed regulatory framework
- vulnerability to cyber-attacks

PLATFORM

The digital economy offers an adequate approach: the organization of DESs operation on the basis of a single platform solution:

- Owners and operators of DERs connect to the platform in order to reduce costs and gain new opportunities

Development of a platform – the project of NTI EnergyNet “Development of a Russian programmable platform for the management of distributed energy systems - ∀Platform”

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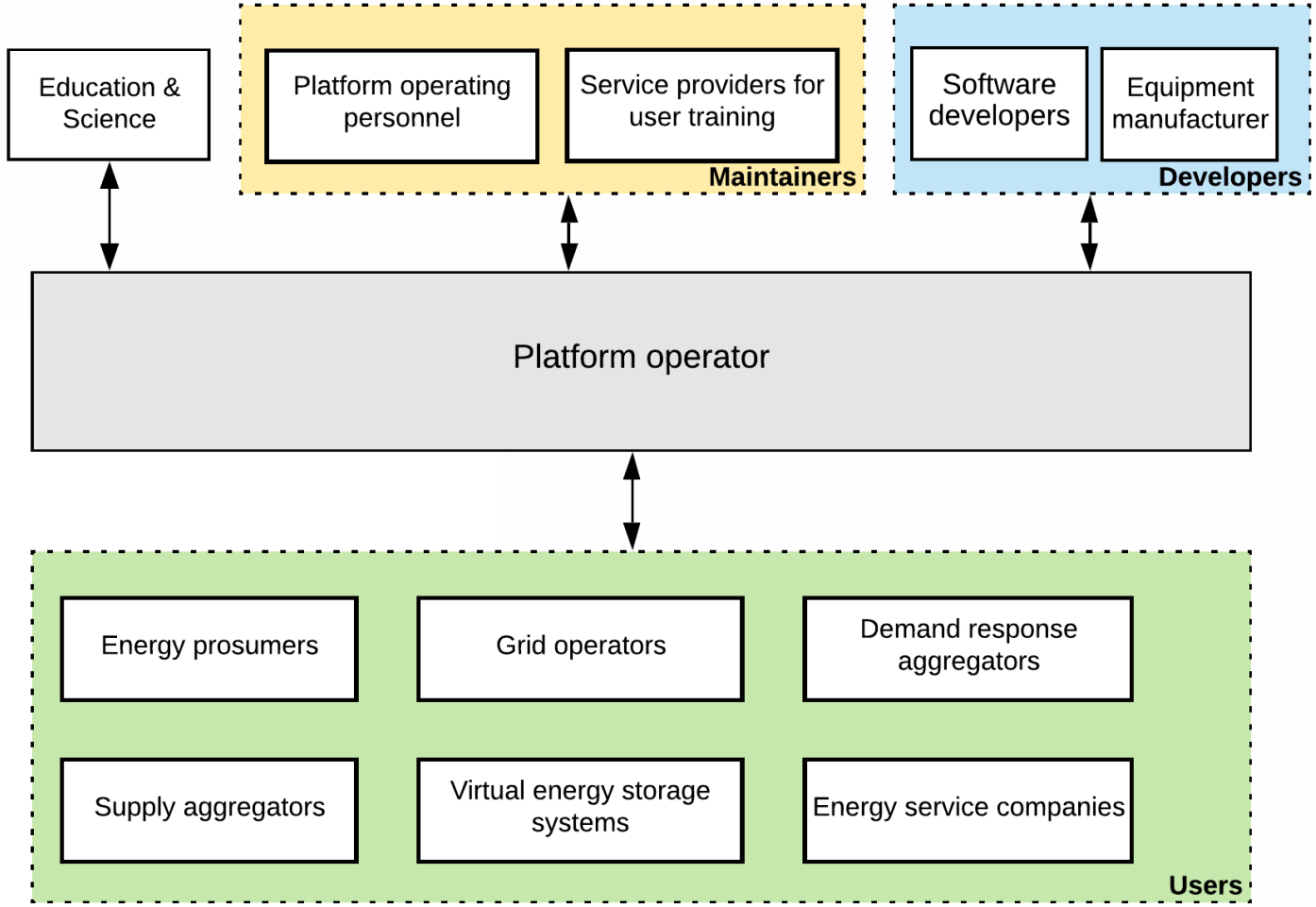
Project description

Ecosystem and use cases of the Platform

- Demand response management, DRM
- Virtual power plant management, VPPM
- Virtual energy storage management, VESM
- Commercial dispatching of consumers, CDC
- EV charge management, EVCM
- Active facility management, AFM
- Microgrid management, MGM
- DER circuit segment management, DERCSM



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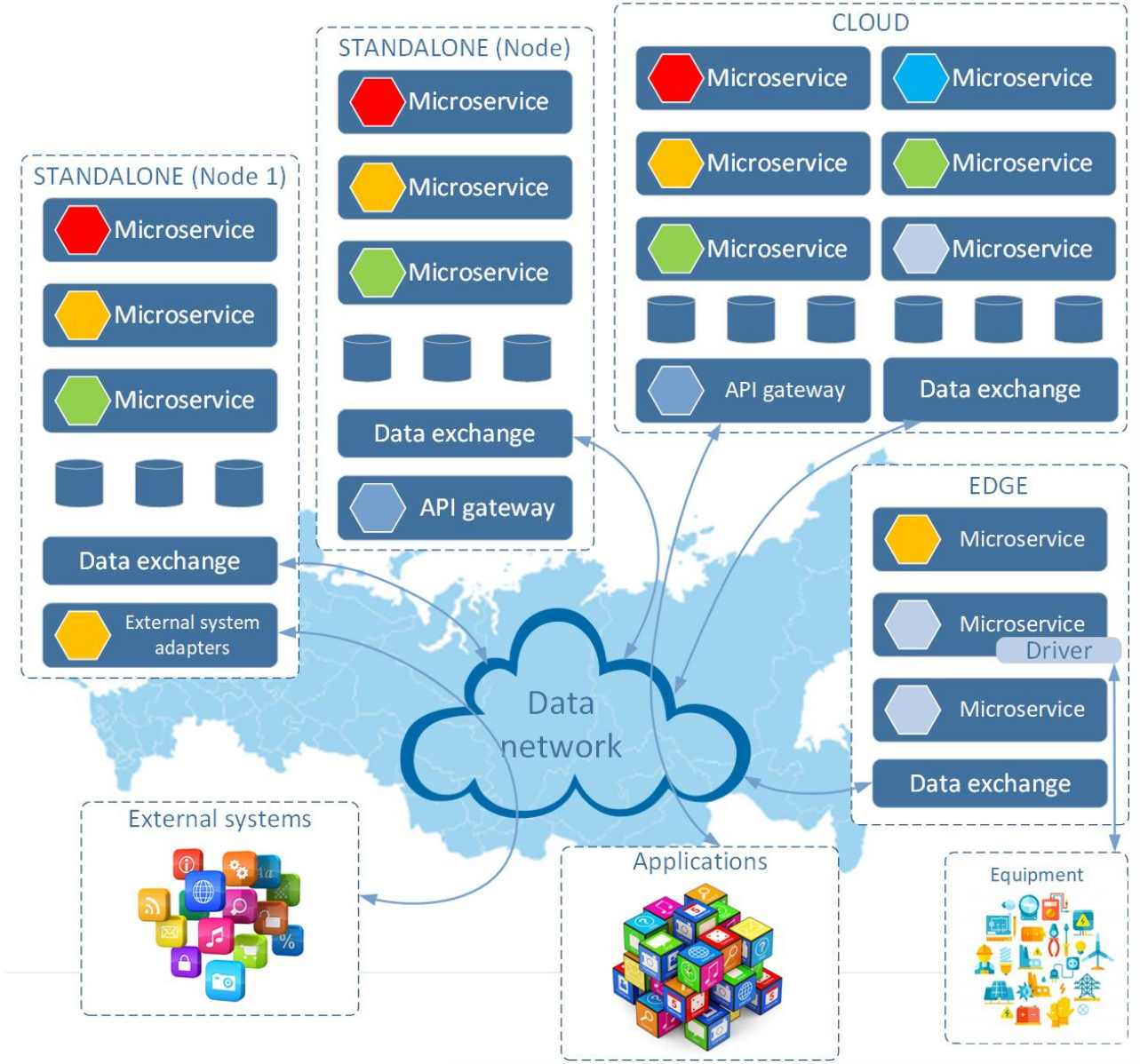
Project description

Platform architecture

Architecturally, the platform consists of microservices that operate in a common environment using messaging mechanisms and communication protocols in the REST style

The system can have a geographically distributed structure, considering the requirements for redundancy and load balancing



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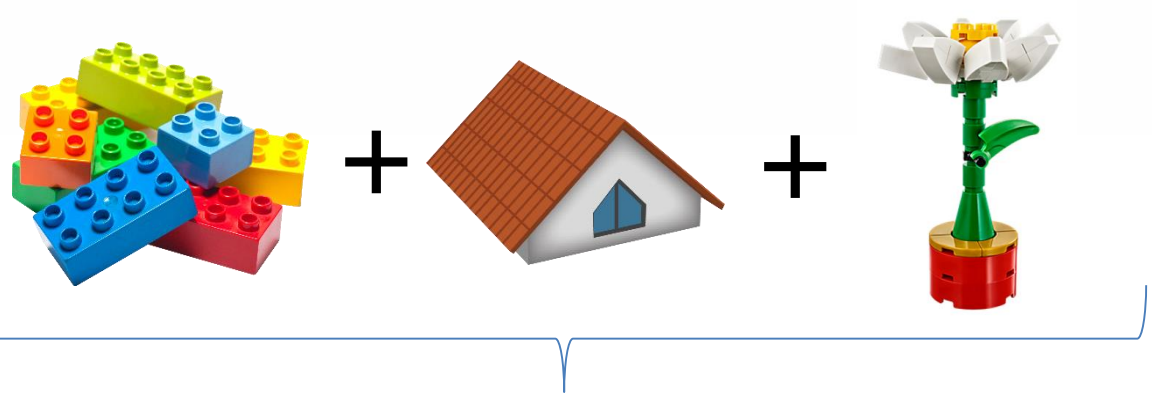
Project description

Building DER control system of your dream

Platform microservices

Application components

External systems



DER control system

The **Platform** allows:

- **To integrate** different software products
- **To reduce** the cost of the control system
- **To reduce** time-to-market for a developed control system
- **To introduce** elements of artificial intelligence through a distributed platform architecture
- **To ensure** the unity of information environment
- **To integrate** the equipment of different manufacturers

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Business Challenge & Why Simulation?

Why Simulation?

- ❑ Visual virtual development of functions for managing smart distributed energy facilities using the platform's products/services
- ❑ Preliminary assessment of the technical and economic effect of using the platform
- ❑ Clarification of the composition and intensity of information flows supported by the platform

Why conventional programming doesn't fit:

- ❑ Requires a lot of time to prepare an MVP
- ❑ Requires to have a lot of specialists and to have a focus on application components
- ❑ Requires more time to develop a Graphical User Interface (GUI)
- ❑ Hard to model specific use cases, where control object can be presented as a population of agents (use case with electric vehicles or aggregated power facilities)

Why Anylogic?

- Agent-based simulation
- Flexible and powerful
- Visualizations make it easy for non-technical stakeholders to understand
- The Anylogic can be easily connected to the digital platform to demonstrate its functions
- Allows to speed up the process of preparing a demonstration of application prototypes which use A-Platform microservices.
- Can be used to expand the Platform ecosystem (creation of training centers, training of specialists for platform-based energy management)

Platform microservices

Application components&GUI

External systems (if needed)

DER control system **simulation**

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Simulation process

Use case development

Decomposition of the technological process into stages

Formation of technical specifications

Creation of information models, definition of a list of constant and variable parameters

Development of a simulation model

Following the tecnical specifications, a model is formed in the Anylogic environment

Discussion and correction of the simulation model

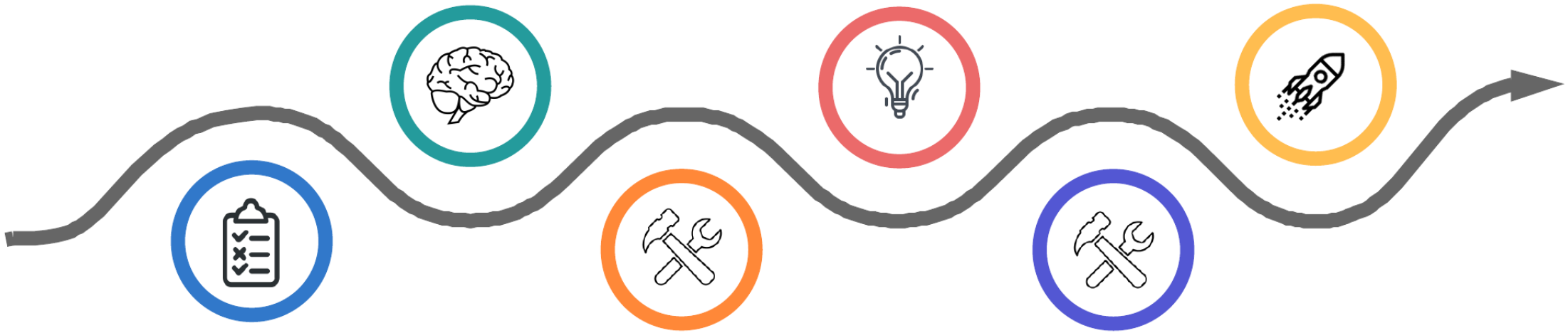
Determination of development directions and adjustments

Adjusting the model to the customer

Adjustment in accordance with the wishes of the customer

Demonstration

The model is demonstrated to a potential customer



Model Demo and Scenario Results

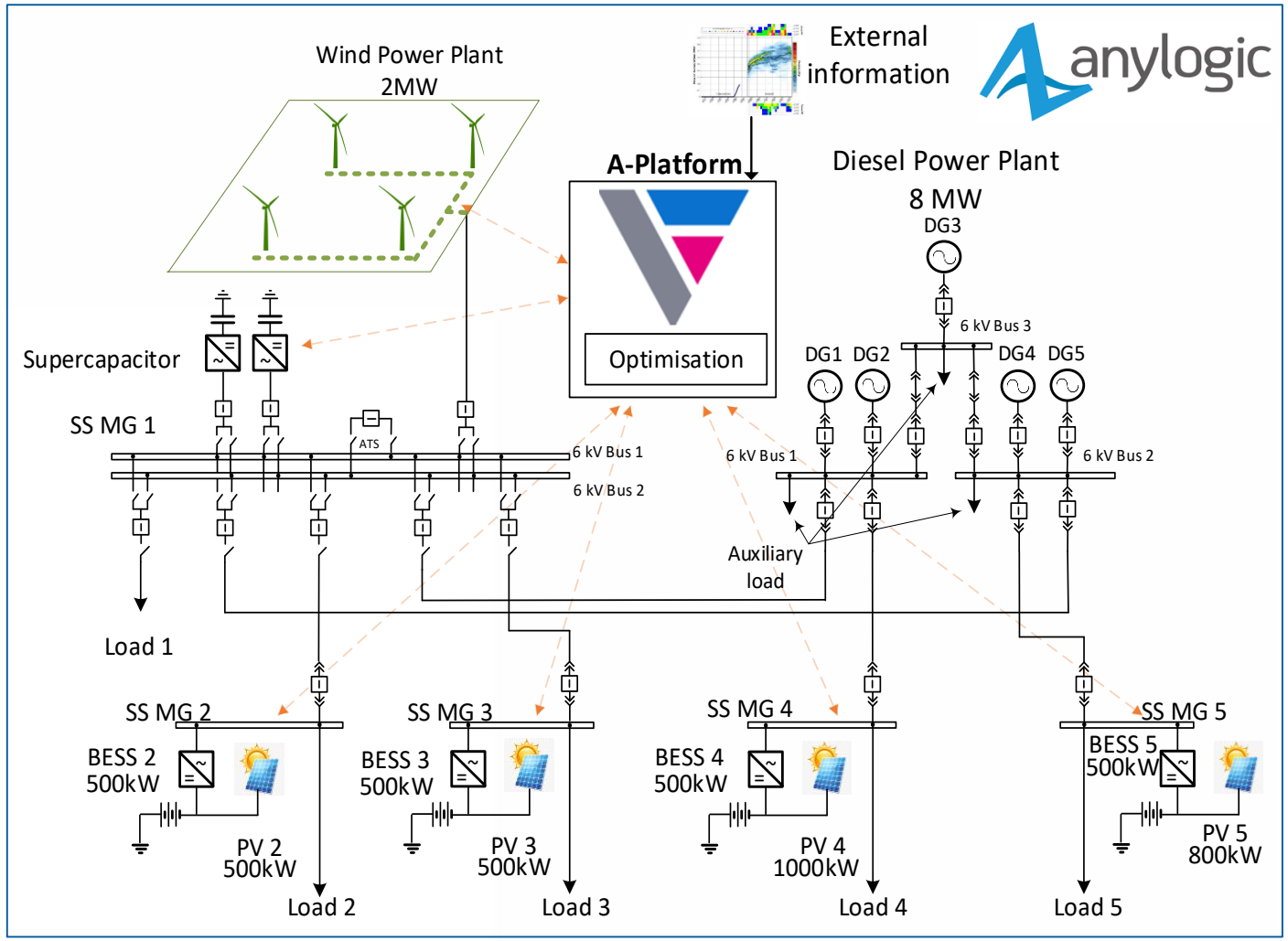
Use case

Microgrid management

Purpose of simulation:
demonstration of the helpful effect of the A-Platform while managing microgrids

Goals and objectives of the simulation: testing the short-term optimization module and demonstrating the benefits of using the optimization algorithm.

Algorithm Objective function: minimize the cost of generating electricity while satisfying system boundary conditions



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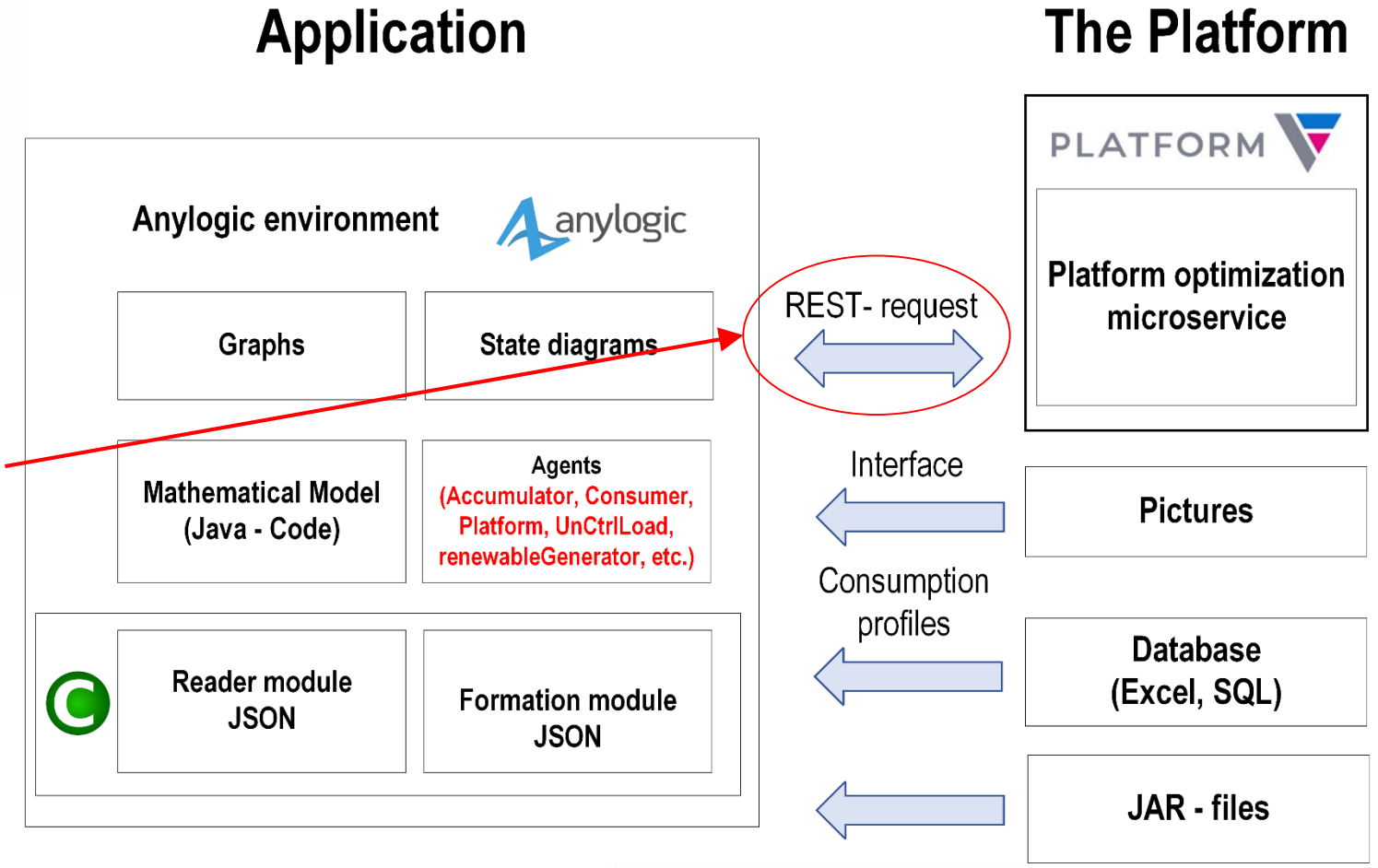
Use case

Structural diagram of the simulation model

Information about the current state of the microgrid, in the form of the REST request from the application to the Platform server, is sent to the **optimization microservice.**

The microservice solves the optimization problem and returns the solution in response to the REST request.



Use case

Model description

The main screen includes the following agents:

1 – Renewable generation (Wind Plant)

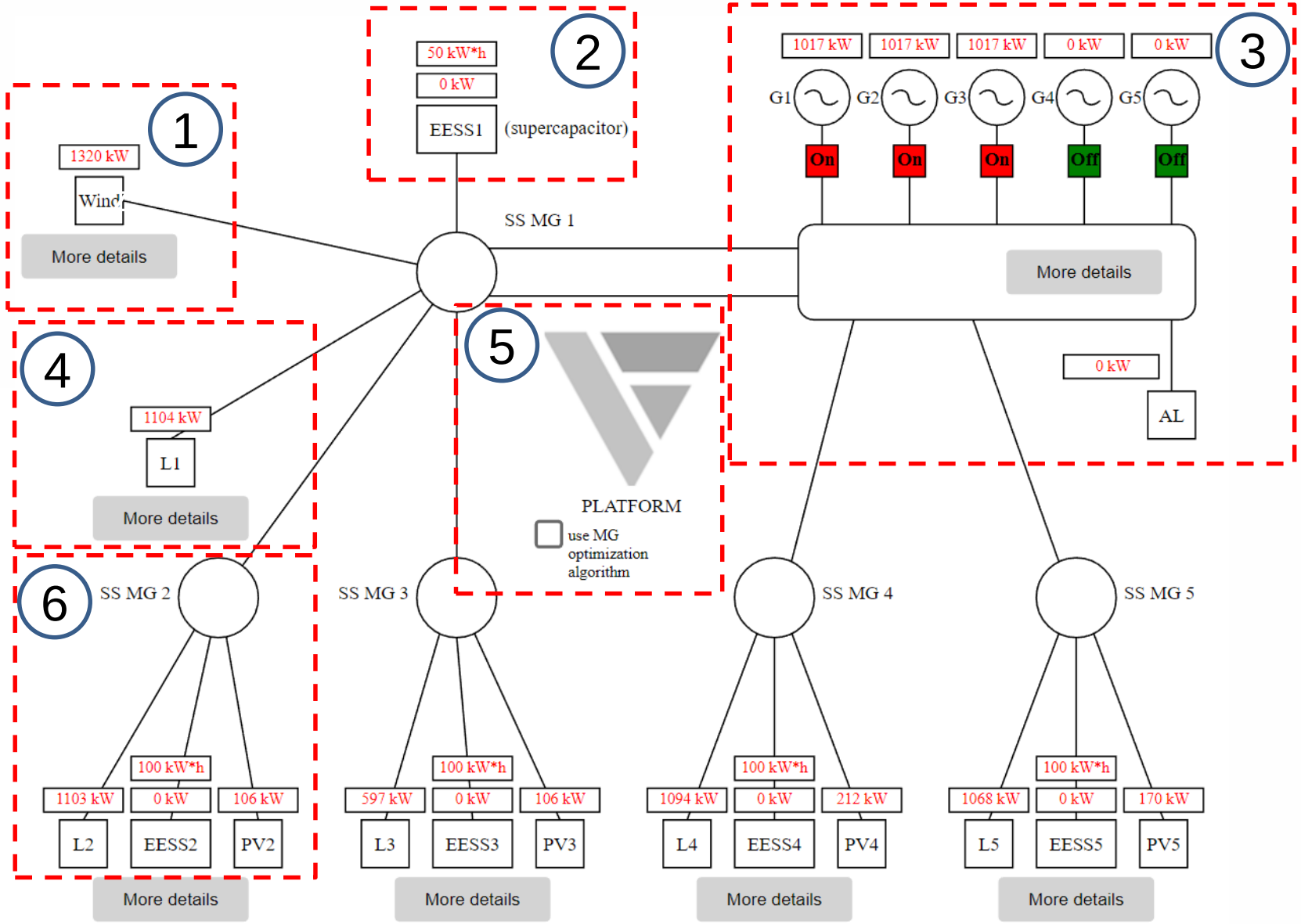
2 – Accumulator (Electrical energy storage system)

3 – Power Plant (Diesel generation sets)

4 – Uncontrolled load

5 – Platform (DER control system)

6 – Consumer



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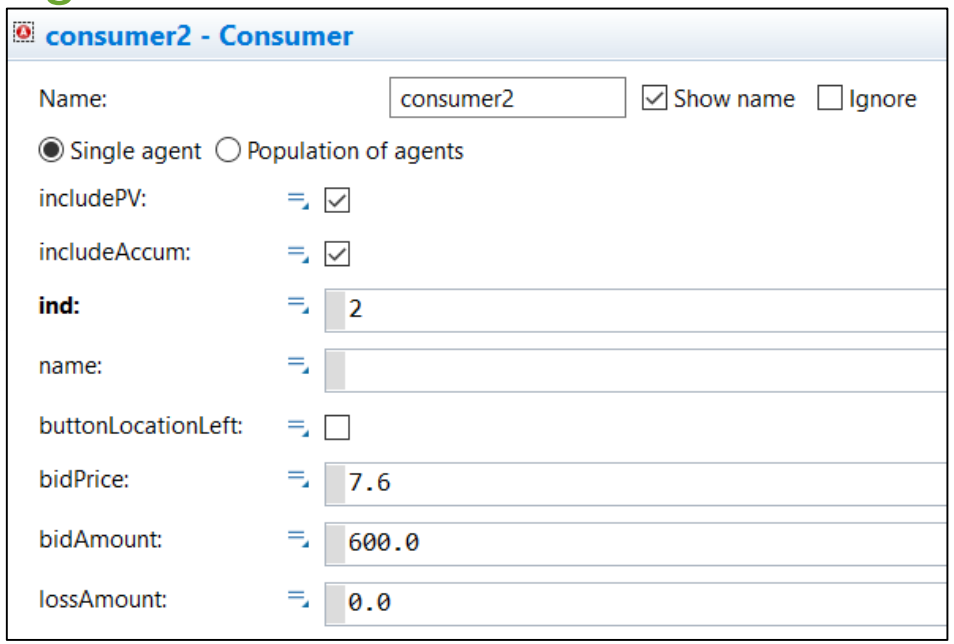
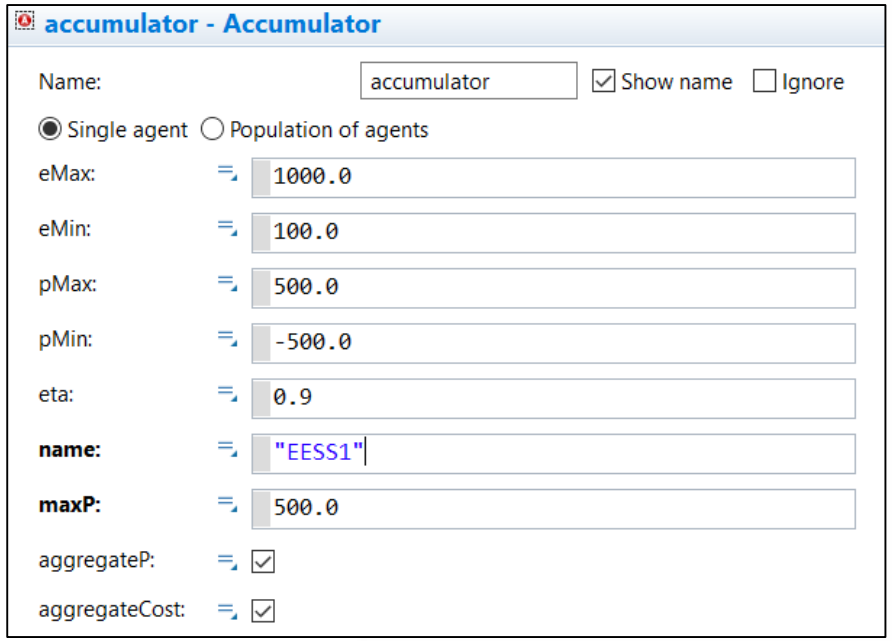
Use case

Agents in the simulation model



Consumer aggregates **UnCtrlLoad, renewableGenerator, accumulator agents** managed by the **Platform** agent that sends a REST request to the optimization microservice:

- sendOptimRequest (request to optimization module)
- sendSetPoints (formation of set points for a diesel power plant)



Outputs:

- Operation time of diesel generators, hours
- Energy generated from the start, MW⋅h
- Self cost, $
- Cost of diesel generation, $/kW⋅h

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Use case

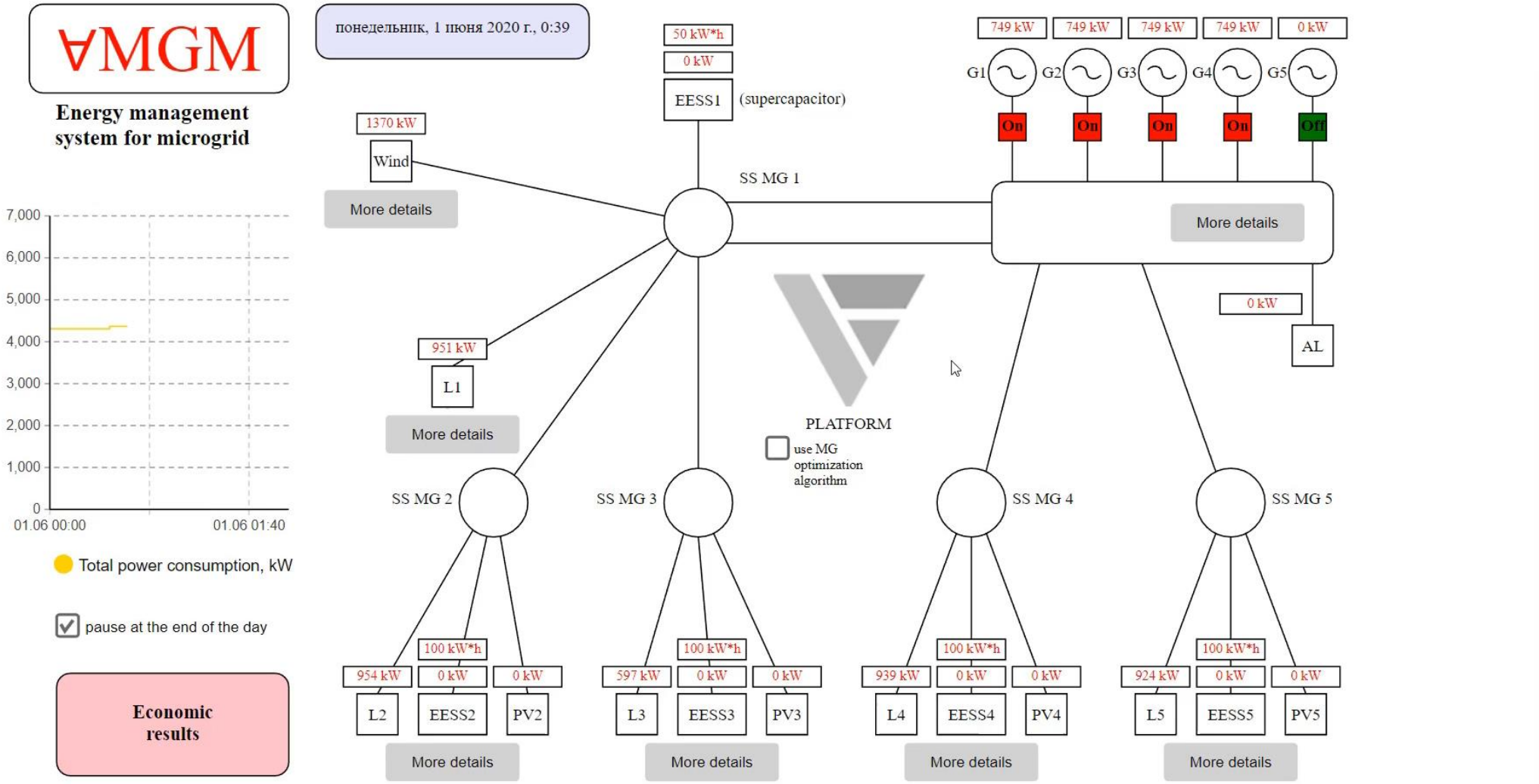
Additional java classes

- ExcelParser
- FLST
- HttpClient
- JsonParser
- OptimRequest
- ReqvAcc
- ReqvFuelGen
- ReqvLoad
- ReqvSimpleGen
- RespAcc
- RespFuelGen
- RespSimpleGen
- SetPoint
- TimeUtils

- parsing Excel Data base
- simulated load prediction (UnctrlLoad)
- allows to send REST API - request to microservice (used by http apache)
- reads the JSON received from microservice and translates the data into the model
- allow to form a request to the Optimization microservice
- reads the JSON received from the microservice and translates the data into the model

Use case

Model demonstration

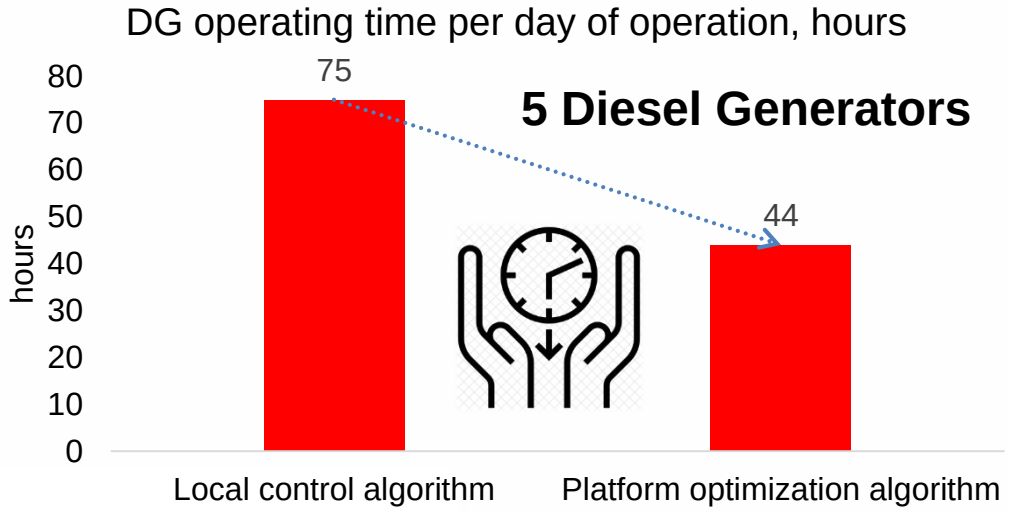


Use case

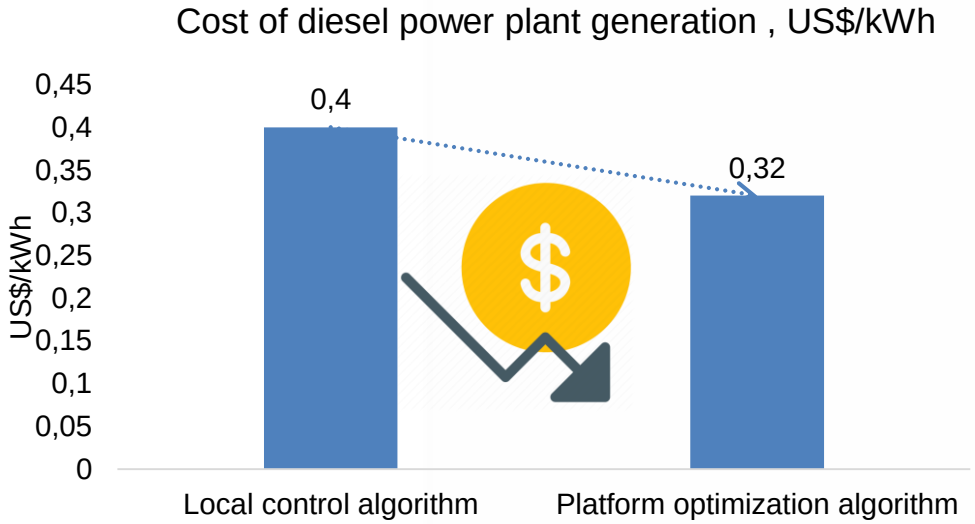
Simulation in Anylogic (results)

Algorithms to compare:

1) **Local control algorithm.** Always maintain the load of the switched-on generators between 37% and 75% of the rated power
2) **Platform optimization algorithm.** Use of the optimization module of the Platform



The number of diesel operating hours is shortened by 41%



Cost of diesel power plant generation reduced by up to 20%

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What's next?

Development prospects

- ❑ Providing simulation models for educational use
- ❑ Prototyping applications based on A-Platform microservices
- ❑ Attracting investments for the development of applied control systems for the least popular use cases of the A-Platform

Interesting use case to model in Anylogic

- ❑ **EV charge management use case.** Anylogic is a perfect solution to model the behavior of electric vehicles. Therefore, it is possible to model the development of electric transport in the city and to assess their influence on the electrical grid (including Vehicle-to-Grid (V2G) use case)

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Conclusion

- For the rapid development of platform applications, the use of the Anylogic is proposed, **which reduces the time spent for the development of MVP application**
- To demonstrate the helpful effect of the Platform while developing an application, **a simulation model was created in Anylogic**, demonstrating the effectiveness of the Platform optimization microservice.
- The **directions** of using models based on Anylogic are determined.
- To simulate such scenarios **as EV charge management**, the use of Anylogic is necessary and can significantly reduce the cost of preparing MVP versions of applications.

Questions?

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