Siemens DEOP – DISTRIBUTED ENERGY OPTIMIZATION

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Senior Project Developer for Siemens New Mexico, Smart Infrastructure Division
Private sector advisor to the NSF New Mexico EPSCoR Smart Grid Project. Renewable energy, microgrids, building automation, mechanical system efficiency, and water conservation. University of Chicago Graduate School of Business and Colorado College.

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Siemens Global Product Manager for Cloud-based Services, Smart Infrastructure Division

Sector: Renewable Energy / Hydro & Ocean
Cloud based services for Distribution Grid Operators, Retailers, Utilities and Microgrids, Virtual Power Plants, Demand Response Systems, Analytics.
Technical University of Munich, Electrical Engineering, Business Administration

MARCELLO POMPONI, Milan, Italy

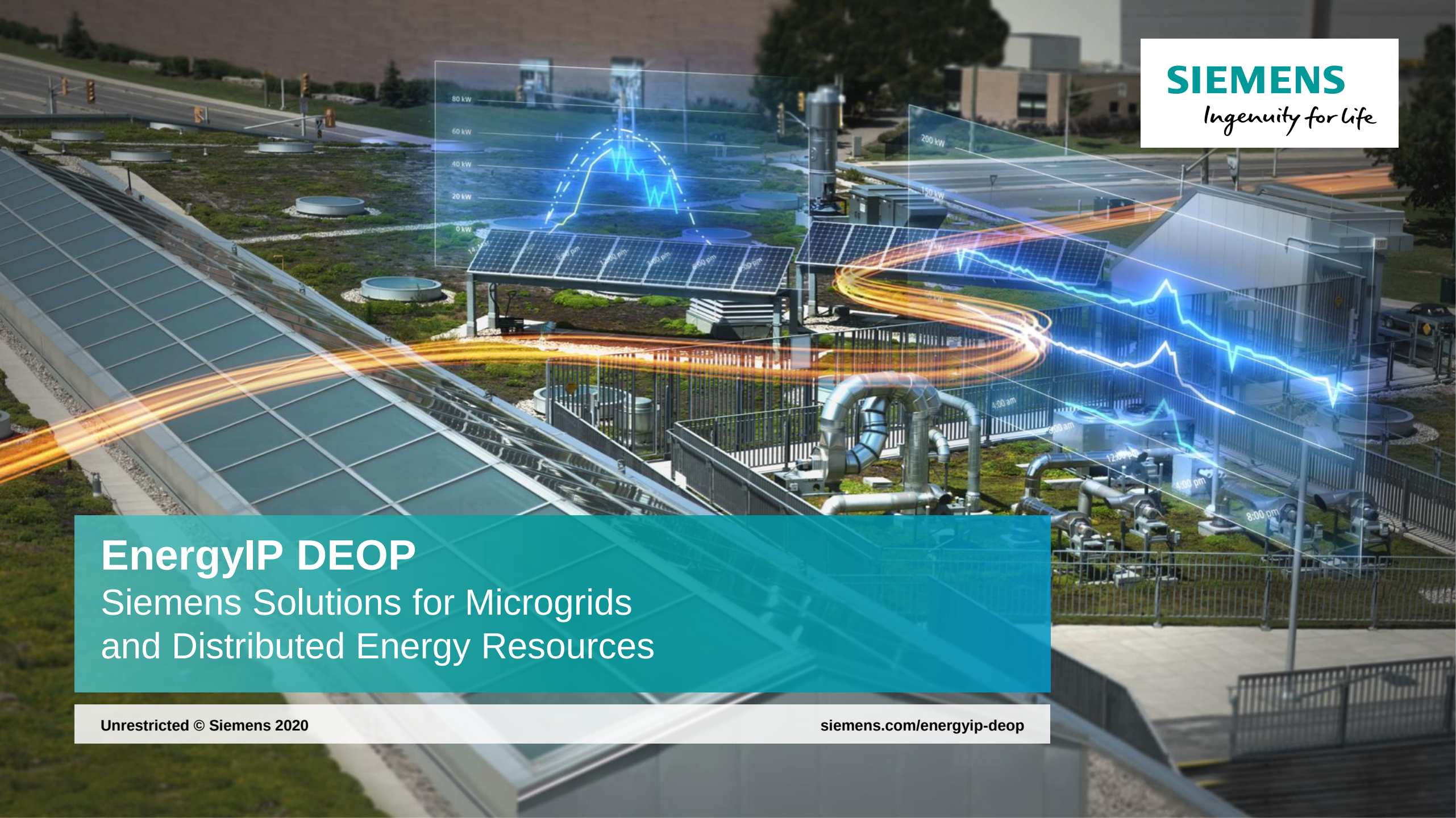
Solution Architect, Siemens Digital Grid Division

Work includes specifications for monitoring and optimization of energy flows within smart grid and microgrids; and developing algorithms to optimize electricity exchanged within a microgrid composed by a molten salt storage and large-scale solar PV. Polytechnic of Milan, Master of Science in Energy Engineering.

PAUL BENNISON, Raleigh-Durham, North Carolina

Business Development Manager – Microgrids

Key solution expertise includes economic dispatch, energy arbitrage, optimization, forecasting efficiencies, protection, control, automation, and power systems design, including real-time load management, grid synchronization and power import export considered. Cranfield University, Mechanical Engineering, Masters in Advanced Manufacturing Technology (Robotics)



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EnergyIP DEOP

Siemens Solutions for Microgrids and Distributed Energy Resources

siemens.com/energyip-deop

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EnergyIP DEOP – DES Performance Monitoring and Decentralized Energy Optimization

for PV Plants, Wind Parks, Commercial Centers, Campuses and Microgrids

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Transparency & Energy KPIs

- Geo/Energy/Tech navigation
- Support of geo maps
- Electric/Thermal/Gas monitoring
- Dashboards & Reporting
- Alarming based on triggers and KPIs

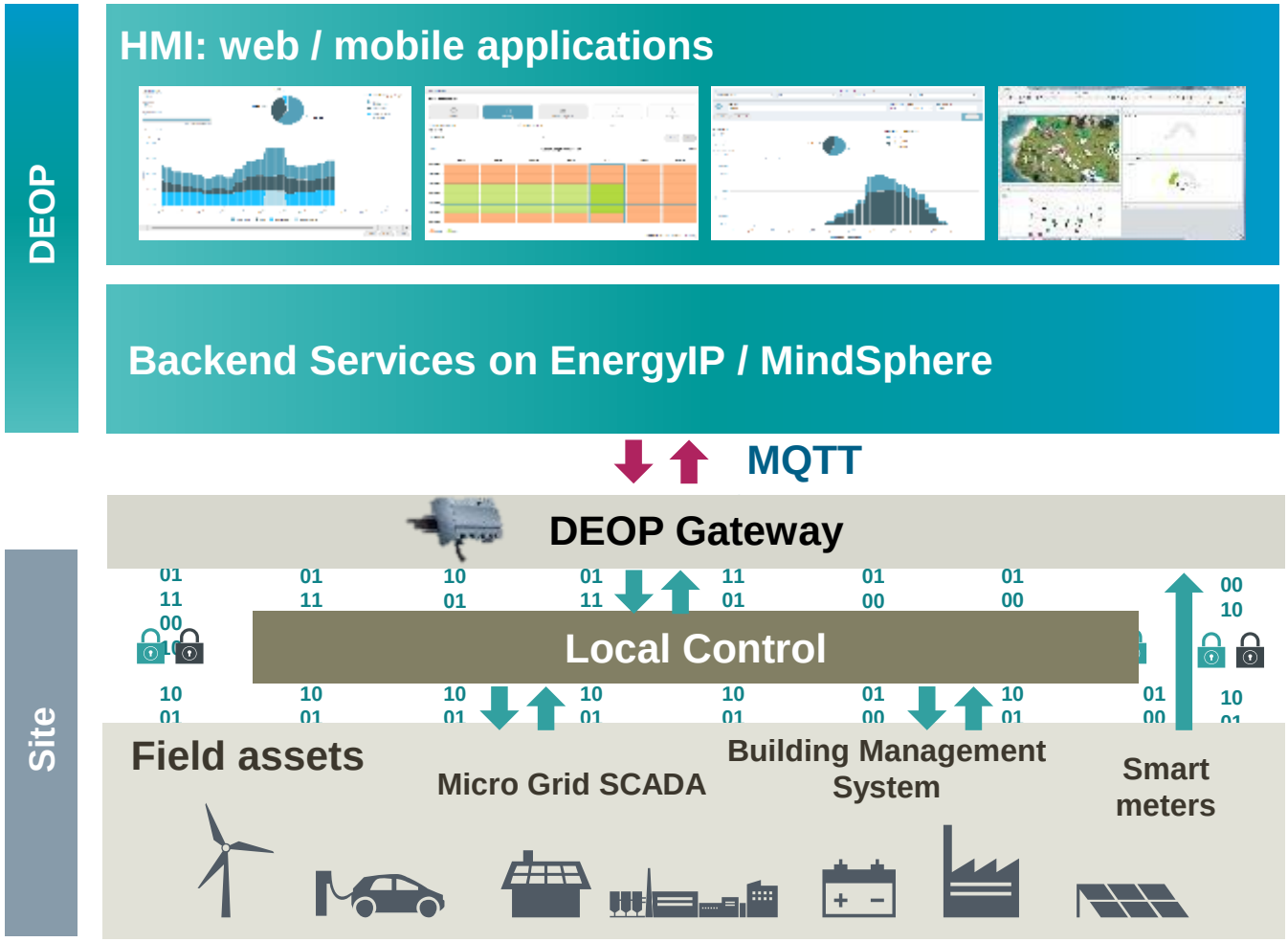
DER Performance Monitoring

- Generation forecast of PV/Wind based on weather forecast data
- Performance monitoring vs. historical data / benchmark
- Financial reporting

Micro-Grid Optimization

- Simple rules based load management
- Self-consumption optimization (Load+ Battery +PV)
- Optimal Scheduling based on units constraints & costs

High Level System Architecture



Monitoring of multiple asset types

Grid, building, generators, storage, loads, sensors, actuators …

Several connectivity options

MQTT as primary communication protocol.

Gateway on cloud or on premise.

Support of wide range of protocols: IEC-104, IEC-61850, MODBUS, OPC UA

Integration with Siemens Portfolio

PSS DE simulation tool for Distributed Energy System

SICAM MG Controller

Ecar OC for EV infrastructure management

Desigo CC for Building Management

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Transparency & Energy KPI Analysis

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Real-time monitoring

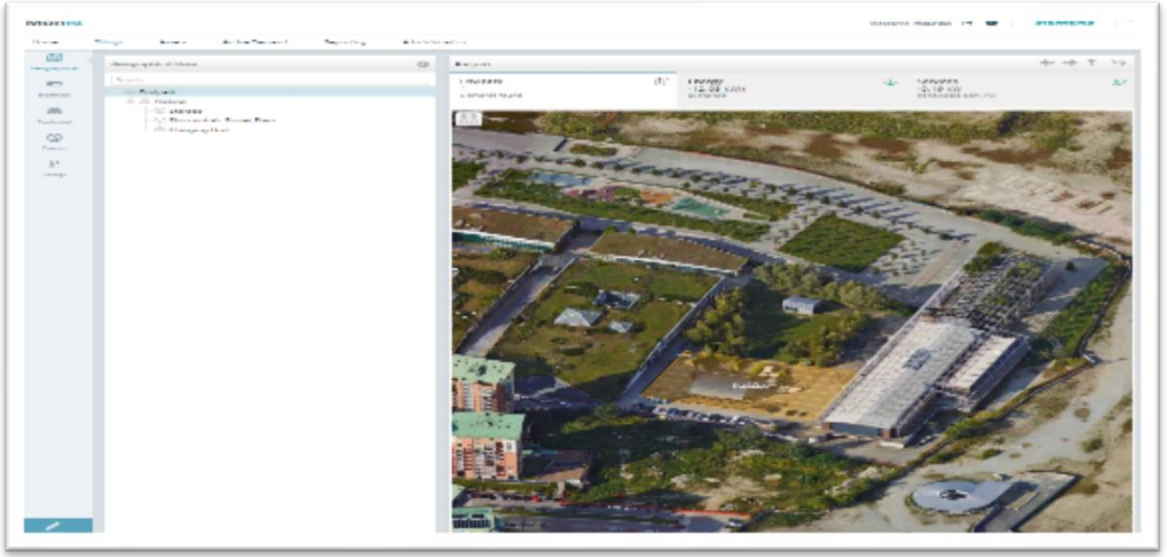
- Geo/Energy/Tech navigation
- Support of geo maps
- Electric/Thermal/Gas monitoring
- Environmental sensors
- Third system data from other systems to correlate

Alarming – based on triggers

- Alarm
- Warning
- Fault
- Anomaly
- Information

Reporting

- Electric/Thermal/Gas Reporting
- Energy Consumption/Cost by Site, Sub-sites/Areas, Usage Groups, …
- Energy vs. Variables (normalization)



Transparency & Energy KPI Analysis \ Reporting

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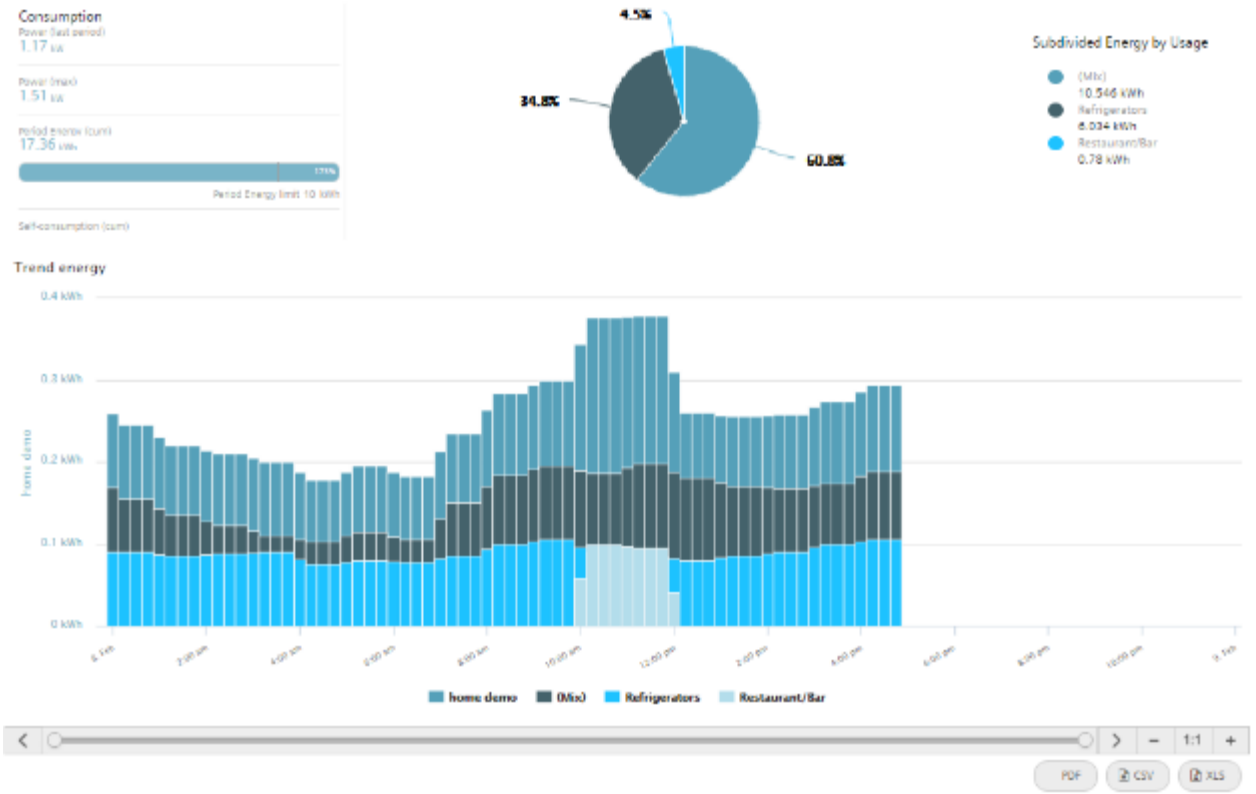
Available reports:

- Energy Consumption/Cost by Site
- Energy Consumption/Cost by Sub-sites/Areas
- Energy Consumption/Cost by Usage Groups

DEOP for Energy Cost calculation supports:

- Energy Tariffs
- Dynamic Energy Curves



Performance monitoring & DES Management

Generation forecast

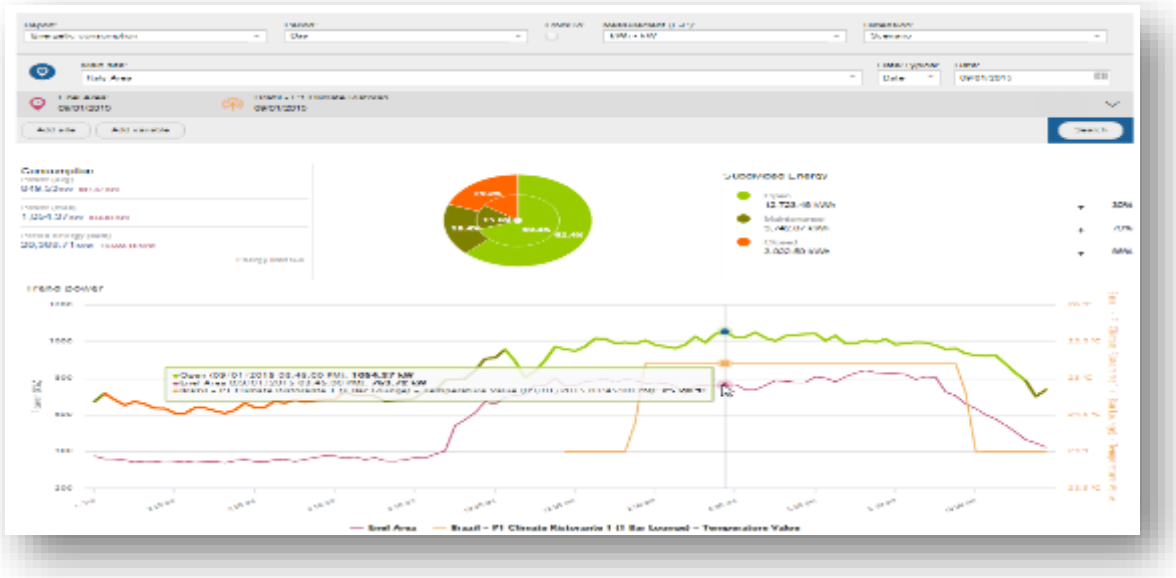
- Algorithm is based on weather forecast data and basic Generator data
- PV & Wind
- Algorithm runs every 24h and provides 72h forecast curves

Performance monitoring vs. historical data / benchmark

- Comparison of historical data with real time data to verify simulation and business plan sustainability / vendor declared data

Financial Reporting

- Consumption and Production forecasting
- Different scenario adjustments suggestion



Performance monitoring & DES Management \ Reporting

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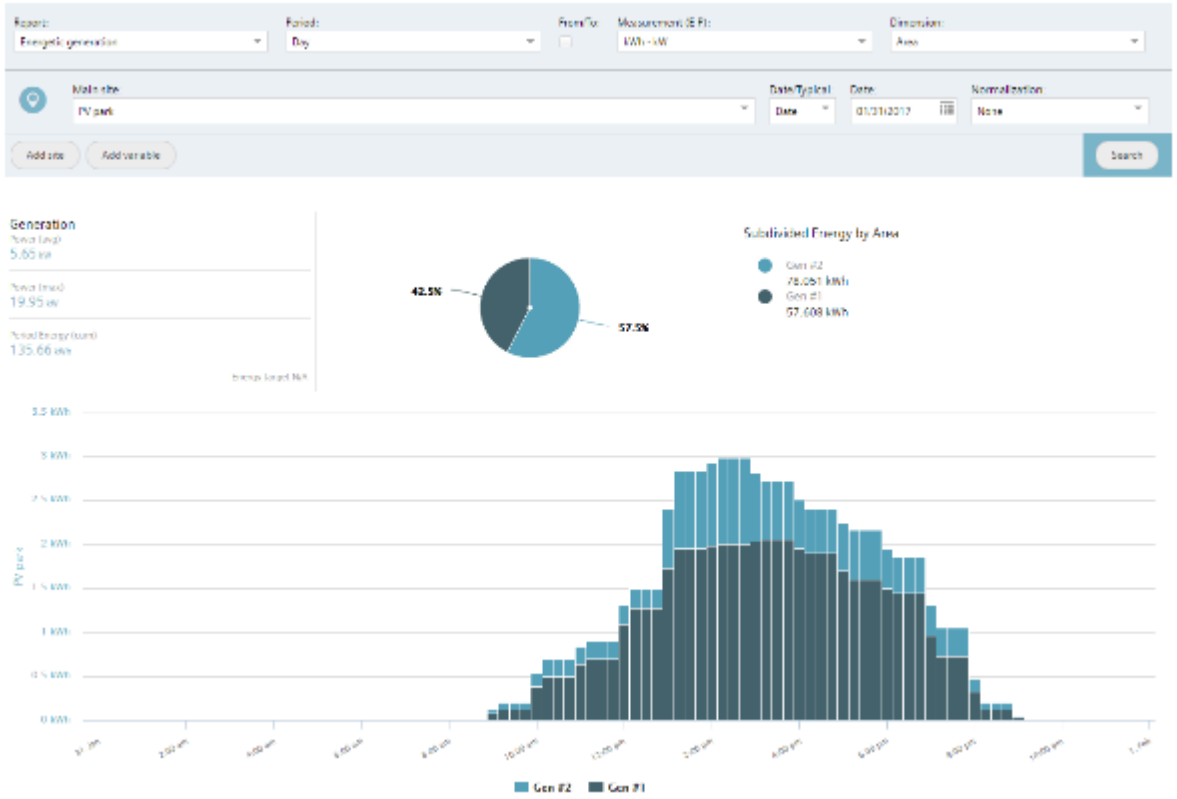
Specific performance reports for:

- PV park
- Wind park
- Programmable Generation: Diesel, CHP
- Storage: electric and thermal
- Building: electric and thermal load
- Micro-Grid



Micro-Grid
\ DES Optimization & Energy efficiency

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Load Management

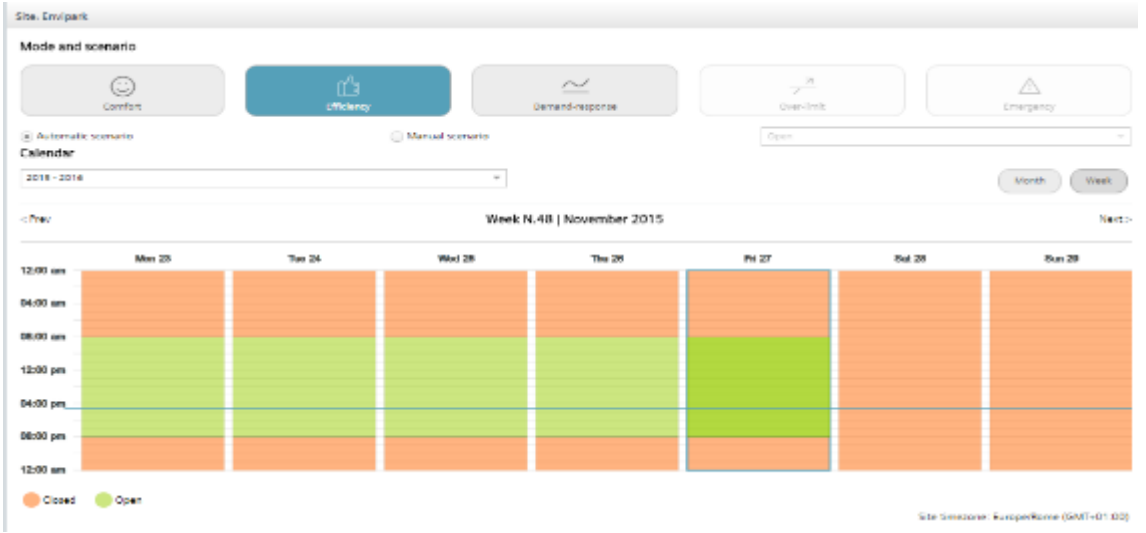
- Simple Rules based engine for managing loads depending on scenarios (calendar) or operating modes

Algorithms Engine

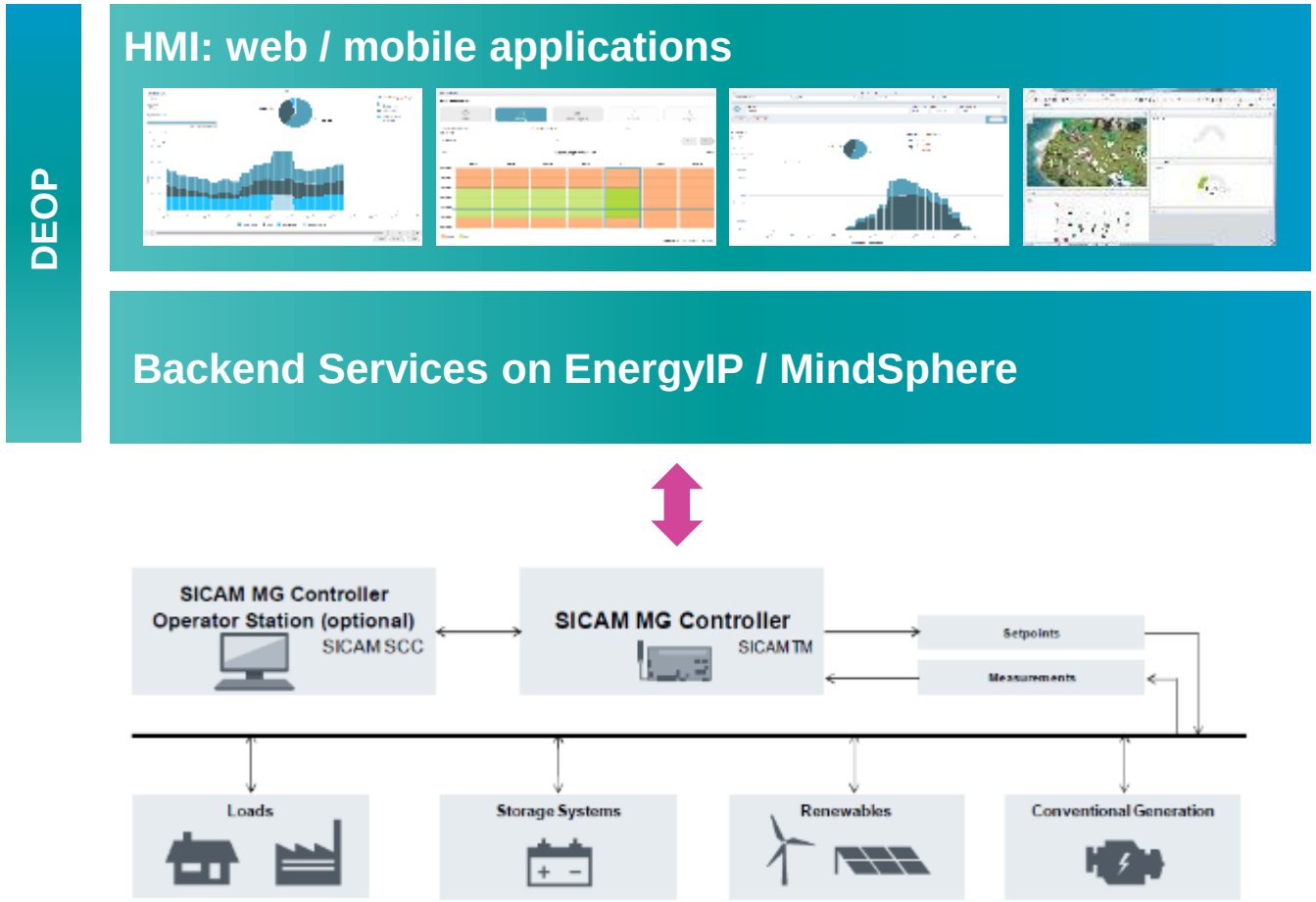
- Generation Forecast
- Load Forecast
- Unit Commitment

Micro-Grid integration

- Integrate MG local controller for primary/secondary MG supervision and control



Micro-Grid
\ Micro-Grid Control Integration



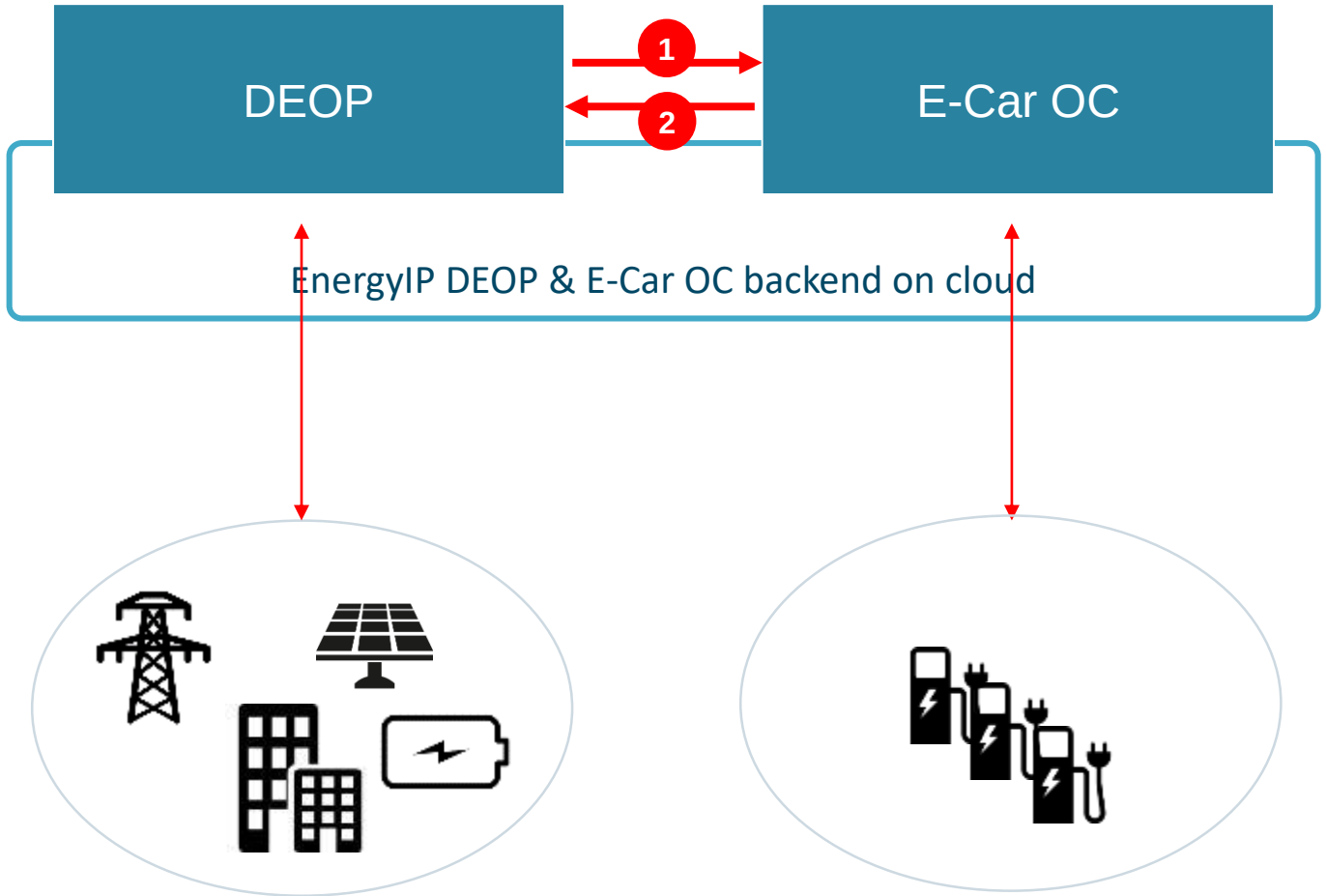
EnergyIP DEOP

- Micro-Grid performance monitoring
- Optimal scheduling
- Optimal set-points curves

SICAM MG Controller

- Primary / Secondary control
- Black-Start
- Network synchronization

Micro-Grid
\ E-Car OC Integration



EnergyIP DEOP

- Monitors CUs consumption data
- Integrates CUs as controllable load in the Micro-Grid management functionality.
- →EnergyIP DEOP may send power set-point to control CUs consumption (1)

E-Car OC

- CUs infrastructure management
- Contracts & Services
- Clearing & Roaming

→Any CU created in the E-Car OC is automatically available in EnergyIP DEOP (2)

→E-Car OC sends CUs measures are status information to EnergyIP DEOP (2)

Micro-Grid Optimization
\ Unit Commitment Algorithm

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- Each Unit is modeled in terms of technical characteristics (power, performance curve, etc…) and in terms of constraints (start-stop limits, etc…)
- Each Unit is modeled in terms of economics characteristics (cost curve per hour or tariffs plans)

- Output: forecast/planned Cost curves for each Unit for the next 24h
- Output: programmable generators set-points (power) for the next 24h
- Output: storage set-points (power) for the next 24h

- Algorithm can be executed every 1-4-8-24 hours

Supported Micro-Grid Units:

- **Electric Load**
- **Programmable Generator (Co-Generator, Gas, Diesel)**
- **Renewable Generator (PV, Wind)**
- **Electric Storage**
- **Charging Unit**
- **Grid**

Micro-Grid Scenario #1

PV + Battery + Load, Self-consumption maximization & Peak leveling

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PV

Production measure / production forecast

Load

Consumption measure / consumption forecast

Battery

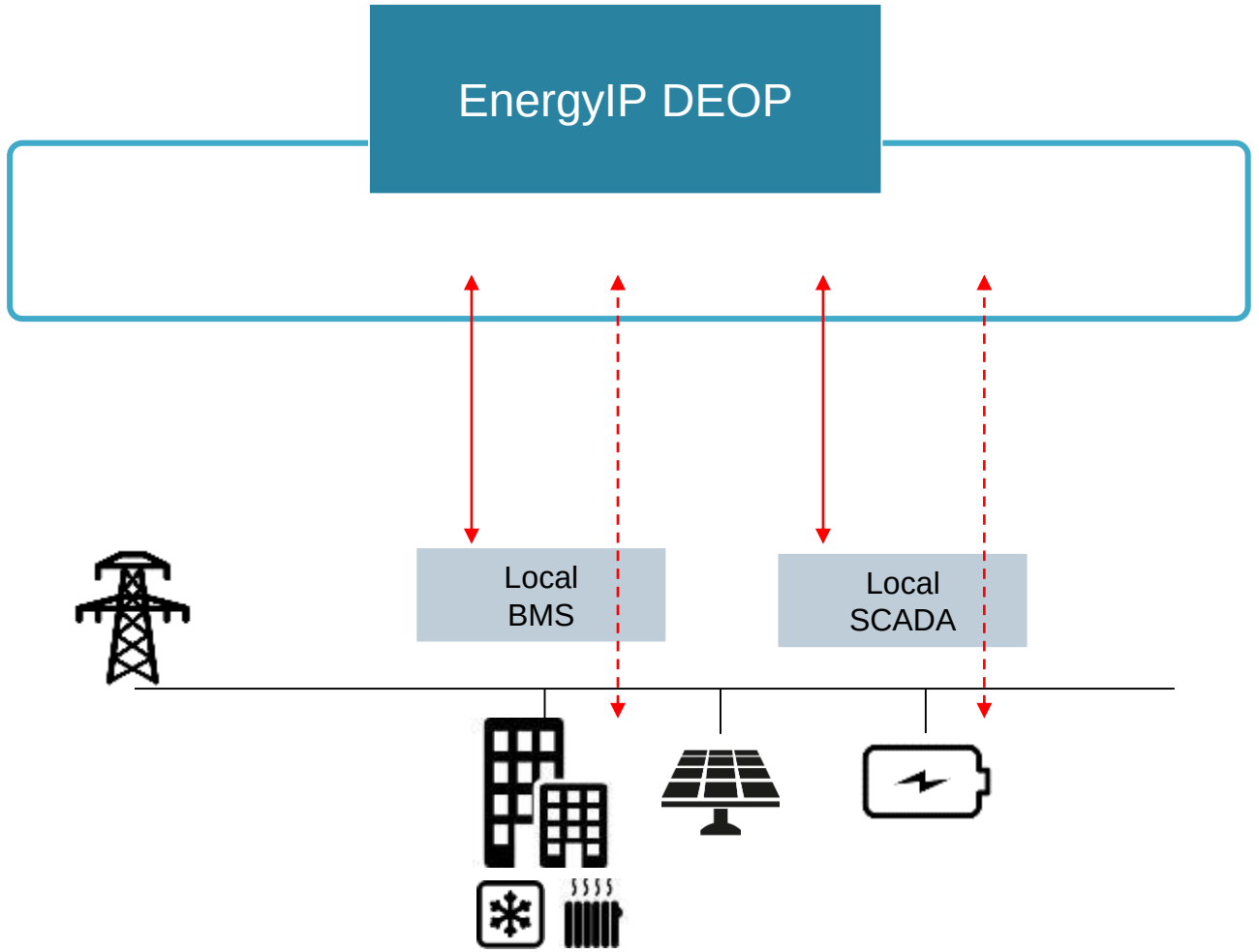
Power set-point

Grid

Maximum power

Unit-Commitment

Algorithm shall calculate the **Battery set-points curve** that maximize the PV production self-consumption respecting the maximum power constraint



Micro-Grid Scenario #2

PV + Battery + Charging Unit, self-consumption maximization & Peak leveling – integration with E-Car OC

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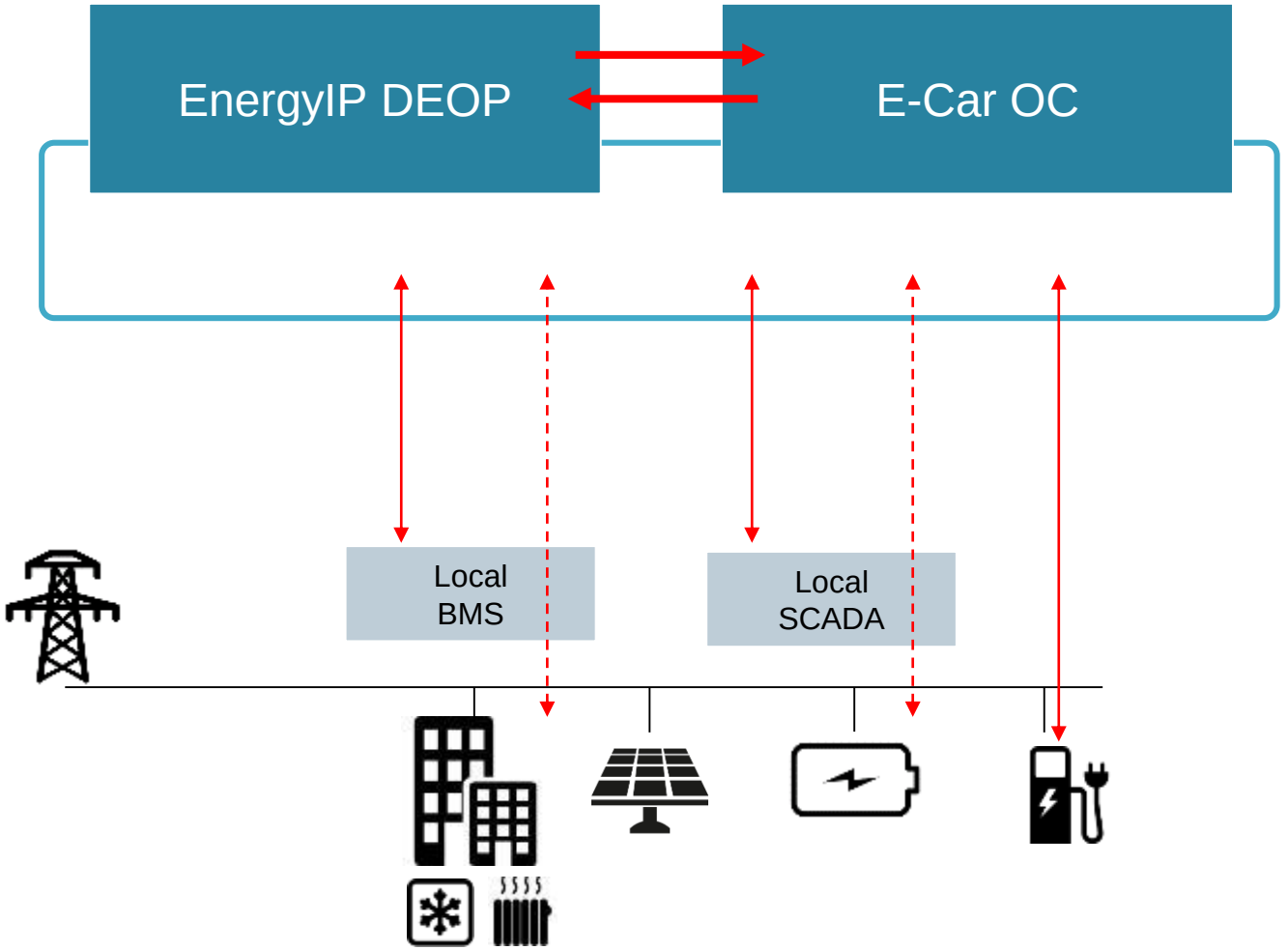
Charging Unit

- % Battery / Energy required
- Time (optional, if not best effort)
- Consumption measures

Unit-Commitment

Algorithm shall calculate the **Battery set-points curve and each CU re-charge curve** that maximize the PV production self-consumption respecting the maximum power constraint



Micro-Grid Scenario #3

PV + Battery + GenSet + Load + Charging Unit, Cost Optimization

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GenSet

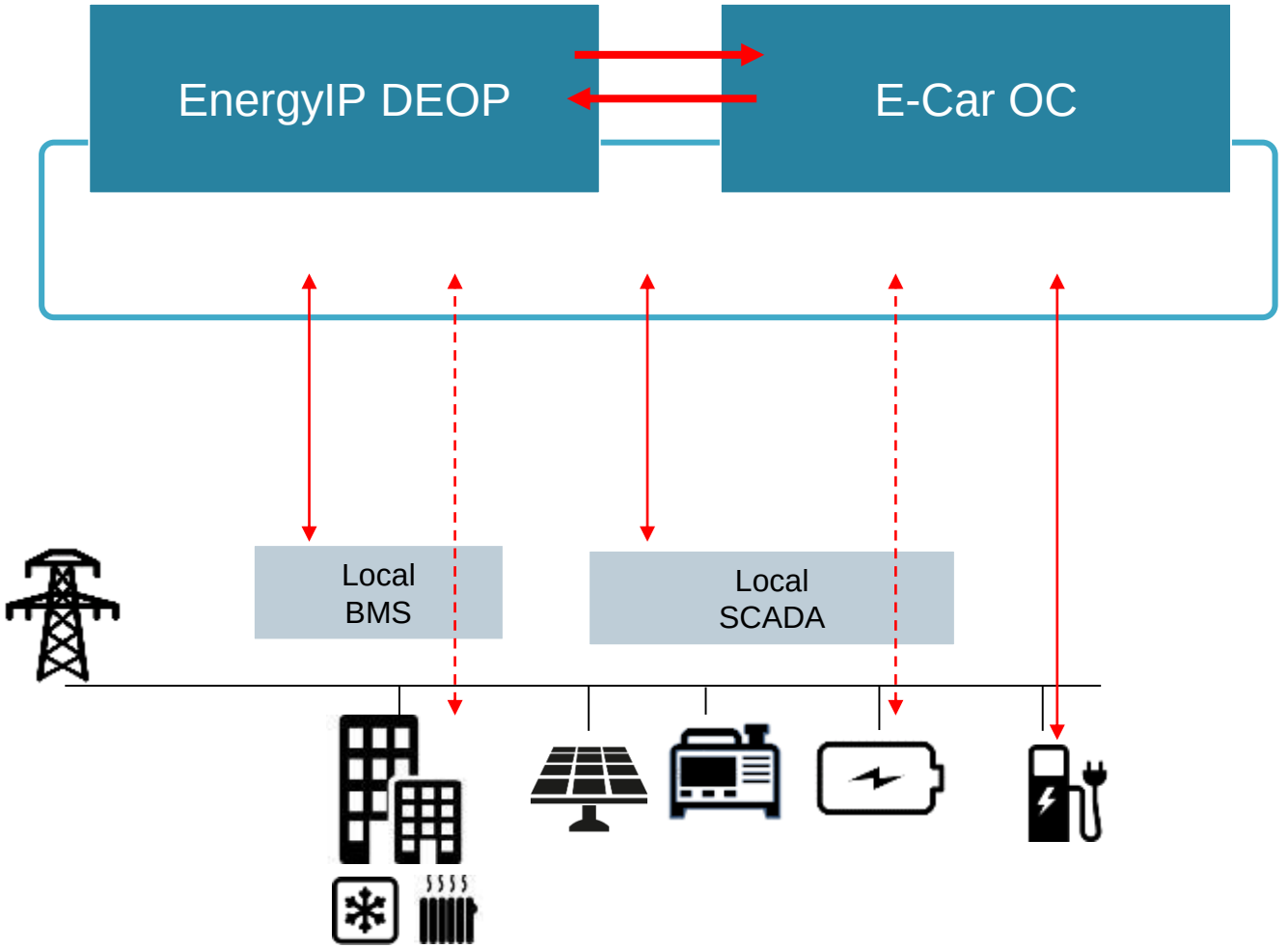
- Technical constraints
- Cost constraints (fuel, startup, shutdown costs)
- Production measures

Grid

- Technical constraints / Cost constraints
- Fed-In / Fed-Out measures

Unit-Commitment

Algorithm shall calculate the **Battery set-points curve, GenSet set-points curve, and each CU re-charge curve** that minimize the operation cost of the Micro-Grid



Demand-Response & Aggregation

Demand-Response

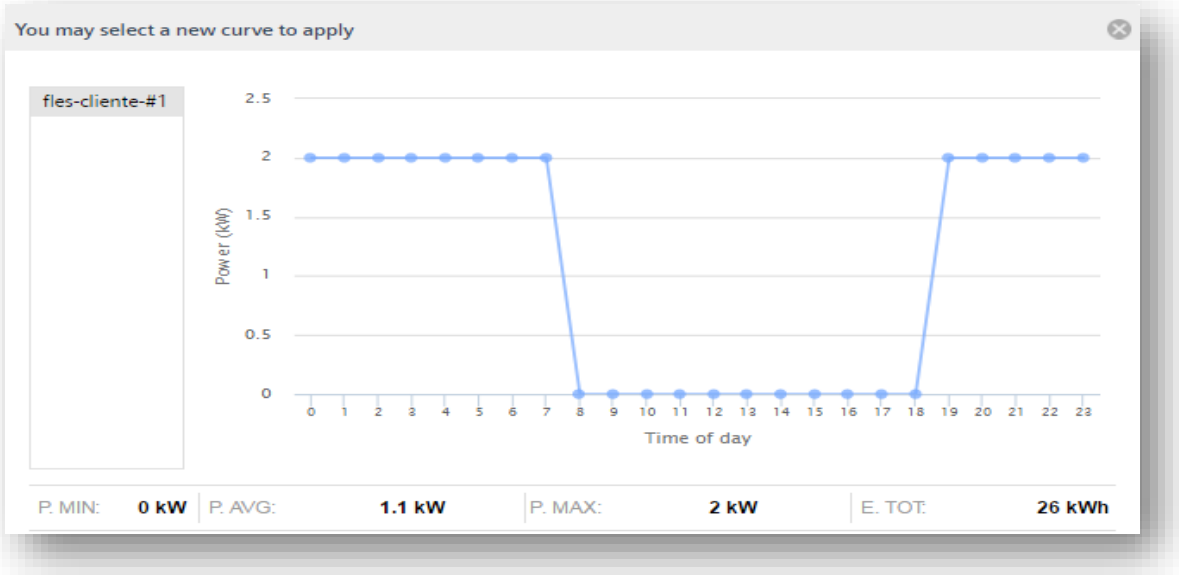
- Interface to TSO/Trader systems for measures and forecasts
- Definition of flexibility curves (up / down)
- Management of flexibility requests from TSO /Market

Virtual Sites

- Manage multiple production sites
- Aggregated measures
- Manage and split power requests set-points

Aggregation

- Aggregate multiple customers
- Aggregated measures, forecasts, flexibility curves
- Manage and split flexibility requests



Demand-Response & Aggregation \ Integration with DEMS

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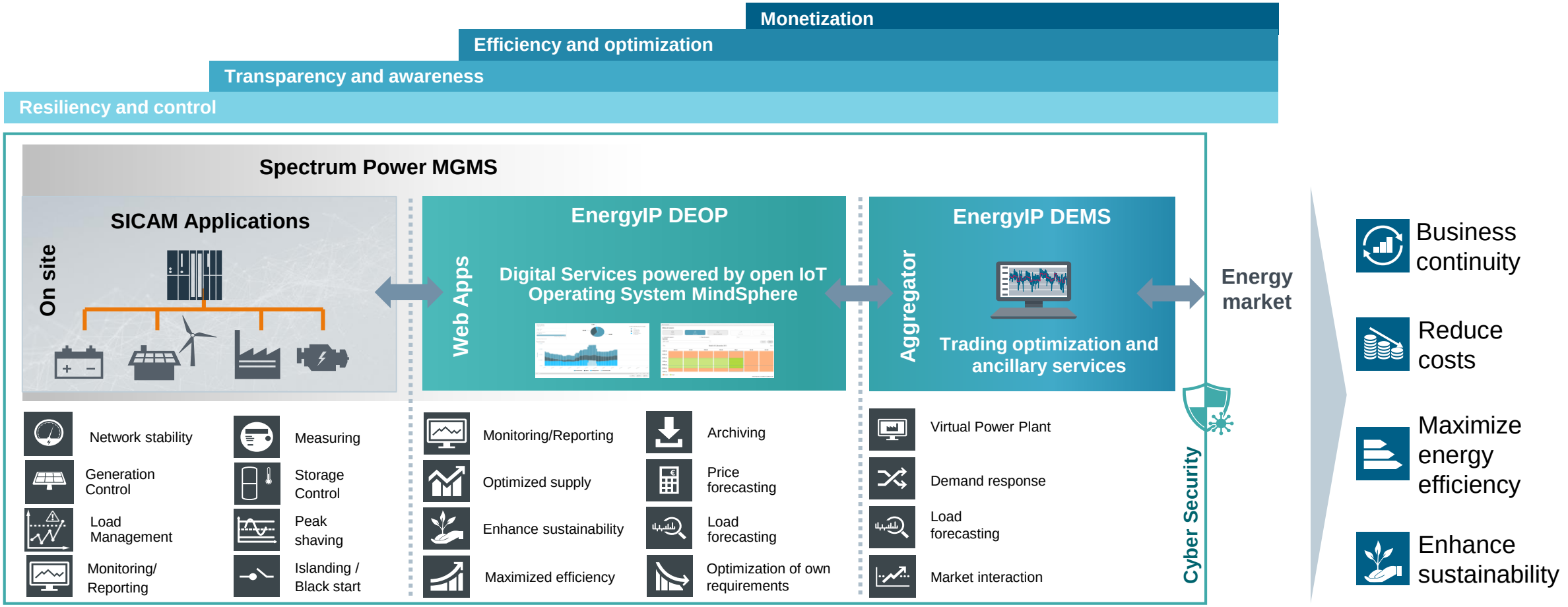

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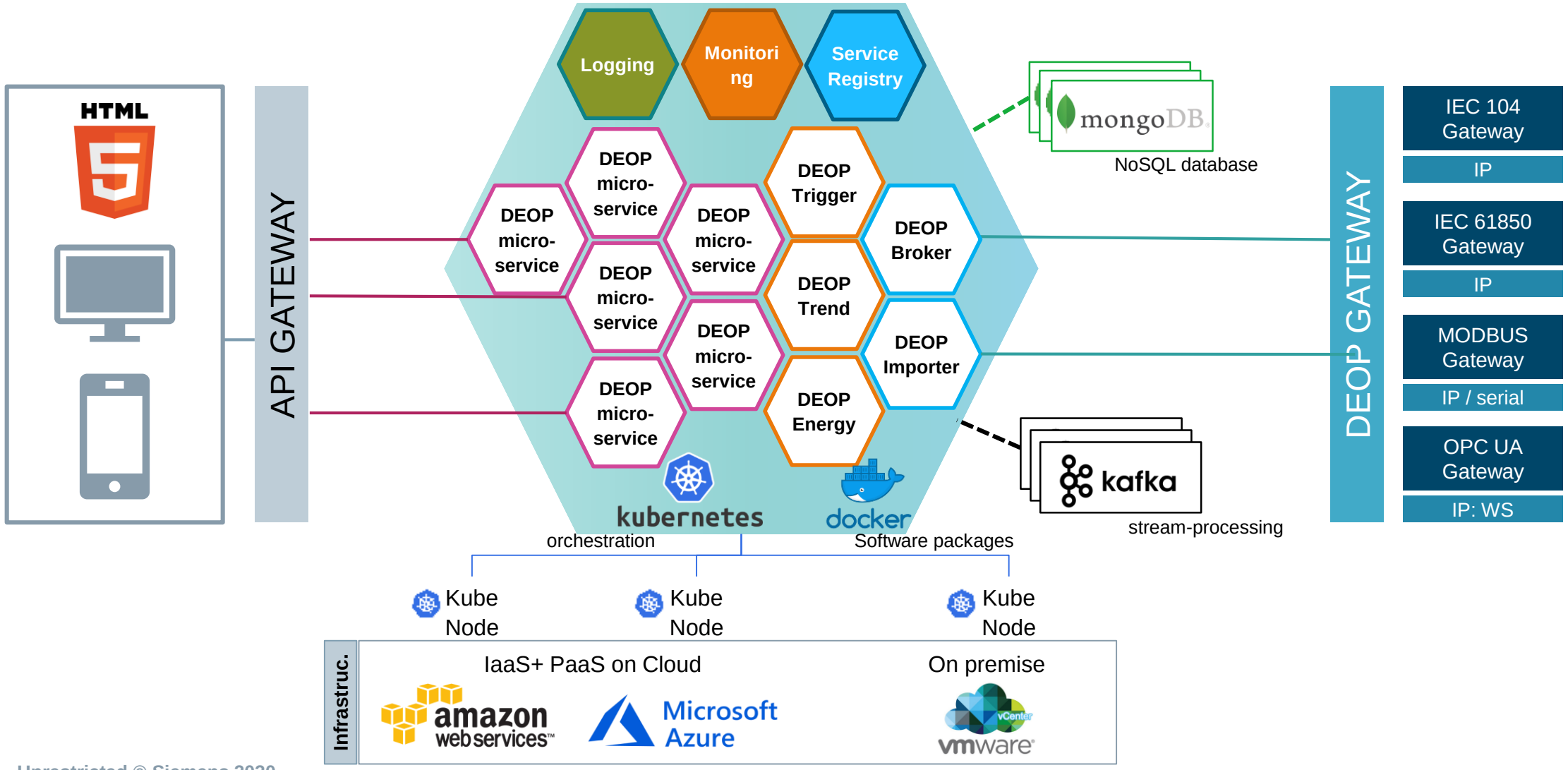
EnergyIP DEOP: New Architecture



Architecture
\ Key Technologies

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- Micro-Services architecture based on **node.js** framework
- Each service deployed as **Docker** package
- Services orchestration based on **Kubernetes**
- Each service exposes a RESTful API
- Non relational database: **MongoDB** with Aggregation Framework
- Inter-service communication based on **Kafka**
- **MQTT** as primary data acquisition protocol
- **HTML5** web application – Sencha ExtJS

Connectivity

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DEOP Gateway – standard protocols

- MODBUS RTU / TCP
- IEC 104
- IEC 61850
- OPC UA

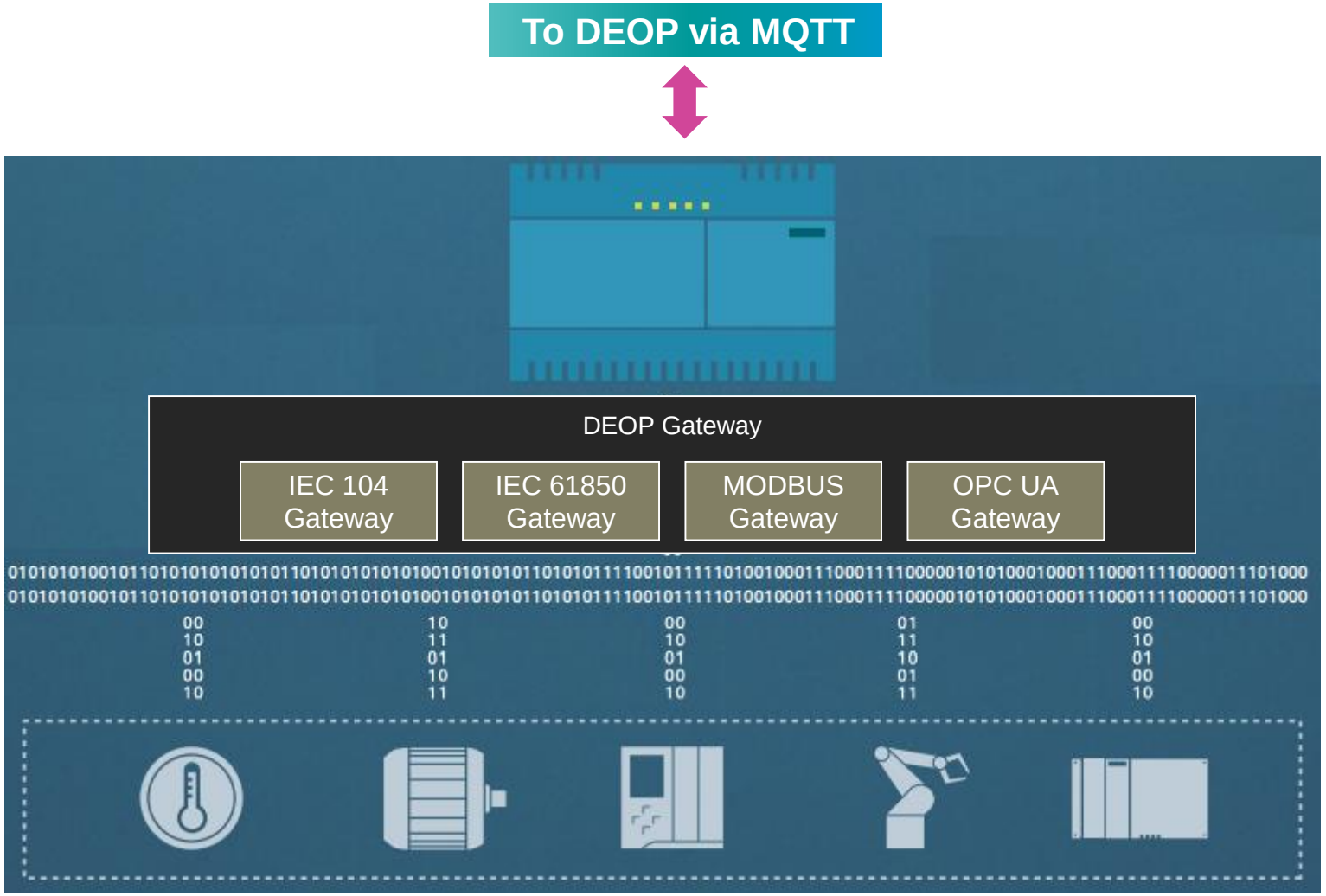
DEOP Gateway – interface with other applications

- Desigo Insight / Desigo CC
- Ecar OC

DEOP Gateway – supported HW

- Any standard PC running Linux Ubuntu
- IOT 2040 → available images for MODBUS
- SGW 1050 → available packages for MODBUS / IEC 61850

EnergyIP DEOP Gateway



DEOP Gateway runs on nano PC running Linux (e.g. **SIMATIC IOT2040 or SGW 1050)**:

- Conversion from standard field protocols (IEC 101, IEC 104, IEC 61850, MODBUS TPC, MODBUS RTU, OPC UA) to MQTT
- Secure connection to cloud using MQTT via SSL or TLS-PSK
- Local buffer to store data when connection to cloud is not available

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Project: Expo Milano 2015

Energy cockpit integrating Smart Grid services: grid, buildings, e-mobility, public lighting

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Customer

- Expo Milano
- Milan (Italy)
- 2015

Site information

- 100 Substations
- 300 Smart Meters
- 1000 Room Automation devices
- 20 Public Lighting concentrators
- 50 Charging Units

Functionality

- Energy Transparency & KPIs
- Energy Reporting
- Energy Storage integration
- Desigo integration
- E-Car OC integration

Project: Campus Savona

Electric + Thermal Micro-Grid / Buildings / Electric Vehicles

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Customer

- University of Genova
- Savona (Italy)
- 2015

Site information

- 2 PV + 3 conc. solar
- 2 battery storages
- 2 heat storages
- 3 micro CHP
- 3 Charging Units

Functionality

- Energy Transparency & KPIs
- Energy Storage integration
- SCC integration
- Desigo integration
- E-Car OC integration

Project: EnviPark Smart Recharge Island
Micro-Grid / Electric Vehicles

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Customer
- EnviPark
- Torino (Italy)
- 2016

Site information
- 1 PV
- 1 battery storage
- 1 Charging Unit

Functionality
- Energy Transparency & KPIs
- E-Car OC integration
- Micro-Grid optimization: algorithm that controls CU load in order to maximize site self-consumption

Project: Enel Info+

Real time meter data / Mobile app for residential customers

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Customer

- Enel
- L'Aquila (Italy)
- 2017

Site information

- > 1000 Smart Info
- Consumer (1 meter)
- Prosumer (PV – 1 meter)

Functionality

- Energy Transparency & KPIs
- Development of ad-hoc Customer Web Application for Enel residential customers (consumer & prosumer)

Project: Horizon 2020 Flexiciency

European platform for energy services / Flexibility services for residential users

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Customer

- European Community funding
- Enel, Endesa, Vattenfall, Verbund
- 2016-2020

Site information

- Enel Smart Info
- Enel Energia Energy Box
- Endesa Energy Box
- Verbund Meter

Functionality

- Flexiciency Market Place and B2B interface
- Energy Transparency & KPIs
- Local Control
- Flexibility Services

Project: Horizon 2020 Sharing Cities

Lighthouse project – energy & environmental dashboard for the municipality

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Customer

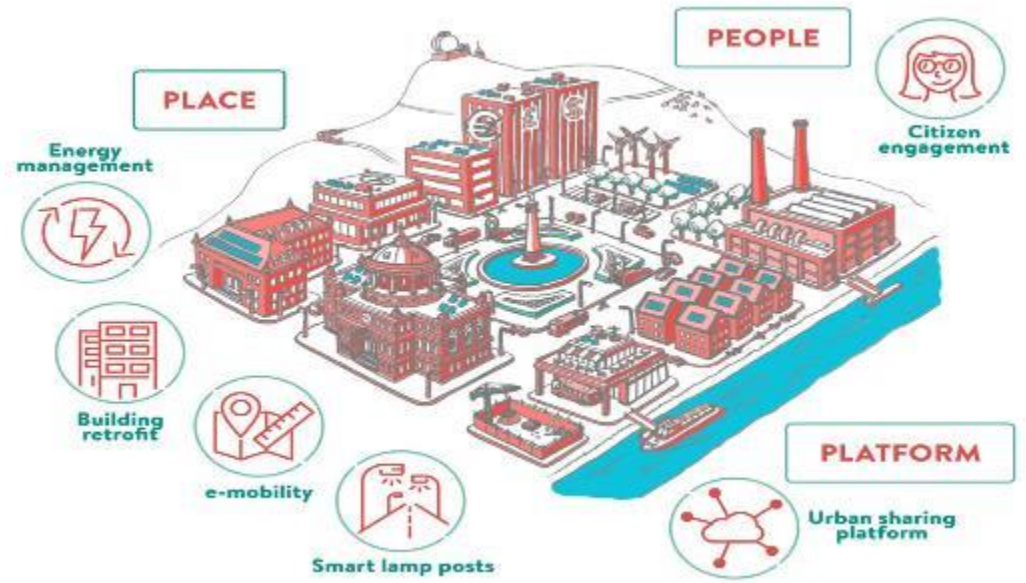
- European Community funding
- Comune di Milano
- 2016-2020

Site information

- Meter data
- Environmental data from LoraWan sensors
- Charging island for e-mobility (ecar & ebike)

Functionality

- Energy Transparency & KPIs
- PV plants
- Building energy efficiency
- Smart charging island



Project: Sello

Integrated (building & energy) mall management for providing flexibility services

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Customer

- Sello Mall
- Finland
- 2018

Site information

- DEMS
- Desigo CC (0.6MW controllable load)
- SIESTORAGE (2.2MW)
- PV (0.8MW)

Functionality

- Flexibility Services
- Demand management
- Load management

Monet

Project: Platform for Italian MSD market

Aggregation & Flexibility services – real-time connection to the TSO (Terna)

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Customer

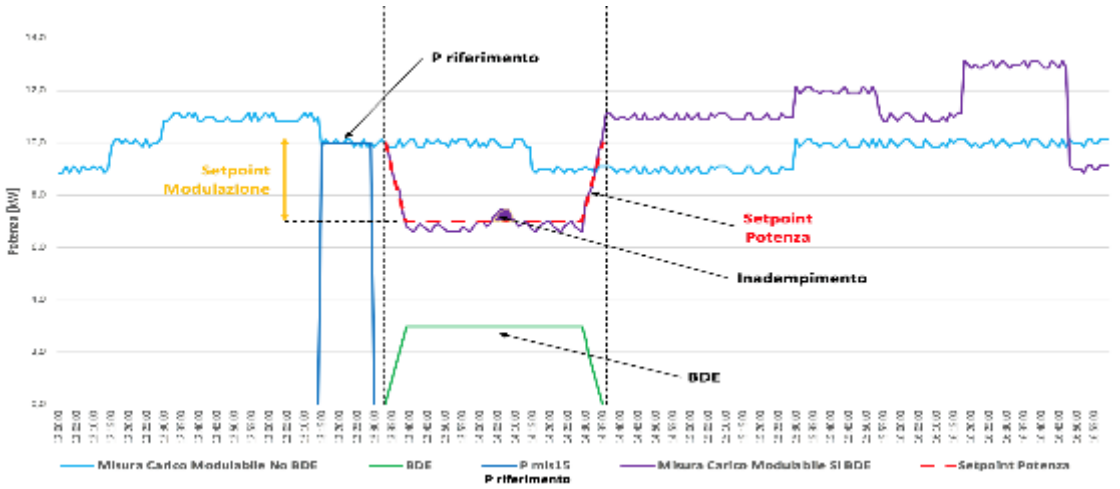
- Edison, EGO, Energy Team
- Italy
- 2018

Site information

- Several sites connected via MQTT / IEC 104

Functionality

- Real-time aggregation toward Terna via IEC-104
- Aggregation and Flexibility Services
- Unit commitment algorithm



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DEOP SaaS – End-Customer vs. Service Provider scenarios

In both cases hosting & application management done by Siemens

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End-Customer

- Option (a) – site on Siemens instance
  - lower start-up cost
  - no dedicated URL & DB
  - customer cannot create new Sites
- Option (b) – dedicated customer instance
  - higher start-up cost
  - dedicated URL & DB
  - customer may create new Sites / Users
- Unrestricted
- SaaS fee depends on no. Sites / Things

Service Provider

- Specific agreement is required
- Dedicated service-provider instance with its own customization (logo & colors)
- Service Provider may create new Sites / Users
- SaaS fee depends on no. of Sites / Things
- The Service Provider agreement establishes the Transfer Price and the Service Provider Sales Margin on fees

Contact us!

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