Grid Edge Solutions

e-mesh for e-mobility

Smart charging and more
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e-mobility, renewables, grid edge technologies and digitalization drive the evolution of future power systems
Impact assessment of e-mobility across electricity supply chain

Can we produce enough energy to satisfy charging needs on different time horizon?
Do we have enough energy sources which may quickly start, ramp up and down, and stop?

Can a simultaneous operation of a number of nearby high power charging poles result in power quality issues?

Do we have enough transmission and distribution grid capacity to accommodate a regional and local charging demand?

Can we use a large number of batteries on wheels to increase grid resiliency and flexibility?
Seamless integration from grid to plug charging infrastructure

Both loads and power sources are changing

**Generation**
- New energy sources
  - High variability
  - Low predictability
  - Local production
- Grid limitations
- Peak loads

**Load**
- New loads
  - Distributed / Centralised
  - Variable
  - Scheduled
- Space constraints

Connect safely, charge smartly

Seamless integration from grid to plug
Grid Edge Solutions
Enabling the future of e-mobility
About Hitachi Energy

- **Headquarters in Zurich, Switzerland**

- **Four Business Units**
  - Grid Automation
  - High Voltage Products
  - Grid Integration
  - Transformers

- **Customers**
  - Transport & Infrastructure
  - Industry
  - Utilities

- **Offering**
  - Services
  - Software & Automation
  - Systems
  - Products

- **Geographies**
  - Asia, Middle East & Africa
  - Americas
  - Europe

- **38,000 employees**
- **90+ countries with 200 offices**
- **~250 years’ heritage combined**
- **5,500 sales employees & field engineers**
- **2,000 engineers & scientists in R&D**
Global technology and market leader

Grid Automation
- 50% of the top 250 global electric utilities supported by our leading portfolio
- ~$4 trillion mission-critical infrastructure assets managed with our software solutions

Grid Integration
- Technology HVDC leader in power quality and grid connection solutions and services
- Leader in HVDC systems with 200 GW installed

High Voltage Products
- 1 in every 4 high-voltage switchgear installed in the world
- More than 1M circuit-breakers installed in the world

Transformers
- World’s largest installed base of power, distribution, traction transformers
- Technology leader in transformer applications for HVDC, renewables and digitalization

Services
- Maintaining and modernizing the world's largest installed base
- More than 200 service centers and 1,500 field engineers worldwide
The Grid Automation portfolio unites deep domain knowledge and innovative technologies to help customers across the globe optimize the critical systems that **POWER, MOVE and CONNECT** us. Together, we’re building a more efficient, productive and sustainable world.
As a pioneer in energy management and optimization, Hitachi Energy Grid Edge Solutions is a trusted partner in the evolving global energy ecosystem.

Our Grid Edge Solutions are leading energy innovation and transition.

The e-mesh™ portfolio includes energy storage and digital automation solutions. Our global footprint covers more than 800 MW and 250 references.

Hitachi Energy helps customers increase profitability and unlock new revenue streams by reducing energy cost, maximizing renewable integration and lowering CO₂.
Enabling new business opportunities while improving reliability and performance
**e-mesh value proposition**

Scalable vertically integrated digital ecosystem managing and optimizing energy at all levels with wide range of applications from the field to the boardroom, on cloud and on premises.

**e-mesh enables:**

- Availability of reliable and resilient power
- Reduction in carbon footprint
- Improved energy costs
- Maximizing integration of renewables
- Enhanced revenue and ROI through “value stacking”
GES market segmentation

Transportation
- Heavy-duty fleets (depots)
- Fast public charging stations

Utilities & Renewables
- RE+BESS capacity firming (inc. forecasting)
- Large islanded systems (geographical islands and remote sites)

Remote communities & industrial
- Remote industrial sites (Mines, Oil & Gas)
- Remote communities

Urban & commercial
- Commercial sites
- Districts
- Hotels & Resorts
e-mobility market support

e-mobility charging HUB’s

- Heavy and light duty commercial vehicles fleet charging at depot.
- Require:
  - High power
  - Optimized schedule

Fast charging

- Dedicated high power charging stations at «gas stations». They can be operated by various private companies.
- May combine additional DERs, like Solar PV

Home / Work / Public slow

- Low power home / work and public charging stations are typically facilities provided by electric utility companies or located at home, retail shopping centers, restaurants and parking places

Rail

- Battery-powered trains
- Charging stations for battery-powered trains in DC and AC.
- Solutions are designed for urban, suburban, regional train and people mover segments.

e-mesh market support
Our customers

90+
Countries supported with Service and Sales organizations

30+
Years of experience

800+
MW of global references of Grid Edge solutions including microgrids and BESS

250+
Projects delivered worldwide

Pioneer in technology, solutions and projects execution
e-mesh portfolio
energy storage, control, energy management
and digital solutions
Digital Solutions for EV Fleets

Scale with Digital Enterprise
SaaS apps for improved depot and fleet maintenance, management & performance

Fleet reliability
Bi-directional & cloud enabled remote monitoring and control at the touch of a screen

Energy Management System (e-mesh™ EMS)
Operational and maintenance efficiencies & optimal energy production. Control, sequence and prioritise charge

Network Automation (e-mesh™ SCADA)
Maximize power availability & operational efficiencies. Monitor vehicles and depot with key indicators in real time

Protection & Control (e-mesh™ Control)
RTU & IED
Feeder and load demand management OCPP and grid code compliance

EV Charging Infrastructure and PowerStore™
Vehicle Fleets
Charging and Power Infrastructure
Stationary Energy Storage
e-mobility is not all the same

**e-mobility charging HUB’s (EV fleet depots)**
- Fleet schedule exists and it is dictated by the fleet or depot management system
- Fleet charging allows flexibility in charging power and duration (overnight or according to work shifts)
- Preconditioning management typically required
- Large number of vehicles and chargers (50-200)

**Fast charging high power stations**
- Unpredictable schedule and limited charging flexibility. Like at a gas station drivers just want to stop and charge as fast as possible to resume their trip
- Possibly located in remote/sparsely populated areas where electric utilities infrastructure could be constrained in capacity
- Small/medium number of vehicles and chargers (10-20)
e-mobility charging HUB’s (EV depots) – challenges and solutions

CHALLENGES

Serve the end users: Charge EVs
→ to the desired level
→ within the desired time

Increase system reliability and resiliency

Reduce costs

Monitor and supervise the charging infrastructure and the facility operations

Increase profitability and ensure future-proofness

SOLUTIONS

Optimize EVs recharge accounting for arrival time, departure time, priority and target state of charge

Comply with infrastructure constraints
Manage maintenance and contingency events
Implement cyber-secure solutions

Optimize EVs recharge to minimize:
Energy cost & Peak demand charges

Dedicated solutions with UI for EVs recharge plan and depot overview, extending to substation automation (SSA) and DERs

Enable new revenue streams related to both behind- and in-front-of the meter strategies
Integration & management of co-located BESS & RE DER
Vehicle-to-Grid (V2G) ready

UI: User Interface
e-mobility charging HUB’s - HE Grid Automation portfolio deployment

DIGITAL ENTERPRISE FLEET MANAGEMENT
- Vehicle Dispatch
- Traffic Control
- Infrastructure Management
- Maintenance

DISTRIBUTED RENEWABLES ENERGY RESOURCES (DERs)
- Rooftop PV

EV CHARGING INFRASTRUCTURE
- L1 chargers
- L2 chargers
- DCFC

e-mesh POWERSTORE
- Modular systems in 1MW blocks
- Grid following and forming operation modes
- Transformer
- e-mesh Automation and Control
- Auxiliary system

e-mesh DIGITAL PORTFOLIO
- SCADA
- Control
- Energy Management System (EMS)

Grid connection

HE Grid Automation
HE
3rd party
EV Charging infrastructure

Uncoordinated charging

- DC distribution
- AC distribution

Grid connection power limit

Situation case: 60 e-busses
- Arrival/departure schedule; Grid supply constraint; Peak demand charge;
- Energy price; Battery recharge; Vehicle preconditioning

e-mesh EMS

- e-mesh EMS peak demand limitation

e-bus #41
- Arrival time: 02:00
- Arrival SoC: 40%
- Dep time: 07:00
- Target departure SoC: 90%

Uncoordinated charging

- SoC
- Preconditioning power
- Recharge power
- Total power

e-mesh™ EMS smart charging

- SoC
- Recharge power
- Preconditioning power
- Total power
Assumptions

Electricity bills typically have binomial formulation:

1. **Energy** charge [$/kWh/month] eventually with multiple time of use tariffs
2. **Peak demand** charge [$/kW/month]
   - Energy consumption is dictated by process needs (e-buss mileage/preconditioning and depot base load) and can only be marginally affected by the recharge dispatch (losses optimization).
   - Energy costs can be reduced installing RE DERs. RE self consumption can be optimized by means of recharge and BESS systems dispatch.
   - Peak power consumption is instead significantly affected by recharge optimization.
   - Monthly energy charge = 50’000 kWh/d * 0.1 $/kWh * 30 d = 150’000 $/month (~ 2 MW average load)
   - Monthly Peak demand charge = 4000 kW * 20 $/kW = 80’000 $/month

E-mesh EMS allows for 10-20% peak demand reduction. For a 4 MW/50 MWh daily load depot this can translate into savings of 90 – 190 k$ per year
Fast charging high power stations – challenges and solutions

### CHALLENGES

- Serve the end users: Charge EVs → to the desired level → within the desired time
- Increase system reliability and resiliency
- Reduce costs
- Monitor and supervise the charging infrastructure and the facility operations
- Increase profitability and ensure future-proofness

### SOLUTIONS

- Leverage e-mesh PowerStore flexibility to meet peak demand avoiding or delaying poles and wires investments.
- Comply with infrastructure constraints
- Postpone poles and wires investments Maximize RE energy harvesting and self consumption
- BESS and charging infrastructure monitoring
- Enable new revenue streams
Fast charging high power stations – e-mesh portfolio deployment

Charging Station Peak Shaving

Station network

Process network

Cloud

e-mesh Monitor

e-mesh EMS

IoT Edge Device

Energy stored in BESS

Scheduled power consumption

Actual power consumption

Absorb power

Supply Power

Ancillary services

f [Hz]

50.02

50.00

49.98

Absorb power

Supply power

t [sec]

Energy stored in BESS

Charge

Discharge

1. e-mesh PowerStore
2. e-mesh Control (HW+pre-engineered SW)
3. Standard field device interfaces
4. EVCI
5. e-mesh Monitor
e-mesh EMS

**Highlights:**

- e-mesh Energy Management System (EMS), an optimizer suite that provides additional features for optimal energy management of distributed energy resources.

- Minimize OPerating Expenses and CO2 emissions through day-ahead and intra-day optimal dispatch

- Take full advantage of renewables power generation and loads power consumption forecast data

- Enables the creation of insightful and handy reports for business executives

- Enhanced visibility into energy saving methods compliant with ISO 50.001

- Supports market participation and energy trading
e-mesh EMS: Key modules

Optimize
- Day ahead optimization (pre-conditioning, charging)
- Intrady optimal loads and e-buses dispatch
- Leverage on renewable generation and storage

Integrate
- Access to all functionalities and data through Web APIs
- Standardized communication with SCADA
- Rich web user interface

Analyze
- Customizable dashboards
- Full visibility of costs and savings
- Detailed insights on future site behavior

Plan
- Simulated scenarios through dedicated environment
- Customizable scenarios
- KPIs and cost details available for each simulation

Four modules to optimize performance, improve energy efficiency and minimize costs
e-mesh EMS: EV smart charging application

- Minimize OPerating EXpenses through day-ahead & intra-day optimal dispatch
- Accurate forecasts of renewables power generation and loads power consumption automatically updated, imported and managed by intra-day, day ahead simulation / optimization
- Prioritize & control the charging of the EV fleet according to energy price & time schedule, e.g. considering the time needed to fully recharge the vehicle
- EV charging station and parking spot coupling
- Limit the overall power demand at the grid, enabling the integration of renewables at depots
e-mesh EMS: EV smart charging application

- Flexible configuration of assets for optimal operation through dedicated webpages
- Secure access to authorized personnel with user groups and roles settings
- Compatible with both utility interconnection and EV protocols (OCPP, OPC UA, IEC 104, Modbus TCP/IP)
- Access to all functionalities and data through Web APIs for e-mesh and 3rd party SW interface
- Rich web user interface
e-mesh EMS: EV smart charging application

- Enables the creation of insightful and handy reports for business executives
- Enhanced visibility into energy cost and saving methods compliant with ISO 50.001
- Default and customizable dashboards – including e-busses specific dashboards
- Detailed insights on current and future site behavior
Select and simulate special predefined scenarios to optimize performance
Design custom scenarios, plan and schedule short-term activities such as maintenance and repairs
Scenario architect: enables operators to build, update, delete off-line forecast profiles (feeder, load, renewables and energy prices) and asset availability (EV chargers, storage and renewable) scenarios
Scenario simulation: enables operators to select and simulate predefined scenarios

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**e-mesh EMS: EV smart charging application**

- **Select and simulate special predefined scenarios to optimize performance**
- **Design custom scenarios, plan and schedule short-term activities such as maintenance and repairs**
- **Scenario architect**: enables operators to build, update, delete off-line forecast profiles (feeder, load, renewables and energy prices) and asset availability (EV chargers, storage and renewable) scenarios
- **Scenario simulation**: enables operators to select and simulate predefined scenarios

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**Chart:**

- **Optimise**
- **Integrate**
- **Analyse**
- **Plan**

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**Diagram:**

- **e-mesh™ SCADA**
- **e-mesh™ EMS**
- **Loads**
- **RE DER**
- **Grid**

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**Diagrams:**

- **Off-line Optimization**
- **Operator Evaluation**
- **Deploy Availability Profiles**

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**Grid:**

- **Timetables**
- **Real time data**
- **Forecasts**

**Bus:**

- **Bus ID**
- **Bus SoC**
- **Bus Status**
- **Bus position**

**Energy:**

- **RE**
- **Load**
- **Energy price**
Benefits

- Gain deep knowledge on site operations and productivity
- Ensure continuous operations of site with minimum outages
- Predict asset failures in advance and increase the lifetime value of assets
- Minimize infrastructure costs and maximize performance
- Get insightful reports on site productivity, efficiency and system uptime

Enhanced assets visibility
PowerStore Battery Energy Storage System enable:

• Maximizing the integration of EV Chargers and solar renewable power generation
• Reduction in carbon footprint
• Manage grid purchases to minimize energy cost
• Less dependence of utility power
• Availability of reliable and resilient power to protect critical infrastructure
• Ability to operate off-grid (islanded microgrid operation) in case of utility outages
• Energy market participation
• Enhanced revenue and ROI through “value stacking” with V2G applications

Towards sustainable Bus depots
e-mesh PowerStore for small depots and city terminals

Enable the integration of renewable energy, power quality and system sustainability

- Designed for grid integration of EV charging infrastructure depots, terminals
- Power/energy up to 500kW-670kWh
- Grid-forming power converter with batteries and battery management system
- Remote monitoring and control system
- Standardised enclosure for fast delivery
Enable the integration of renewable energy, power quality and system sustainability

**e-mesh PowerStore Modular**

- Modular systems in 1MW blocks
- Grid-forming power converter with batteries and battery management system
- Can connect to all voltage levels via external transformer
- Remote monitoring and control system
- Fulfill health, safety and environmental requirements

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**Converter**

- Transformer(s)

**Charging points**

- PowerStore Modular
- EMS, SCADA & Control
- Batteries
- Controller
- External transformer(s)

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e-mesh customer stories
SnoPUD: Microgrid as a platform for resilient V2G

About the project

- **Project name:** SnoPUD Arlington Microgrid
- **Location:** Washington, USA
- **Customer:** Snohomish Public Utility District
- **Completion date:** 2021

Customer benefits

- Reliability and resiliency for Clean Energy Center, North County Data Center, and Local Office
- Integration of community solar renewable generation
- Stacking multiple values from energy storage: microgrid, grid stabilization, renewable integration, peak shaving, renewable back-up
- Exploring the future of vehicle electrification
- Utility reliability maximizing the value of batteries

Solution

- Community Solar PV (500 kWp)
- Electric Vehicle (EV) Charging
- PowerStore Battery (1 MW / 1.4 MWh)
- e-mesh Control System
- e-mesh SCADA
- Back-up Genset
- Vehicle to Grid (V2G) Integration

Snohomish County PUD (SnoPUD) developed a state-of-the-art microgrid with solar PV, generator and battery storage with electric vehicle-to-grid (V2G) integration. The Arlington Microgrid demonstrates all the things a microgrid can do to support an electrified future—from grid stabilization to V2G integration to ancillary services to operation on 100% renewable power.

In the media (1) / In the media (2)
Gigastation “Køge”: e-mobility

About the project
- **Project name:** Gigastation “Køge”
- **Location:** Køge – Denmark
- **Customer:** Clever A/S
- **Completion date:** Estimated 2022

Customer benefits
- BESS enables integration of 2.4MW EV charging
- BESS enables integration of Solar Power
- Revenue streams through Frequency Regulation
- Fast external P/Q control (<250ms)
- Modular BESS design which is simple to upgrade
- Li-ion LFP technology with +15 years lifetime
- Top Class Safe and Sustainable BESS solution

Solution
- EV charging (8x 300kW)
- Solar (0.1 MWp)
- PowerStore Battery (1.2 MW / 1.5 MWh)
- e-mesh Control System
- e-mesh SCADA
- Solar Power & EV AC-home charging (aggregated assets)

Clever is the largest EV charge solution provider in Denmark with +2.300 public chargers and +20.000 private home chargers installed (2021). Clever has a target to expand the installed capacity with 500% in 2025 and enable the use of 100% renewable energy. Battery Energy Storage will be an integrated solution at all High-Power Charge locations in Denmark.

Press release / Video