ABB ABILITY ENERGY MANAGEMENT FOR SITES

OPTIMAX® for Industrials, Commercials and Virtual Power Plants

Turning disruption into opportunities
OPTIMAX® for Industrials, Commercials and Virtual Power Plants

As power networks increasingly depend on renewables and distributed energy systems, controlling and optimizing those systems -- reliably and profitably -- is now a priority.

With OPTIMAX®, customers can reduce energy cost and emissions by optimizing the collection and dispatch of distributed energy resources (DERs).
### Overview

#### Customer challenges

<table>
<thead>
<tr>
<th>Need to cut energy cost and emissions</th>
<th>New assets need coordinated control</th>
<th>Business models shifting</th>
</tr>
</thead>
<tbody>
<tr>
<td>- <strong>Need to comply</strong>: Customers have corporate or regulatory requirements to reduce energy costs and emissions.</td>
<td>- <strong>Energy transformation drives change</strong> in generation, transportation, consumption.</td>
<td>- Shift away from selling electricity to end users → energy suppliers are changing business models.</td>
</tr>
<tr>
<td>- <strong>Need to control</strong>: Many site owners can’t measure, monitor or control energy usage and so lack ability to do so.</td>
<td>- <strong>Bi-directional energy and info flow</strong> redirects focus away from traditional grid</td>
<td>- <strong>Bi-directional energy and info flow</strong> accelerating due to innovations, new business models and enabling policies</td>
</tr>
<tr>
<td>- <strong>Need to communicate</strong>: Customers spend valuable time reporting energy consumption or reduction to authorities</td>
<td>- <strong>Decentralized energy environment</strong> means producers maximize generation resources to cut costs and shape demand</td>
<td>- <strong>Expansion into new markets and functions</strong> limited by inability to support or scale energy optimization.</td>
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<tr>
<td></td>
<td>- Avoid peak energy charges</td>
<td></td>
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<td></td>
<td>- Avoid time-of-use charges</td>
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</table>
Where energy costs are high, prospects may:

1. **Replace** energy-hungry assets
2. **Monitor** energy use by asset
3. **Adjust** operations to minimize peak load
4. **Invest** in on-site renewable generation
5. **Utilize** on-site energy storage
6. **Install** software to manage assets & loads

Some utilities have **demand-response applications** for power flow optimization.

- These were **designed before** the shift to bi-directional energy and info flow.
- Utility-scale applications **don’t effectively manage** distributed assets.
- Two-way flow more complex than one-way; existing solutions **aren’t up to task**.

- Companies operating as utilities are moving to **aggregator** roles
- Prospects are changing from traditional to **Energy as a Service (EaaS)** providers.
- Prospects seek **partners** to develop solutions that support these changes

**Need to cut energy cost and emissions**

**New assets need coordinated control**

**Business model shift**
Benefits - OPTIMAX® for Industrials, Commercials and Virtual Power Plants

- **Enables** addition of new generation assets
- **Aggregates** decentralized generation and flexible loads
- **Empowers** customers to increase revenue and decrease cost
- **Fulfills** needs of many, from multiple grid-connected asset operators to single-site operators
OPTIMAX® for Industrials, Commercials and Virtual Power Plants

Value

**Reduce energy costs and site emissions**

- **Costs**: Enables industrial and commercial sites to cut energy costs by 5-10% without impacting operations.

- **Emissions**: Enables industrial and commercial sites to integrate more renewables and minimize use of costly, CO2-emitting fossil fuel without risking reliability or grid stability.

**Enable participation in wholesale energy markets**

- **Integrate small-scale generators**: Enables distributed providers to seamlessly integrate, optimize & trade production from 1000s of small-scale generators across large areas.

- **Create Virtual Power Plants**: Enables multi-unit power plants to optimize production and respond quickly & flexibly to changing markets by operating as a virtual power plant.

- **Balance production and consumption**: Enables utilities to balance production and consumption in multi-source systems (CHP, Water, HVAC) through day-ahead and intra-day planning.

- Reduced energy costs • Fewer emissions • Lower production costs • Higher efficiency • Profits
**OPTIMAX® for Industrials, Commercials and Virtual Power Plants**

**Control & optimize grid-connected assets**
- **Coordinate** networked generation by creating “virtual power plant.”
- **Optimize** points of connected units and grid service delivery while considering constraints
- **Enable** trading of power plants, generation units, energy storages and controllable loads.

**Optimize single sites; aggregate many sites**
- **Monitor** and **optimize** local generation and demand; **enable** market trading flexibility.
- **Integrate** with aggregators’ and utilities’ trading and billing systems.
- **Maximize** generation consumption to **reduce** energy costs and **minimize** emissions.

**How - OPTIMAX® for Virtual Power Plants**
- **Control** and **optimize** centrally to create a Virtual Power Plant (VPP)
- **Combine** multiple, geographically dispersed energy resources (from 10s to 1000s) into a single optimizable entity
- **Plan and adjust** production dynamically with forecasting
- **Implement** unique business models with a flexible architecture
- **Couple** sectors for electricity, gas, heating & cooling, water and e-mobility

**How - OPTIMAX® for Industrials and Commercials**
- **Forecast** and **optimize** DERs and loads
- **Enable** bulk trading & grid services for additional revenue
- **Allow** cross-vector optimization (power, CHP2, HVAC, water)
- **Apply** vendor-agnostic communication standards
ABB delivers OPTIMAX for virtual power plants vertically integrated utilities, aggregators, and cities.

ABB operates the OPTIMAX for industrial and commercials cloud and provides services to utilities, aggregating many local sites and exchanges with the VPP for trading.

ABB delivery of Edge Gateway and eBOP (solar, storage, ...)

Site data

Site EMS 1

Site EMS n

EV Fleet Optimization

Relevant aggregated data for trading

Distributed 3rd-party assets

Plants

Solar

Wind park

OPTIMAX® for virtual power plants

OPTIMAX® for industrials and commercials

Site EMS
How it works and what’s delivered
**ABB Ability™ Energy Management for sites**
Aggregation and Virtual Power Plants

**OPTIMAX® for virtual power plants**
Aggregates and integrates decentralized generation, flexible loads and storage systems to enable cost-effective participation in energy markets

- **Control** and optimize from central control system to create a Virtual Power Plant (VPP)
- **Combine** multiple, geographically dispersed DERs (from 10s to 1000s) into a single optimized entity
- **Plan** and **adjust** production dynamically thanks to forecasting
- **Trade** intelligently on the energy market
- **Implement** unique business models with flexible architecture
- **Couple** electricity, gas, heating & cooling, water and e-mobility
OPTIMAX® for Virtual Power Plants
Major software components and modules

3 Forecasting & Planning Modules
- Load Forecasting Module
  Non-controllable loads
- Renewable Generation Module
- Trading Module
  Bid Generation
  Decision Support
  Links to Trading

3 planning horizons available:
- Day ahead
- Intra-day
- Real-time

3 objective functions available for real-time operation:
- Asset scheduling and execution
- Ancillary service calls & Demand Response
- Power Pool Balancing

2 objective functions available for day ahead or intra-day planning horizons:
- Minimize operational cost (efficient operation)
- Power production surplus/shortage

3 SCADA Functionalities
- Data Visualization Module
  Direct Control and Monitoring
- Data Archiving Module
  Data integrity requirements
- Reporting Module
  Invoicing support
OPTIMAX® for Virtual Power Plants

System architecture

- Application server
  - Monitoring
    - SCADA/DCS
      - Alarms & Events
      - Data Historian
      - Plant Schedule
    - Real-time gateway (OPC-UA/Modbus)
  - Real-time gateway (Modbus TCP, IEC 60870-5-104)
- Excel configuration
- Optimization Engine
  - Forecast and Trading
    - Load and Renewable Forecast
    - Flexibility Indication
    - Trading Decision Support and Interface
  - Day-Ahead & Intra-Day Planning
    - Day-Ahead Schedule Generation
    - Intra-Day Schedule Generation
    - Power production surplus/shortage (Flexibility Indication)
  - Real-Time Optimization
    - Power Pool Balancing
    - Automatic Asset Dispatch
    - Ancillary Service and Demand Response Calls
  - Aggregation / Disaggregation / Forecast Importer

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OPTIMAX® for Virtual Power Plants

What is included

Scope of Supply and Services

Real-Time Optimization (see system architecture)

Day-Ahead & Intra-Day Planning (see system architecture)

Optional Modules (see system architecture)

Annual Services
- Annual Review
- Application Support (hotline/remote during office hours)
- Patch Management Service
- Software Update Service

Communication / Interfaces
- OPC UA, Modbus to SCADA, field PLCs or local control systems
- ascii, csv, xml for import data via web services

Project Services
- Functional Design Specification
- Optimization Module generation and parameter configuration
- Visualization configuration
- Interface configuration
- Commissioning
- Documentation

Delivery and Milestones

<table>
<thead>
<tr>
<th>Item</th>
<th>Time to completion</th>
<th>Comment</th>
<th>Payment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Award of contract (AoC)</td>
<td>when contract signed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Commencement (latest Kick-off)</td>
<td>+ 2 weeks</td>
<td>Refine project schedule during kick-off</td>
<td>50%</td>
</tr>
<tr>
<td>Design input** received / design input freeze</td>
<td>+ 6 weeks</td>
<td>First design input should be delivered after 2 weeks to complete input freeze in time</td>
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<tr>
<td>Software delivery</td>
<td>+ 16 weeks</td>
<td>Runtime for OPTIMAX® for Virtual Power Plants to be installed.</td>
<td></td>
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<tr>
<td>Model delivery</td>
<td>+ 20 weeks</td>
<td>OPTIMAX® for Virtual Power Plants model to be uploaded</td>
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</tr>
<tr>
<td>FAT</td>
<td>+ 24 weeks</td>
<td>Completion of FAT in test facility and FAT certificate issued</td>
<td>40%</td>
</tr>
<tr>
<td>Start Commissioning*</td>
<td>+ 24 weeks</td>
<td>All components are available and all network connections exist.</td>
<td></td>
</tr>
<tr>
<td>PAC / Taking-Over</td>
<td>+ 28 weeks</td>
<td>SAT complete and PAC certificate issued</td>
<td>10%</td>
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ABB Ability™ Energy Management for sites

Site Energy Management

OPTIMAX® for industrials and commercials

Delivers energy cost reduction for consumers and provides new revenue streams for service providers

- Forecast & optimize DERs and loads
- Enable participation in electricity markets (bulk trading & grid services\(^1\)) for additional revenue
- Allow cross-vector optimization (power, CHP\(^2\), HVAC, water)
- Apply vendor – agnostic communication standards\(^3\)
OPTIMAX® for Industrials and Commercials
Major software components and modules

3 “active” site modules available
- Load Forecasting Module
  Non-controllable loads
- Renewable Generation Module
- Trading Module
  Provide links for energy trading

3 “passive” site modules available
- Reporting Module
  ISO 500001 certification aid
- Data Visualization Module
  Executive-level dashboards
- Data Archiving Module
  Data integrity requirements

3 planning horizons available:
- Day ahead
- Intra-day
- Real-time

3 objective functions available for day ahead or intra-day planning horizons:
- Peak shaving
- Energy cost minimization
- Power production surplus/shortage

3 objective functions available for real-time operation:
- Asset scheduling and execution
- Demand response
- Ancillary service calls
OPTIMAX® for Industrials and Commercials

System architecture

- Weather/Load
- Trade
- Forecast import
- Schedule export
- Delivery obligations
- Real-time Database
- Optimization Engine
  - Microservice #1 (Day-Ahead)
  - Microservice #2 (Intra-Day)
  - Microservice #3 (Real-time)
  - Microservice #4 (Active Site Module)
  - Microservice #5 (Passive Site Module)
- Web-Server
- Docker
- Technical units
- Edge gateway
- Cloud support
- Operation

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## OPTIMAX® for Industrials and Commercials

What is included

### Scope of Supply and Services

#### Real-Time Optimization
- Day-Ahead & Intra-Day Planning

#### Optional Modules (Active Site and/or Passive Site Module)

#### Annual Services
- Annual Review
- Application Support (hotline/remote during office hours)
- Patch Management Service
- Software Update Service

#### Communication / Interfaces
- OPC UA, Modbus to SCADA, field PLCs or local control systems
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<td></td>
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</tr>
<tr>
<td>Commencement (latest Kick-off)</td>
<td>+ 1 weeks</td>
<td>Refine project schedule during kick-off</td>
<td>50%</td>
</tr>
<tr>
<td>Design input** received / design input freeze</td>
<td>+ 4 weeks</td>
<td>First design input delivered after 2 weeks to complete input freeze on time</td>
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<tr>
<td>Software delivery</td>
<td>+ 8 weeks</td>
<td>Runtime for OPTIMAX® for Industrial and Commercial installed.</td>
<td></td>
</tr>
<tr>
<td>Model delivery</td>
<td>+ 10 weeks</td>
<td>OPTIMAX® for Industrial and Commercial model uploaded</td>
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</tr>
<tr>
<td>FAT</td>
<td>+ 12 weeks</td>
<td>FAT completed and certificate issued</td>
<td>40%</td>
</tr>
<tr>
<td>Start Commissioning*</td>
<td>+ 12 weeks</td>
<td>All components and network connections available</td>
<td></td>
</tr>
<tr>
<td>PAC / Taking-Over</td>
<td>+ 13 weeks</td>
<td>SAT completed and PAC certificate issued</td>
<td>10%</td>
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Case Studies
- Virtual Power Plant
- Vertically integrated utility
- Microgrid
- Industrial facility
Integrating 5,400 units in 8 countries with 4.5 GW

- In 8 years, Next Kraftwerke grew from a modest start-up to one of the biggest virtual power plant operators in Europe.
- Next Kraftwerke is based in Germany where renewable energy counts for more than 1/3 of the country’s power generation.
- Next Kraftwerke’s virtual power pool links more than 5,400 producing and consuming units across 8 countries. The pool manages around 4,500 MW of capacity.
- The smallest unit generates a few kilowatts of solar power, while the largest -- a biomass plant -- produces 20 MW.

Solution: OPTIMAX® for virtual power plants

- Given the flexibility of the ABB-supplied control and optimization system, Next Kraftwerke grew from a pool of 20 units to 2,800 in its first 3 years.
- New customers and generating units are added continually without interrupting operations because all hardware and software additions are made without system shutdown.
- The solution is a win-win-win for the Next Kraftwerke, the transmission system operators responsible for the grids, and the 1000s of small and medium-size producers connected to the virtual power pool and energy market.

Enabling Next Kraftwerke’s business model
Customers with control of grid-connected assets
Stadtwerke Trier

Managing multiple municipal energy sources

- **Stadtwerke Trier** is a municipal energy company for the city of Trier, Germany and surrounding area that:
  - Supplies electricity, gas, drinking water and district heating to the municipality
  - Treats wastewater
  - Operates the public transport system.
- **Stadtwerke Trier** generates electricity from a range of sources including: wind power, solar photovoltaic, biomass, and combined heat and power (both large-scale conventional and micro CHP).
- Energy network includes battery storage and electric vehicle chargers, and will include a 300 MW pumped storage plant by 2020.
- With such a high amount of intermittent renewables in its energy system, **Stadtwerke Trier** needed an energy management system to maintain grid reliability and maximize usage of renewable assets.

Solution: OPTIMAX® for virtual power plants

- ABB’s solution optimizes production, matches production with consumption, helps forecast weather and load, provides intra-day trading functionality.
- The scalable and flexible solution integrates new generation units, storage devices and vehicle charging stations without disrupting operations.
- Trier is now a recognized leader in smart city development because of this energy management system and use of digitalization to integrate and manage municipal assets.

Made it easier and cost effective to meet the load demand at any time in a volatile, decentralized market
Customers with control of a single site
WEB Aruba

Making a Caribbean energy system fossil-fuel free

- The Caribbean island of Aruba has a population of 103,000 and a thriving tourism industry of 1.5 million visitors per year. WEB Aruba is the public utility responsible for supplying the island with reliable power and clean drinking water.
- WEB Aruba has a generating capacity of 134 MW produced by thermal (fuel oil), wind, and solar photovoltaic plants.
- As part of its long-term ambition to become fuel-oil free, WEB Aruba intends to generate half its annual energy from renewables and the other half from alternative fuels by 2020.
- Given the volatility and intermittency of wind and solar power, it is vital for the island’s grid stability and supply reliability that production and consumption are balanced.

Solution: OPTIMAX® for virtual power plants

- ABB’s extensive microgrid experience and a complete microgrid portfolio contributes to a control and optimization solution that allows WEB Aruba to meet its fuel-free target.
- The ABB solution enables WEB Aruba to maximize renewable use and minimize dependence on fuel oil.
- Other features include day-ahead optimization based on weather and load forecasts, real-time optimization to balance fluctuations in supply and demand, and dynamic load shedding to ensure grid stability.

Increase share of renewable while reducing operational cost and emissions with focus on grid stability
Customers with control of a single site

Process industries

Reducing industry energy costs by 5-10%

- Energy-intensive industries such as cement, metals and pulp & paper are cutting energy costs by 5-10% with energy optimization solutions (eg OPTIMAX).
- Many large industrial plants have their own power generation, often a combination of conventional and renewable sources, as well as heat production and energy storage devices.
- Through a combination of production planning, energy management and energy trading, these plants can minimize energy costs and maximize energy revenues without impacting production targets or delivery schedules.

Solution: OPTIMAX® for industrials and commercials

- Implementing a grid-connected energy optimization solution requires:
  - Coordinating onsite power and heat generation production needs
  - Dynamically optimizing energy consumption according to price signals and availability indicators.
- Using weather, load and generation forecasts, industrial plants can optimally plan the on-site generation, storages, controllable loads and grid purchase – without impacting production.
- Alternatively, industrial plants can generate and trade surplus energy when prices are favorable.
- At a current installations (German Smart Farm) we could show that self-consumption has increased from 31 to 50%, grid purchases reduced by a quarter and peak demand by 10%.

Reduce energy cost and emissions as well as save time on reporting
Why ABB?

- As the top global DCS supplier to the power industry, we understand your needs and markets
- With 40+ years of experience in developing digital solutions, ABB understands the convergence of IT, OT and operations
- ABB invests heavily to define the challenges and success criteria to build a business case to support your digital investments
- Together, we identify the capabilities that will meet your needs, starting with an assessment
<table>
<thead>
<tr>
<th>Leaders</th>
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<tbody>
<tr>
<td>As the top global DCS supplier to the power industry, we work closely</td>
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<tr>
<td>with customers to leverage digital solutions to help solve their</td>
</tr>
<tr>
<td>challenges.</td>
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<tr>
<th>Experienced</th>
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<tr>
<td>Our engagements have been in mature markets that must find ways to</td>
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<tr>
<td>address new challenges associated with:</td>
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<tr>
<td>- Wholesale market development</td>
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<tr>
<td>- Increased renewables</td>
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<tr>
<td>- Distributed energy resources</td>
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<table>
<thead>
<tr>
<th>Early adopters</th>
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<tbody>
<tr>
<td>- ABB prioritizes software quality as part of our “evolution-without-</td>
</tr>
<tr>
<td>obsolescence” framework</td>
</tr>
<tr>
<td>- We were early adopters of international cyber security standards.</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Collaborative approach</th>
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<tbody>
<tr>
<td>- In this transformational time, we must move beyond transactional</td>
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<tr>
<td>relationships to collaborative relationships.</td>
</tr>
<tr>
<td>- ABB invests in identifying needs, challenges and success criteria,</td>
</tr>
<tr>
<td>and collaboratively develops business cases supporting digital</td>
</tr>
<tr>
<td>investments.</td>
</tr>
</tbody>
</table>
Grid Edge Technologies

Definition
An ecosystem of
- distributed energy resources,
- digital solutions
- and services

helping customers manage their “energy trilemma”.
- Reliability
- Sustainability
- Affordability
Grid Edge Technologies

Key elements

- **EV**: Electric Vehicle; **V2G**: Electric Vehicle-to-Grid; **VPP**: Virtual Power Plant; **XaaS**: Anything-as-a-Service; **EaaS**: Energy-as-a-Service; **MaaS**: Microgrids-as-a-Service; **EMS**: Energy Management System; **DERMS**: Distributed Energy Resource Management System—A collection of aggregation, demand response, and energy market places

---

**Microgrid**
- Off-grid and grid connected

**Controllable loads**

**Power quality assets**
- Capacitors, harmonic filters, …

**Distributed storage**
- Energy storage including thermal

**E-mobility**
- EV charging, smart charging, V2G, e-buses

**Power quality assets**
- Capacitors, harmonic filters, …

**Distributed storage**
- Energy storage including thermal

**E-mobility**
- EV charging, smart charging, V2G, e-buses

**Controllable loads**

**Microgrid**
- Off-grid and grid connected

---

**Home & building automation**
- Monitoring and control of security / comfort

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**Communication & Cyber security**

**Distribution Automation**
- ADMS, DERMS

**Asset health**
- Remote monitoring and control

**Energy Management for Sites**
- Virtual Power Plants (VPP)
  - Aggregation, Demand Response
- Transactive energy
  - Peer2peer, block-chain solutions

**Consulting, design & engineering**
- Services supported by digital tools

**Operations and maintenance services**
- Services supported by digital tools

**Financing**

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**XaaS** (EaaS, MaaS, SaaS)

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**Metering**
- Smart meters, sub-metering

**Distributed generation, heating and cooling**
- Traditional & renewables generation

**Energy efficiency**
- Solutions often offered as a service

**Energy Management for Sites**
- Virtual Power Plants (VPP)
  - Aggregation, Demand Response
- Transactive energy
  - Peer2peer, block-chain solutions

**Consulting, design & engineering**
- Services supported by digital tools

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**Physical**

**Digital**

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ABB in Grid Edge Technologies

Enabling new business opportunities while improving reliability and performance

- Site Energy Management suite (Commercial, Industrial & Multi-use sites)
- Microgrid
- EV Charging & EV fleet management
- Communications, cyber-security and Asset Health
- Industrial automation
- Utility operations ADMS / DERMS
- Solar PV
- Energy storage
- Home and building automation
- Aggregation (VPP, demand response)
- Lifecycle services including consulting and design

ADMS: Advanced Distribution Management System
DERMS: Distributed Energy Resource Management System
EV: Electric Vehicle
How ABB engages on digital

All Factors

ABB’s digital engagement model considers the people and process factors that are critical for successful pilot and solution adoption.

People:
- **Industrial Enterprise Customer Lead** - Drives large pilots for fleet/enterprise digital opportunities, coordinating with regional teams.
- **User Experience Lead** - Captures customer and end-user needs, requirements, and success criteria. Identifies potential changes in customer business processes and supports development of pilot interfaces.
- **Digital Architect** - Develops service oriented architecture, works with customer control specialists and IT leads to define data sources, secure architecture, and reporting requirements.

Projects:
- **Pilots**: ABB supports customer pilots with broad digital solutions targeted to multiple plants or enabling technologies. Our process:
  - Aligns to corporate strategic priorities.
  - Captures requirements from all key stakeholders, including IT, compliance and groups outside plant operations and maintenance.
  - Develops Service Oriented Architectures that meet national regulations, international standards and corporate policies on cyber security, data and IT related user requirements.
  - Proves a business case during a pilot; giving customer champions strong support to implement solutions more broadly.
- **Lighthouse** projects provide integrated new product development.
Contact

- Put contact info here