Power Quality
Enabling a Stronger, Smarter and Greener Grid  |  Fahd Hashiesh
01. Improving Power Quality
   A growing challenge

02. Why Hitachi ABB Power Grids?
   Unmatched knowledge and experience

03. Our Solutions
   Addressing Power Quality challenges across the grid

04. At a Glance
   Improving Power Quality across the board
A Day Without Power

For large companies, the cost of an outage can escalate into the millions of dollars per hour of downtime. In fact, the DoE recently estimated that outages are costing the U.S. economy $150 billion annually.

Studies have shown that the cost of data center outage has grown to more than $8,000 per minute.

For large manufacturing enterprises, a single hour of downtime tops the $5 million mark.

For large retailers, that cost is even higher, reaching upwards of $5 million.

0.1% down of availability can lead to 90% up of outage-related costs.
Poor Power Quality
Consequences

1. Wind power generation
   Not able to connect to the grid in case of overvoltage or undervoltage or if pollution emitted is too high.

2. Marine
   Non-compliance, not allowed to connect to grid, increase in running costs, frequent outages and downtime.

3. Industry
   Non-compliance to grid codes, not allowed to connect to grid, penalties, lower productivity, potentially higher CO₂ emissions.

4. Conventional power generation
   Higher stress on generators leading to premature failure / erratic behavior, higher running costs.

5. Power distribution
   Not able to connect to the grid – in case of overvoltage or undervoltage or if pollution emitted is too high.

6. Solar power generation
   Not able to connect to the grid in case of overvoltage or undervoltage or if pollution emitted is too high.

7. Railway
   Non-compliance, penalties, frequent outages and downtime, reduced operational efficiency.

8. Infrastructure
   Penalties, frequent outages and downtime, reduced equipment life, potentially higher CO₂ emissions.
The changing power landscape
Many drivers – one common need

Generation
- Increasing energy production
- Integration of renewables
- Deal with distributed generation

Transmission and Distribution
- Aging infrastructure
- Changing regulations
- Grid code compliance
- Energy trading between regions
- Reversible power flow

Consumers
- Increasing power consumption
- New grids in emerging markets
- Faster and stronger transportation systems
Future drivers and challenges
Power Quality is under pressure

- Electrification of transport, including cars, buses and ships
- Electrification of heating and cooling sector through heat pumps

- Grid codes compliance, voltage and frequency support
- Resonances and harmonics due to power converter
- Offshore grid connections, weak grid support

- Fast frequency response
- Avoid cycling of power plants

- Electrification of industrial sector
- Financial optimization, avoid penalties
- Compliance with new grid codes

- Penetration of distributed generators
- Manage voltage profiles along the feeders
- Microgrids and Energy storage systems
- Ensure connectivity for e-mobility

- Integration of remote renewables
- System stability with renewables, inertia
What is Power Quality?
The broader definition

Ensuring the continuity of supply
Consumers can utilize electricity from the supplying network efficiently without interference or interruption. Suppliers can generate power consistently over a planned life expectancy.

Less interruptions per year

Enhancing the electrical parameters
The technical shape of voltage waveform and all electrical parameters are according to specifications and defined limits.

Pure sine-wave

Optimizing the commercial quality
The speed and accuracy with which interruptions’ complains requests are handled.

Fast response of maintenance teams

Good Power Quality is a measure of the availability, quality and efficiency of the electricity being supplied and utilized on a consistent basis.
How to achieve good Power Quality?

Analyze  →  Optimize  →  Realize
# Power Quality

## The market

### Drivers

- Need of power is the main priority/infrastructure
- Applications of Microgrids (connected or islanded)
- Increased trends of connected renewables
- Lot of PV connected to LV/MV
- Developing Grid Codes & regulations
- Increased volume of connected DG including renewables
- Integration of EV chargers & heat pumps
- Power electronics interference loads
- Grid codes, regulations and environment

### Needs

- Availability of the supply
- Energy efficiency
- Reliability and availability of the supply
- Advanced automation applications
- Energy efficiency
- Reliability and availability of the supply
- Reduction of CO\textsubscript{2} emission

### Our Solutions

- Passive technologies:
  - Capacitors and filters
  - Shunt and series reactors
- Passive technologies
- Consultancy and system studies
- As the % of renewable increases, the active technologies will pick up
- Active technologies (passed on power electronics)
- Communication, monitoring and control solutions

### Developing Electricity Markets/clients

- Capacitors and filters
- Shunt and series reactors

### Emerging Electricity Markets/clients

- Consultancy and system studies
- As the % of renewable increases, the active technologies will pick up

### Mature Electricity Markets/clients

- Active technologies (passed on power electronics)
- Communication, monitoring and control solutions
Power Quality
A growing market

~7-10% annually

<table>
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<tr>
<th>Year</th>
<th>Value (in Billion USD)</th>
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<td>2019</td>
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Approximate figures – not all products are included
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Why Hitachi ABB Power Grids?
Unmatched knowledge and experience

Our engineers have the experience and expertise to help customers at every stage from measurement and analysis, through designing and building tailored solutions, to providing ongoing lifecycle services and training.

We have a broad portfolio of power quality solutions in-house.
Always close to you

We are geared towards listening and serving our customers wherever in the world they are located, all the time.

We have a long-standing experience in Power Quality that enables us to understand the challenges and local market needs of our customers, and to tailor lifecycle solutions accordingly.

60 Countries with operational offices

>300 Employees dedicated to Power Quality services

>60 Years of delivering services to utility and industrial customers

24/7 Availability with our rapid response care agreements
Power Quality experience
Largest installed base and footprint in the world

Hitachi ABB Power Grids has over 60 years experience in delivering effective Power Quality solutions to customers around the world.

E.g. we pioneered FACTS technologies that enable our customers to use their grids with maximum efficiency, stability and reliability.

+60
Years

+8300
Installations

+400
Customers

+80
Countries
Power generation
Delivering reliable power efficiently and consistently

E.ON’s new 400 MW Rampion offshore wind farm, on the UK’s south coast, includes 116 turbines, with the nearest located 13 kilometers from shore.

Hitachi ABB Power Grids delivered a turnkey onshore substation equipped with four STATCOM units, to ensure grid code compliance and reliable, green power production from the wind farm.

The STATCOM provides reactive power compensation by detecting and instantaneously compensating for voltage fluctuations associated with the intermittent nature of wind energy.
Power consumer
Boosting productivity, efficiency and grid compliance

The Bulgarian State Railway is one of the oldest in Europe, and today provides passenger and freight services across more than 4,200 kilometers of track. The electrical railway traction system comprises large and varying loads, which generates large amounts of dynamic reactive power. This often led to low power factor and voltage fluctuations and disturbances.

This was not only harmful to the traction system itself, its effects could also potentially spread to the local grid, cause disruption to other users and incur financial penalties.

To minimize these effects on the utility grid, Hitachi ABB Power Grids designed and supplied a PQCR-based reactive power compensation solution, which dynamically varies reactive power at various key nodes across the rail network. This provides an instantaneous and step-less compensator for dynamically varying reactive power and unbalanced loads.

The Bulgarian railways now benefit from precise compensation without the need for manual intervention, with a stable voltage and power factor compliant with utility standards – so avoiding penalties. The railways also benefit from increased reliability and availability of supply, energy-efficiency and lower maintenance costs.
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Improving Power Quality across the board

Hitachi ABB Power Grids in-depth knowledge of Power Quality technology combined with our comprehensive experience in addressing Power Quality challenges and practices means we can offer a wide portfolio of products, systems, solutions, services and consulting capabilities to satisfy almost every customer needs.

How to improve Power Quality across the board?

1. In depth knowledge
2. Wide portfolio of solutions
3. Services and care
Switch your challenges into your values

Renewable
Not able to connect to the grid if over or under voltage or pollution emitted is too high.

Generation
Higher stress on generators leading to premature failure / erratic behavior, grid instability, blackouts.

Industrial
Non-compliance to grid codes, penalties, higher CO\textsubscript{2} emissions, production down-time.

Transport
Non-compliance, increase in running costs, frequent outages, penalties, reduced operational efficiency.

Infrastructure
Penalties, frequent outages and downtime, reduced equipment life.

Customer needs
- Availability and reliability
- Avoid penalties
- Reduced emission
- No downtime

Market Drivers
- Grid Codes
- Regulations
- DG Integration
- Disturbing or Sensitive Loads

Ensuring the continuity of supply

Enhancing the electrical parameters

Optimizing the commercial quality

Our knowledge, experience & capabilities
- Site Assessment
- Consulting
- Solution Optimization and Delivery
- From product to Turnkey
- Monitoring, Protection and Control
- Digitalization and Services

Ensuring the continuity of supply

Enhancing the electrical parameters

Optimizing the commercial quality

Our knowledge, experience & capabilities
- Site Assessment
- Consulting
- Solution Optimization and Delivery
- From product to Turnkey
- Monitoring, Protection and Control
- Digitalization and Services
Your benefits
Widest range of products, services and solutions

SOLUTIONS

- Consulting
- FACTS
- Shunt reactors
- Capacitors and filters
- Active filtering solutions
- Voltage conditioning and regulation
- Monitoring, protection and controls
- Volt-VAr management
- Energy storage
- Surge arresters and surge capacitors

BENEFITS

- Optimized revenue – lower running costs
- Enhanced grid reliability and stability
- Deferral of grid upgrades
- Ease of integration or realization of integration
- New revenue from ancillary grid services
- Reduced penalties from harmonic pollution and demand peaks
- Improved productivity and saving on maintenance costs
- Increased self-consumption of renewables

VALUES

1. Sustainability
2. Reliability
3. Productivity
4. Cost optimization
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Your partner of choice for Power Quality

One stop shop
Hitachi ABB Power Grids has one of the broadest portfolios of Power Quality technologies, solutions and products for all voltage levels and segments. We are able to provide exactly what our customers need, whatever the application, whether in power generation, power grids, industry, transport, infrastructure, commercial and residential.

Always by your side
We support our customers every step of the way, from proposing the optimal Power Quality solution to maximizing the value of the asset during its whole lifecycle.

“
Our mission is to solve Power Quality problems, not only through our extensive power industry expertise but also with the capability to develop and deliver the right Power Quality solution for virtually any application.

Our attention to Power Quality paves the way for a more efficient, sustainable and greener grid.

Fahd Hashiesh
Power Quality INL
Hitachi ABB Power Grids"