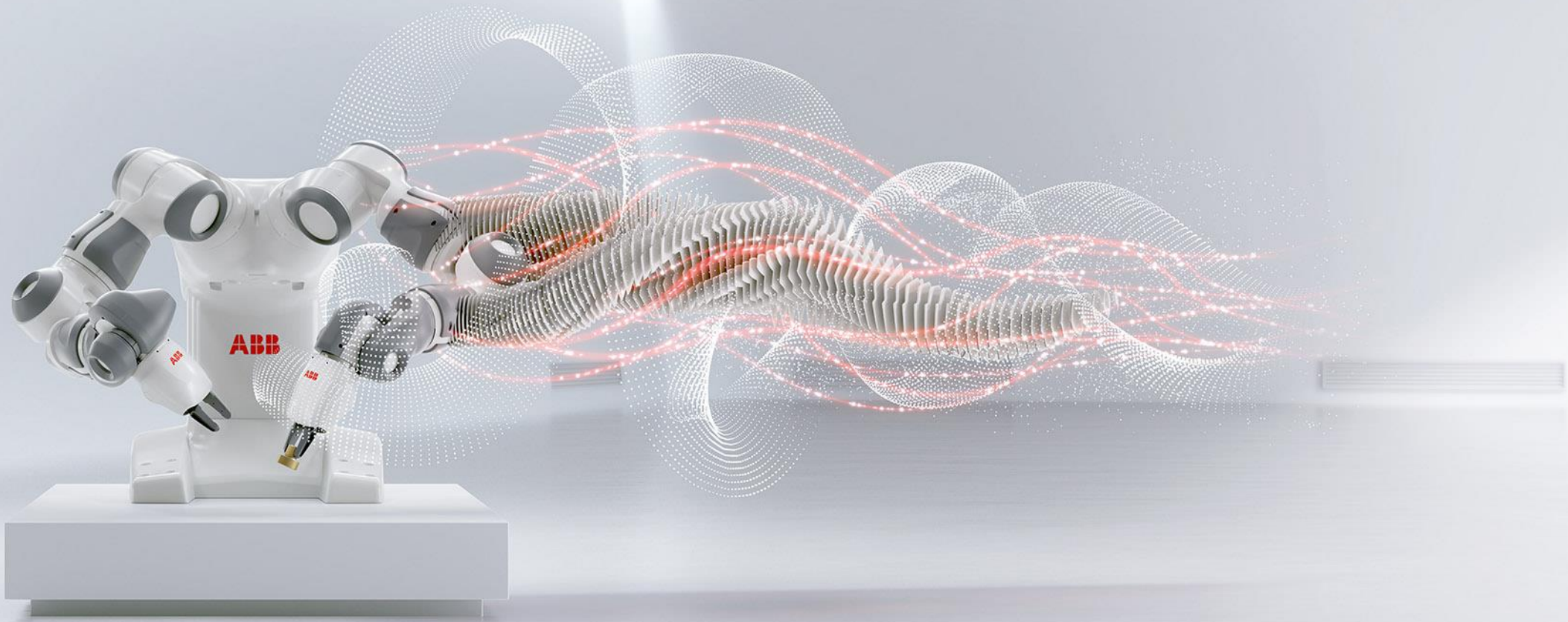


NORDIC ENERGY SOLUTIONS FOR GLOBAL CHALLENGES, ADDIS ABEBA, OCTOBER 31, 2019

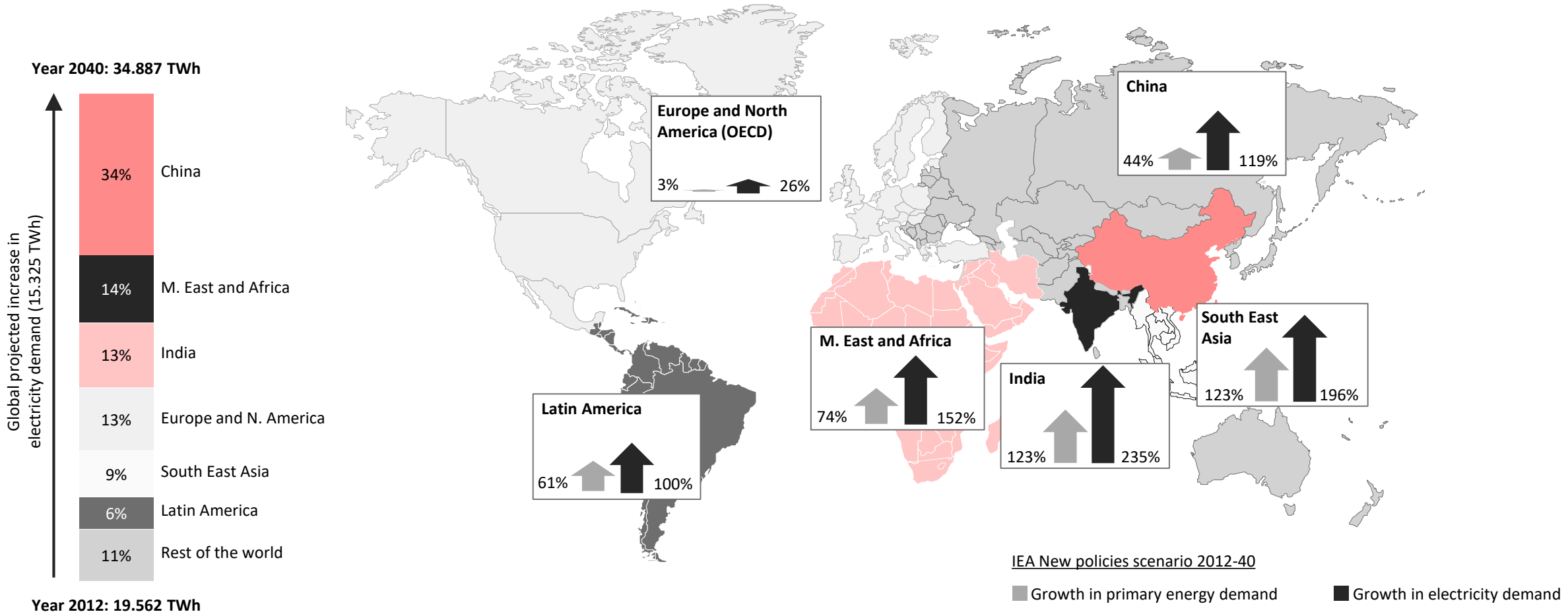
Power grids for the future

How digitalization revolutionizes energy transformation

Conny Wahlberg, Global Sales & Marketing Manager, Network Control

Electricity demand to rise by around 80% through 2040

Significant increase from developing markets

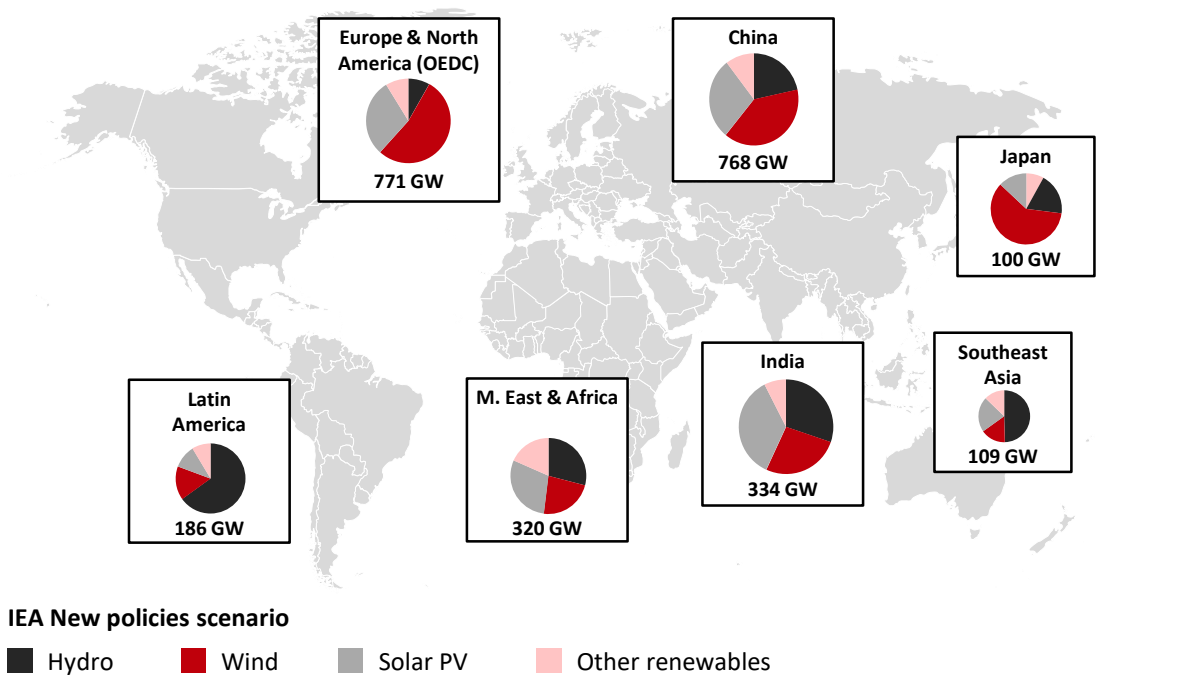


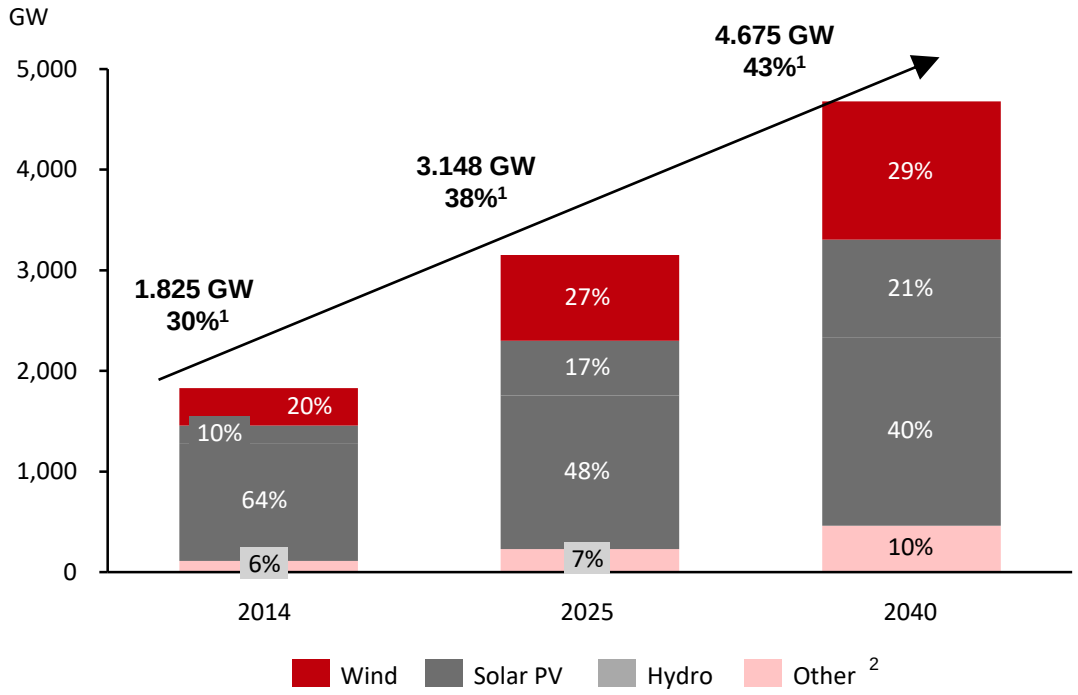
Source: International Energy Agency (IEA), WEO 2014

Renewable energy

Global installed capacity more than double by 2040

Net capacity additions 2014-2040





Wind and solar amount to 50% of total renewables in 2040

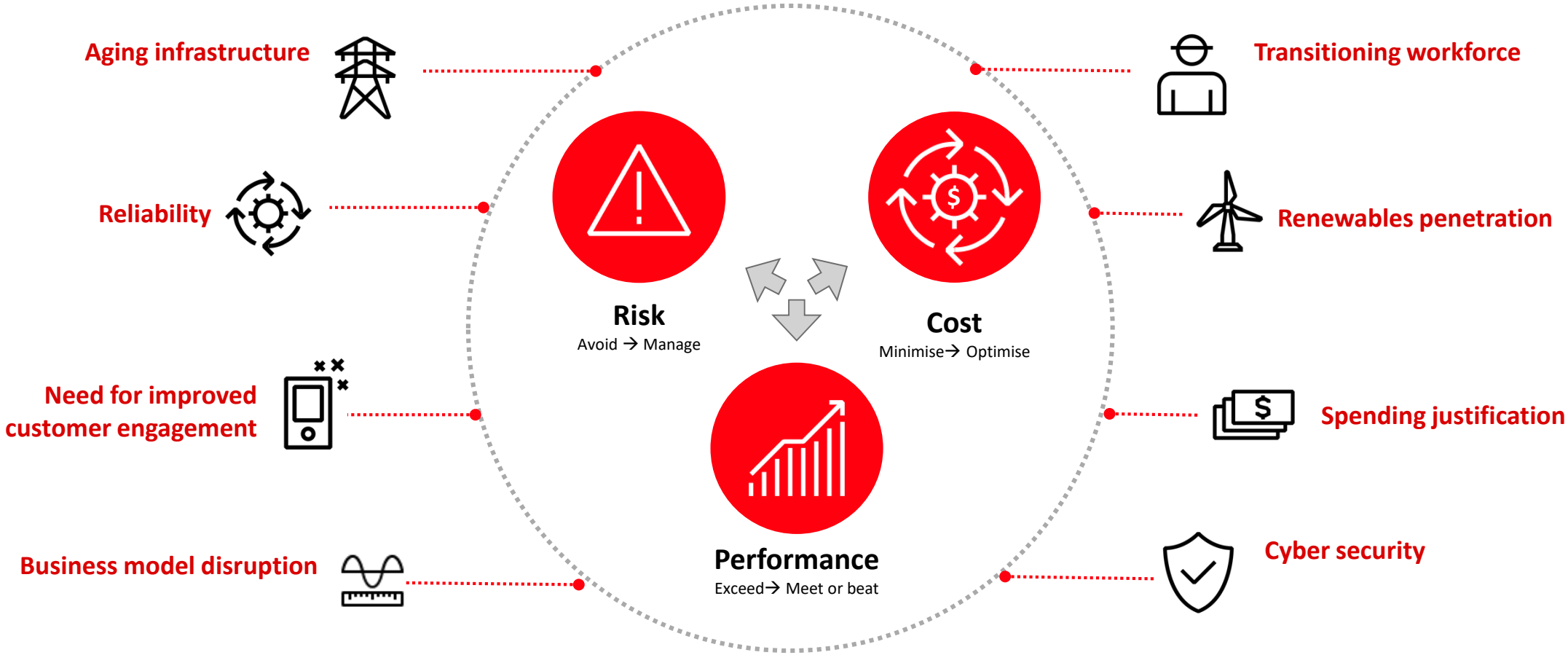
Source: McKinsey 2011, UNEP 2009, EIU 2012

[1] Share of total power capacity

[2] Other include bioenergy, geothermal, CSP and marine

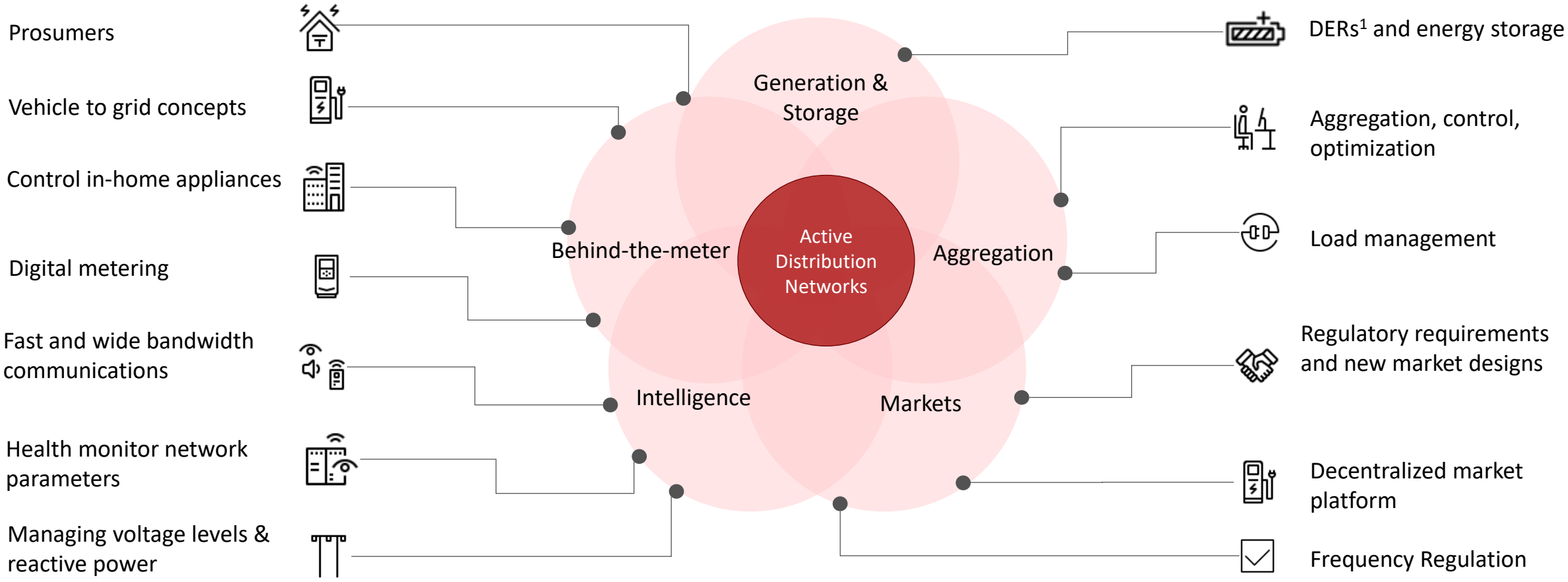
Current challenges and changes facing the energy sector

All stakeholders are affected and there is need for transformation



Increasing complexity in distribution networks

New challenges for traditional paradigms for control and commerce



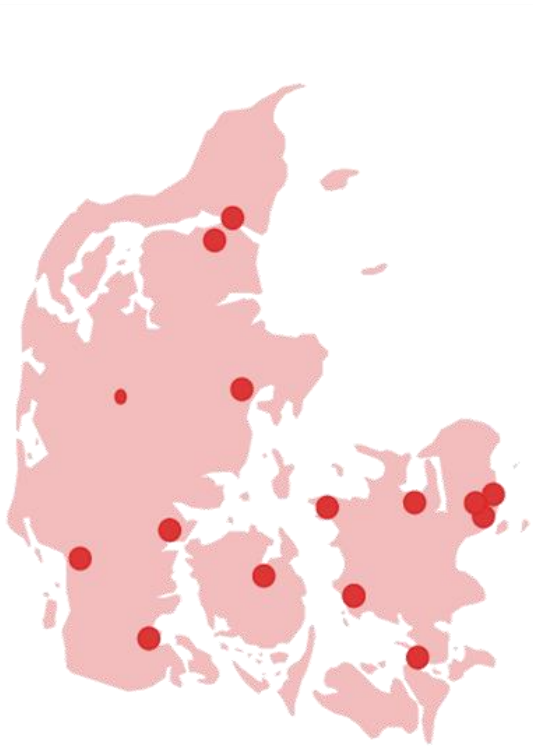
[1]Distributed energy resources

Complexity – what does it look like?

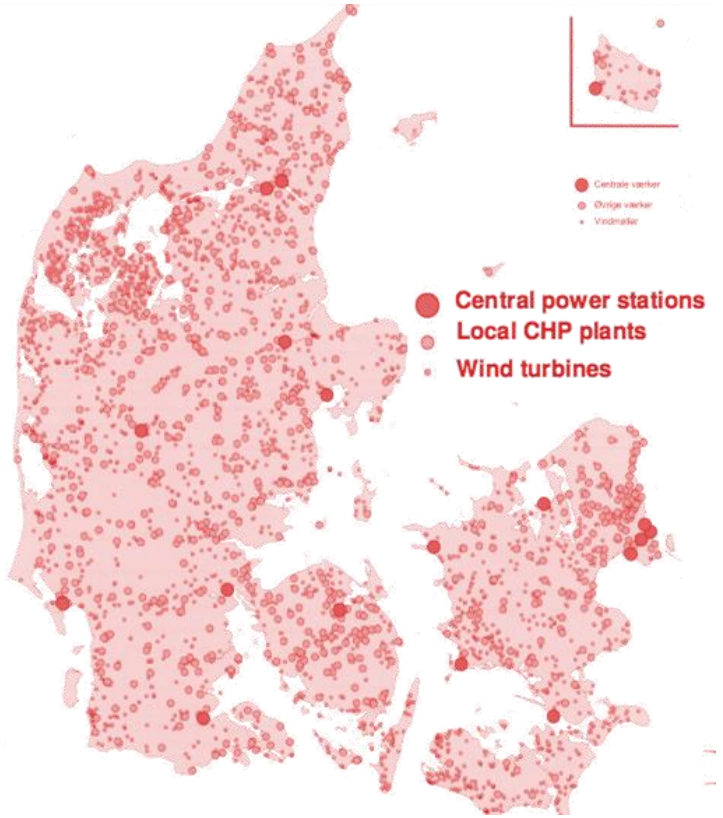
Decentralization of energy production has challenged many countries in the world

Energy transformation

- From bulk, centralized and well controlled generation to distributed and weather dependent generation
- From deterministic and well defined load profiles to volatile and reverse power flows
- From load following control to demand integrated in system operations
- From operations based on historical experience to operations based on real time data



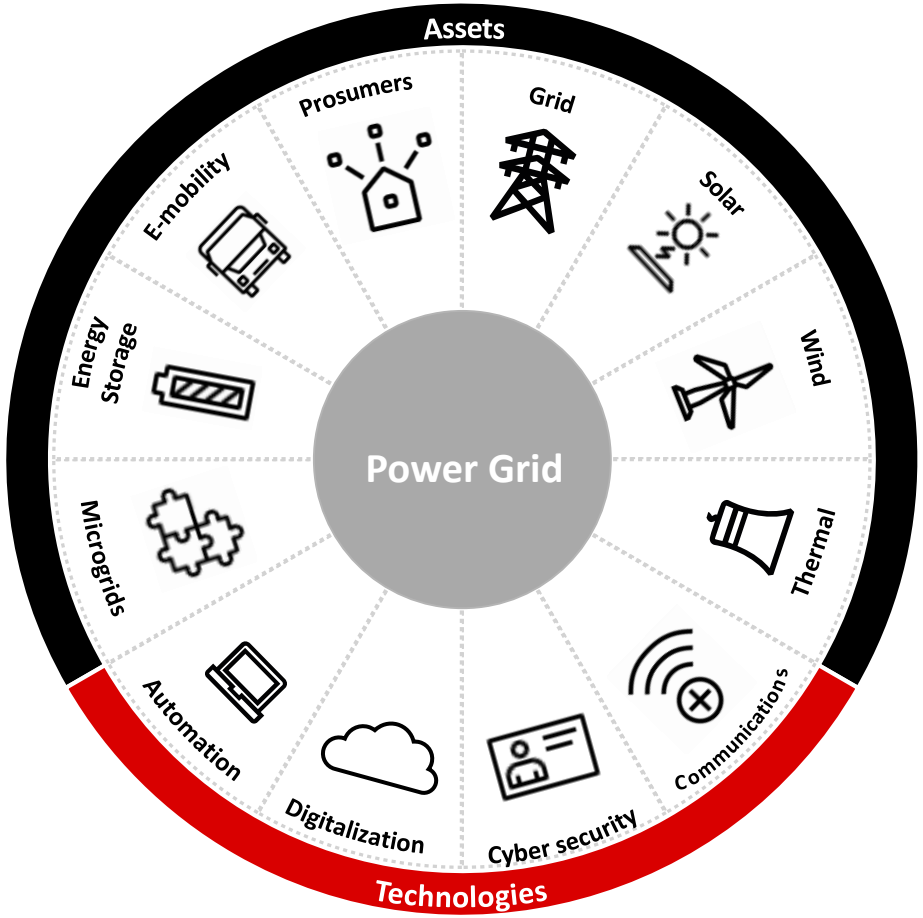
*Denmark, 1990



*Denmark, 2014

Complexity – what does it look like?

The adoption of new generation and load technologies challenges current operating practices



1 New generation technologies

- Weather dependent, volatile power production
- Power electronics interfaces, no more natural inertia
- Digital control more important than ever

2 New load technologies

- New loading patterns driven by the emergence of roof top solar, batteries and e-mobility behind the meter
- Power electronics interfaces affecting power quality
- Prosumers want to play an active role

3 New digital technologies

- Emergence and adoption of cloud & artificial intelligence
- Higher bandwidth and higher speed communications
- Better sensors, digitizing the assets

Uniquely positioned and a pioneering technology leader

Enabling a stronger, smarter and greener grid

Stronger

Protection and Control technology

Mission Critical Communications

Cyber Security Solutions

Wireless Communications

Utility & Industry Hardened Technology

Smarter

Digital substations

Distributed Energy Resource Management Systems (DERMS)

Distribution Automation Systems

Connected Asset Lifecycle Management

Energy Portfolio Management

Workforce Management Solutions

Greener

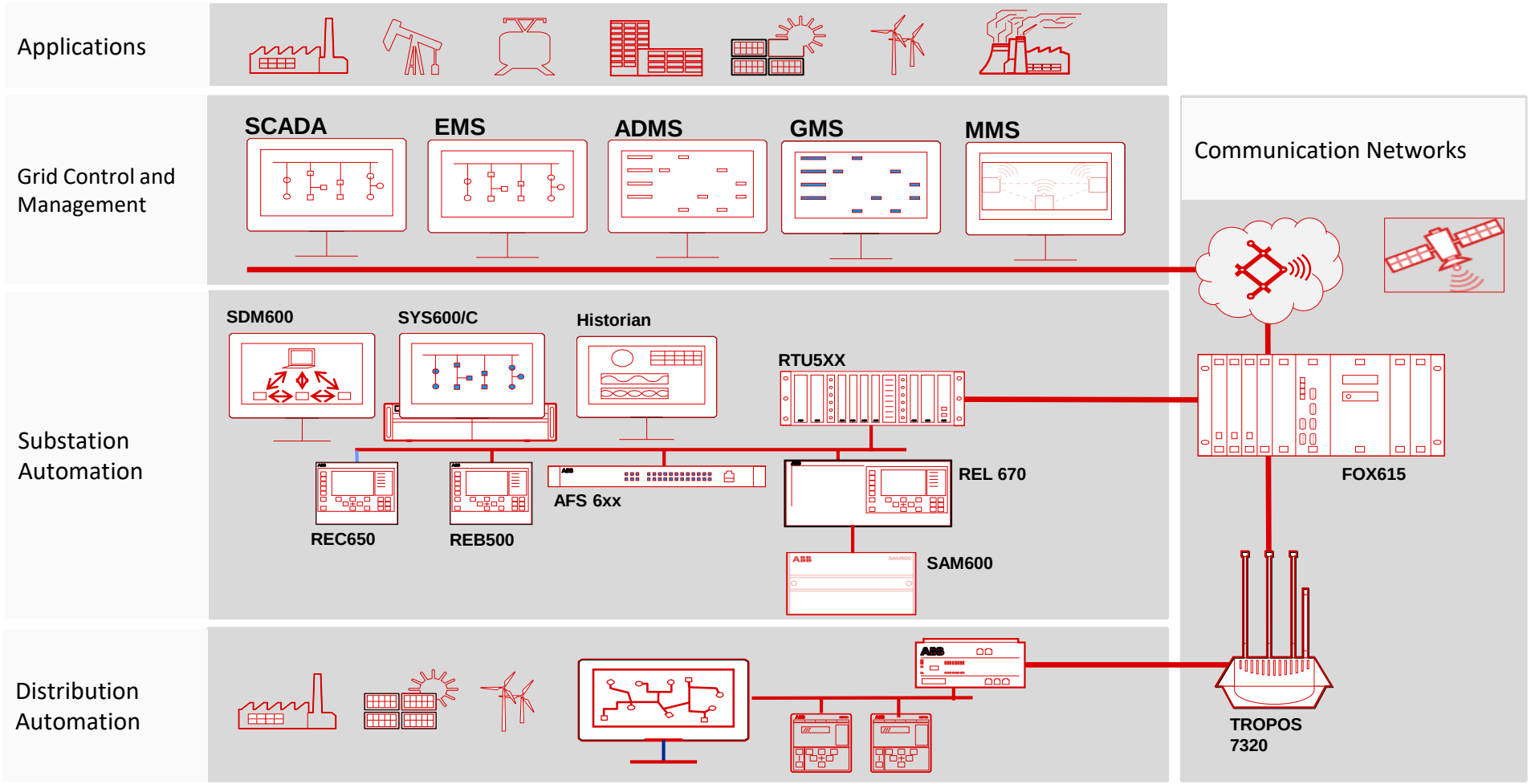
Renewable Automation

Microgrids

Battery Energy Storage Systems

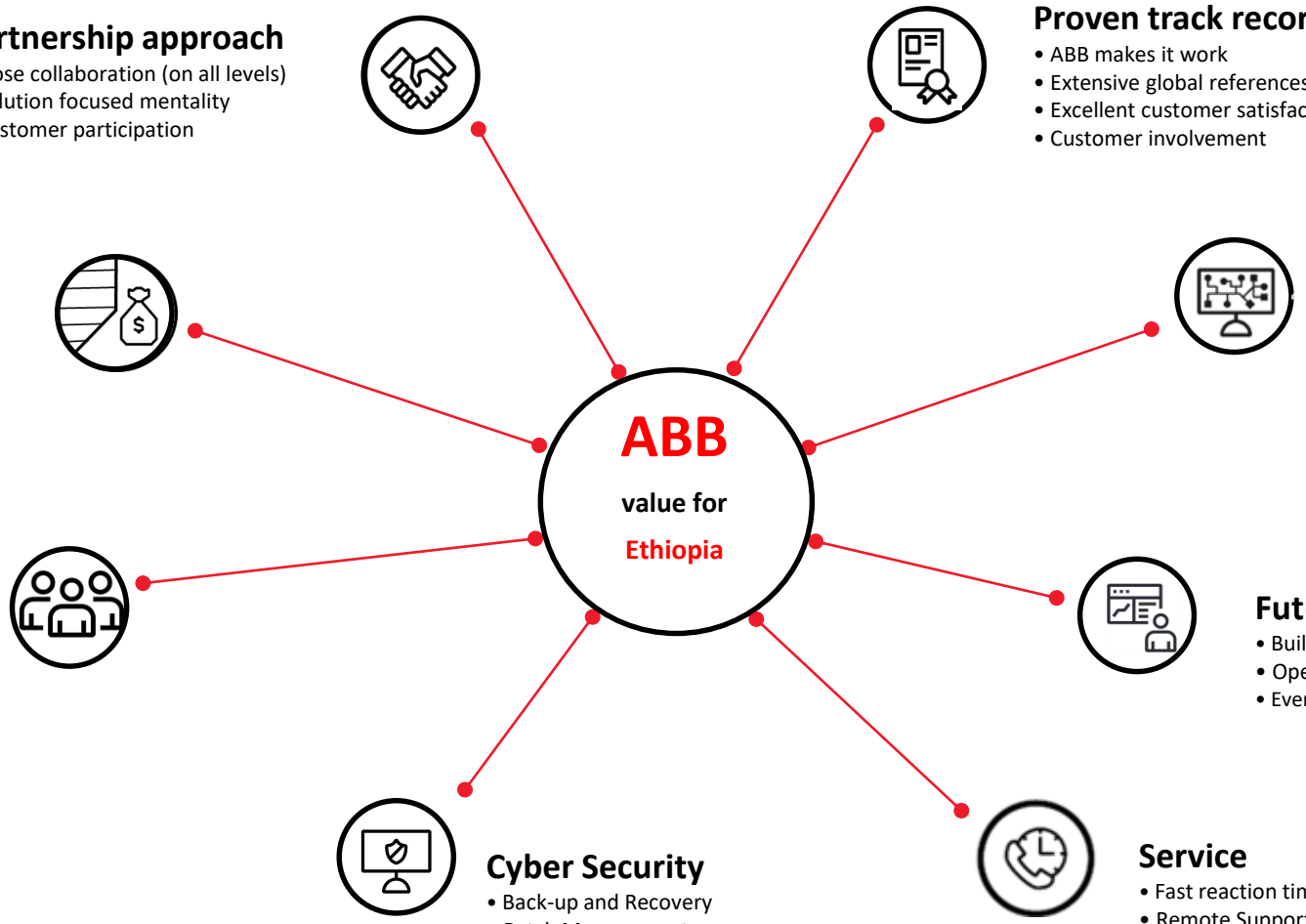
It is a part of integrated grid automation solution

ABB offering covers full spectrum of customer needs



State-of-the-art control room environment (example)

Why ABB?



Partnership approach
- Close collaboration (on all levels)
- Solution focused mentality
- Customer participation

Proven track record
- ABB makes it work
- Extensive global references & success stories
- Excellent customer satisfaction rate
- Customer involvement

Optimized CAPEX & OPEX
- Extensive lifecycle management
- High quality / MTBF
- Fast fault clearance
- Best in class total cost of ownership TCO

Technology leadership
- Guaranteed network performance reliability
- High network service availability
- Extensive know-how in Power sector (61850)
- Scalable solution

Know-how
- Flexible Training modules
- High R&D investments
- Proven know-how transfer

Future proof technology
- Built on industry standards
- Open interfaces
- Evergreen concepts

Cyber Security
- Back-up and Recovery
- Patch Management
- Extensive Products tests
- Audits & Recommendation

Service
- Fast reaction time from ABB
- Remote Support & Remote Services
- On site support
- 24/7 service


ABB