MVDC PLUS
Managing the future grid

**Underlying technology**
How does it work?

**Increase power infeed**
How can we enhance existing infrastructure?

**Connecting weak or unstable grids**
How will we integrate and stabilize grids?

**Bridge the distance**
How should we connect Islands, platforms, and remote areas?

**Reduce footprint**
What's the best way to make network upgrades with little visual impact?

**Obtain transmission autonomy in power ranges up to 150 MW**
How will we fulfill the enhanced tasks as a DSO?
Challenges
- Growing number of decentralized and volatile energy sources
- Stabilize weak networks
- Provide high-quality power supply
- Optimize and control load flow
- Serve spot markets

Solution
Connecting weak or unstable grids
How will we integrate and stabilize grids?

MVDC
Connecting weak or unstable grids
How will we integrate and stabilize grids?

Challenges

Solution
- Load flow control through MVDC: Connect grids via active elements that control load flow and provide reactive power
- Decouple grids with different frequencies, voltage levels and quality with DC link
Connecting weak or unstable grids
How will we integrate and stabilize grids?

Challenges

Solution

Customer benefits

Simple integration of volatile energy sources

Safeguarding the power supply, power exchange between grids to optimize losses and asset utilization

Grid stabilizing, load flow control, grid independence.

Improved grid quality
Bridge the distance
How should we connect islands, platforms, and remote areas?

Challenges
- Connect remote energy loads (for example, islands, industries, small cities)
- Reduce CO₂ footprint and prevent pollution (for example, diesel generators)
- Distance of 110-kV AC lines limited due to reactive power losses

Solution
Bridge the distance
How should we connect islands, platforms, and remote areas?

Challenges

Solution
- Install compact and cost-efficient medium-voltage DC connections
- DC Link via cable or compact overhead lines
- Economical power transmission over long distances
- Remote restart of autark areas with tailor-made black-start functionality

Customer benefits
Bridge the distance
How should we connect islands, platforms, and remote areas?

Customer benefits

- Reduced costs for transport, storage, and maintenance for diesel generators, for example
- Cost advantage due to higher efficiency compared with HVAC
- Reduced CAPEX due to larger MV supplier base and commodities
- Reduced visual and environmental impact (approvals and CO₂ reduction)
Increase power infeed
How can we enhance existing infrastructure?

Challenges
- Increase rating of existing lines to satisfy growing power demand
- Connect urban centers with outside transmission system
- Improve grid stability without network expansion

Solution

Customer benefits
Increase power infeed
How can we enhance existing infrastructure?

Challenges

Solution
- Convert from existing AC to DC system that enables greater power transfer
- Improve grid stability with MVDC PLUS system that provides STATCOM functionality

Customer benefits
Increase power infeed
How can we enhance existing infrastructure?

Challenges

Solution

Customer benefits

Avoid network expansions

Increased asset utilization by up to 20-80 percent more transmitted power

MVDC PLUS converters provide grid stabilization features
Obtain transmission autonomy in power ranges up to 150 MW

How will we fulfil the enhanced tasks as a DSO?

**Challenges**
- Connect regions where no HV connection is available
- Additional connection of energy producers to loaded areas
- Get more transmission autonomy
- Reduce transmission and dispatch fees

**Solution**

Customer benefits
Obtain transmission autonomy in power ranges up to 150 MW
How will we fulfil the enhanced tasks as a DSO?

**Challenges**

**Solution**
- Establish direct MVDC transmission links and additional grid nodes
Obtain transmission autonomy in power ranges up to 150 MW

How will we fulfil the enhanced tasks as a DSO?

**Challenges**

**Solution**

Customer benefits

- Be more independent of HV
- More flexibility for line planning
- Enhanced possibilities for integrating decentral energy supply
Reduce footprint
What’s the best way to make network upgrades with little visual impact?

**Challenges**
- High visual impact of HV lines with large lattice structures
- Public resistance against high voltage lines
- Getting permits for new HV corridors is becoming nearly impossible

**Solution**

Customer benefits
Reduce footprint
What’s the best way to make network upgrades with little visual impact?

**Challenges**

**Solution**
- Medium-voltage level allows for lines with heights below the treetops (<15 m height)
- Simple MV overhead lines require smaller corridors
- MV overhead lines with wood poles or simple steel structures
Reduce footprint
What’s the best way to make network upgrades with little visual impact?

Challenges
Solution

Customer benefits

Low visual impact
Faster and less complex implementation that speeds up construction and permitting
Get public acceptance for infrastructure upgrades
Lowering stranded planning investments
Grids are facing new challenges from decentralization and renewables

**Past:** Unidirectional energy flow HV → MV → LV via alternating current (AC)

**Future:** Omnidirectional energy flows that require control

- High-voltage transmission network ≥220 kV
- Regional sub-transmission network 110 kV
- Medium-voltage distribution network ≤33 kV
- Low-voltage level ≤1 kV

**Underlying technology**
MVDC PLUS combines the best of AC and DC transmission

- Simple design
- Robust and reliable technology
- Cheap and can be applied with no power electronics
- Easy integration into existing transmission networks

- Power transmission over long distances
- Same power transfer at lower voltage level possible
- No additional reactive power compensation equipment necessary
- Facilitates connection of asynchronous systems
- Seamless control of the active power flow
- Low contribution to short-circuit currents
Modular multilevel converter in MVDC PLUS ensures stable power quality
May I introduce myself?
I’m cost-efficient and fast thanks to standardized type ratings

1. Converter tower with IGBT
2. Control & Protection

MVDC PLUS is based on HVDC PLUS technology, standardized for different type rates with positive impacts on costs and execution time
Control and protection system

Operation via operator interface
Switchyard control
Interlocking
Start-up/shut-down
Sequence of event recording
Controller setting

AC feeder protection
Transformer protection
Converter AC busbar protection
DC supervision
Converter protection
DC line/cable protection

Station control
Closed-loop control
Protection
SCADA, communication, fault recording, IT security

Active power control
Bi-directional power flow
STATCOM operation
AC voltage control
Black start (*)
AC fault ride-through (**)