Agenda

- Why 1,100 kV?
- Potential markets
- Challenges
- System design
- Type tested apparatus
- DC yard apparatus
- The full setup
- Production and test facilities
- Summary
Why a new rated UHVDC?

Meeting increasing energy demands
- Energy consumption projected to increase by 50% by 2040*)
- Almost all growth will come in non-OECD countries, more than half from India and China.
- Electricity demand projected to grow by 70% by 2040*)

Lowering environmental impact and footprint
- Electric power generation mix moving towards renewables
- Renewable energy sources are often located far from load centers
- Right of Way (RoW) is limited and becoming an environmental, permitting as well as a cost issue.

Capacity
- 1,100 kV UHVDC increases capacity up to 20%, a prodigious upgrade from 800 kV UHVDC
- Opens a new range of voltage levels, above 800 kV.
- Even lower transmission losses over long distances

*) Source EIA
Potential markets

- UHVDC is the number one choice when it comes to bringing huge amounts of energy from renewable resources, often far away, to large load centers.
- China, India, Africa and the South America are potential markets with these conditions.
System design
Changji - Guquan UHVDC link – technical data

- Rated voltage: ± 1,100 kV
- Rated current: 5,455 A
- Power rating: 12,000 MW
- 2 hour overload*: 12,600 MW
- No of converters in series: 2
- Converter voltage rating: 1050/775/510 kV
- Reactive voltage drop, dx: 10/11 %
- Delay angle, nominal: 15 degrees
- Margin of commutation: 18 degrees
- Overhead line length: 3,284 km

*with redundant cooling
Challenges
Higher voltage level brings new requirements

- Higher insulation requirement – nonlinearly, length and diameter.
- Higher and larger equipment.
- Increased challenges in mechanical, thermal, valve hall and DC yard design.
- How to avoid a run-away situation?
- New thinking required.
From 800 kV to 1,100 kV
Difference mechanical design

- Insulator diameter increases
- Insulator length increases
- Pollution/Rain withstand decreases
- Creepage increases
- Mechanical

Wind load ↑ → Insulator diameter
Bus bar diameter ↑ → .... ↑
Possible run-away situation!
From 800 kV to 1,100 kV

Solutions to avoid a "Run-away situation"

- **Valve Design**
  - Optimized Electrodes
  - More efficient shielding

- **Indoor DC Yard**
  - To avoid Wind loads
  - To avoid pollutions

*Image: SGCC Xiangjiaba project China*
System design
Station layout – external view
System design
Station layout – internal view
System design
Performed studies

Fundamental system studies
- Main circuit parameters
- Insulation coordination
- Transient studies
- Technical specification

Insulation design & testing
- Large air clearance
- Optimized shield design

Station layout
System design
Cooperation between ABB and SGCC

*SGCC = State Grid Corporation of China.

System studies
- System optimization
- Insulation coordination

Station layout
- Valve hall design
- Indoor/Outdoor DC yard

Equipment qualification
- Review of design and test results

Transformer site assembly

Discussion and assessment on insulation test
Type tested apparatus
Successful performance

- Wall bushing
- Transformer bushing
- Transformer mockup
- By-pass switch
- Surge arrester
- DC coupling capacitor (RI filter)

ABB finished the R&D of critical equipment within the time frame given by SGCC.
DC yard apparatus
DC filter capacitor

800 kV UHVDC DC filter capacitor.

- Original design did not withstand specified wind loads.
- New design to fulfill mechanical requirements
1100 kV UHVDC
The full set of equipment developed by ABB

- Converter Transformers
- Valves
- Wall Bushing
- Bypass Breaker
- DC Capacitors
- Radio Interference Capacitors
- Surge Arresters
- Post insulators
The production and test facilities were built or upgraded for the new UHVDC technology – 1,100 kVDC

- New Composite Insulator production line
- Increased Lab capacity
- New winding machines for the bushing condenser core
Summary

ABB can provide

- Complete system solutions between 800-1,100 kV
- A solution including all critical equipment
- An optimized technical – economical solution
- A solution that minimizes risk

ABB is fully committed to the delivery of UHVDC systems between 800 and 1,100 kV

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Power and productivity for a better world™