ECE 529
Utility Applications of Power Electronics
Session 33
Introduction to High Voltage Direct Current (HVDC) Transmission

- Update to Edison's Vision
- AC Power Generation at Relatively Lower Voltage
  » Step Voltage Up to High Levels
- Convert From AC to DC and Back
  » DC Voltages: Pole to Ground up to 800 kV
  » Currents up to about 3000A
- Most Systems Presently Point to Point—Evolving
- Multiterminal Grids
A Little History

- First "Static" Var Compensator (Germany, late 1930’s)
  - saturated reactors in combination with capacitors
  - Continued into the 1960’s (Dr. Erich Friedlander)
- First HVDC project: Berlin-Charlottenburg 1942
- Moscow 1951
- Gotland 1954 (first successful operating project)
- Pacific HVDC Intertie 1970 (one of last Mercury Arc Valve)
- Thyristor Controlled Reactors (TCR), GE, 1970
- HVDC projects move to Thyristors in early 1970’s

Berlin Mercury Arc Valves 1942
Gotland Mercury Arc Valve

HVDC Transmission 5 Spring 2021

Lecture 33

LCC versus VSC HVDC

- The majority use line commutated converter (LCC)
- VSCs are have advantages in several applications
  - Independent control of real and reactive power injection
  - Provide dynamic voltage support to the ac system
  - Less harmonic filters requirement
  - Easier for multiterminal HVDC
- Also disadvantages
  - Losses
  - Lower Vdc and MW ratings (so far)
  - DC faults

HVDC Transmission Lower

current

Spring 2021
### HVDC Power Transmission

- No distance limitation for stability
- No distance limit for underground/sea cables
- Controlled power flow
- High power transfer, fewer lines,
  - Narrower ROW
  - Lower losses
- Potentially a firewall against cascading outages

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### Basic Concepts with HVDC

- Overhead Lines
  - Bulk Power Transfer Over Long Distances
  - Possibly Connecting Asynchronous Systems
- Underwater or Underground Cables
  - Distance Limits Underwater Cables
  - Longer Distances Where Overhead Lines Infeasible
- Back-to-back interconnections
  - Asynchronous systems — same or different frequency