

# **POWER CABLE**

**DAY 2 – Breakouts II and III**

# Assumptions

- Offshore
  - Less than 20 miles
  - Water depth 1,200 m or less
- Floating
- Moored
  - Cable and termination design depends on dynamics and azimuth constraints on platform and mooring configuration
  - Potential requirement to disconnect for weather drives complexity
- Potentially Relocatable (platform)
  - Not applicable for cable
  - Interconnect design depends on location
- 5-10 MW to commercial scale (100 MW)
  - Three phase AC cable, up to 10 MW
  - Three single phase AC cables, 100 MW
  - Cable includes power and communication controls
  - Cable includes own diagnostic system, fiber optic for temperature sensing

# Breakout II – Manufacturability

- Fabrication
  - Cable: Commercially available
  - Termination: Custom design b/c of motion
    - Fatigue testing required
- Deployment
  - Difficult but well understood
    - Difficult on steep shelf
  - Issue with depth b/c of limited experience
  - Handling the weight of cable
  - Cable site survey and route planning necessary
- Installation
  - Need sufficient space for platform substation
  - AC equipment requires less space

# Breakout II – Operability

- Operation
  - Fully automated and controlled from shore
  - Enclosed environmentally controlled substation
    - Keep out salt water and humidity
    - Dry type oil free transformer
- Maintenance
  - Cleaning
    - Periodic marine growth (diver), and full cable inspection
    - Annual maintenance of substation
  - Cable Repair
    - Standard practice in shallow water
    - More difficult in power cables in deep water
    - Splice requires mobilization of ship
  - Replacement
    - Leave adequate time to order new cable
    - Depends on location of fault

# Breakout II – Reliability

- Monitoring performance
  - Fiber optics to monitor temperature
  - Online methods for monitoring partial discharges in cable insulation
  - Location of cable faults done with injected voltage pulse
- Fatigue Mitigation
  - Control of abrasion on cable at the sea floor and sea junction near platform
  - Strumming suppression?
  - Flexing fatigue (bend strain relief and/or flotation)
- Personnel Safety and Emergency Preparedness
  - National Electric Safety Code or international equivalent
  - OSHA
- Decommissioning
  - Recovery of cable depends on environmental permit agreement

# Breakout II – Logistics

- Specialized ships needed for repair and deployment
- Shore landing equipment e.g.
  - Horizontal directional drilling (HDD)
  - Trenching
- Utility interconnect study needs to be done to establish shore side transmission capacity

## Breakout II – Scalability

- Cables are commercially available from 10 kV to 500 kV
- Unlikely using same type of cable from 10MW plant to 100 MW plant
- Should cable be planned for future upgrade on the platform?

# Breakout II – Life Cycle

- Risks from Failure?
  - Failure to comply with terms and conditions of contractual obligations
  - Not generating revenue for lack of power generation
  - Downtime could be long
    - Lack of repair ship
    - Time to find fault location
    - Long lead time for ordering new cable



# Breakout II – Life Cycle

- Cost limiting factors?
  - Material costs such as copper and steel
  - Shortage of cable manufacturing capability
  - Limited number of cable laying ships
  - Weather and location
  - Scheduling of ships
  - Survivability mitigation (burying or trenching, micro tunneling)

# Breakout II – Life Cycle cont.

- Cost savings?
  - Tagging on to existing orders
  - Location closer to shore landing means less cable
  - Distance to shore from interconnect should be shorter
  - Overhead line from shore to utility connection
- Research for cost reduction?
  - Reducing weight with use of different materials
  - Flexible connection and termination to platform
  - Fatigue testing

# Breakout III

- Technologies viable?
  - Cable
    - TRL-8/9
    - MRL-9/10
  - Cable connection at platform
    - TRL and MRL-5? Depending on requirements (like mooring, platform dynamics, quick disconnect) and needs further study
    - Custom solution
    - Site specific
- Economic factors?
  - Exchange rate
  - Cost of materials

## Breakout III cont.

- Hurdles or limiting factors?
  - Cable route
  - Limited supplier of armored cable
  - Riser Cable
  - Flexible connection to platform
  - Availability of ship

# Breakout III

- Development time frame?
  - 2-3 years
    - Driven by OTEC system level modeling, simulation and design
  - Cable connection to platform
  - Integrated platform mooring cable simulation
  - Normal design and development time frame for pilot plant