



Transmission Expansion Advisory Committee

MAPP Project Update
June 12, 2008

- A technical comparison of using 500 kV AC for the entire line versus a combination AC / DC line has been completed
- HVDC Voltage-Sourced Converter (VSC) (i.e. Light / Plus) technology is being considered primarily for the underwater crossing of the Chesapeake Bay
- Voltage rise concerns for a 500 kV AC submarine cable crossing of the Chesapeake Bay

	Comparison of AC versus DC	
	AC	DC
Number of Submarine Cables	Based on ampacities and losses, the current 500kV AC design would call for 3 parallel cables per phase for a total of nine (9) cables.	Assuming a bipolar system, the 640kV pole-to-pole DC design would consist of three 1000MW DC circuits for a total of six (6) cables.
-Cost impact	There are 9 complex cables thus the overall cost of the cable system will be costly.	Since there are only 6 cables instead of 9, the overall cost of the cable system will be less costly than the AC system. In addition, the DC cable itself is a simpler design and the overall diameter will be less than the proposed 500kV AC cable, leading to some additional cost savings based on the cable itself.
-Design/Construction	The cable laying equipment will make nine (9) passes across the Bay.	The cable laying equipment will only need to make six (6) passes across the Bay as opposed to nine passes.

Comparison of AC versus DC		
	AC	DC
Disturbed area for the Bay Crossing ^[1]	The total disturbed area with the AC cables would be 400' in width.	The total disturbed area with the DC cables would be 250' wide; 40% less than the disturbed area with the AC design. This same 40% reduction in disturbed area will be realized no matter what the cable spacing ends up being.
-Mitigation costs	More costly to mitigate for impacts to oyster beds or subaqueous vegetation. ^[2]	Less costly to mitigate for impacts to oyster beds or subaqueous vegetation.
Potential Permitting issues		The permitting agencies could look upon the DC alternative as having less impact than AC from an environmental perspective.

^[1] Based on guidance from outside experts, spacing between submarine cables will be a minimum of up to 'one times the water depth.'

^[2] Much of the permitting and mitigation process in the Bay will center around the disturbance of oyster beds, aquatic species, subaqueous vegetation, cultural resources and sediment released into the Bay during installation.

	Comparison of AC versus DC	
	AC	DC
Length of Cable	<p>The distance from the west shore of the Chesapeake Bay to the east side of the Chesapeake Bay is approximately eight miles, not allowing for the bottom profile. This distance is approaching the limit for the AC system without adding reactive compensation. Furthermore, in an effort to miss some onshore environmentally sensitive areas the design may call for the submarine cable to be installed in a cable length of 10-12 miles. The AC option will trigger the need for a new Reactor Substation at the east side of the Chesapeake Bay with a cable length of 10-12 miles. This will create siting issues.</p>	<p>The DC system will allow the cable to be installed for as long a distance as necessary with no need for reactors, thus there is added flexibility as to where the cable can be brought ashore, which can minimize impacts to communities as well as environmental resources.</p>
Cable Design	<p>Most of the 500 kV AC cable designs are either fluid filled or impregnated with oil.</p>	<p>The DC cables available in this voltage are solid and contain no fluids.</p>
Cable Outages – Maintenance or Forced out	<p>AC cables will be operated as a single circuit. The underground is a continuation of the aerial circuit. Any cable or termination failure would result in total outage.</p>	<p>The fact that three individual DC circuits are being installed will allow power to continue to flow if there is a scheduled or forced outage on one of the DC cables.</p>

Comparison of AC versus DC		
	AC	DC
<p><u>Aerial portion from a terminating point somewhere in Eastern Shore, MD to Vienna</u></p>	<p>The 500kV AC aerial construction is proposed to be one circuit consisting of three phases of bundled 3-1590 kcmil ACSR conductor for a total of 9 conductors. Estimated Right-of-Way (ROW) Width: 200'. Probable construction type: single circuit H-frame design.</p>	<p>The DC construction in this section will consist of three separate 640kV pole-to-pole DC circuits in a Bipolar configuration, with a probable conductor design of bundled 2-1590 kcmil ACSR or a total of 12 conductors for the three (3) separate circuits. Estimated ROW width: 200'. Probable construction type: double circuit H-frame design or a double circuit vertical construction.</p> <p>The fact that three separate circuits are being installed negates any appreciable structure, right of way or permitting savings for this portion of the line over the AC design. However, the installation of 3 separate DC circuits for this portion of the line will allow for continued flow of power if one of the circuits is out on maintenance or forced out.</p> <p>Also, the DC electromagnetic fields are equivalent to the earth's electromagnetic field.</p>

	Comparison of AC versus DC	
	AC	DC
<p><u>Aerial portion from Vienna to Indian River</u></p>	<p>The 500kV AC aerial construction is proposed to be one circuit consisting of three phases of bundled 3-1590 kcmil ACSR conductor for a total of 9 conductors. The intent is to utilize the existing 150' right of way for this section.</p> <p>Since the existing 138kV line will be rebuilt in conjunction with this project, the probable construction type will be a double circuit H-frame design.</p>	<p>The DC construction in this section will consist of two separate 640kV pole-to-pole DC circuits of bundled 2-1590 kcmil ACSR or a total of 8 conductors for the two circuits.</p> <p>The intent is to utilize the existing 150' right of way for this section.</p> <p>Since the existing 138kV line will be rebuilt in conjunction with this project, the probable construction type will be some sort of double circuit H-frame design.</p> <p>There will be no appreciable structure, right of way or permitting savings for this portion of the line over the AC design.</p> <p>However, the installation of 2 separate DC circuits for this portion of the line will allow for continued flow of power if one of the circuits is out on maintenance or forced out. Also, the DC electromagnetic fields are equivalent to the earth's electromagnetic field.</p>

- Voltage rise concerns for a 500 kV AC submarine cable crossing of the Chesapeake Bay limit the length of the submarine cable that can be used without shunt reactors to reduce voltage rise.
- The limitation with the AC cable length limits route options.
- HVDC will require fewer cables and a resulting smaller footprint for the Chesapeake Bay crossing.
- Use of DC technology would allow the use of solid dielectric cable. AC cables would be oil filled or oil impregnated.

- AC cables will be operated as a single circuit
- DC cables will be set up as three individual circuits allowing power to continue to flow during forced or planned outages of one of the DC cables
- DC VSC technology system benefits
 - Controllability – optimize flow without generation redispatch
 - Improve transfer capability
 - Transient stability

- The combined AC and DC solution is preferred over the all AC solution given its siting advantages and operational flexibility.
- The initial estimate for the MAPP line was \$1.05 billion
- The expected increase in cost of the MAPP project is expected to be approximately \$400 million
- We expect to request the PJM Board of Managers to endorse the change in scope which would bring the expected cost to \$1.45 billion.