Artificial Island

Dominion High Voltage MidAtlantic

Projects:

P2013_1-1A

P2013_1-1C

TEAC – Finalist Presentation

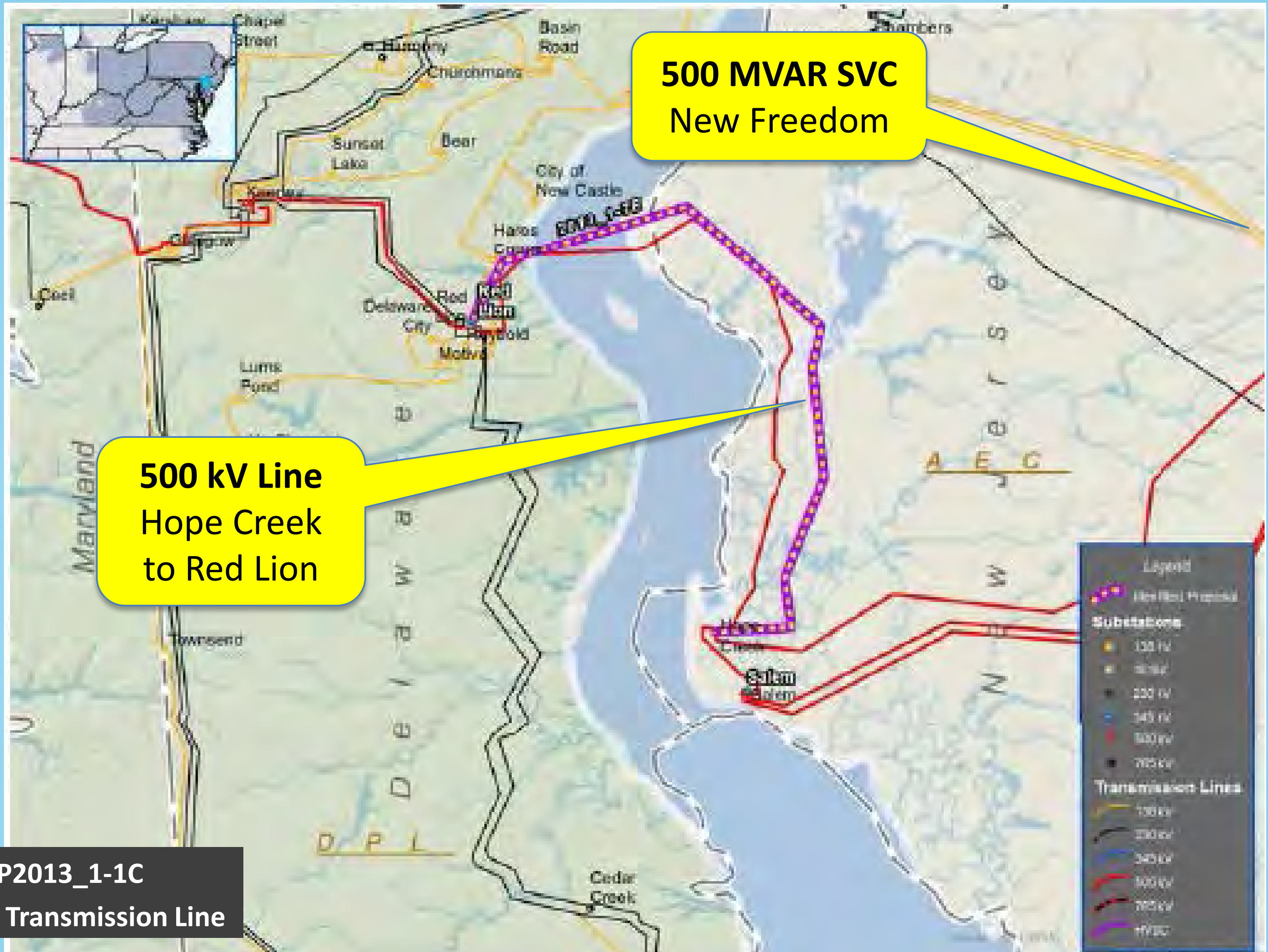
December 9, 2014

DHVM Projects

- Dominion High Voltage MidAtlantic (DHVM) proposals selected as Artificial Island finalists
  - **P2013_1-1C** – 500 kV Transmission Line
  - **P2013_1-1A** – SVC/TCSC Solution

P2013_1-1C

500 kV Transmission Line



P2013_1-1C
500 kV Transmission Line

Dominion

Dominion High Voltage MidAtlantic

Project Scope: P2013_1-1C

- **Key Components**
  - Hope Creek to Red Lion 500kV Line – Approximately 17 miles
  - 500 kV 500 MVAR SVC at New Freedom
- **Estimated Cost**
  - $322 M to $372 M
- **Permitting & Construction**
  - Delaware River Crossing
  - Approximately 60 Federal, State and Local Permits
  - Total Project Schedule from PJM Approval – 75 Months
- **Partnership with PHI**
  - MOU with PHI provides 50/50 Partnership should PJM approve 1-1C
  - Provides Dominion access to LDV via PHI – *reduces project costs and schedule risks for right of way acquisition*

P2013_1-1A

SVC/TCSC Solution

Project Scope: P2013_1-1A

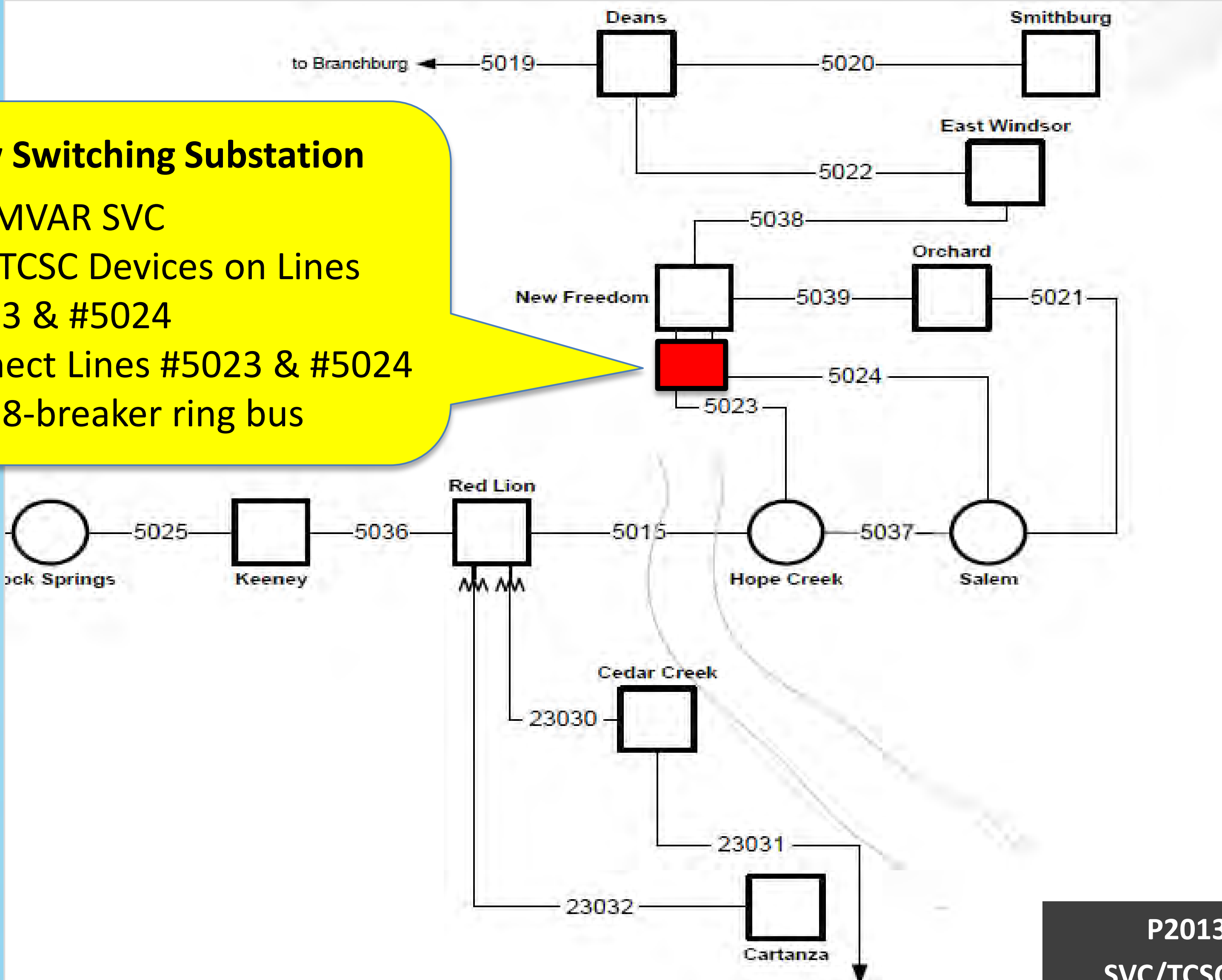
- **Key Components**
  - New 500kV Switching Station near New Freedom Substation
  - Seven 500 kV Breaker Installations at four existing substations
- **Estimated Cost**
  - $164 M to $174 M
- **Permitting & Construction**
  - New Substation in New Jersey
  - Approximately 25 Federal, State and Local Permits
  - Total Project Schedule from PJM Approval – 36 to 48 Months
- **Access to LDV not required**

Project Details: P2013_1-1A

- **Tie 500 kV Lines #5023 and #5024 together by constructing new eight-breaker 500 kV Transmission Switching Station near the New Freedom Substation, including**
  - One 750 MVAR SVC
  - Two Thyristor Controlled Series Compensation (TCSC) Devices
  - Eight 500 kV breakers
  - High-security Control House to contain all controls and protection
- **Install a total of seven 500kV breakers at four Substations**
  - East Windsor – two
  - Hope Creek – two
  - New Freedom – two
  - Red Lion – one

New Switching Substation

- 750 MVAR SVC
- Two TCSC Devices on Lines #5023 & #5024
- Connect Lines #5023 & #5024 with 8-breaker ring bus



P2013_1-1A
SVC/TCSC Solution

How will the TCSC Function?

STATE	TCSC/SVC Response
NORMAL STATE	The normal steady state of the **TCSC's** will provide the following line compensation • Line #5023 is at 40% • Line #5024 is at 45%
FAULT OCCURS	During a fault, the each **TCSC** controller will bypass the series capacitor in one cycle. The **TCSC** impedance becomes inductive to eliminate SSR and protect the capacitor from over-voltage.
AFTER FAULT IS CLEARED – AREA OF CONCERN FOR ARTIFICIAL ISLAND	• The **TCSC** controllers will sense the change in power flow and reinsert the capacitor and boost the compensation to 90% on both lines 5023 and 5024. • In the boosted mode, the **SVC** becomes electrically "closer" to the Artificial Island generators and contributes to the synchronizing torque by maintaining the scheduled voltage
RETURN TO NORMAL	• After approximately 3 seconds in the boosted state, the **TCSC** controllers will move the series compensation back to 40% and 45% compensation

Why is TCSC a superior solution?

- **TCSC eliminates the risk of SSR**
- **Proven Technology; TCSC is a part of the reputable FACTS family of devices**
  - Identical controls and components as SVCs
  - Series compensation used worldwide to increase transfer capability of transmission lines and improve transient stability of power plants
  - Multiple SVC's in service today throughout PJM
  - Two series capacitors have been in service for over 10 years on Bath County Power Station 500kV Lines to Lexington and Valley
- **PJM analysis presented at TEAC (Oct 2014) found the TCSC solution to be very robust, performing beyond the criteria for failure mode evaluation**

Use of TCSC continues to grow worldwide to resolve stability and oscillation problems in a low-cost manner

TCSC – Proven Technology

Figure 5 shows a 500-kV AC feeder (on the left side), the transformers (three single-phase units plus one spare), the medium-voltage bus, and three thyristor-switched capacitor (TSC) banks, as well as the building that houses the thyristor switches and controls.

California

Figure 5 - 500 kV, 400 MVAr SVC at Adelanto, California (by SIEMENS)

Brazil

Fig. 7: TCSC in Brazil: 500 kV AC Long Distance Transmission

The SVC shown in *Figure 6* is connected to the 420-kV Norwegian ac grid southwest of Oslo. It uses thyristor controlled reactors (TCR) and TSCs, two each, which are visible together with the 9.3-kV high-current buswork on the right side of the building.

Norway

Figure 6 - 420 kV, ±160 MVAr SVC at Sylling, Norway (by ABB)

Figure 7 show photos of two 500-kV TCSC installations in the U.S.. The platform-mounted valve housings are clearly visible. Slatt (U.S.) has six equal TCSC modules per phase, with two valves combined in each of the three housings per bank.

Oregon

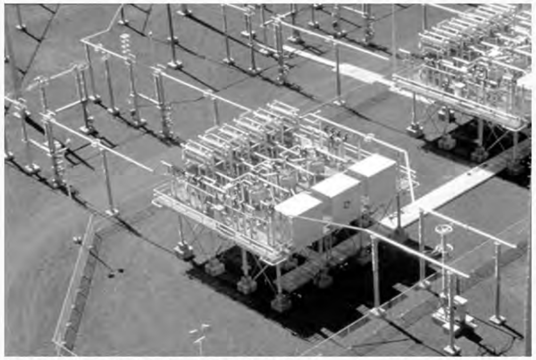


Figure 7 - Aerial view of BPA's Slatt, Oregon, 500kV TCSC (by GE)

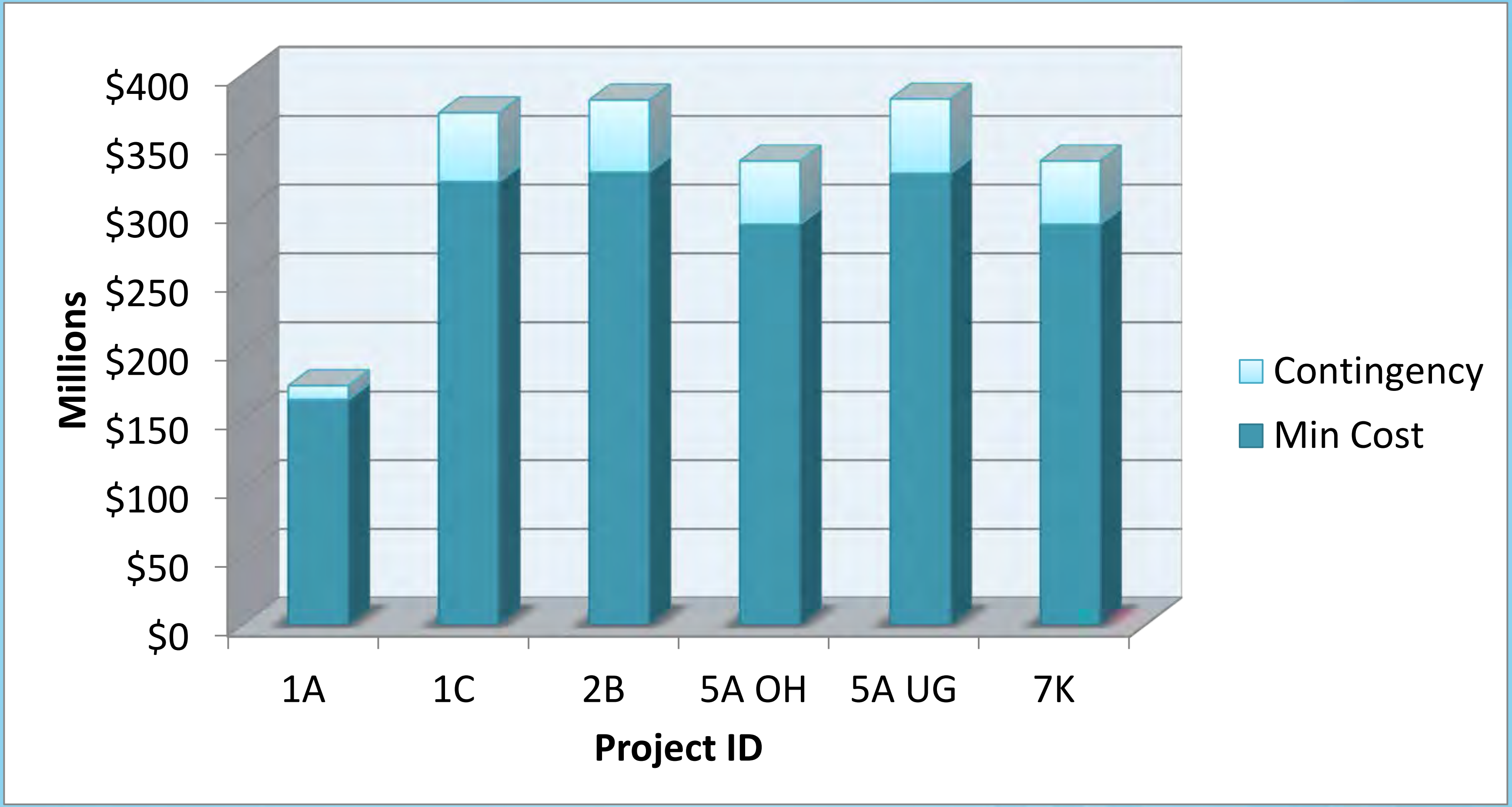
Source: Siemens, *Transmission & Distribution*

Option Comparisons

Topic	Dominion 1A	Line Options
Cost	✓ $164-174 Million (total cost for SVC and two TCSC's)	$ 291-382 Million (includes $80M for SVC)
Stability Performance	✓ Solves Problem	✓ Solves Problem
Environmental	✓ No river crossing	Significant wetlands
Permitting	✓ 25 permits, mostly routine	60 permits, very difficult
Time to construct	✓ 36-48 months	60-75 months. High risk of delays.
Overall	✓ Robust solution, per PJM*, providing benefits as early as spring 2018	✓ Reliable solution but significant schedule risk – 2020+

* PJM statement, TEAC Oct. 2014 slide 45, "TCSC Outage and Failure Mode Evaluation" revealed stable operations for many "Beyond criteria" scenarios (i.e. N-3, N-1-2)

Cost Comparison



Costs for proposals 1A, 1C, and 2B taken from the supplemental responses to PJM.

Costs for 5A OH, 5A UG, and 7K taken from TEAC slides 6/16/2014.

All estimates include the cost of an SVC.

Dominion

Dominion High Voltage MidAtlantic

Advantages of P2013_1-1A Project

- ✓ **Construction** – significantly less impact; one new substation and limited work at others
- ✓ **Lowest regulatory risk** – significantly less permitting and land acquisition
- ✓ **Reduced overall project impact** to the PJM territory, New Jersey, and localities
  - Minimal land use impact and environmental issues
  - No transmission line siting; no River crossing
  - No condemnation
- ✓ **Dominion experience** with building and operating Series Compensating Devices
- ✓ **Shortest duration** for Project Execution and Commissioning; only 36-48 months
- ✓ **Earliest in-service date** of all proposals
- ✓ **Limited number of outages** required over a relatively shorter period of time
- ✓ **Lowest cost solution** $164 M to $174 M with least risk of cost overrun
  - Real estate and permitting accounts for only 5% of total project cost
  - SVC and TCSC estimates are cost capped – approximately 50% of total project cost

~ ~ QUESTIONS ~ ~

Artificial Island

DHVM Projects

P2013_1-1A

P2013_1-1C