CAPITAL COSTS FOR TRANSMISSION AND SUBSTATIONS

Recommendations for WECC Transmission Expansion Planning

B&V PROJECT NO. 176322

PREPARED FOR

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capability. Transformers can vary in cost substantially based on variables such as copper commodity prices, as well as cost of freight; however, the costs considered and vetted by the WECC stakeholders are typical in the industry. The costs considered include foundation and oil containment for the transformer.

Table 3-3 below identifies the capital costs associated with each voltage class in a cost per mega-volt ampere (MVA), which is dependent on the amount of current carrying capability necessary to deliver from the high voltage side to the low voltage side of the transformer.

Table 3-3 Transformer Capital Costs

TRANSFORMER COST ($/MVA)	230 KV SUBSTATION	345 KV SUBSTATION	500 KV SUBSTATION
115/230 kV XFMR	$7,000	-	-
115/345 kV XFMR	-	$10,000	-
115/500 kV XFMR	-	-	$10,000
138/230 kV XFMR	$7,000	-	-
138/345 kV XFMR	-	$10,000	-
138/500 kV XFMR	-	-	$10,000
230/345 kV XFMR		$10,000	-
230/500 kV XFMR	$11,000	-	$11,000
345/500 kV XFMR	-	$13,000	$13,000

3.4 REACTIVE COMPONENTS

An ideal transmission system does not require any reactive support; however, this is rarely the case. Many transmission networks are integrated in a manner that supports voltage dips across the network; however, some weaker systems may require additional reactive power support to maintain grid reliability. The amount of reactive support, and the speed with which the support needs to be transferred to the grid, will determine what type of reactive component is required at the substation.

Black & Veatch identified three key reactive components commonly used for transmission level grid support. Each piece of equipment has its own level of complexity, size, and cost.

- Shunt Reactor
- Series Capacitor
- Static VAr Compensator (SVC)

Shunt reactors are commonly used to reduce voltages due to high line charging on lightly loaded transmission networks. Series capacitors do the exact opposite – they increase voltages by providing additional reactive charging to the transmission network to maintain system voltages.

Black & Veatch worked with stakeholders to assume a "turnkey" installation, which includes with engineering, design, and construction support for a site that "has been rough-graded and has access to a source of medium voltage auxiliary power"[7]. Table 3-4 identifies the typical costs for shunt reactors and series capacitors.

Table 3-4 Shunt Reactor and Series Capacitor Capital Costs

EQUIPMENT	230 KV SUBSTATION	345 KV SUBSTATION	500 KV SUBSTATION
Shunt Reactor ($/MVAR)	$20,000	$20,000	$20,000
Series Capacitor ($/MVAR)	$30,000	$10,000	$10,000

Static VAr Compensators (SVCs) combine both technologies, while adding speed of support. SVCs are constantly connected to the grid, whereas capacitors and reactors typically have to be switched. SVCs are more expensive than their static counterparts; however, they offer more flexibility in resources. The costs for SVCs vary based on size and the assumptions made about the ease of installation. Table 3-5 below shows SVC costs identified by HydroOne, Arizona Public Service Company (APS), and the Peer Review Group adopted costs. Like Shunt Reactor and Series Capacitor capital costs, SVC costs assume a "turnkey" installation.

Table 3-5 SVC Capital Costs

VOLTAGE CLASS	HYDRO ONE[8]	APS[9]	WECC
500 kV	-	-	$85,000
345 kV	-	-	$85,000
230 kV	$94,500	$75,000	$85,000
115 kV	$141,000	-	-
Medium Voltage	$142,000	-	-
Low Voltage	$250,000	-	-

[7] Stakeholder comment from Eric John of ABB, regarding turnkey SC turnkey installation.
[8] http://www.appro.org/docs/HONIconnectionsJan2009/Naren_Pattani_%20-_Tx_presentation_at_%20APPrO-CanWEA-OWA_workshop,_Jan_22_2009.pdf
[9] http://www.wecc.biz/committees/BOD/TEPPC/020209/Lists/Agendas/1/Reactors%20%20Capacitors%20%20SVC%20%20PSS.pdf