Introduction to
The Trans Bay Cable Project
We’ve come a long way...
But thanks to the advances of two men and...
The Battle of Currents...
Utilities are able to choose the most effective and efficient means for their unique power transmission challenges.

Typical investment costs for an overhead line transmission system with HVAC and HVDC.

The Supergrid Initiative - e-Parliament
http://www.e-parl.net/epar/limages/general/pdf/081029/The_Supergrid_Initiative_nb.pdf
Uses of HVDC

HVDC has two main purposes

- Back-to-back interconnections
  - Useful for connecting mismatched AC Networks
  - Can convert 50-60 Hz

- Point-to-point connections
  - Connects remote generation to load centers
  - Bulk power transmission over long distances
<table>
<thead>
<tr>
<th>LCC (Line Commutated Converter)</th>
<th>VSC (Voltage Sourced Converter)</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Thyristor (Turn on capability only)</td>
<td>- IGBT (Turn on/off)</td>
</tr>
<tr>
<td>- Active Power Control Only</td>
<td>- Active and Reactive Control</td>
</tr>
<tr>
<td>- AC Filters</td>
<td>- No AC Filtration</td>
</tr>
<tr>
<td>- No Black Start Capability</td>
<td>- Black Start Capable</td>
</tr>
<tr>
<td>- Higher Capacity</td>
<td>- More Flexible</td>
</tr>
<tr>
<td>- Large Footprint</td>
<td>- Small Footprint</td>
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</tbody>
</table>
Why TBC

Post the 1998 blackout event and part of the CAISO long term plan, the CAISO put into place a team called the San Francisco Stakeholder Study Group (SFSSG).

The CAISO and the SFSSG proposed the following long term projects to meet the need of the energy demands of San Francisco:

- Status Quo
- Upgrade and replace existing facilities
- Trans Bay Cable Project
- Moraga-Potrero 230 kV Line
- Tesla-Potrero 230 kV Line

In summary Trans Bay Cable was a fast, affordable, effective solution to solve the long term energy needs of San Francisco.
- TBC was originally slated to be an LCC facility
- Available land in the city proved challenging
- Smaller footprint of VSC reduced amount of land required and cut costs
- TBC Selected Siemens’ Modular Multilevel Converter HVDC PLUS
- Smoother waveform
- Each module is a discrete voltage source
- Each arm has 216 sub-modules (16 spares)
System Data:

Transmission Capacity: 400 MW
DC Voltage: 400 kV DC
Simplified Project One-Line Diagram
Potrero Converter Station

- Transformers
- Converter Hall
- DC Reactors
- AC Reactors
- Control & Protection Room
- Condensers (cooling fans)
Operational Performance
### Operational Performance

<table>
<thead>
<tr>
<th>Year</th>
<th>SEU</th>
<th>FEU</th>
<th>Avail</th>
<th>Utilization</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>2.8%</td>
<td>0.2%</td>
<td>97.0%</td>
<td>92.8%</td>
</tr>
<tr>
<td>2012</td>
<td>1.55%</td>
<td>0.81%</td>
<td>97.64%</td>
<td>96.92%</td>
</tr>
<tr>
<td>2013</td>
<td>3.23%</td>
<td>0.48%</td>
<td>96.3%</td>
<td>86.4%</td>
</tr>
</tbody>
</table>

- Utilization is based on average MW per day
- CAISO has recently started to aggressively use TBC for power flow management within SF and peninsula - lower MW average per day - leverages flexibility and agility of VSC system
AC - DC Converter Hall
Active power is controllable between 0MW and 400MW in increments of 1MW.

Reactive power can be generated/absorbed within limits at each Converter Station, independent of the other Converter Station.

- ±145MVAr at Pittsburg (at full active power)
- ±170MVAr at Potrero (at full active power)
- Smoother waveform, lower harmonics, less filtering, smaller “footprint”
- Low system losses.
- Independent and fully controllable reactive power
Project Real and Reactive Power Capability

Operation in RED AREA
Available at Expense of Real Power Transmission

P Extracted from Pittsburg POI (MW)
Q Deliverer d to POI (MVAr)
Q Absorbed from POI (MVAr)
P Delivered to Potrero POI (MW)

P/Q at Pittsburg POI
(0,+300)
(-418,0)
(-418,+145)
(-418,-145)

P/Q at Potrero POI
(0,-300)
(+400,0)
(+400,+170)
(+400,-170)
OPERATOR
Project O&M Structure

TBC LLC owner

Siemens Operator

TBC Operations LLC
24hr Site O&M
CABLE
• 53 miles
• Burial depth 6ft
• Follows deep water channel
• Numerous infrastructure crossings
• Interfaces with multiple bay agencies
Ship: Giulio Verne (Deep Water Cable Installer)

Hydroplow
Submarine cable laying ship
Submarine cable laying
Change in Utilization?
TBC Utilization

Summer Dispatch Comparison

MW

DATES


2012 MW
2013 MW
2011 MW
2013 Accumulated and Monthly Ramping
TBC’s Plans for the Future
Siemens currently using Inelfe Project (Spain - France Interconnect) as base design

Upgrade to address lose of PG&E Martin substation

Will bring Black Start functionality to the Trans Bay Cable

Allows TBC to support up to ~350 MW of critical load in San Francisco

Scheduled for Q3 2016 completion
NOT SURE IF CLAPPING FOR THE SPEECH
OR BECAUSE ITS OVER