Success story

Bayamon
Puerto Rico’s electrical network revamp

A unique approach allowed Alstom Grid to design, deliver and install an SVC solution in record time.

Finding the right partner
Designing the SVC and its control system was very challenging. It had to meet stringent technical requirements for a very sensitive system, including many interfaces with other units. Alstom Grid found the winning combination for PREPA.

Customer profile
The Palo Seco plant is an important source of real and reactive power in the area, and the location and interconnections to other transmission centres are of key importance for the reliability of the island’s electrical system.

Business challenges
On December 29 and 30, 2006, the Puerto Rico Electric Power Authority (PREPA) suffered a major power plant failure when several fires broke out at the Palo Seco power plant, one of Puerto Rico’s main plants near the capital, San Juan. The fires affected about 600 MW (and 370 MVAr) of installed generation.

Project objectives
- Determine the viable alternatives and install them in the shortest possible time
- Create an innovative but effective solution
- Commission the SVC solution within six months

Alstom Grid solution
The Alstom Grid solution was to supply and install a 90 MVAr SVC that, to shorten the project schedule, would include an already available power electronics system previously constructed for another customer - but of course modified to meet the precise requirements of the Puerto Rican utility. The proposal also included the supply of new capacitors, reactors, filters, control and protection systems, cooling system, circuit breakers and other high voltage equipment.

Alstom Grid repairs Puerto Rico’s electrical network
Alstom Grid designed, delivered and installed the SVC solution in less than six months and at a reasonable cost. The SVC system was commissioned in November 2007 and has been successfully in service since then.
Emergency in Puerto Rico

Instability and voltage collapse
As more than two-thirds of the installed generation is located on the southern side of the island, the loss of the Palo Seco power plant (located in the North) left no dynamic reserve of reactive power and no margin for the dispatch of generation in the north, where most of the load is concentrated (around the capital San Juan), especially during the summer peak period. PREPA’s electrical system was seriously vulnerable to instability and voltage collapse.

Securing the operation of the electrical system
As none of the available systems had the capability to replace the lost generation capacity, PREPA’s planning division started to look at solutions to secure the operation of the electrical system during repairs (which were expected to last until early 2008). Time was short and the stakes were high - an imaginative solution was needed.

Key customer benefit
The SVC improves system voltage stability margins.

An unusual but convenient solution
Alstom Grid proposed the supply and installation of a 90 MVar SVC that would include an already available power electronics system previously constructed for another customer, modified to meet the precise requirements of the Puerto Rican utility.

The proposal also included:
• New capacitors
• Reactors
• Filters
• Control and protection systems
• Cooling system
• Circuit breakers and other high voltage equipment.

The Bayamon site, close to San Juan, was selected to derive maximum benefit from the operation of the SVC.

Stringent requirements for the Bayamon SVC
The main purpose of the SVC is to improve system voltage stability margins by regulating the voltage of the 115 kV busbar. Coordinated voltage and reactive power control as well as improvements of transient stability limits were also part of the main objectives of the SVC project. Dynamic voltage regulation is provided via control of Mechanically Switched Capacitors (MSC) and Load Tapchangers (LTC). The control system provides the online capability and flexibility to establish and modify several control parameters and operational settings such as regulation slope, reference voltage and set points, maximum and minimum steady-state reactive power outputs, dynamic reactive power reserve, etc. This is done in real time by SCADA and local control software. Bandwidth control was also required on 38 kV and 115 kV, as the distribution system bus at 38 kV - where the SVC is connected - is tied to the 115 kV bus without a dedicated transformer.

Key customer benefit
Alstom Grid managed to deliver the SVC system in a record time of six months.
Product focus

**Static VAR Compensator (SVC)**
Main SVC Components
- Thyristor valve, cooling system, controls
- TCR (90 MVar)
- 5th harmonic filter (40 MVar)
- 7th harmonic filter (50 MVar)

**Control System**
Key Components
- HPC (High Performance Controller)
- HMI (Human Machine Interface)
- VME based digital processor
- PLC (Programmable Logic Controller)

**SPECIFICATIONS**

<table>
<thead>
<tr>
<th>Type</th>
<th>TCR / FC</th>
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</thead>
<tbody>
<tr>
<td>Rated power</td>
<td>0 / + 90 MVar</td>
</tr>
<tr>
<td>Connection voltage</td>
<td>38 kV</td>
</tr>
<tr>
<td>External device control for</td>
<td>MSCs, LTCs</td>
</tr>
<tr>
<td>Cooling type</td>
<td>water</td>
</tr>
</tbody>
</table>

**KEY CUSTOMER BENEFITS**
- Modular compact design
- Direct connection to 38 kV
- Strengthens system stability for critical contingencies

**Harmonic filter reactors / Air Core Reactors (ACRs)**

**SPECIFICATIONS**

<table>
<thead>
<tr>
<th>Type</th>
<th>Air core, dry type, outdoor</th>
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</thead>
<tbody>
<tr>
<td>Design</td>
<td>Single phase coils, aluminium</td>
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<tr>
<td>Ratings for 5th harmonic filter reactor</td>
<td>4.34 mH, 1.64 ohms, 608 A, 699 A-max, 11.21 kA/0.5s</td>
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<tr>
<td>Ratings for 7th harmonic filter reactor</td>
<td>1.63 mH, 0.62 ohms, 791 A, 900 A-max, 21.19 kA/0.5s</td>
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<tr>
<td>Connection voltage</td>
<td>38 kV</td>
</tr>
</tbody>
</table>

**KEY CUSTOMER BENEFITS**
- Space-saving, maintenance free design
- High mechanical strength to withstand elevated short-circuit forces
- Low noise levels

**Dead-tank circuit breakers**

**SPECIFICATIONS**

<table>
<thead>
<tr>
<th>Type</th>
<th>DT1-72.5 F1, SF6, outdoor</th>
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</thead>
<tbody>
<tr>
<td>Rated max voltage</td>
<td>72.5 kV</td>
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<tr>
<td>Duty cycle</td>
<td>0-0.3s-CO-15s-CO</td>
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<tr>
<td>Connection voltage</td>
<td>38 kV</td>
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<tr>
<td>Rated frequency</td>
<td>60 Hz</td>
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<tr>
<td>Rated interrupting time</td>
<td>30 cycles</td>
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<td>Rated short circuit current</td>
<td>40 kA</td>
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<tr>
<td>Rated current</td>
<td>2000 A</td>
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<tr>
<td>Capacitive current switching</td>
<td>630 A</td>
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</tbody>
</table>

**KEY CUSTOMER BENEFITS**
- Proven solution with advanced thermal-assisted interrupters
- C2 class for capacitor switching with very low re-strike probability
- Trouble free lifetime operation with near zero maintenance
Alstom Grid’s scope of supply

Tailored to the utility’s operational needs, the Bayamon SVC has various modes of operation: steady-state voltage regulator mode, fixed MVar mode, reduced dynamic range mode, relaxation mode, and so on. The control system was designed in such a way that SVC operation can be changed from one mode to another without shutting down the SVC and without changing its existing output. It also ensures that the system does not go into instability at the time of mode change.

“"The only alternative available to deal with the voltage instability was the dynamic reactive power source provided by a Static VAR Controller (SVC)"

Samit Shah, Engineering Manager
Alstom Grid

Achievements & customer benefits

In service in a record time
The biggest challenge for the SVC system at Bayamon was the delivery and in-service date. As PREPA was in critical need of reactive power support to its system, the SVC solution had to be commissioned in six months. Thanks to its ingenious approach, Alstom Grid was able to deliver the equipment in a record time of six months, and at a reasonable cost. The SVC system was commissioned in November 2007 and has been successfully in service since then.

“"The problem here, however, was the time needed to design, construct, install and commission the SVC, normally about 16-18 months from project start to energisation and commercial operation. We managed to finish this project in 6 months."

16-18 months
is the time normally needed for this kind of project.

It took only 6 months for Alstom Grid to deliver the equipment