Since introducing turbocharger upgrades for land-based medium-speed engines in 2013, ABB Turbocharging has undertaken a series of turbocharger upgrades on Wärtsilä medium-speed engines powering generator sets in electrical power generation plants.

One of the most logistically demanding upgrades was undertaken recently by engine builder Wärtsilä and ABB Turbocharging in Portugal, and involved upgrading eight TPL 77 turbochargers on the engines at the Caldeirão Thermal Power Plant. The plant is located on São Miguel, one of the islands in the Azores group, Portuguese territories in the Atlantic, some 1,800 kilometers to the west of the Portuguese mainland.

Customer and plant
The Caldeirão plant is run by EDA Electricidade dos Açores S.A. (EDA) which is responsible for the supply of electrical power to the public grid in São Miguel Island.

“We supply about 45 percent of the electrical power produced in the Azores, with the balance coming from renewable sources, namely geothermal, wind and hydroelectric,” notes Alberto Borges, the Operations Coordinator for the power plants on São Miguel Island and Manager of the Caldeirão Thermal Power Plant.

The upgrade involved service engineers from ABB Turbocharging changing the cartridges on two turbochargers per engine on four generator sets powered by 18 cylinder, Wärtsilä type 18V46 engines, each rated 17 MW.

Increasing efficiency
An upgrade entails fitting turbochargers installed as original equipment on diesel and heavy fuel engines with the latest versions of key components, developed to give increased turbocharging efficiency, longer maintenance intervals and improved charge air delivery.

The benefits to the operator include reductions in engine fuel consumption, higher engine power density and increased operating safety margins for the turbocharger and engine.

Upgrading and scheduled maintenance
Since most of the performance-critical components exchanged during a turbocharger upgrade – like the turbine and compressor wheel – are those that would, in any case, be renewed during a major overhaul, executing an upgrade as part of scheduled maintenance is an extremely cost-effective route to improved engine economy, longevity and performance.

“As the rotating components of the turbochargers on our engines at the Caldeirão Thermal Power Plant had already exceeded their designated operating life of 50,000 hours, it was possible to take advantage of an imminent major overhaul to incorporate their replacement with upgraded components into forecast expenditure,” Borges observes.
Reducing fuel consumption

Reducing specific fuel consumption at the plant was the overriding motivation for the upgrade, Borges confirms. “Fuel costs had been on the rise in recent years, due both to the price of oil and the type of operation expected of the plant, which serves as back-up to the sources of renewable energy that had been introduced into the electricity supply grid.”

The project achieved the targeted reduction in specific fuel consumption, while complying with applicable emissions standards. Borges: “Overall, the turbocharger upgrade was instrumental in a decrease in specific fuel consumption on the Wärtsilä engines of approx two percent per engine. In a situation where fuel represents about 90 percent of the total direct costs of the plant, in six months, this has already translated into a reduction of about € 160,000.”

In addition, staff at the Caldeirão Thermal Power Plant also recorded a decrease in the temperature of the exhaust gases which has a positive effect on thermal stress on engine components.

Working with ABB

EDA confirms good cooperation with the ABB Turbocharging upgrade team, with only four days downtime per gen-set.

“The work was extremely well planned and executed, with daily project meetings that allowed EDA to adequately accompany and follow all stages of the work,” Borges states. “The planning aspect was critical, due to the location of the Azores, in mid-Atlantic. Close collaboration between the ABB Turbocharging and EDA teams allowed the project to be completed entirely according to schedule.”

The commissioning of the engines with upgraded turbochargers and the measurement of key engine parameters to determine the new engine operating conditions was carried out together with Wärtsilä. The measurements confirmed the computer simulations of the benefits of the turbocharger upgrade.

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### Measurements summary: Engine measurements showed actual performance slightly better than simulations

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Unit</th>
<th>TPL 77-A30TA14</th>
<th>TPL 77-A32TA14</th>
<th>TPL 77-A32TA12</th>
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</thead>
<tbody>
<tr>
<td>Fuel consumption (100% load)</td>
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<td>Speed margin (%)</td>
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<td>Turbocharger inlet temperature [°C]</td>
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<tr>
<td>Firing pressure average [bar]</td>
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<td>180</td>
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<tr>
<td>Highest cylinder pressure (A1) [bar]</td>
<td>179</td>
<td>182</td>
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