TNB Janamanjung Sdn Bhd, a subsidiary of Malaysia’s state-controlled power generation, transmission and distribution company Tenaga Nasional Bhd (TNB) has awarded the turnkey engineering, procurement and construction (EPC) contract for the Manjung 4, 1000 MW, ultra-supercritical, coal-fired steam power plant to Alstom, project leader and its consortium partner, China National Machinery Import and Export Corporation.

The contract follows TNB’s 1999 contract with Alstom to build the 3x700 MW Manjung coal-fired power plant that went into operation in 2004. These units also utilise Alstom’s clean coal combustion technology and market leading environmental control systems.

The new power plant will be constructed next to the existing power plant, at Perak, 10 km south of the nearest town Lumut, approximately 288 km north of Kuala Lumpur. It will be the first coal-fired power plant in Malaysia utilising ultra-supercritical technology and the single largest unit in South East Asia.

**Customer:** Tenaga Nasional Berhard Janamanjung  
**Scope of supply:** Engineering, Procurement and Construction (EPC) consisting of 1x1000 MWe USC two-pass boiler, 1x1000 MWe STF100 steam turbine and 1 two-pole GIGATOP turbogenerator  
**Electrical output:** 1000 MW (net)  
**Commercial operation:** Scheduled for 2015

### PROJECT FEATURES

The Manjung 4 Project benefits from the superior integration resulting from Alstom’s project management skills, EPC capabilities, and state-of-the-art key components:

- Two-pass, ultra-supercritical, once-through PC boiler (tangential firing, low NOx combustion system)
- STF100 steam turbine with one high-pressure, one intermediate-pressure and three double-flow low-pressure turbines for high efficiency and reliability
- Two-pole GIGATOP turbogenerator with the most advanced water hydrogen-cooling technology for generators, providing high efficiency, outstanding reliability and simple maintenance
- Alstom’s latest ALSPA® Series 6 Distributed Control System
- Environmental control systems including seawater flue-gas desulphurisation (SWFGD) and pulse-jet fabric filter (FF) to reduce flue gas emissions.
Manjung 4: State-of-the-art boiler for ultra-supercritical power plant

Alstom’s market-leading ultra-supercritical technology at Manjung will provide additional capacity to meet the increasing demand in one of the world’s fastest growing economies, producing enough electricity to supply power to nearly 2 million Malaysian households.

The outstanding feature of the Manjung 4 power plant will be its ultra-supercritical boiler, the first of its type to be built in Southeast Asia, and an important development for improving overall energy efficiency in the region.

The key to greater efficiency in a steam power plant is more advanced steam conditions. The higher the temperature and pressure at which the steam is produced by the boiler, the greater the potential efficiency of thermal to electricity conversion in the steam turbine / generator portion of the plant.

The unit will provide TNB customers with clean, reliable and economical electricity from Indonesian, Australian and South African coal resources.

With the quality of the available coal decreasing as the best coal reserves are exhausted, modern, high-capacity steam plants must now be able to cope with a wider range of coals than has traditionally been the case.

With these limitations in mind, the new plant at Manjung 4 is being specified with a net plant electrical output of 1000 MW and an efficiency nearly five percentage points higher than the existing three subcritical units at Manjung.

An increase of five percentage points is an extremely significant advance. It will result in a reduction in operating costs because each tonne of coal burned at Manjung 4 will generate close to 14 per cent more power than in the existing subcritical Manjung power plant.

Furthermore, emissions will improve with nitrogen oxides (NOx), sulphur dioxide (SO2), carbon dioxide (CO2) and particulates all lower.

And since a supercritical plant costs only slightly more to build than an ultra-supercritical plant of a similar size, the unit cost will be competitive as well.
**Two-Pass Boiler:** High efficiency with low emissions and highly reliable operation

The Manjung 4 boiler is a vertical wall, two-fireball, two-pass design equipped with Alstom’s unique TF 2000® firing system that will burn bitumous & sub-bitumous coals.

The boiler’s high pressure, high temperature, advanced steam cycle significantly increases plant efficiency, thus also minimising emissions and fuel costs.

**MANJUNG 4 SPECIFICS**
- The boiler features a main steam flow of 3226 tonnes/hour (t/h) at 282 barg and 600°C, categorising it as an ultra-supercritical boiler.
- The vertical tube design incorporates rifled tubing and stress reduction features for the furnace wall, allowing sliding pressure operation for more flexibility during daily load swings, lower maintenance and improved availability.
- The combustion system composed of a main windbox and a separate overfire air windbox allows the adjustment of fuel and air conditions to suit different types of coal, maximising combustion efficiency while maintaining low emissions.

### Technical Specifications

<table>
<thead>
<tr>
<th>Technical Data of Steam Generator</th>
<th>Guarantee</th>
<th>Mode of Operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main steam flow</td>
<td>3226 metric tons/hr</td>
<td>7111 M Lb/hr</td>
</tr>
<tr>
<td>Superheater outlet steam pressure</td>
<td>282 barg</td>
<td>4090 psig</td>
</tr>
<tr>
<td>Superheat/reheat steam temperature</td>
<td>600 °C / 605 °C</td>
<td>1112 °F / 1121 °F</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Fuel (as received)</th>
<th>Design</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gross calorific value (kcal/kg) (Btu/lb)</td>
<td>5200</td>
<td>9360</td>
</tr>
<tr>
<td>Moisture content (%wt)</td>
<td>22.1%</td>
<td>8% – 30%</td>
</tr>
<tr>
<td>Ash content (%wt)</td>
<td>1.6%</td>
<td>1.5% – 13.9%</td>
</tr>
<tr>
<td>Sulphur (%wt)</td>
<td>0.47%</td>
<td>0.1% – 0.94%</td>
</tr>
<tr>
<td>Volatile matter (%wt)</td>
<td>35%</td>
<td>22% – 45%</td>
</tr>
<tr>
<td>Fixed carbon (%wt)</td>
<td>41%</td>
<td>35% – 58.1%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Flue Gas Emission Levels at Stack</th>
<th>MG/NM3 = 6%O2</th>
<th>LB/MMBTU</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sulfur dioxide (SO2)</td>
<td>500</td>
<td>0.41</td>
</tr>
<tr>
<td>Nitrogen oxides (NOx)</td>
<td>500</td>
<td>0.41</td>
</tr>
<tr>
<td>Carbon monoxide (CO)</td>
<td>200</td>
<td>0.16</td>
</tr>
</tbody>
</table>

**Design Features**

**Tangential Firing System**
- Excellent fuel/air mixing:
  - Wider tolerance to fuel fluctuations
- Low NOx emissions at high combustion efficiency:
  - Advanced burner design and fuel/air staging
  - Efficient use of furnace volume
- Low slagging tendency:
  - Reduced cleaning requirements
  - Maximum sustained efficiency

**Tilting Burners**
- Ability to control reheat temperature over a wide load range
- No spray attemperation for reheat temperature control:
  - Higher efficiency
  - Avoidance of backpass
- Highest cycle efficiency over widest load range

**Grinding and Firing Plant**
- 8 gravimetric raw coal feeders
- 8 HP 1023 pulverisers with dynamic classifiers
Case Study: Steam

Boiler: Unmatched experience in steam generation and fuel combustion technologies

Today, our advanced, high-efficiency, pulverised-coal ultra-supercritical boilers offer plant owners many benefits.

The technology’s higher steam temperature and pressure parameters provide the most economical solution to improving plant efficiency and operating flexibility, achieving fuel cost savings, and reducing emissions for each kWh of electricity generated.

Alstom’s ultra-supercritical boiler designs are at the heart of today’s state-of-the-art plants, meeting the diverse requirements of projects all over the globe and firing the full range of international coals.

Alstom designs and supplies utility-scale boilers that combust an extensive range of fossil fuels for steam power generation.

<table>
<thead>
<tr>
<th>ALSTOM BOILER EXPERIENCE</th>
<th>FUEL CAPABILITIES</th>
<th>APPLICATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Largest installed base, with approximately 30% of boilers installed and under construction worldwide using Alstom technology, totalling 835 GW</td>
<td>• Coals (anthracite, bituminous, sub-bituminous, lignite)</td>
<td>• Utility and independent power production</td>
</tr>
<tr>
<td>Alstom has been providing utility boilers since the 1920s</td>
<td>• Co-firing of coal waste, sludge and industrial waste, oil refining waste and biomass</td>
<td>• Combined heat and power production</td>
</tr>
<tr>
<td>World leader in the development of materials and standards</td>
<td>• Oil (crude, heavy residual)</td>
<td>• Industrial</td>
</tr>
<tr>
<td>Worldwide manufacturing experience</td>
<td>• Gases (natural gas, others)</td>
<td></td>
</tr>
</tbody>
</table>