Session: Modernisation
How can existing assets be optimised?

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Tractebel Energia

For more information:  www.hydropower.org/congress
Modernization

Salto Santiago HPP

1,420 MW (4 x 355 MW)

José Carlos Cauduro Minuzzo
Production Director

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Salto Santiago HPP – Modernization

- **Tractebel Energia S.A. - Overview**
  - **Acquired in 1998**, in a privatization process, with 3,719 MW installed
  - **8,748 MW** of capacity in operation (2015) - **27 plants** (hydro, gas, coal, wind, biomass and photovoltaic), **84% in renewable energy**.
  - **Very high operational standards** with 100% of its HPPs certified under ISO 9001, 14001 and 18001
  - **400 industrial clients** from all sectors
  - **1,145** employees
  - **Part of ISE - Índice de Sustentabilidade Empresarial do BOVESPA** (stock market)
  - **Market Value of BRL 24 Billion** in 10/05/2015
  - **Projects under construction / expansion**: Jirau HPP (3,750 MW), Santa Monica WPP (97.2 MW), Ferrari Biomass TPP (65.5 MW + 15 MW)
  - **Successful projects in the A-5 auction of Nov/14**: Pampa coal-fired TPP (340 MW), Campo Largo WPP (330 MW), Ferrari Biomass TPP (15 MW)
  - **Several greenfield projects under development**: HPPs, gas-to-power TPPs, WPPs
Salto Santiago Hydroelectric Power Plant

- **Installed Capacity** = 1,420 MW - 4 x 355 MW (after 1997)
- **Project Installed Capacity** = 1,332 MW - 4 x 333 MW
- **Assured Energy** = 723 MW
- **Reservoir Area** = 208 km²
- **Turbine Type** - Francis
- **Start of Operation** = U#1 - 1980/ U#2 - 81/ U#3 and U#4 - 82 (35 years)
- **Operation Hours:** ~ 250,000h

- **Forced Outage Rate – FOR (increasing from 2007 to 2014)**
  - 2007 – FOR = 0.5%
  - 2014 – FOR = 3.8%
Salto Santiago HPP – Previous Conditions

➢ Turbine: Francis: Lack of rigidity of the turbine head cover and supporting cone; Breakage of a turbine head cover bolt during a disassembly (2011)

➢ Speed Governor and Voltage Regulator: Old technology, end of lifetime of electronic components and obsolete oil system, low reliability.

➢ Water Intake and Spillway

➢ Generator: 19 kV – 120 rpm – 60 poles
  - Generalized corona incidence along the operation lifetime. Intermittent and successive repairs
  - Ripples (*ondulações*) and difficulties in magnetic core torque stabilization
  - Radial deformations of the stator as function of radial non-uniformity in the expansion of its bases, while operating
  - Increase of maintenance cost: time, materials, personal;
  - Limitation of Unit 1 (active power) from 355 MW to 300 MW since April, 2011.
Modernization

Decision by Modernization (April, 2011)
- Due to the end of the lifetime, mainly of the generators, Tractebel Energia has decided by a refurbishment of the generating units
- At this time there was identified an opportunity for a modernization

Expected Benefits of a Modernization
- Return equipment to original condition and improve performance (reliability, availability, security and integrity)
- Increase of the reliability and efficiency
- Revenue growth - New turbine’s rotor (increase in assured energy - new technology and design changes)
- Efficiency improvement
- Reduction/restore of maintenance cost (equipment better condition, new materials - less maintenance)
- To guarantee power plant performance indexes according to standards established by electrical sector agencies
- Extending operational lifecycle of equipment and power plant
Salto Santiago HPP – Modernization Plan

- **Technical Specification – Concluded in December/2011**
  - **Generator:** Stator winding, magnetic core and instrumentation replacement; Rotor poles reinsulating; Replacement of bearing and generator coolers.
  - **Turbine:** New turbine’s rotor; Replacement and project improvements in turbine head cover; Repositioning the bearing coolers to outside of the bearing housing; Improve the strengthening of the supporting cone with ribbing (nervuras).
  - **Speed governor:** Replacement of modules, panels, proportional valves and over speed device; Supply of distributing valve, piping and instrumentation for the pressurized oil system.
  - **Voltage regulator:** Replacement of VR, excitation and transformers.
  - **DCS – Digital Control System:** Relay system to digital system.
  - **Electrical auxiliary systems:** Replacement of the electric motors control center and direct current panels.
  - **Mechanical auxiliary systems**
  - **Water Intake and Spillway:** Servomotors and hydraulic central; Refurbishment of water gates and fixed parts.

**Objective – increase the generating unit efficiency from 90.0% to 93.6% with the gain of 24.2 MW avg**
Choosing Company Responsible for Modernization

- **For choosing the company was taken into account:** Technical aspects; Risks involved; Commercial aspects (price)

- **The contract should take into account:** Technical Specifications; Guarantees; Bonus; Fines; Health & Safety; Environment; Commercial and legal aspects.

- **Looking for:** Not the lowest price but the best price

- **Contracted company (December, 12/2012):** Supply of materials, equipment and manpower; Modernization implementation

- **Owner’s Engineer (May, 30/2013):** Project evaluation; Execution process monitoring; Equipment’s commission and testing

- **Own team (engineering and technical):** Management and supervision; Execution evaluation; Participation in the implementation; Learning opportunity; Knowledge keeping

- **Activities in the Factory:** start in January/2013

- **Activities in the Power Plant:**
  - **Unit 01:** March/2014 to April/2015
  - **Unit 02:** May/2015 to January/2016
  - **Unit 03:** February/2016 to October/2016
  - **Unit 04:** November/2017 to July/2017
Salto Santiago HPP – Tests of New Turbine’s Rotor

Conclusions:

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<thead>
<tr>
<th>Assured Energy - Salto Santiago HPP</th>
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<tbody>
<tr>
<td>Current Value</td>
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<td>---------------</td>
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<tr>
<td>723,0 MW</td>
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<th>Average Weighted Efficiency of the Unit</th>
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<tr>
<td>Current Value</td>
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<td>---------------</td>
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<td>90,0%</td>
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- **Testify according international standards** (April/2015)
  - Specifics Tests in the Generator and Turbine after first modernized unit.

- **Assured Energy Ratification by Regulatory Agency**
  - 3 or 4 months after the first modernized unit including the specific tests report (Expectancy).

The power gain after modernization due to the increase of the turbine efficiency confirmed the results of the model turbine test in laboratory.