

International workshop
Digitalisation in the
hydropower sector

27-28 August 2018

Salto Grande Hydroelectric Complex
Argentina • Uruguay



HPP MODERNIZATION PROJECT

Organiser



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AGENDA

1. ITAIPU BINACIONAL
2. HPP MODERNIZATION PROJECT
 - ✓ *HISTORICAL*
 - ✓ *MOTIVATION*
 - ✓ *SCOPE / OUT OF SCOPE*
 - ✓ *STRATEGIC PLANNING*
 - ✓ *BASIC DESIGN*
 - ✓ *EXECUTION PLANNING*
3. DIGITAL ARCHITECTURE
4. FINAL CONSIDERATIONS



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ITAIPU BINACIONAL

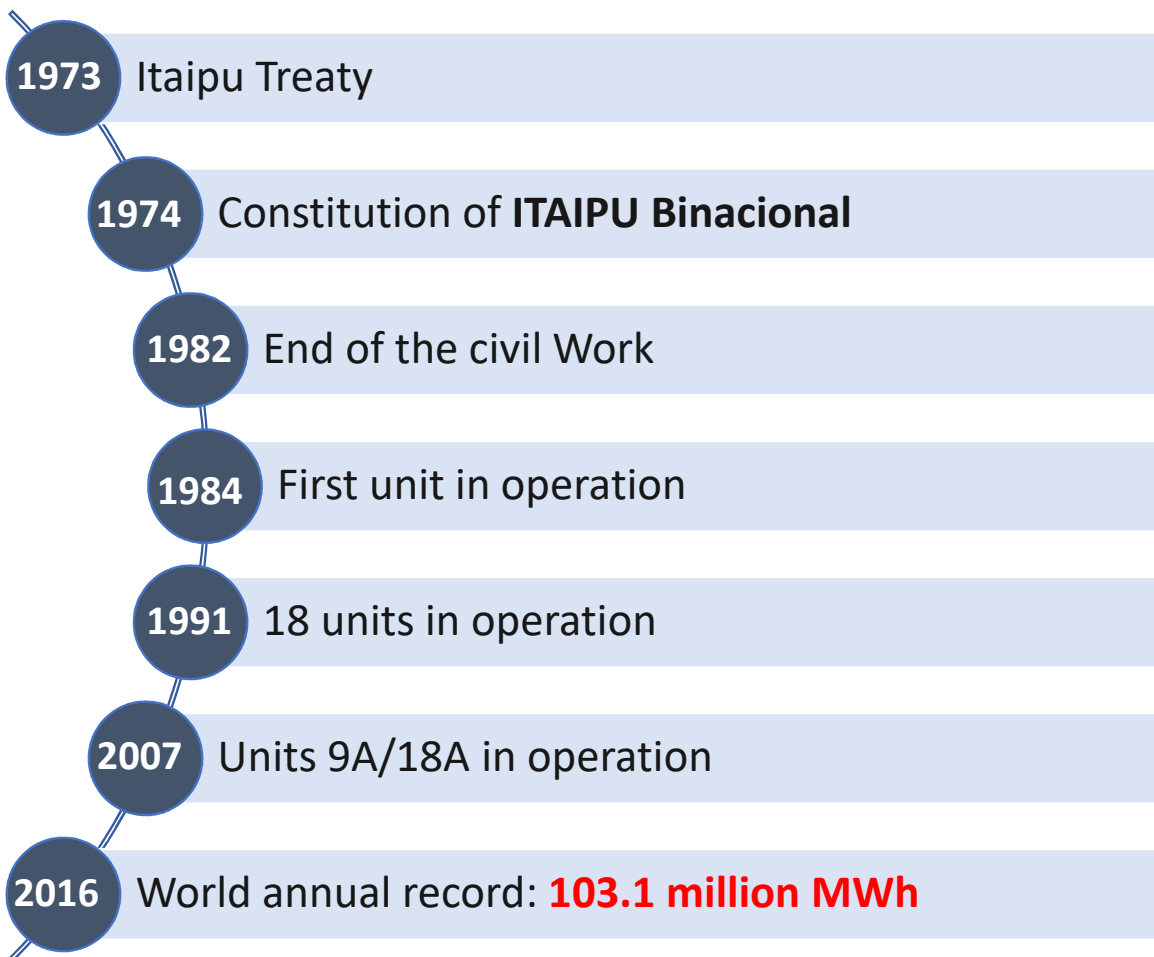


ITAIPIU BINACIONAL - GENERAL DATA

- Localization: **Paraná River**
- Regulation: **Less than monthly** (run of river);
- Installed Power: **14.000 MW**;
- Generating Units: **20** (700MW);
 - ✓ 60Hz Sector: 10;
 - ✓ 50Hz Sector: 10;
- Reservoir: **1.350 km²** (7th in Brazil);
- Production index: **10,4 MW / km²**;
- Rated head: **118,40m**.



CHRONOLOGY – MAIN EVENTS



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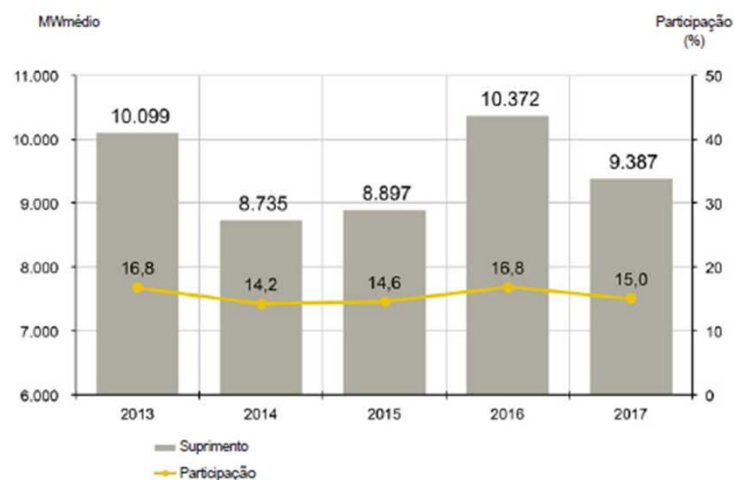


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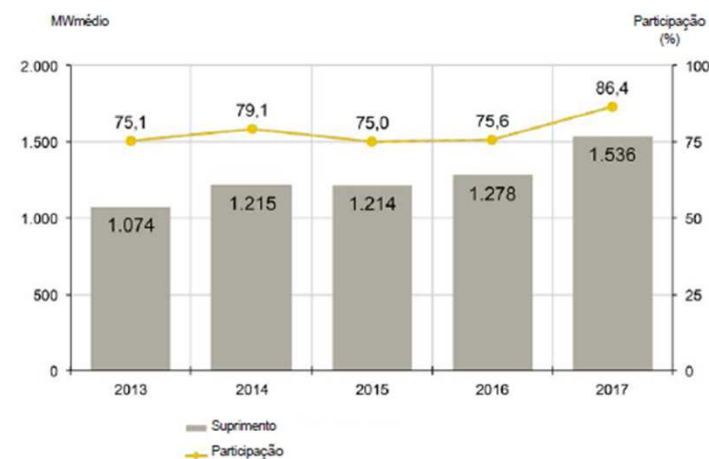


ENERGY – MARKET SHARE

BRAZILIAN MARKET - ANNUAL (MWmédio)



PARAGUAYAN MARKET - ANNUAL (MWmédio)



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HPP MODERNIZATION PROJECT

HISTORICAL

2003 - 2008

- ✓ Initial studies and discussion;
- ✓ Condition Assessment;
- ✓ Technological Modernization Plan (PAT).

**PAT
1st cycle**

2009 - 2012

Project interruption: strategic convenience

2013 - 2014

- ✓ Strategic Planning definition (stages);
- ✓ Technology investigation;
- ✓ Hydro Market review.

**PAT
2nd cycle**

2015

Bid & Hiring: Basic Design

2016 - 2017

Basic Design: Execution and Completion

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MOTIVATION

Obsolescence

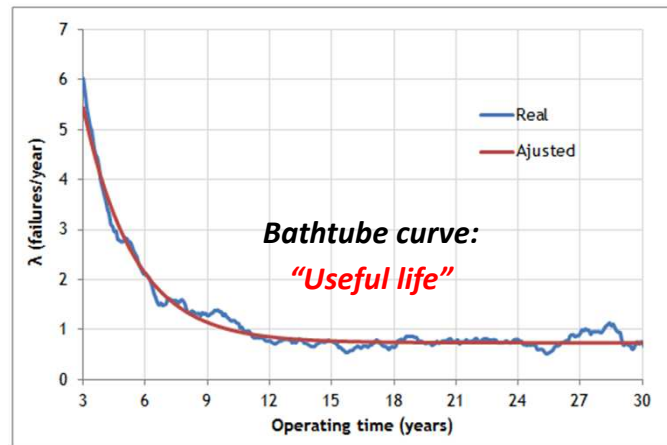
- ✓ lack of: functionality, spare parts, technical expertise

End of Life

- ✓ Availability index, Low MTBF, High MTTR

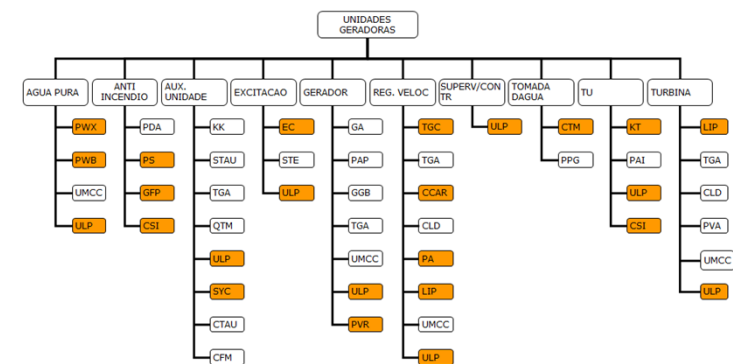
Condition Assessment

Generator Failure rate Curve



Generator Unit

Supervision, Control, Protection and Regulation Systems



OBSOLESCENCE END OF LIFE BOTH NONE

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SCOPE

Focus on: Supervision, Control, Regulation, Protection and Monitoring

Centralized Control



Generation Unit



500kV GIS



Auxiliary Systems



Spillway

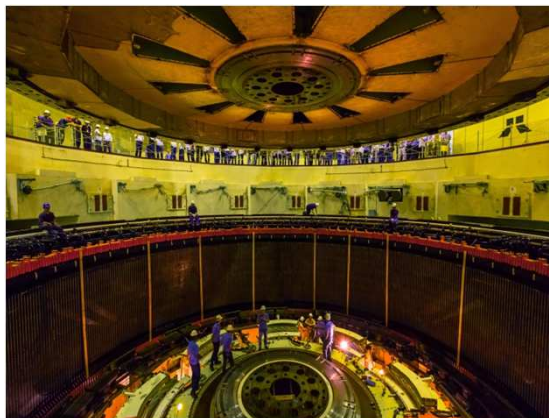


Right Margin Substation



OUT OF SCOPE

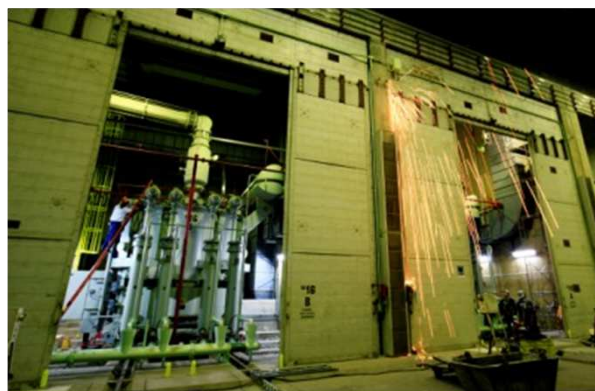
Generator



Turbine



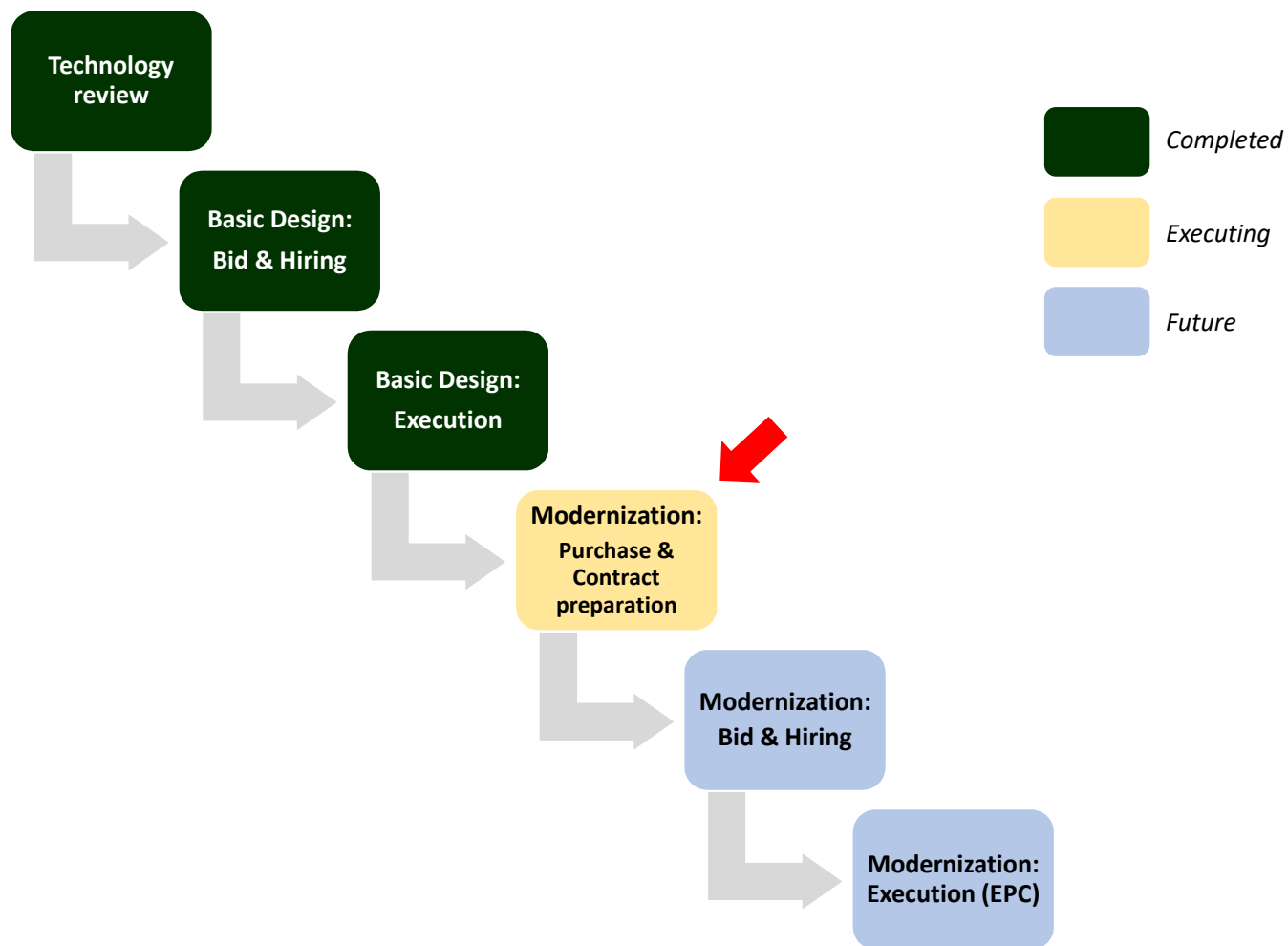
Main Transformers



GIS: High Voltage equipment



STRATEGIC PLANNING (Stages)



BASIC DESIGN

1

PRELIMINARY ANALYSIS

DATA SURVEY

FUNCTIONALITY MAPPING

EXECUTION ALTERNATIVES ANALYSIS

VIABILITY STUDY

2

STRATEGIC ANALYSIS

REFERENCIAL ARCHITECTURES

STRATEGIC STUDIES

ASSUMPTIONS ANALYSIS

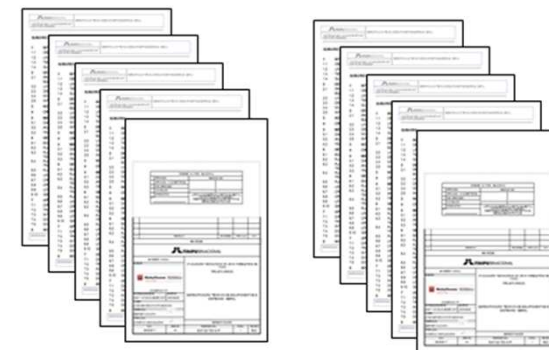
MODERNIZATION PLAN &
SCOPE DEFINITION

WORKSHOP 2016

3

TECHNICAL SPECIFICATION

SPECIFIC REQUIREMENTS



WORKSHOP 2017

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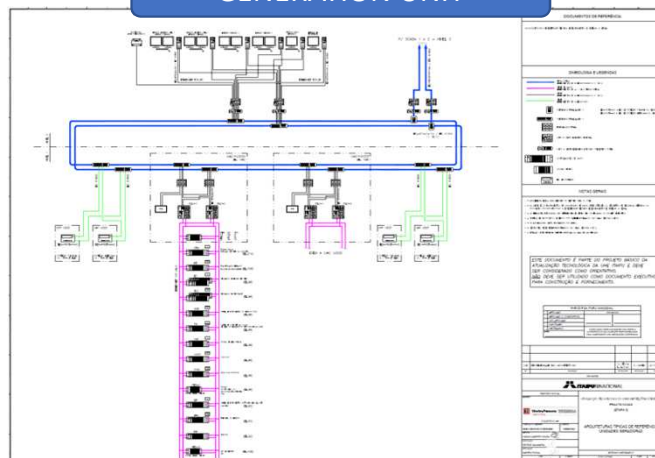


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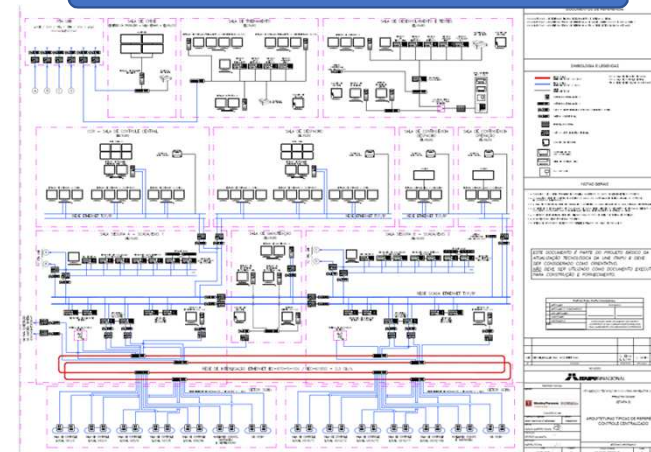


BASIC DESIGN: Referencial Architectures

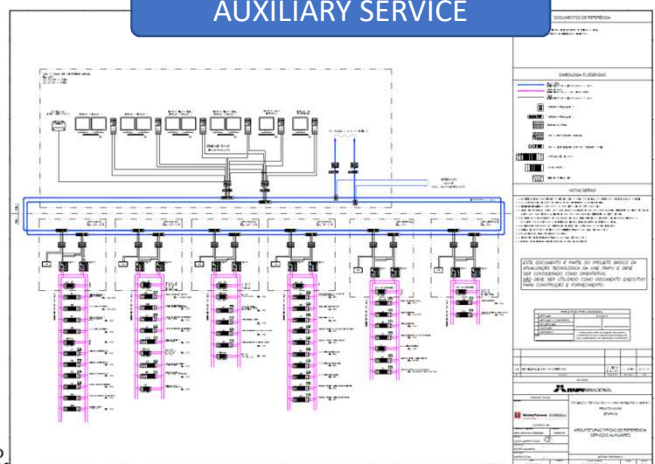
GENERATION UNIT



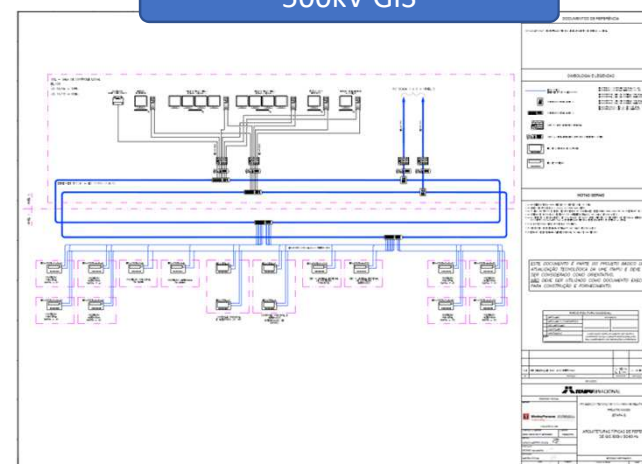
CENTRALIZED CONTROL



AUXILIARY SERVICE



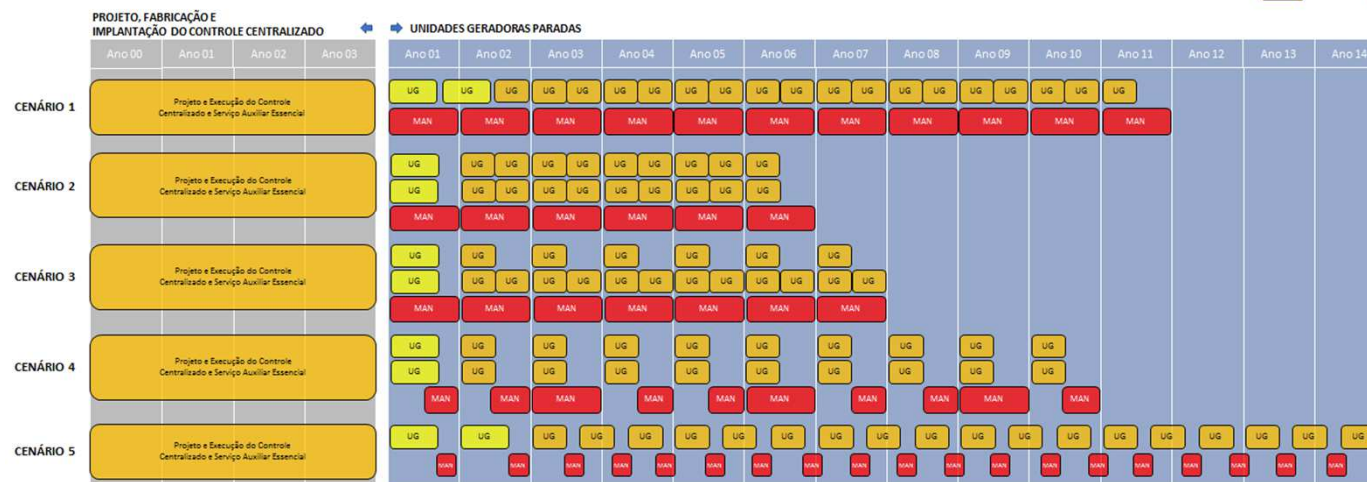
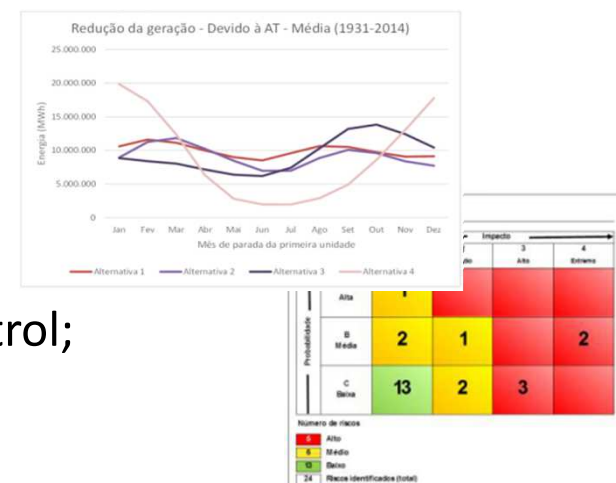
500kV GIS



EXECUTION PLANNING

Based on scenarios analysis

- First step: Modernization of the Centralized Control;
- Generation Unit: **Vertical strategy**
- Unit stop Baseline: **sequencial / 1 per time**
- Mean time per Unit: **6 months** (10 years)



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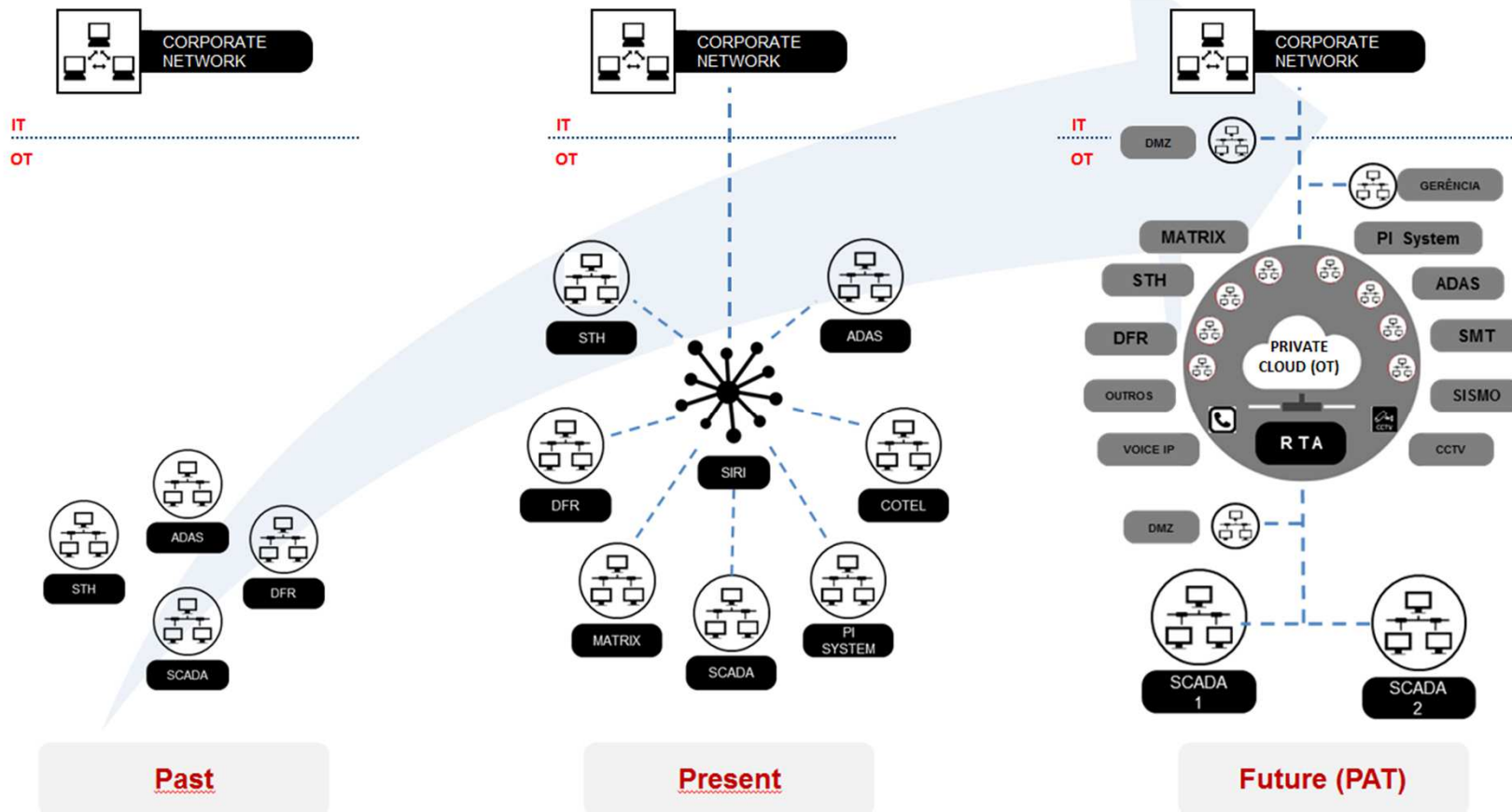


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DIGITAL ARCHITECTURE

EVOLUTION



- ✓ *Isolated systems*
- ✓ *Supervision & Control: Analog and Digital*
- ✓ *No Cyber Security*

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- ✓ *Interconnected systems*
- ✓ *Supervision & Control: Analog and Digital*
- ✓ *Low Cyber Security components*

- ✓ *Virtualization (OT Private Cloud)*
- ✓ *Supervision & Control: Digital*
- ✓ *Complete Cyber Security strategy*

SUPERVISION & CONTROL (PAT)

Centralized Control

- ✓ 2 x SCADA/EMS in a multi-site arrange;
- ✓ EMS applications: AGC, AVC, HSM, ESM, State estimator, etc.
- ✓ Production, Development and Training environments;
- ✓ Central Control Room (CCR) and Contingency Room.

Local Control

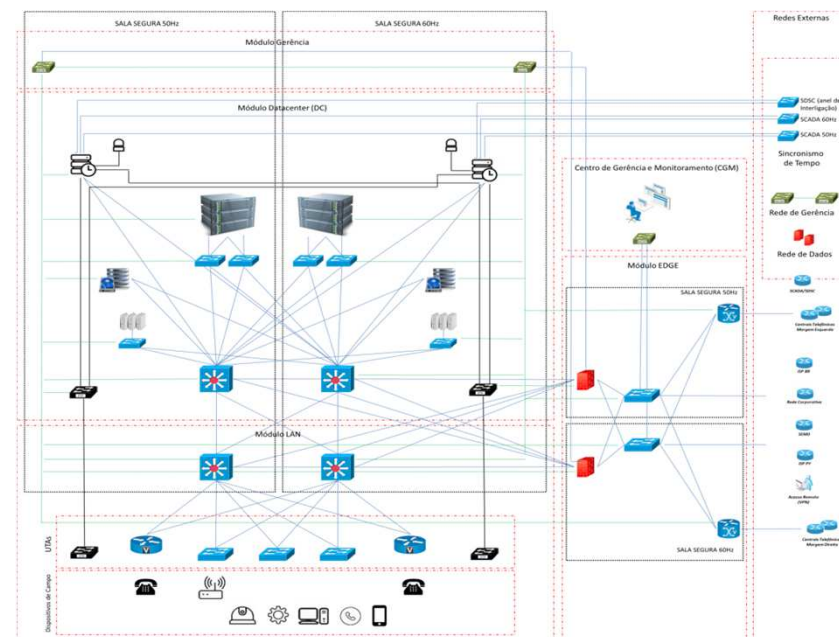
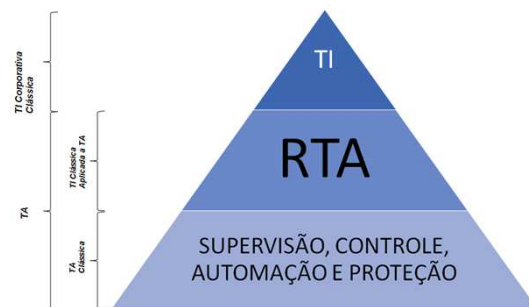
- ✓ 14 x DCS: Generation Units, SS AA and GIS;
- ✓ Dual main controller with distributed field controllers and I/Os;
- ✓ Main Functions: start / stop sequences, cooling, intake, speed governor, excitation;
- ✓ Instrumentation based on AS-i;
- ✓ Local Control Room (LCR).

Protection

- ✓ Based on IEC 61850 (IEDs)

OT NETWORK (PAT)

- Network infrastructure designed to fulfill **Operational Technology** requirements;
- Based on IT equipment and technologies;
- Services:
 - ✓ *Industrial communication;*
 - ✓ *Video monitoring;*
 - ✓ *Industrial Datacenter (OT Private Cloud);*
 - ✓ *Access network (wired / wireless);*
 - ✓ *Timesync (NTP and PTP);*
 - ✓ *Centralized Historian (PI System, OSIsoft);*
 - ✓ *External interface (IT);*
 - ✓ *Network Monitoring Center (CGM)*



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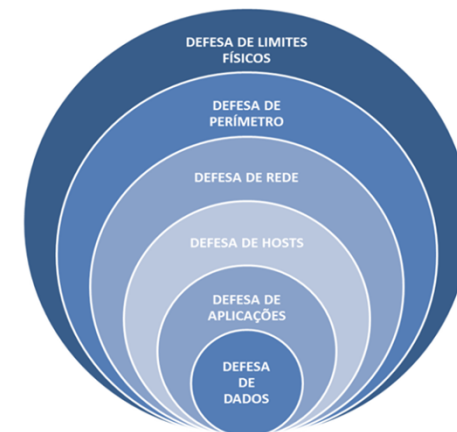
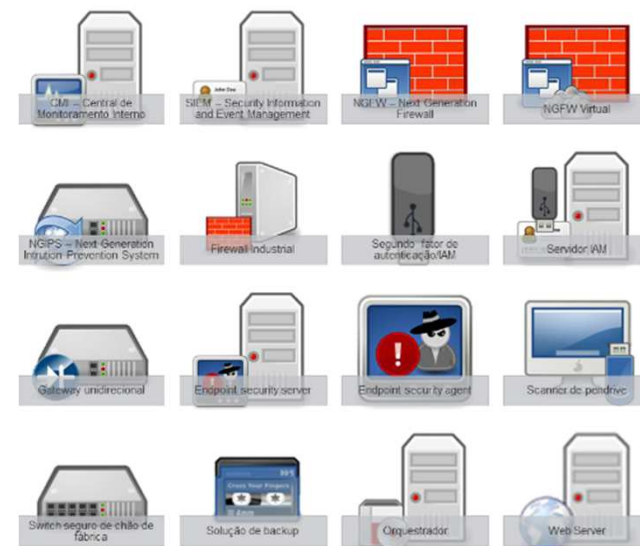
CYBER SECURITY (PAT)

- Cyber Security strategy definition: Policies and Regulation;
- Methodology according to **ANSI-ISA/99**;
- Zone and Security Level definition;
- Security control organized in six domains:
 - ✓ *Governance and monitoring*;
 - ✓ *Bord security*;
 - ✓ *Supervision and Control network protection*;
 - ✓ *Malware control*;
 - ✓ *Data security*;
 - ✓ *Training*;
- Business continuity (ISO 22301);
- Directions for Test and Acceptance procedures (ISO 15408);

METHODOLOGY



CONTROLS



SOFTWARE & TOOLS (PAT)

Operational Data Strategy

- ✓ Centralized Historian based on PI System (OSIsoft) platform;
- ✓ Data analysis and Operational intelligence tools;
- ✓ Link to Corporate Systems and other BI tools.

Engineering Software

- ✓ Unified software solution for equipment life-cycle management;
- ✓ Intelligent tools to improve the design and execution.



FINAL CONSIDERATIONS

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FINAL CONSIDERATIONS

HPP Digitalisation Challenges

1. A full digital HPP demands multidisciplinary knowledge and teams;
2. Cyber threats are real: Create a Cyber Security Strategy (People, Process and Technology)
3. The digital systems life cycle is short ➡ be prepared to plan and execute continuous upgrades stepwise;
4. Operational Data Strategy: collect, store and analyse a massive amount of data (Operational Intelligence tools);
5. There is no “on size fits all” to approach digitalisation.

FINAL CONSIDERATIONS

HPP Digitalisation Benefits

1. Keep up to date with technological evolution;
2. Broaden Visibility and insights into the HPP performance;
3. Reduce unplanned outages and downtime;
4. Improve productivity through more intelligent tools (simulation, AR, etc.);
5. Optimize O&M costs (Ex.: predictive & condition-based maintenance);
6. Extend the operational lifetime of the assets;
7. Improve HPP efficiency and reliability;

Thank you!

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