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TotalEnergies: Predictive Analytics from O&G to Renewables

Remote monitoring for equipment failure prediction

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TotalEnergies

Summary

1. The Genesis
2. An Integrated & Centralized Monitoring Center
3. Feedback & Benefits
4. What's next ….

01.

Remote Assistance Intervention & Diagnosis

The Genesis

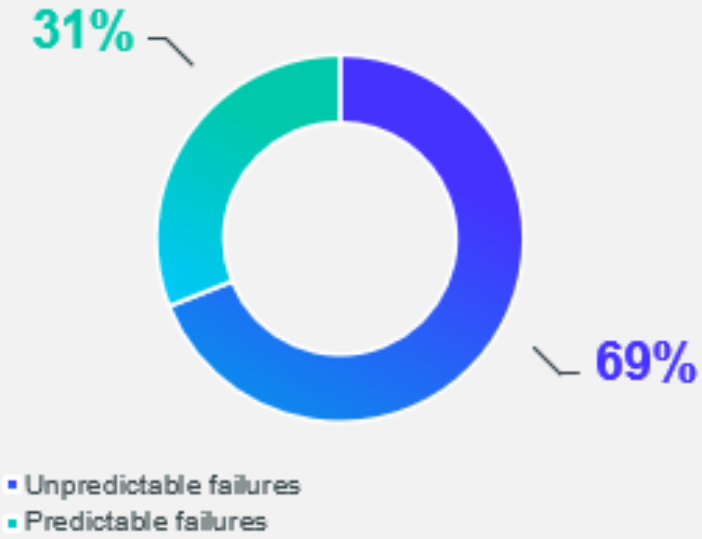
Genesis of the RAID - EP

From 2006 to 2010

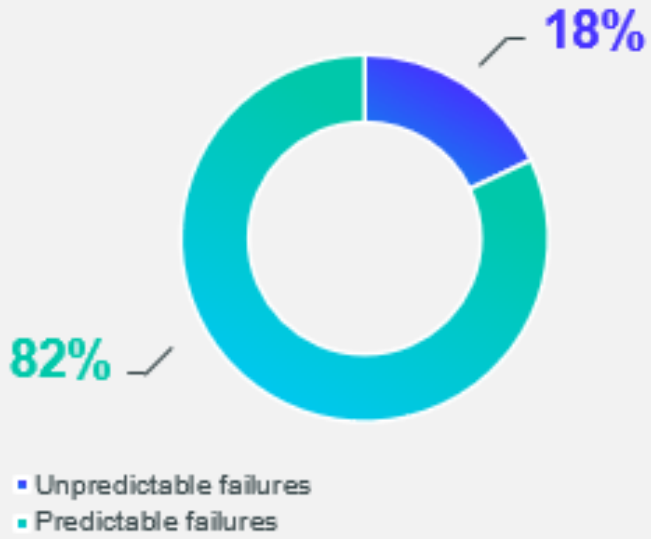
- Growing fleet – more than **4.5 GW** installed
- **Increased** number of mechanical **failures** across TotalEnergies
- E&P **2009** – **Accident offshore** with severe consequences

Analysis

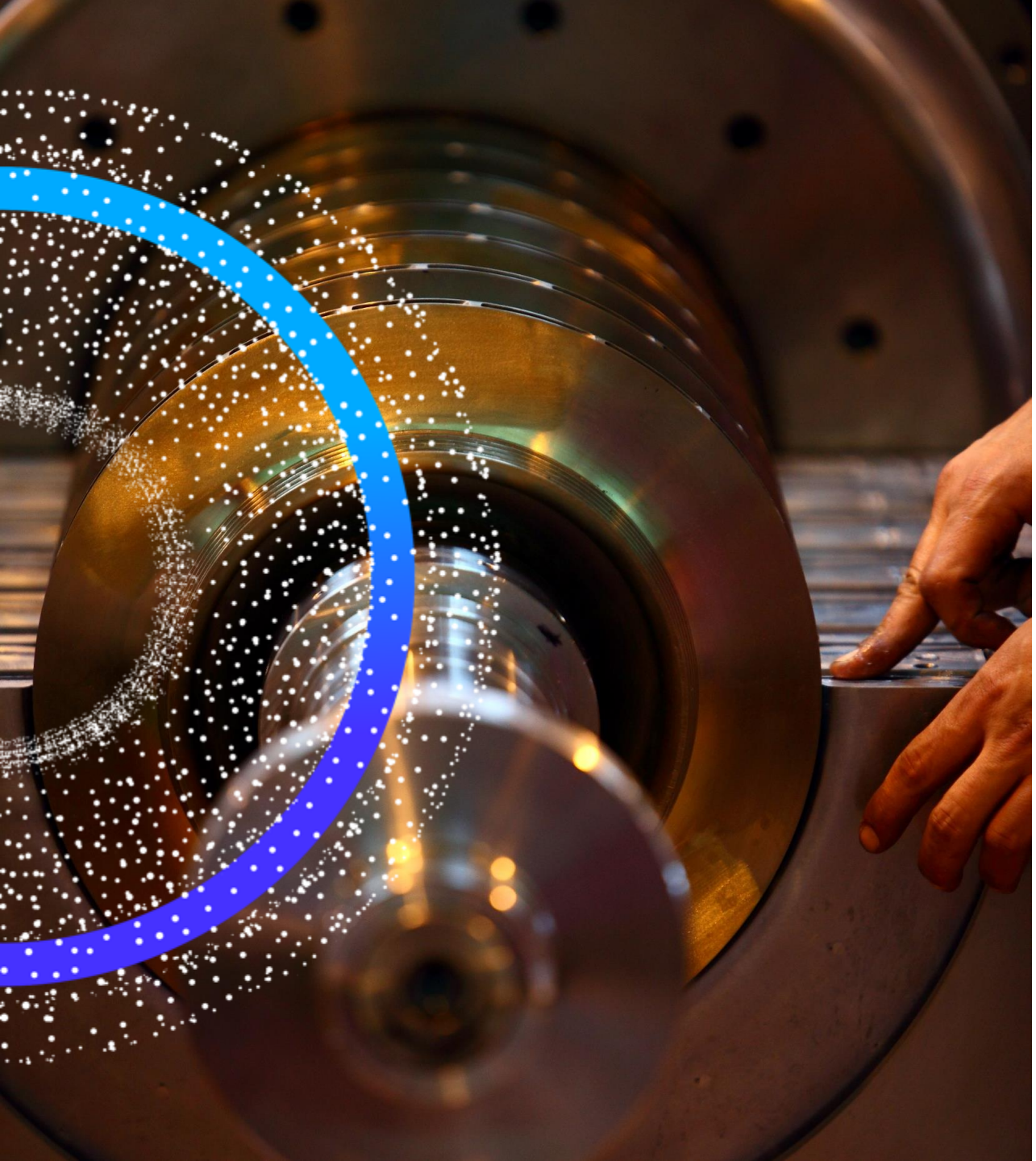
71 GT Failures



34 Centrifugal Compressors failures



Among 105 breakdowns recorded, **half of them could have been avoided** with a proper remote monitoring and **condition-based** maintenance

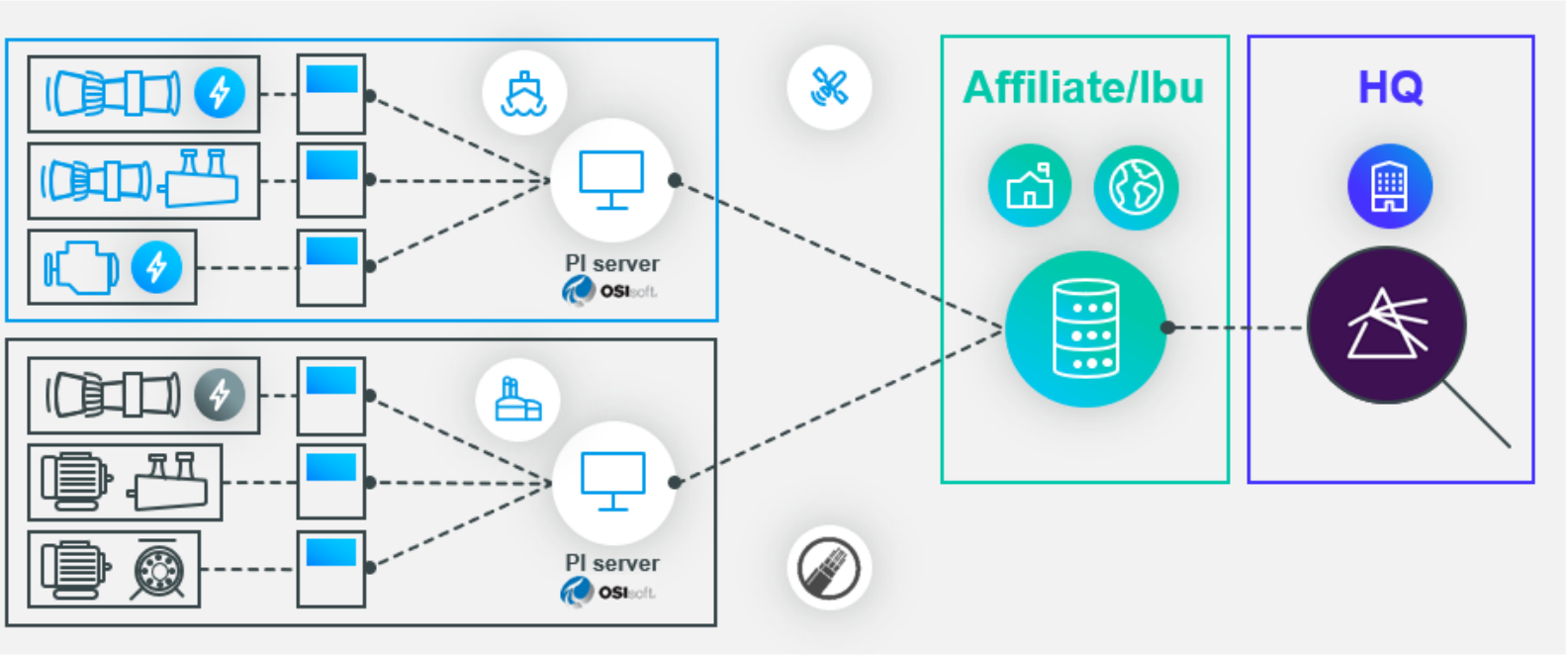


02.

Remote Assistance Intervention & Diagnosis

An Integrated and Centralized Monitoring Center

Principles



Packages Instrumentation

- Turbocompressor: **~250 sensors**
- Turbogenerator: **~200 sensors**
- Critical Moto pump: **~100 sensors**

PI Data retrieval

Datasets every 10 minutes (NOT a strict real time)

Mid term to long term support

Remote Monitoring

- Does not request **additional sensors**
- Rely on **PI data**
- **Processes PI data with softwares**

Measure | **Anticipate**

Diagnose | **Support**

- **Anticipation** of **slow** temporality **phenomena** vs. **rapid events** (High Cycle Fatigue)
- Detection **~50%**

Remote Assistance Intervention & Diagnosis Towards Operation Excellence

Use of Predictive Analytics suite for anticipating critical machinery failures

Centralize the TotalEnergies' Monitoring In House

- Analyze the **entire process** around each machine
- **Correlate similar issues** and experience through our extended fleet
- Capitalize on **Internal Competences** developed and Operational Data

Maintenance Philosophy

- Prefer **condition-based maintenance** vs. planned maintenance
- Extend **gas turbine MTBO**

Improve Operational Efficiency

RAID acts as an **Advisor** ➡ No **Interference** with daily **Operation** or **Site** Personnel

Deployment Status – TotalEnergies Operated Assets

Downstream (PRiSM)

- Deployment started **2018**
- **7** LBUs
- **172** shaft line monitored ~10 000 alerts/y
- **210** catches*/y (2022)

Electrical Combined Cycle Power Plant (PRiSM/Other)

- Deployment started **2022**
- **3** CCGT
- **19** shaft line monitored

Upstream (Other)

- Deployment started **2013**
- **10** Affiliates
- **~320** shaft line monitored
- **~36,000** alerts/y
- **429** catches*/y (2022)

*catch: alert leading to corrective action

03.

Remote Assistance Intervention & Diagnosis

Feedback and Benefits

RAID Benefits after 10 years

Prevent failures brings Direct savings…

- **Production shortfall avoided** – half a day of yearly Upstream Production in 2022
- Potential **Downtime saving** (0.07% in RC in 2020)
- Avoid catastrophic **failure** (no more predictable one since) and **plan** for **repairs**

… and valorizing the operation data, Long term savings

- **Optimize maintenance** intervals
- **Enhance asset management** vs. OEM

Foster our internal capabilities to build tools

- Online Gas Turbine **CO_2 Emission** monitoring
- **Centralized Centrifugal Compressor** Performance monitoring
- **Power Reserve** monitoring tool

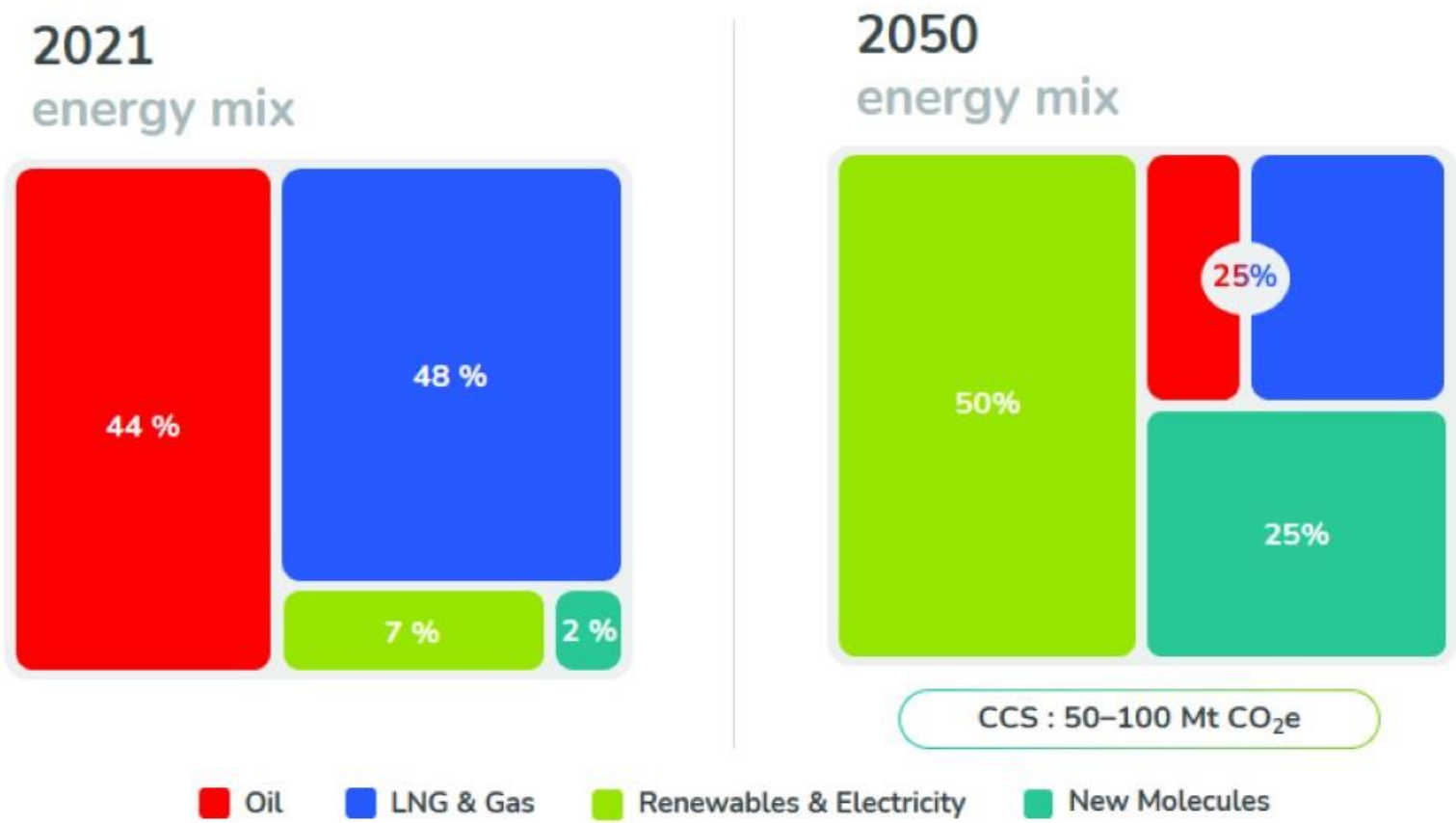
Focus on the most strategic and value-added topics

04.

Remote Assistance Intervention & Diagnosis

What's next…

Our vision for TotalEnergies in 2050



To preserve the planet in the face of the climate challenge, we are moving forward, together, towards new energies.

OIL GAS ELECTRICITY HYDROGEN BIOMASS WIND SOLAR

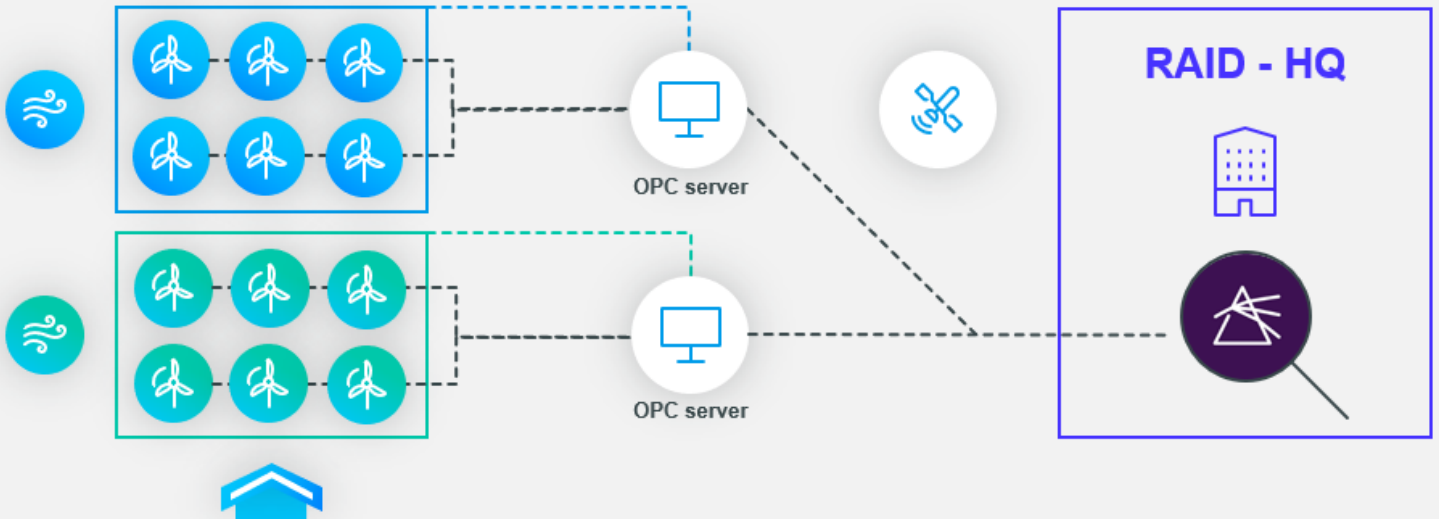
Focus on Wind – RAID Roadmap

Wind turbine monitoring

- Customized & create **templates**
- Develop **specific models**
- Develop **specific diagnostics**

Wind farm monitoring

- Customized **templates**
- Develop **specific models**
- Develop **specific diagnostics**



Application to wind energy

- Balance of **plant**
- **Farm production**
- Global turbine **availability**
- Plant **performance**
- Yield model **analysis**
- Capitalize on **data**
- Weather **History**
- Climate change **impact on yield**
- **Follow-up** contractual aspects
- **Support dialogue** with OEM
- Be part of the **world's industrial leader** in the **Renewables**

Upskilling competencies and Continuous Improvement Toward Operation excellence

Questions?

Please wait for the microphone.

State your name and company.

Please remember to…

Navigate to this session in the mobile app to complete the survey.

Thank you!

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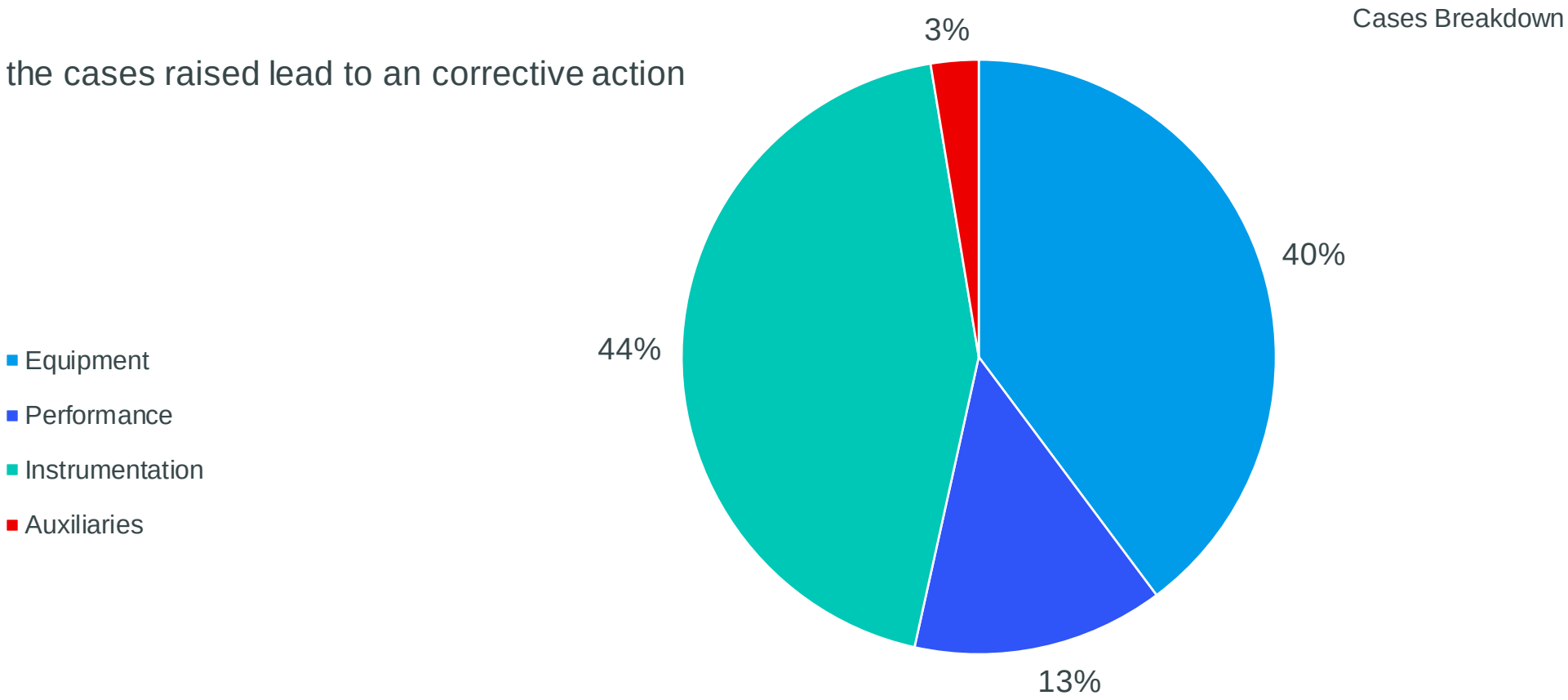
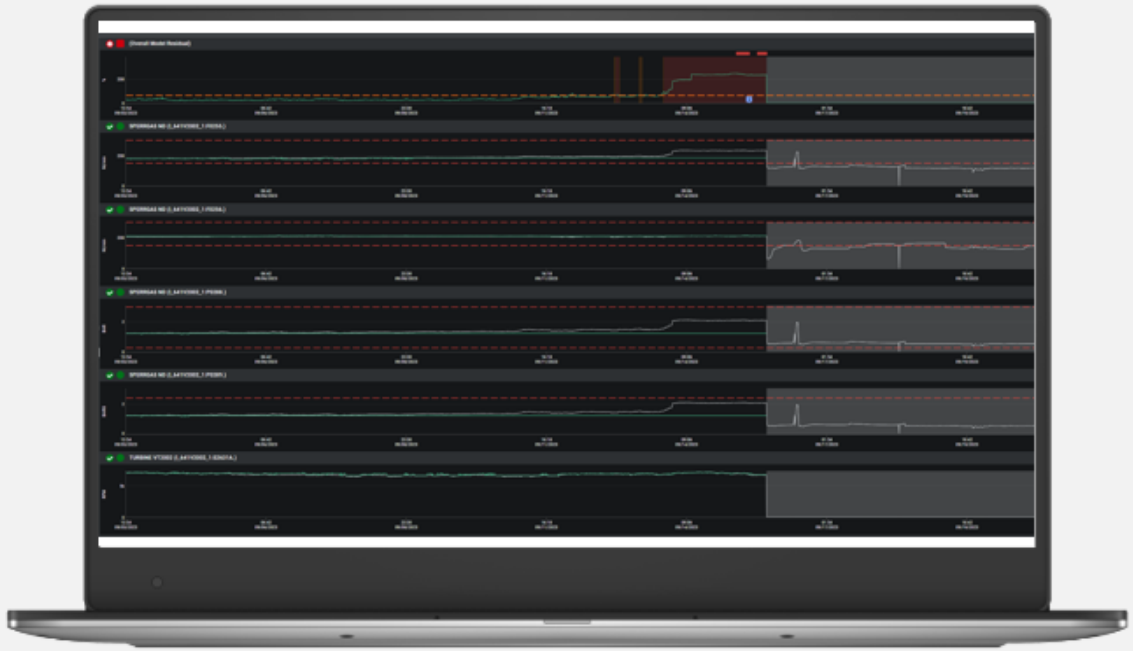
Backup

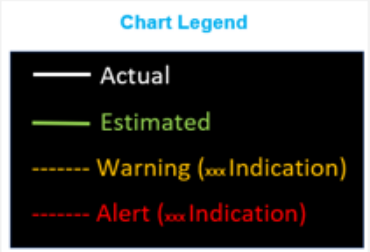
RAID
Feedback on Cases

- 2 462 Cases raised since January 2016
  - Half of the cases raised lead to an corrective action on site



PRiSM Catch Example – DGS primary seal failure





Issue

RAID operator observed pressure and flow from NDE primary seal gas **gradually increased**, which is a serious indication of **primary seal wrong behaviour**.

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Potential

Serious indication of either an **open primary seal or damaged seal.**

Solution

Recommendation to **check first sensor** and then stop the machine until the issue is ruled out with a **seal change**.

Outcome

Primary seal found leaking (**hang-up faces**) and **seal gas not 100% clean** (process related). Not detected by site team as at the time, surge tuning on going on compression train.

PRiSM Catch Example – Oil cooler efficiency loss

Chart Legend

- Actual
- Estimated
- Warning (xxx Indication)
- Alert (xxx Indication)

Issue

RAID operator observed DE & NDE bearings temperature **increase simultaneously** with lube oil temperature too.

Potential

Miscalibrated sensors or lube oil cooler **efficiency loss.**

Solution

Recommendation to **check first sensor** and then verify lube oil **cooler operation**.

Outcome

Lube oil cooler found **heavily clogged**. Swapped to spare one and then later replaced. **Avoid stop of vapo-cracker** compressor and then of complete refinery train.

PRiSM Catch Example – Vibrations increase

Issue

After start-up, DE & NDE bearings **vibrations** found **much higher**, at same load, than before shutdown.

Potential

Faulty sensors, damaged shims on coupling, misalignment, unbalance,….

Solution

First perform **instrumentation check** and if ok, perform **vibration analysis** to find root cause.

Outcome

Unbalance, due to compressor fouling.

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