Solar Turbines
A Caterpillar Company

Sustaining CHP Performance in District Energy Applications

IDEA Conference – Scottsdale, AZ

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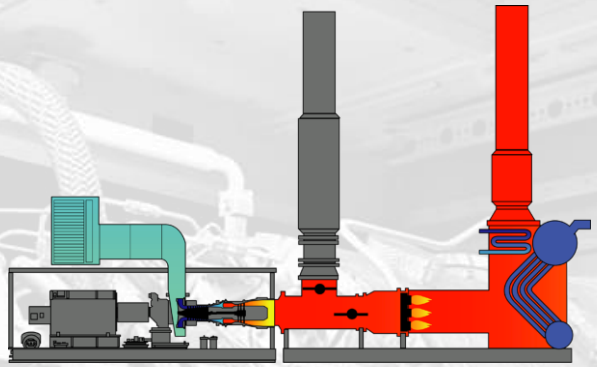
BIG DATA



Internet of Things (IoT)

CHP

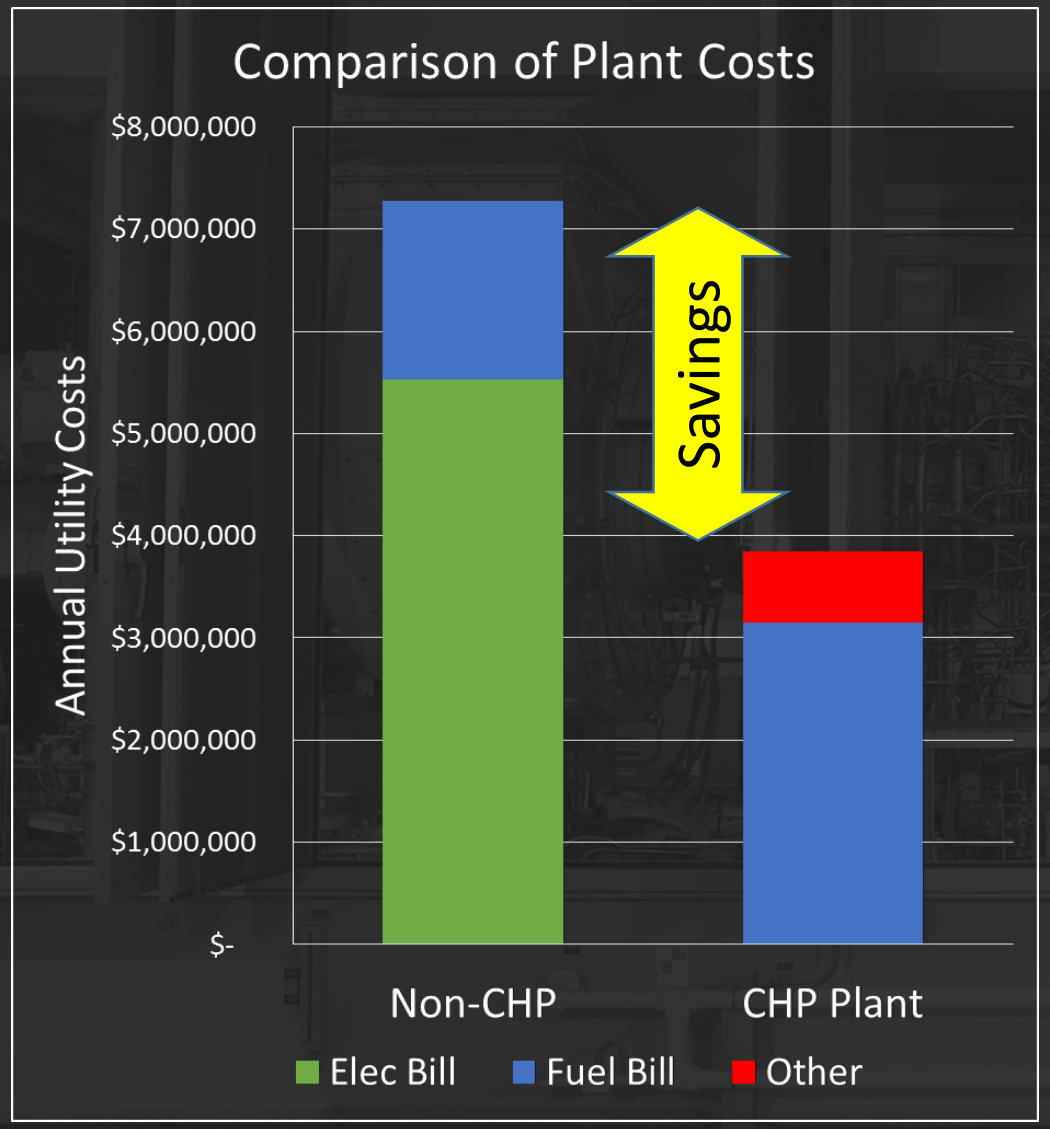
Technology is Making Our Lives More Productive and Efficient

OVERVIEW

AGENDA

1. Sustaining the Value of CHP
   - Improving Availability through Local Support and Analytics

2. Case Study on Caterpillar CHP Plants
   - Awareness and Monitoring (Internet of Things)
   - Fleet Statistics drive Action (Big Data)



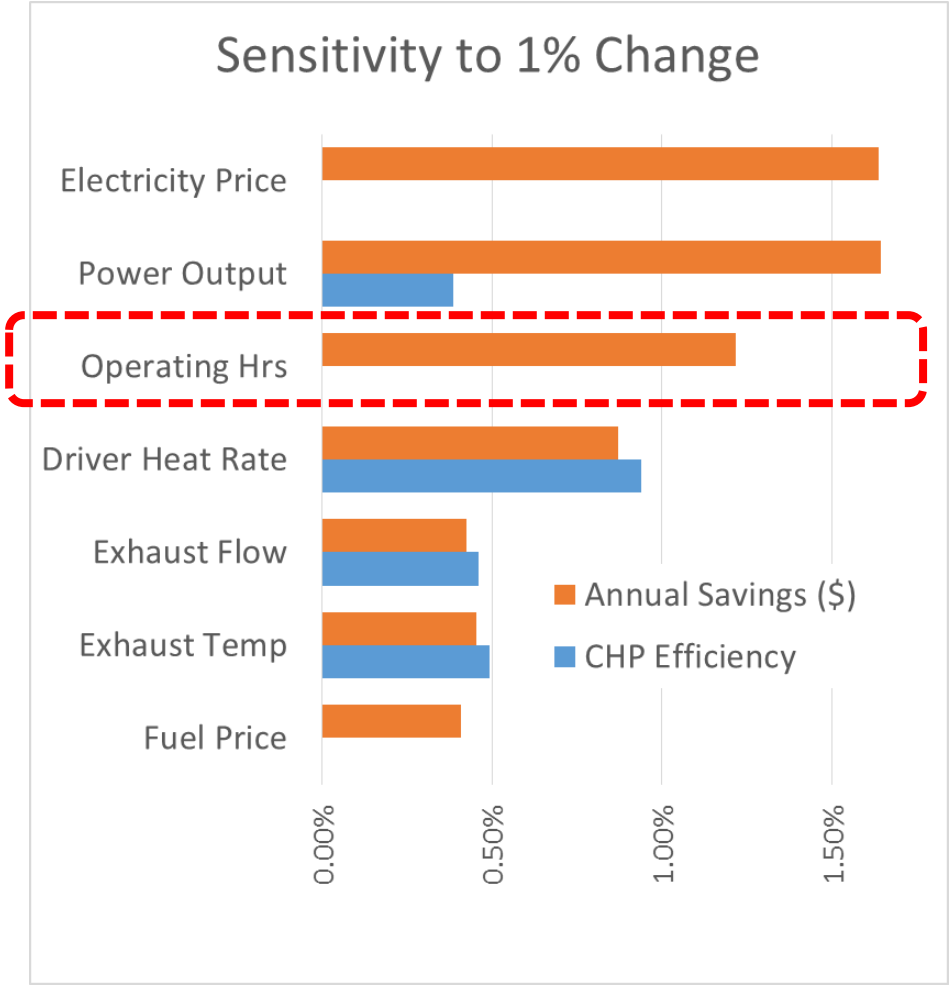
CHP ECONOMICS

- What does it cost to run a plant without CHP vs with CHP?
- Annual Savings determine the financial value of CHP

Assumes a Taurus 70 with Duct Firing to 40,000 lbm/hr of steam, $0.085/kW electricity, $4.00/MMBtu natural gas operating at full load 97% availability.

What Factors Most Affect the Savings

- Electricity price and being able to use all the electricity is key
  - 1% change in parameter delivers a 1.6% change to the annual savings
- Operating Hours has the second highest sensitivity
  - Availability and Reliability
- The highest sensitivity factors driving CHP Efficiency are not the same as the financial payback



What can be done to improve availability?

IoT and Big Data to CHP

CHP Plant

Fleet Manager

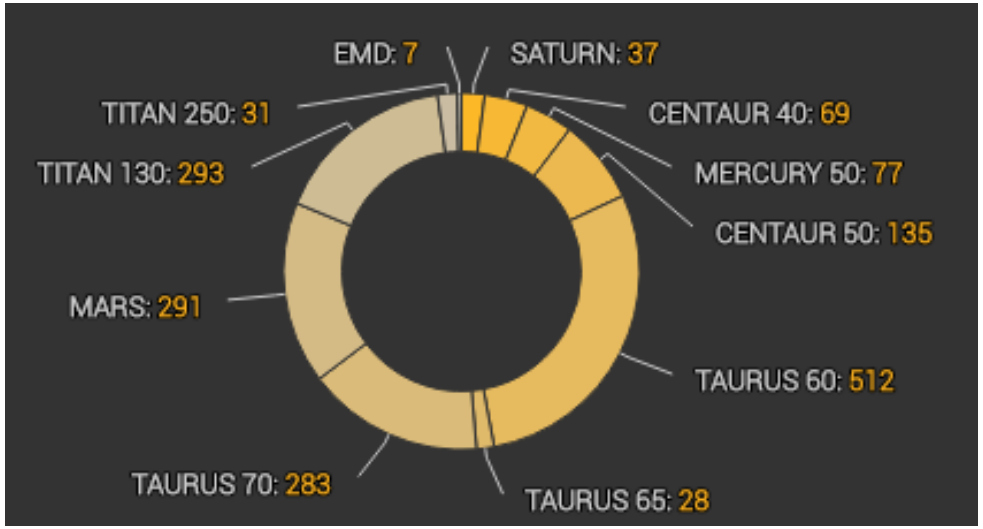
Technical Experts

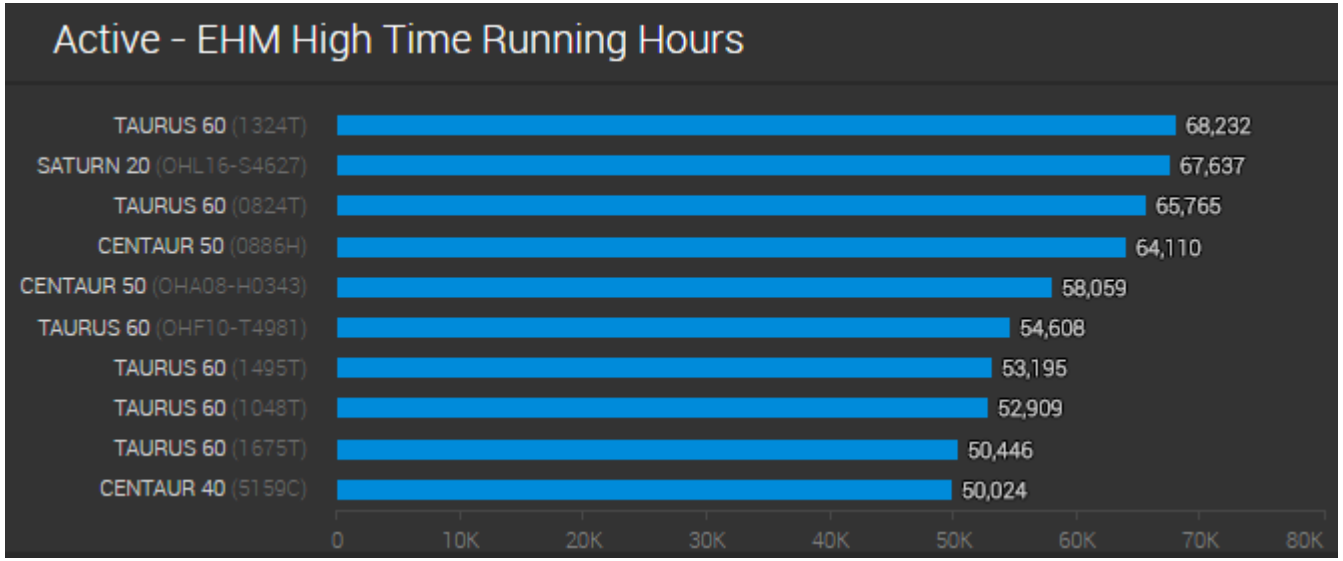
Easy Access
to Plant Data
from Anywhere

BIG DATA - Fleet Statistics

BIG DATA – Fleet Statistics

- All Solar:
  - 1750+ Units Connected
  - 900+ sites
- Generator Sets:
  - Nearly 1200 Units Connected
  - 650+ sites
- Power Gen Units:
  - Nearly 800 units Connected
  - 550+ sites





Case Study - Caterpillar

- Aurora, Illinois
  - Manufactures Articulating Wheel Loaders
  - 2x Taurus70 - 7.5MW units
  - Fleet Manager: Gary Stuenkel

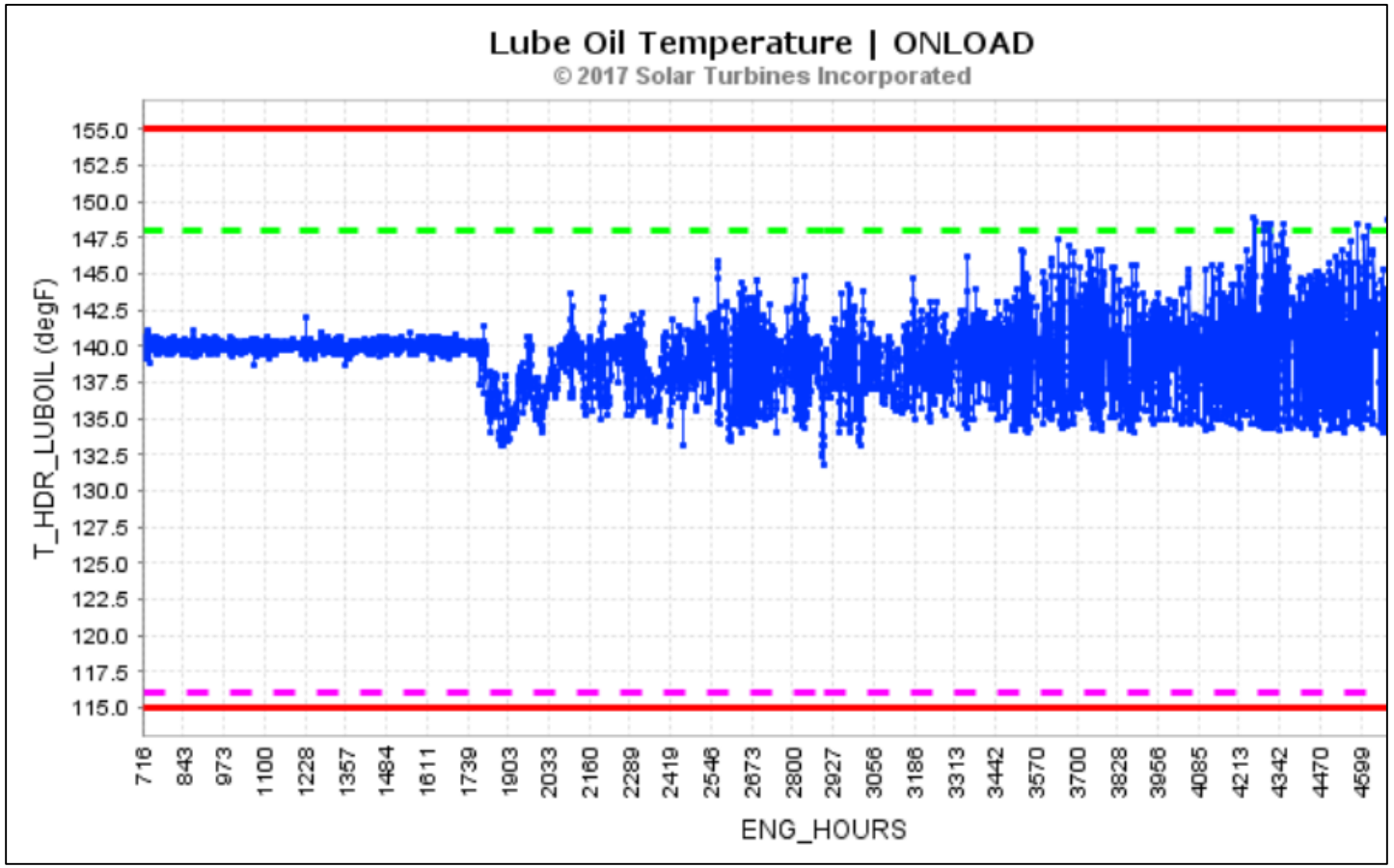
- Mossville, Illinois
  - Manufactured Engines
  - 3x Titan130 – 14.2MW units
  - Fleet Manager: Shane Kowalewski

- Two recent examples
  - Lube Oil Temperature
  - #3 Bearing Vibes

Lube Oil Temperature

- Symptom: Lube Oil Temperature oscillating
- Action #1: Discover if this Normal

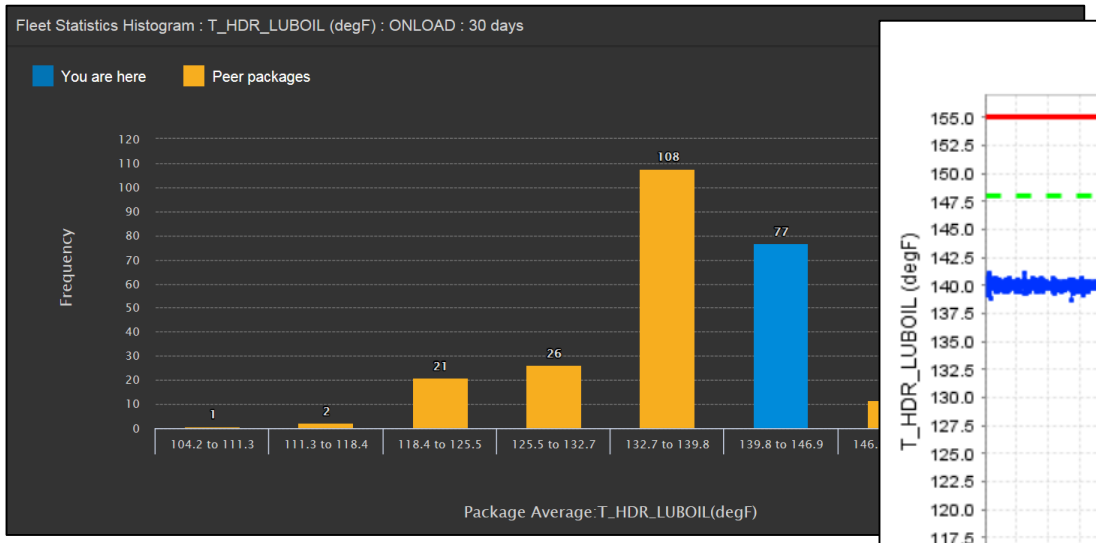
- Awareness and Monitoring

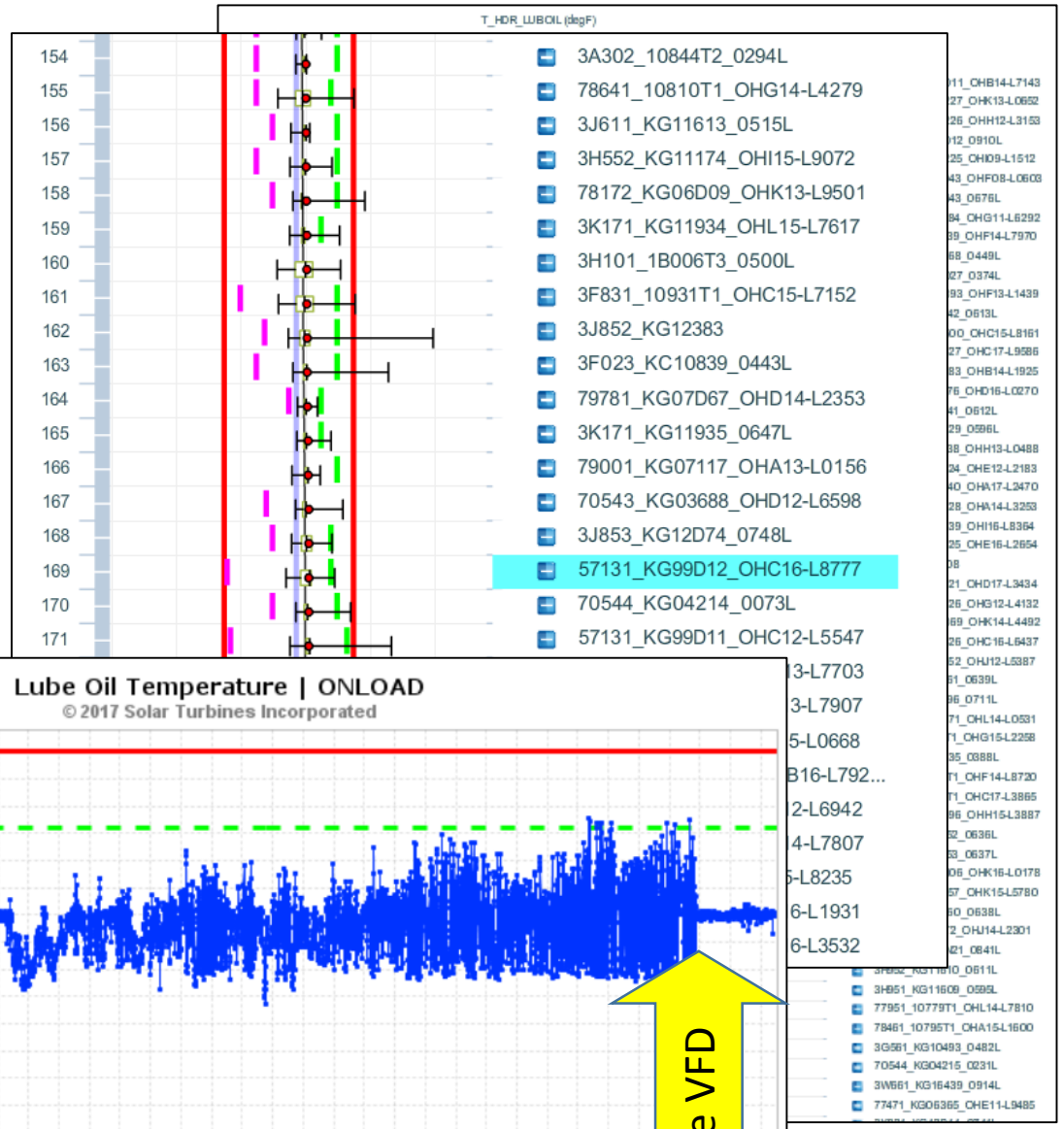


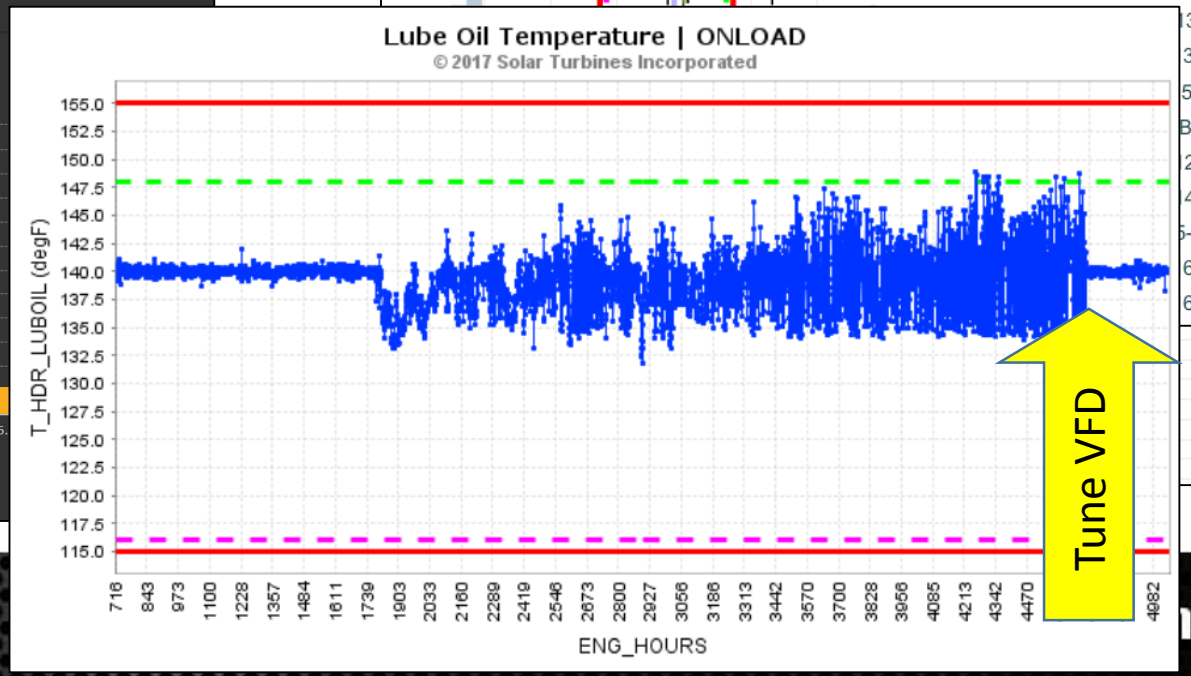
Lube Oil Temperature Do we have a problem?

- Fleet Manager quickly compared to over 250 units being monitored

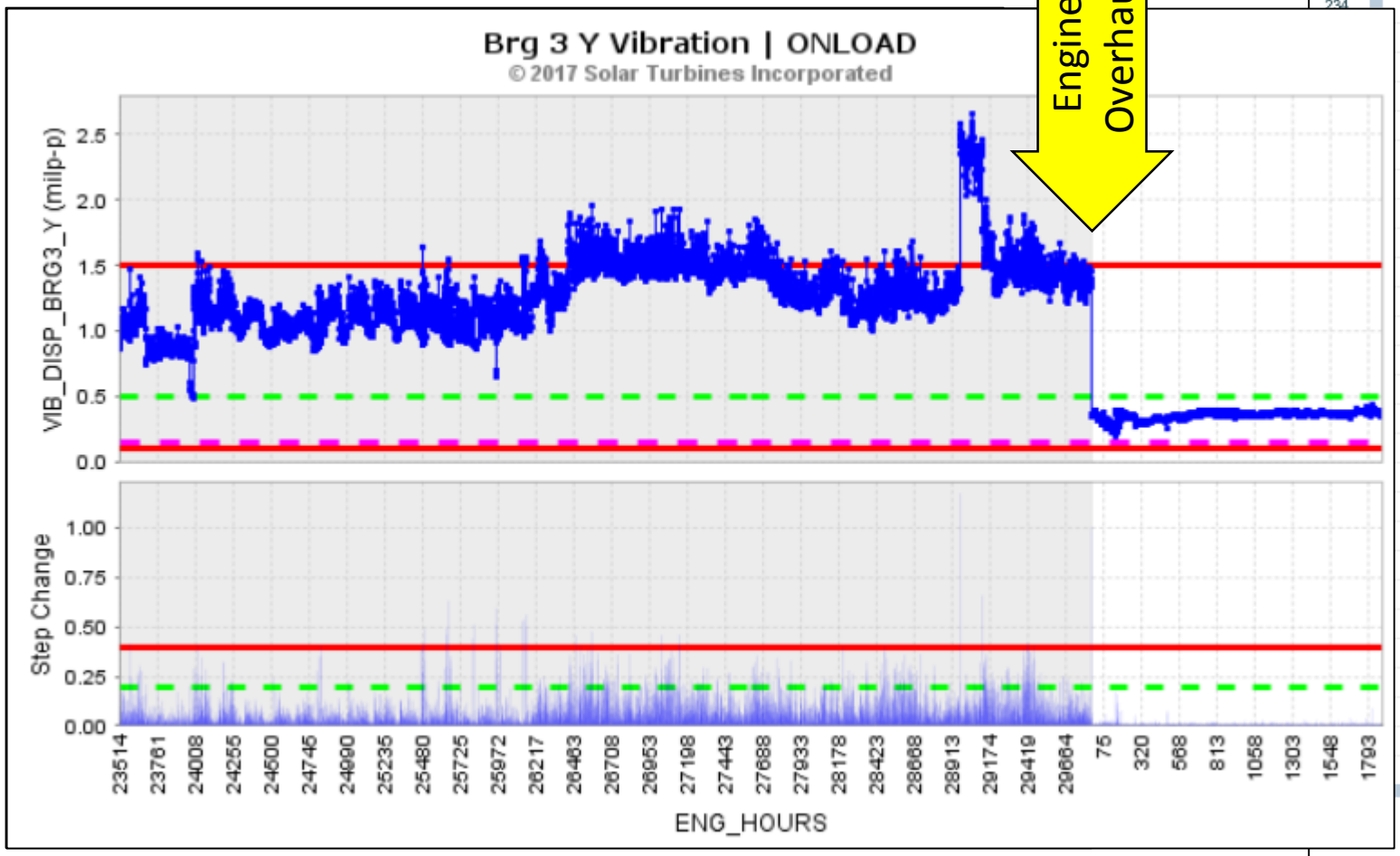
Accessible in InSight

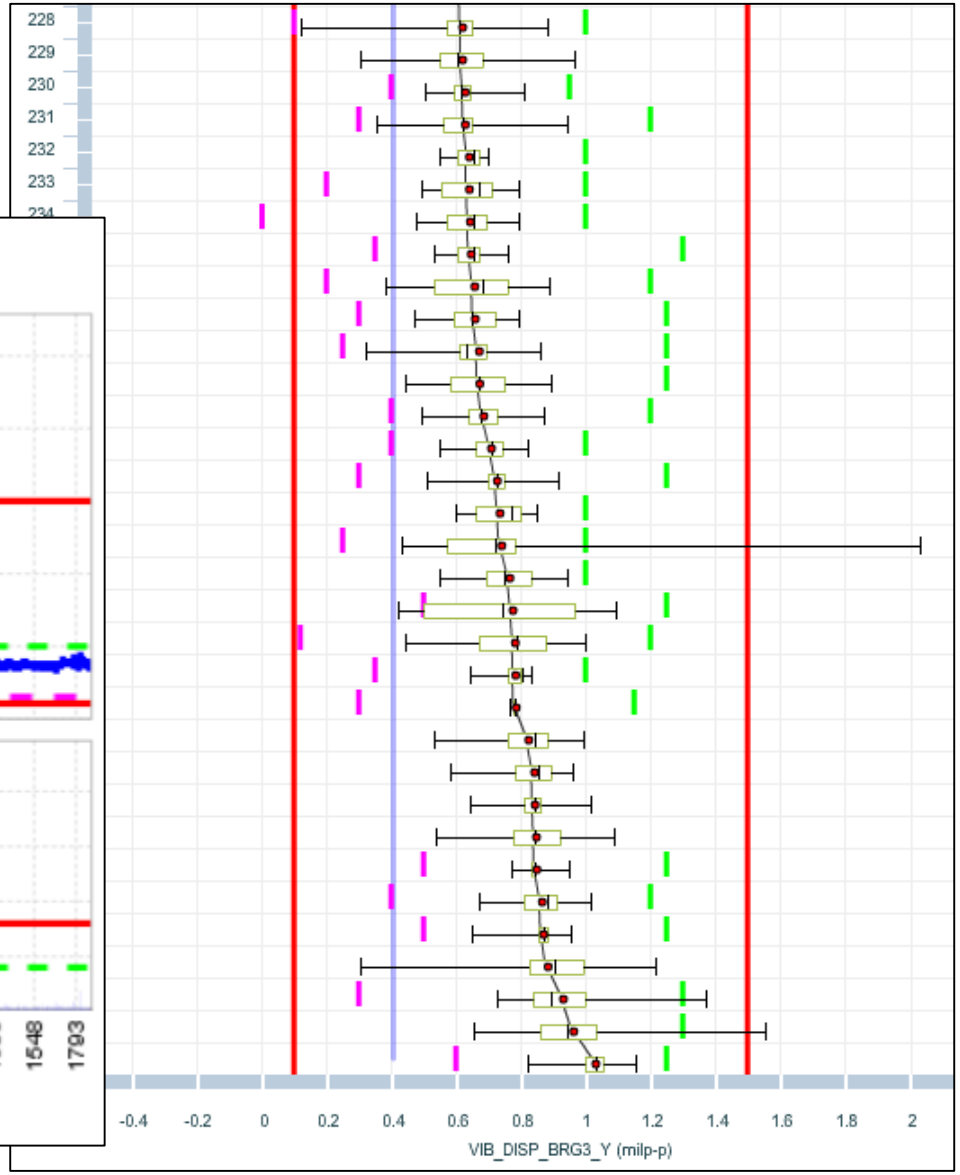






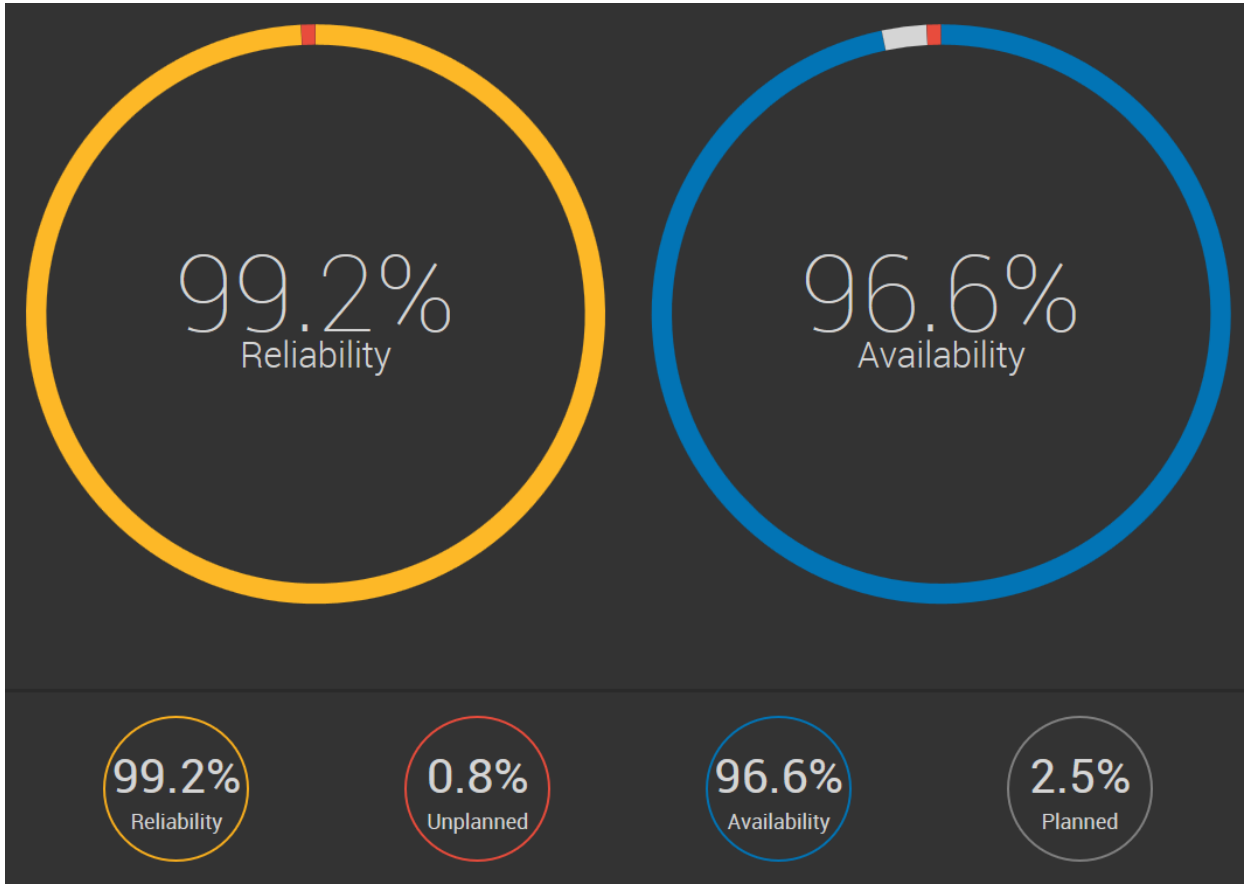
#3 Bearing Vibration

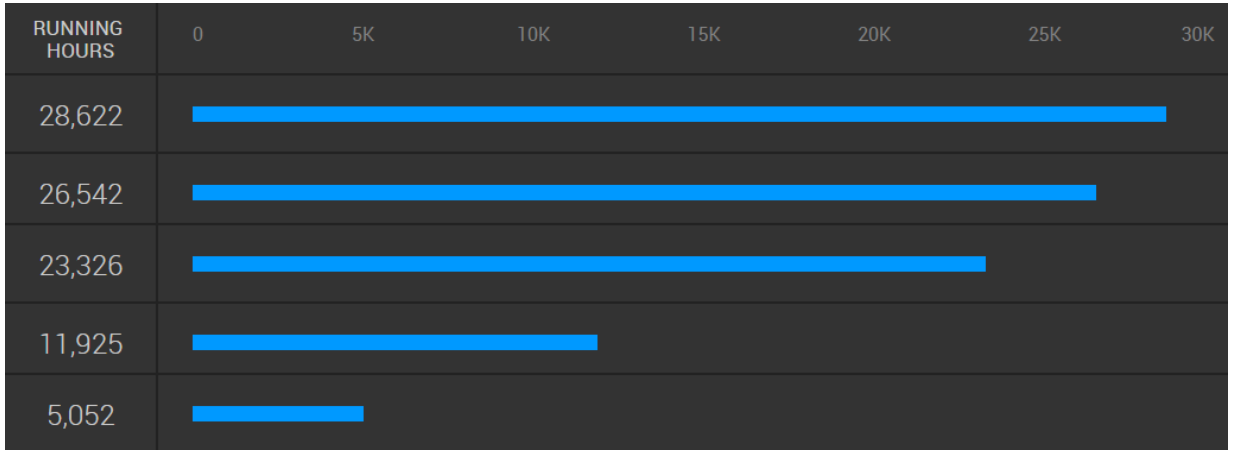




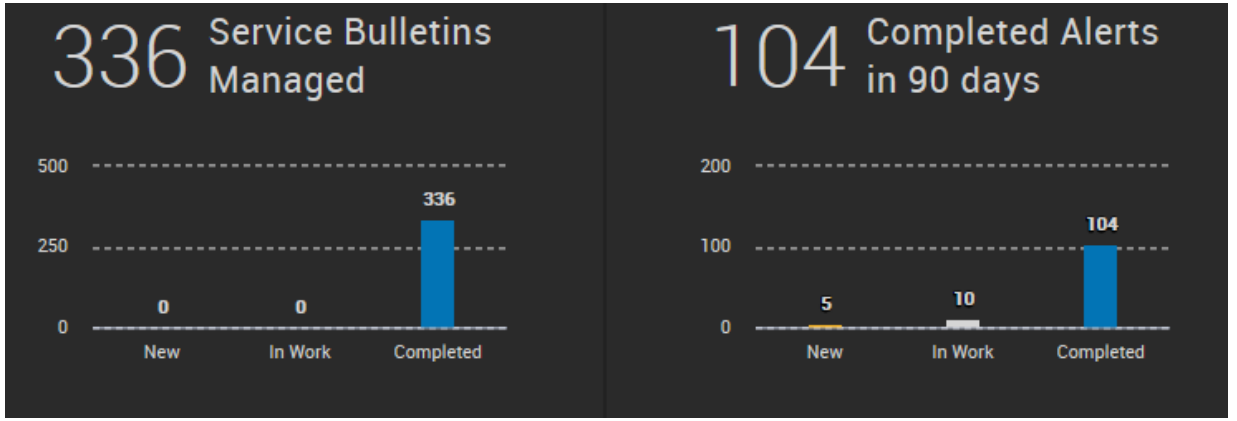
Results - KPIs

Data for 2015 and 2016





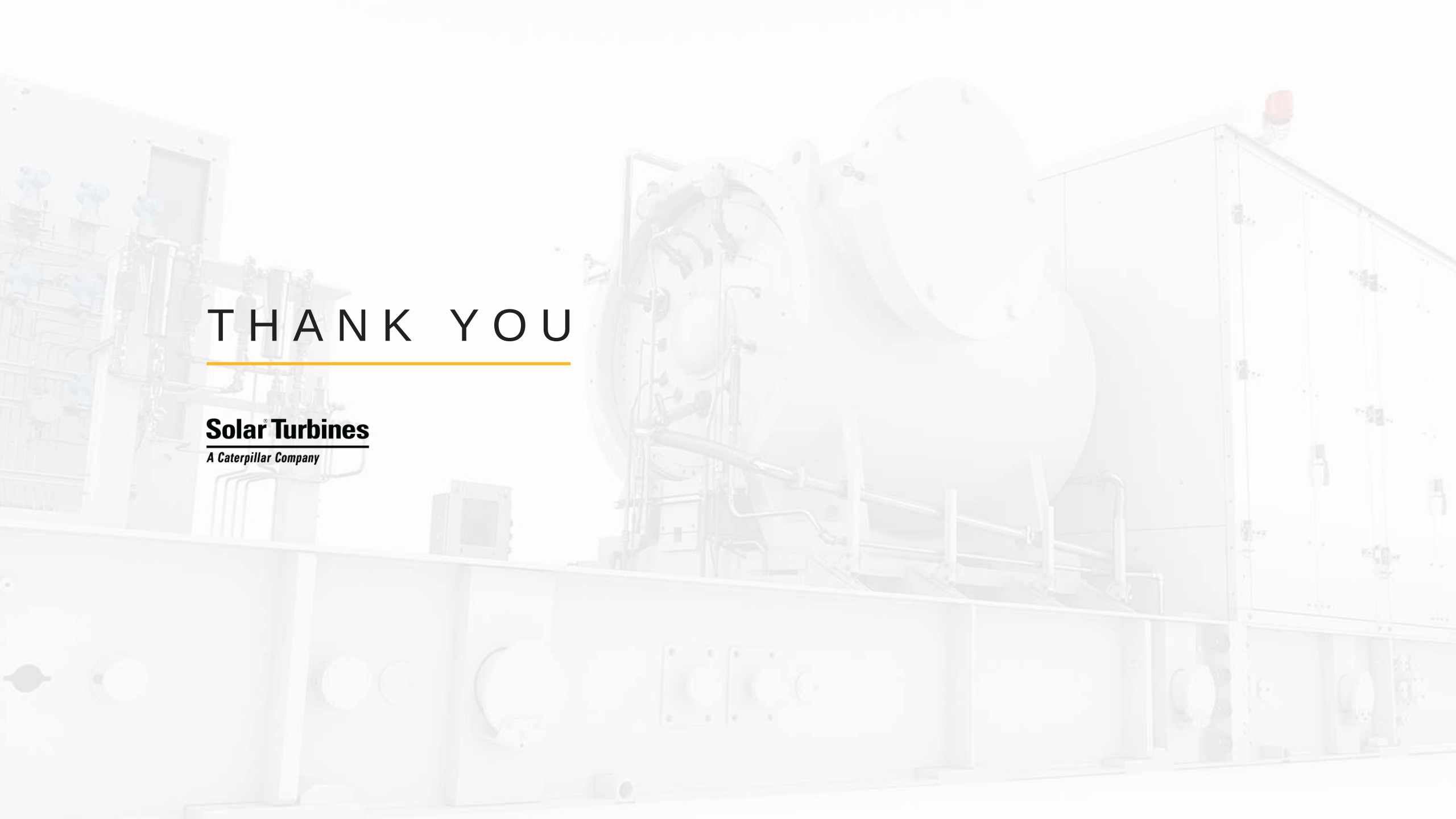
Past 12 Months



CONCLUSIONS

1. *Big Data* and *Internet of Things* are helping CHP
2. Availability is an important consideration in projects
3. Caterpillar has utilized RM&D to improve operation of CHP System

Technology is Making Our Lives More Productive and Efficient Through Improved Availability and Reliability of the Equipment



THANK YOU

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