

HALLIBURTON

Geothermal Electric Submersible Pump Virtual Parameters Optimize Well Performance Through Real-Time Monitoring and Machine Learning Diagnostics

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Intelevate™

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Agenda

October 18th, 2023

1 Introduction

2 Methodology

3 Results

4 Conclusion

Introduction

Problem

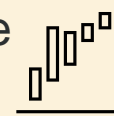
ESP operation challenges:

- Scale detection
- Absence of backup downhole gauge
- Optimize power consumption

>175 °C pump setting
depth fluid temperature



Not reliable ESP downhole
gauge technology



Inability to optimize
geothermal energy
generation

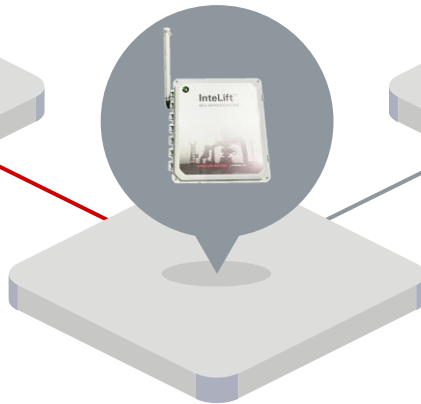


Introduction

Geothermal Projects Digitalization

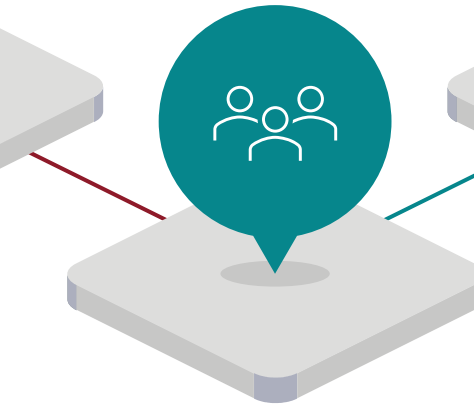
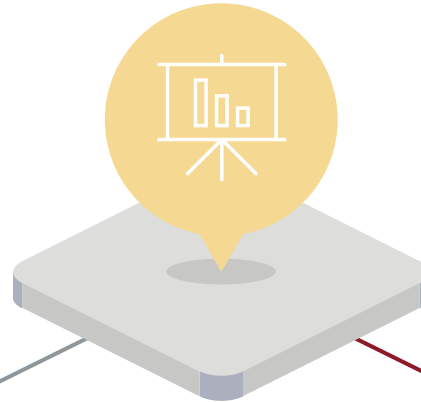


Intelevate™
Well manager cloud platform



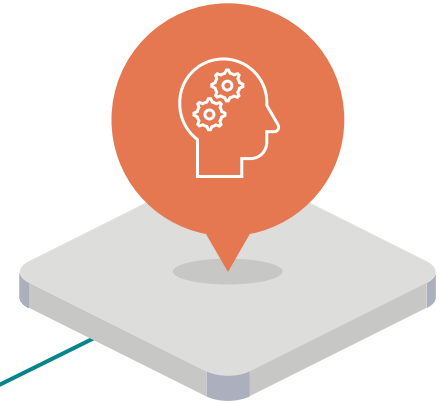
IIOT RTU
Data capturing
and Edge computing

24/7/365 Real-time Monitoring
Troubleshooting and
performance evaluation



Optimization Playbook
Recommended
operating limits

Machine Learning
Parameters prediction and
events diagnostics



Methodology

Machine Learning



What is it?

- Branch of intelligence and computer science
- Data collection
- Algorithms
- Supervised ML models



How does it work?

- All-encompassing data analysis
- Understanding the system and equipment
- Applicable in dynamic well conditions

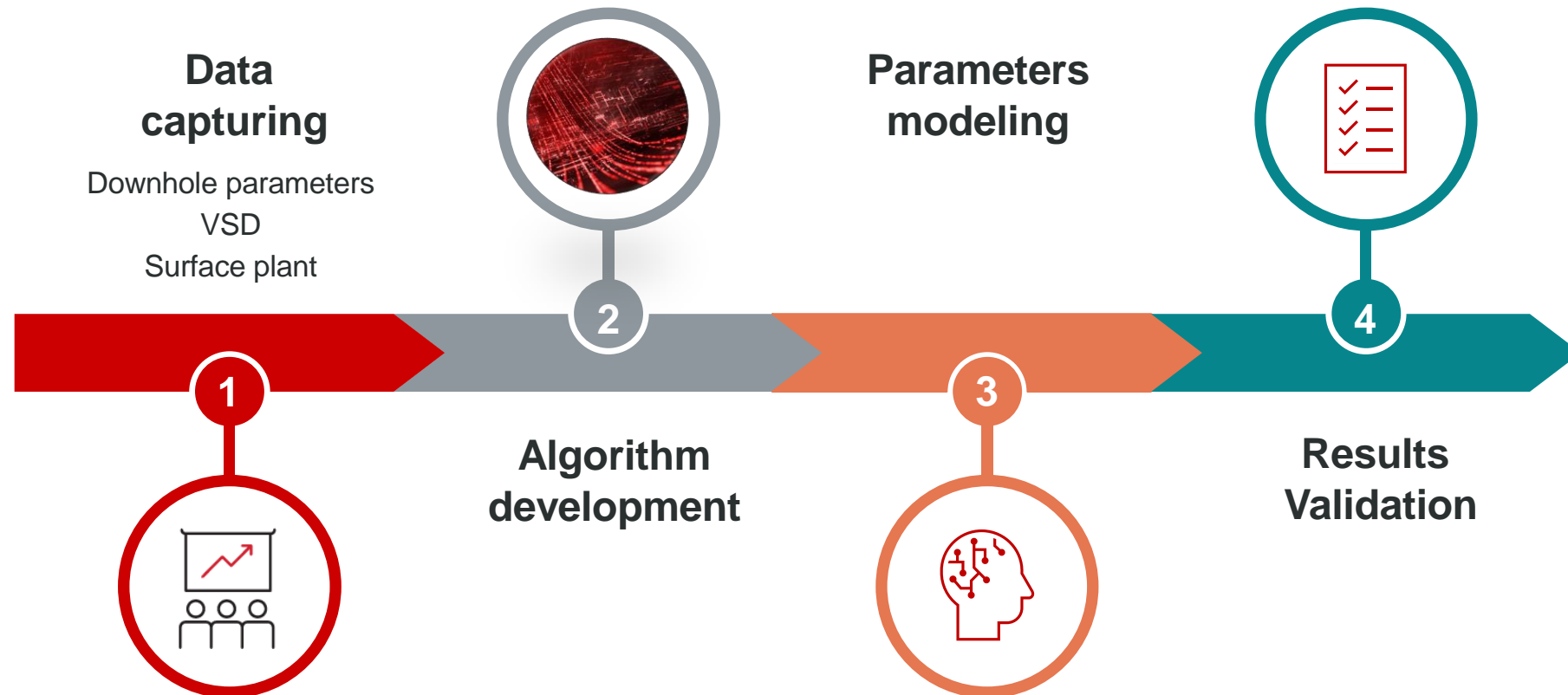


How is it applied to geothermal projects?

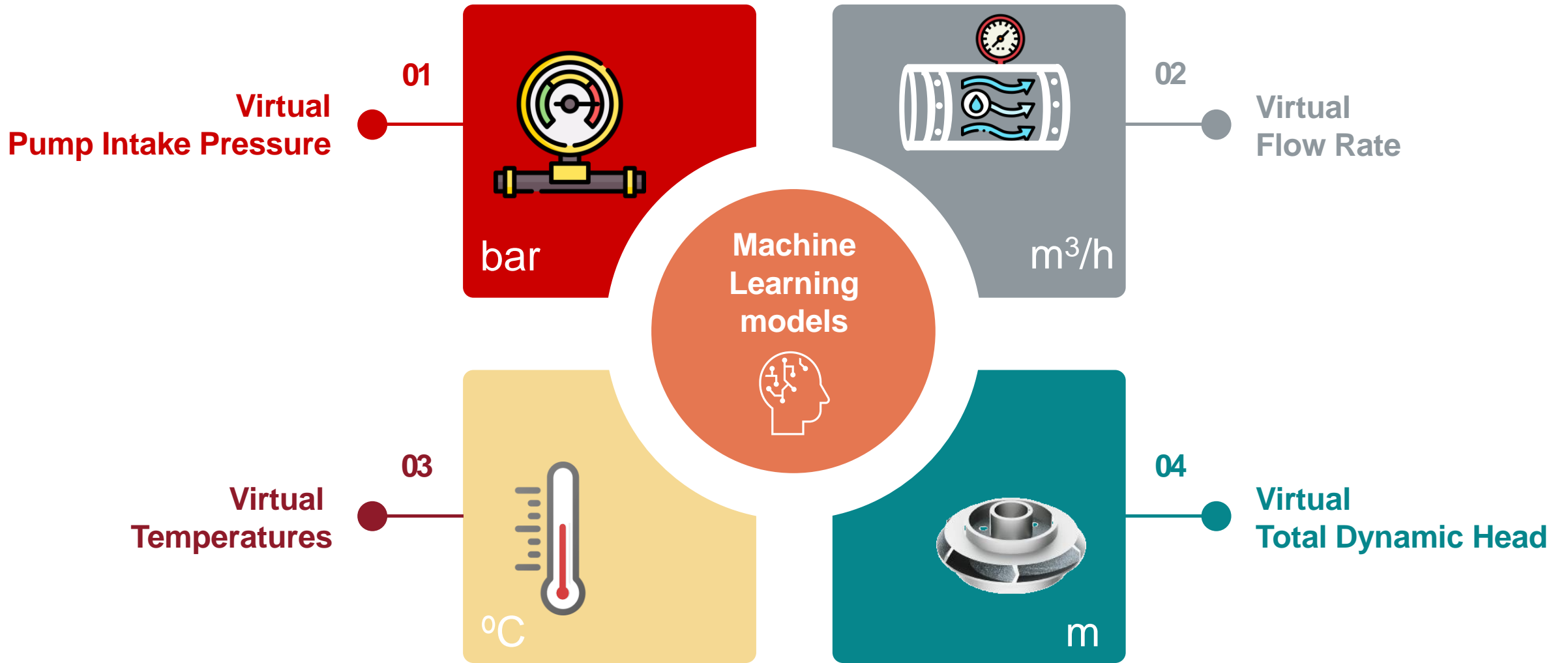
- Predicting the operating parameters
- Detecting abnormal conditions (benchmarking)
- GeoESP® digitalization

Methodology

Machine Learning



GeoESP[®] Virtual Parameters



Accurate real-time virtual results under dynamic conditions

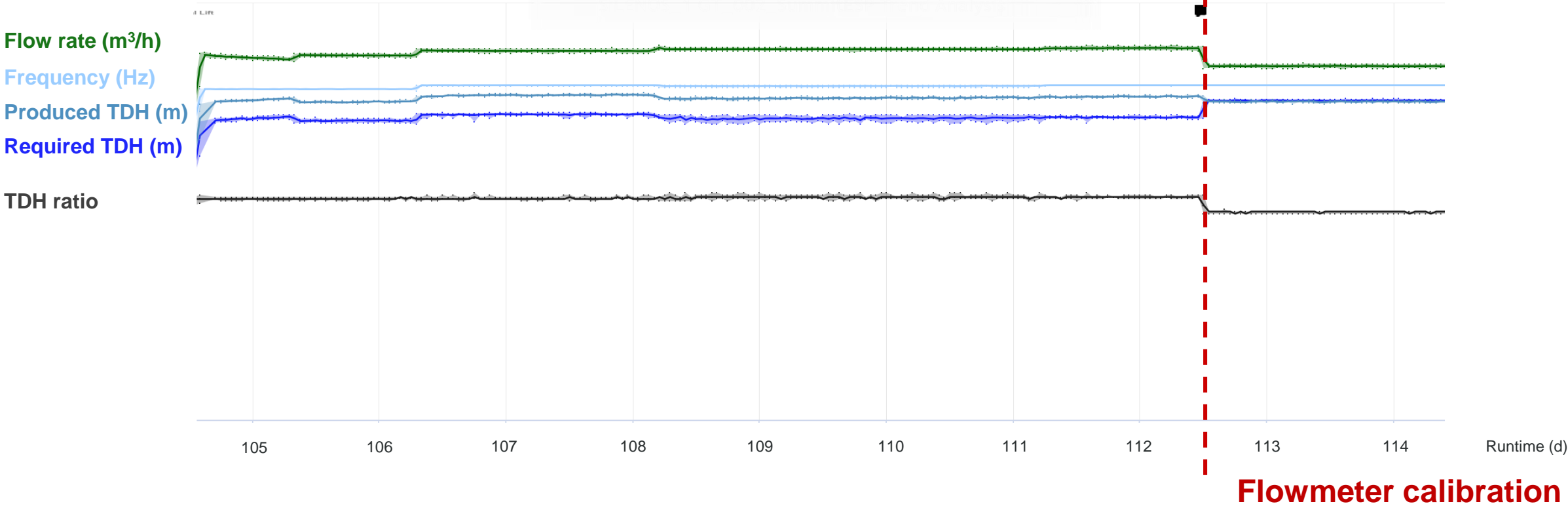
Virtual Pump Intake Pressure



Real and Virtual full overlap with error < 3%

Scale detection at the flowmeter

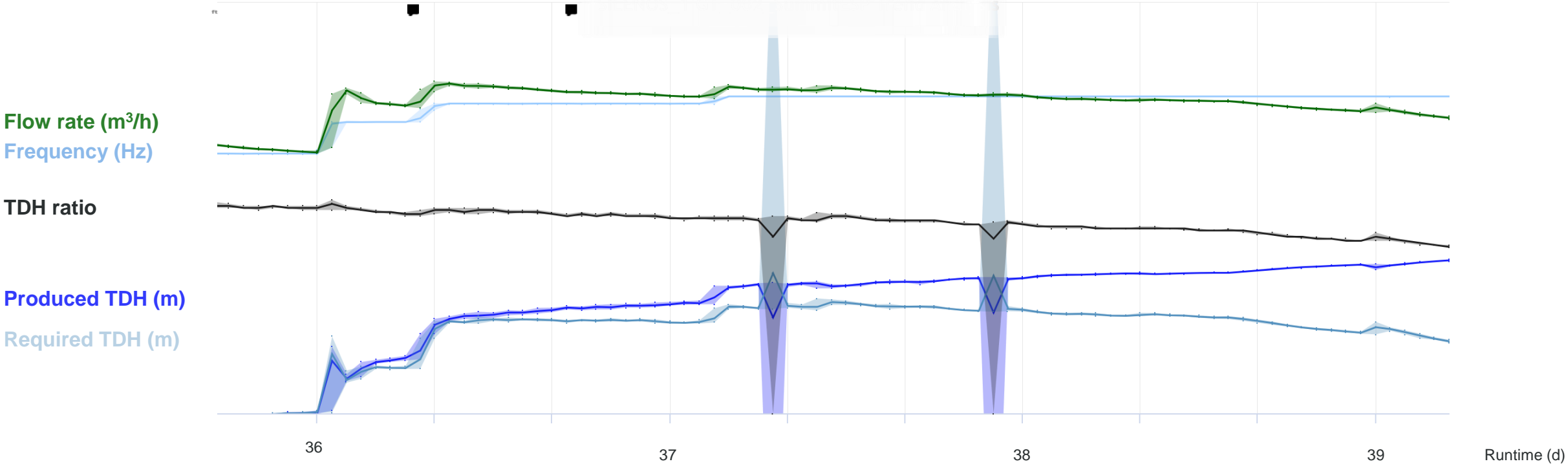
Virtual Total Dynamic Head (TDH)



Early detection and data-driven decisions

Scale detection at the pump intake

Virtual Total Dynamic Head (TDH)



Early detection and data-driven decisions

Accurate motor temperature tracking

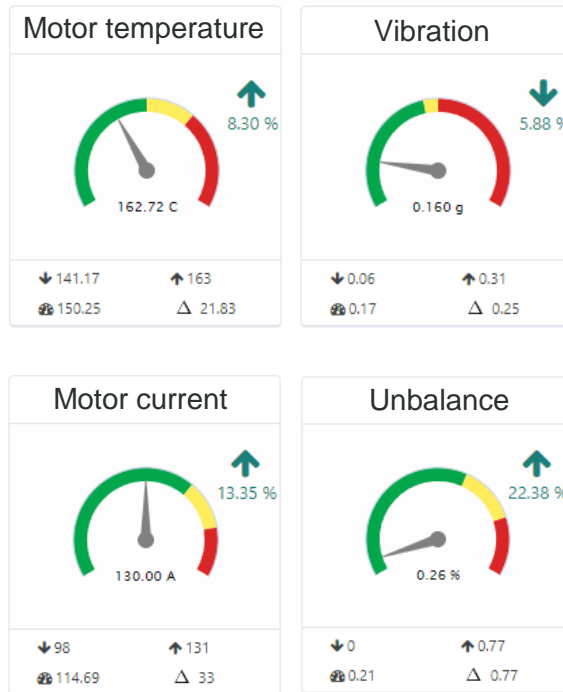
Virtual Temperatures



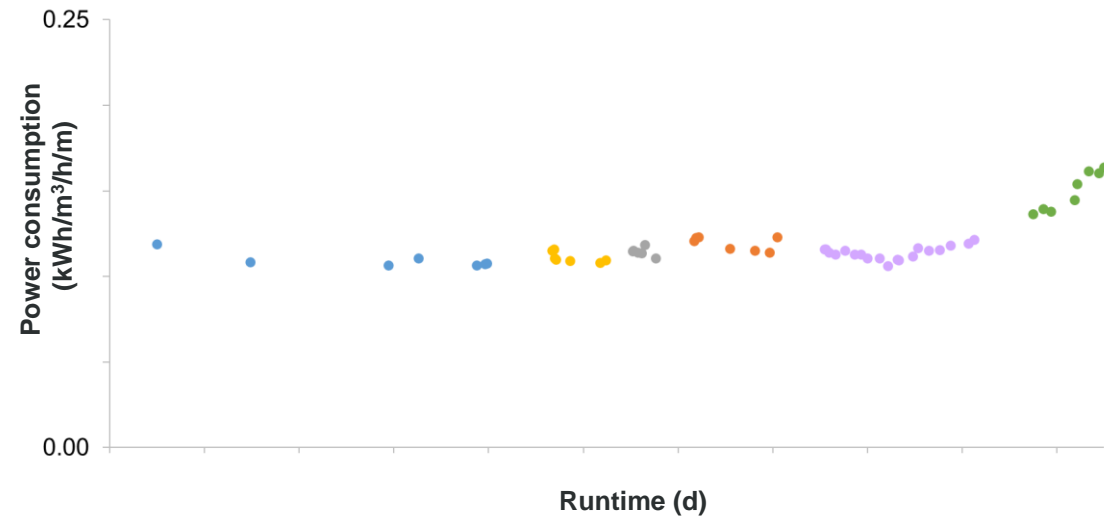
Reliable estimation in high-temperature applications

Customized real-time dashboard for easy visualization

Operational Performance Indices



Normalized power consumption tracking



Uninterrupted real-time data availability throughout the GeoESP® run life

Conclusion

Solution

- Scale detection
- Absence of backup downhole gauge
- Optimize power consumption

12 applications and
>1500 days of run life



<3% error under dynamic
conditions



24/7/365 continuous
monitoring



Thank you

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