

**HALLIBURTON**

Real-time Electric Submersible Pump  
Machine Learning diagnostics  
enable Scale Detection and Power  
Optimization in Geothermal Applications

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# Agenda

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1 Introduction

2 Methodology

3 Results


4 Conclusion

# Introduction

Geothermal ESP challenges:



Scale



Power consumption



Run life



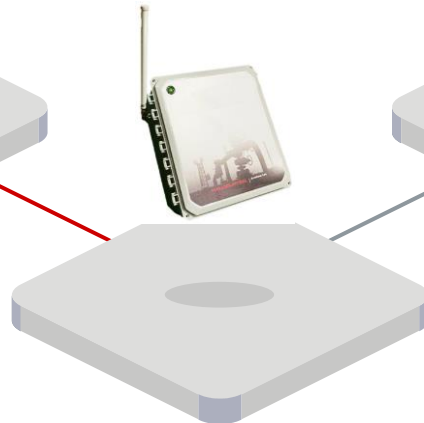
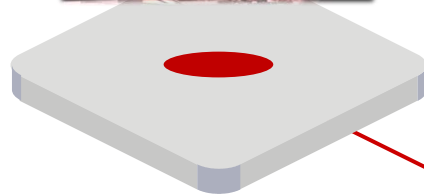
# Methodology

## Solution: GeoESP<sup>®</sup> Digitalization



### Intelevate<sup>™</sup>

- 24/7 Well Manager Platform

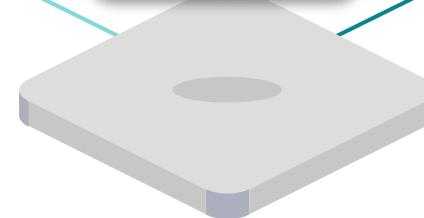
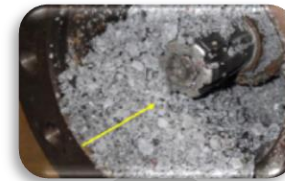
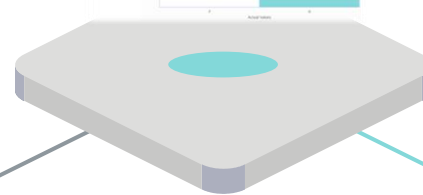


### IIOT RTU

- Data capturing
- Edge computing

### Machine Learning

- Virtual parameters
- Events detection

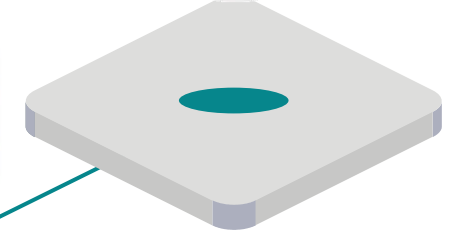


### Scale detection

- Real-time early recognition

### System optimization

- Input power
- Run life



# Results

## Virtual Pump Intake Pressure



- Real and Virtual parameters fully overlapped
- Error < 3%

# Results

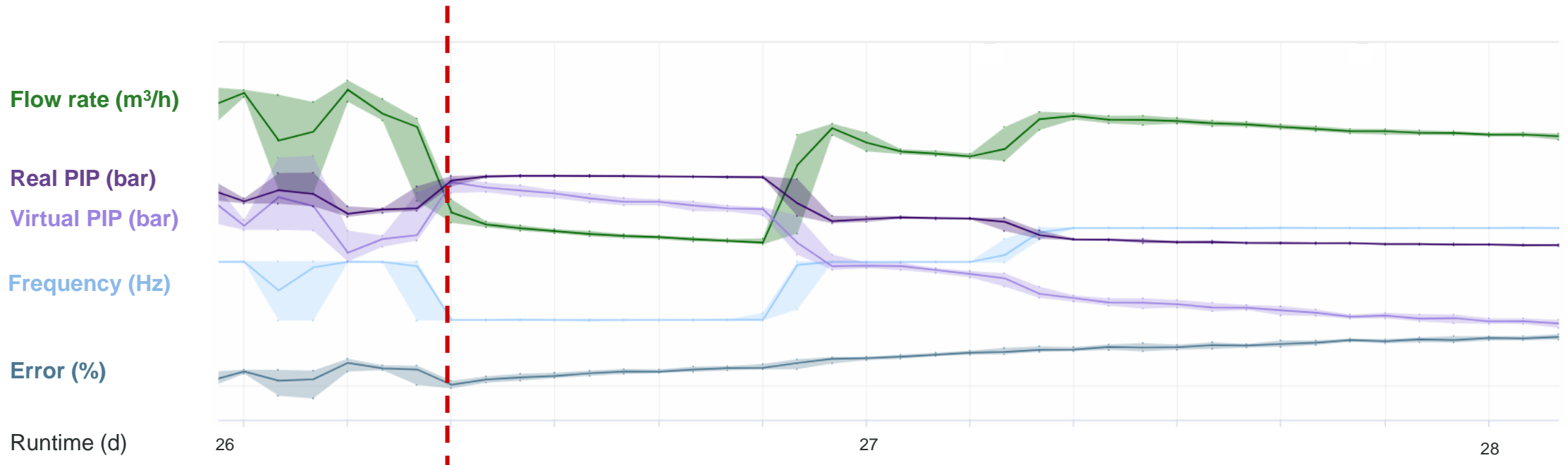
## Virtual Temperatures



- Accurate estimation in high-temperature applications
- Virtual Gauge

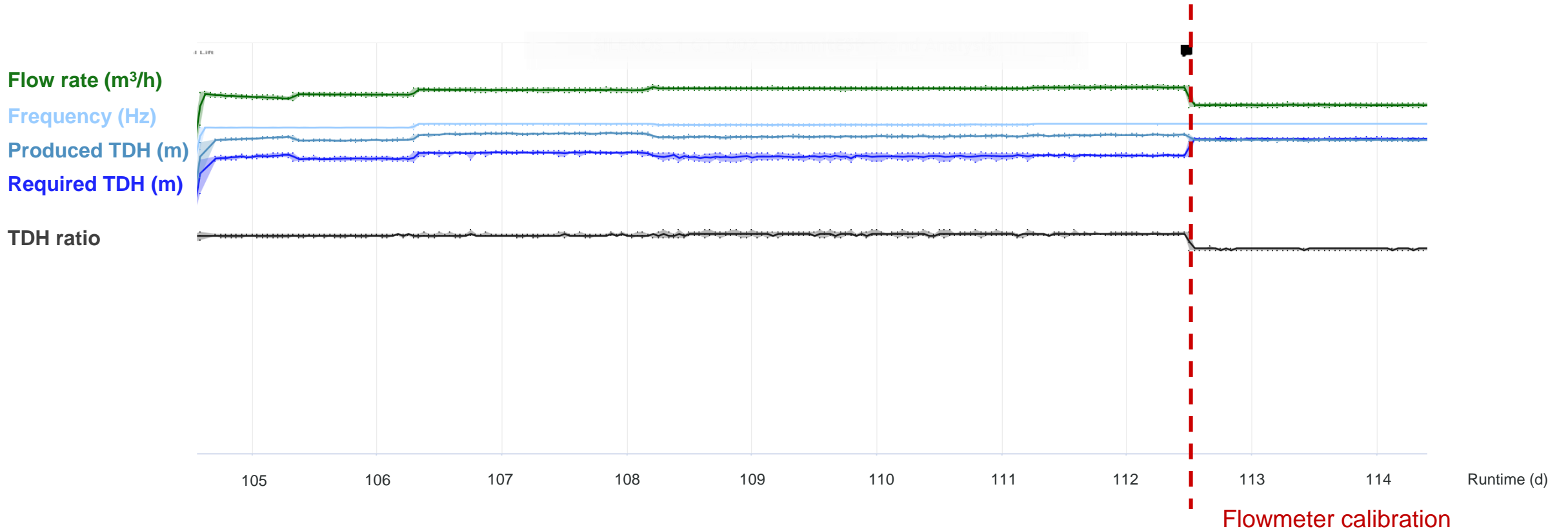
# Results

## Events detection: Scale at the intake



# Results

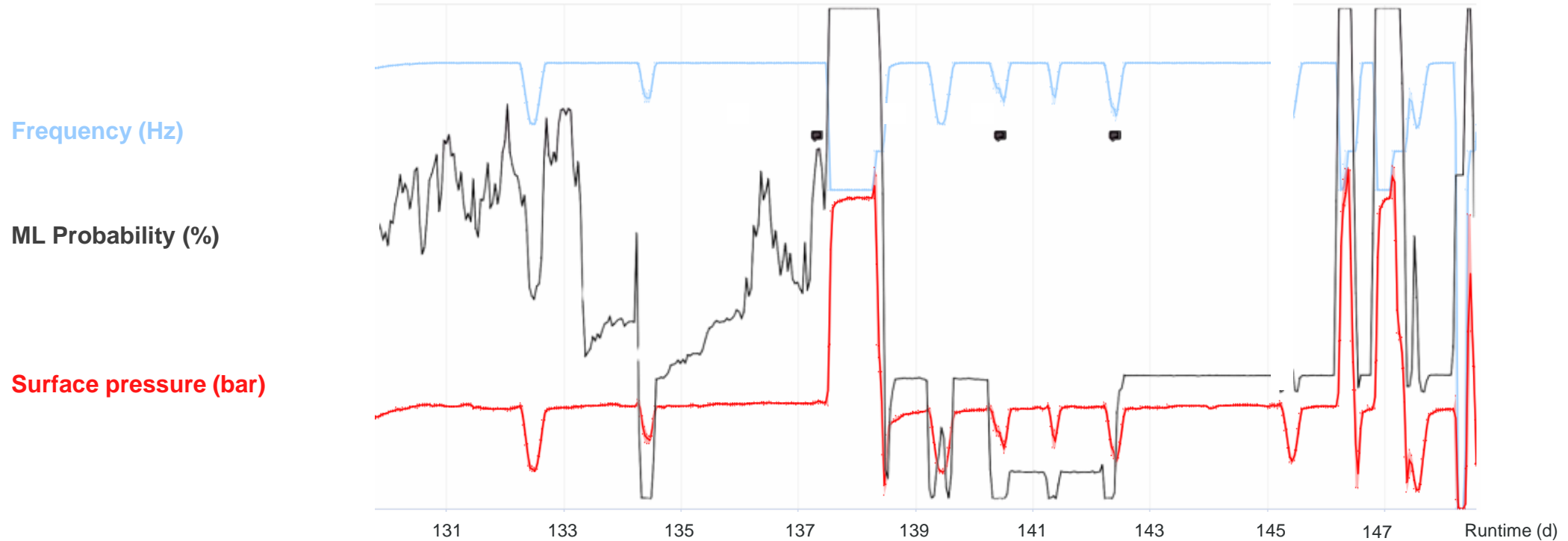
## Events detection: Scale on the surface





# Results

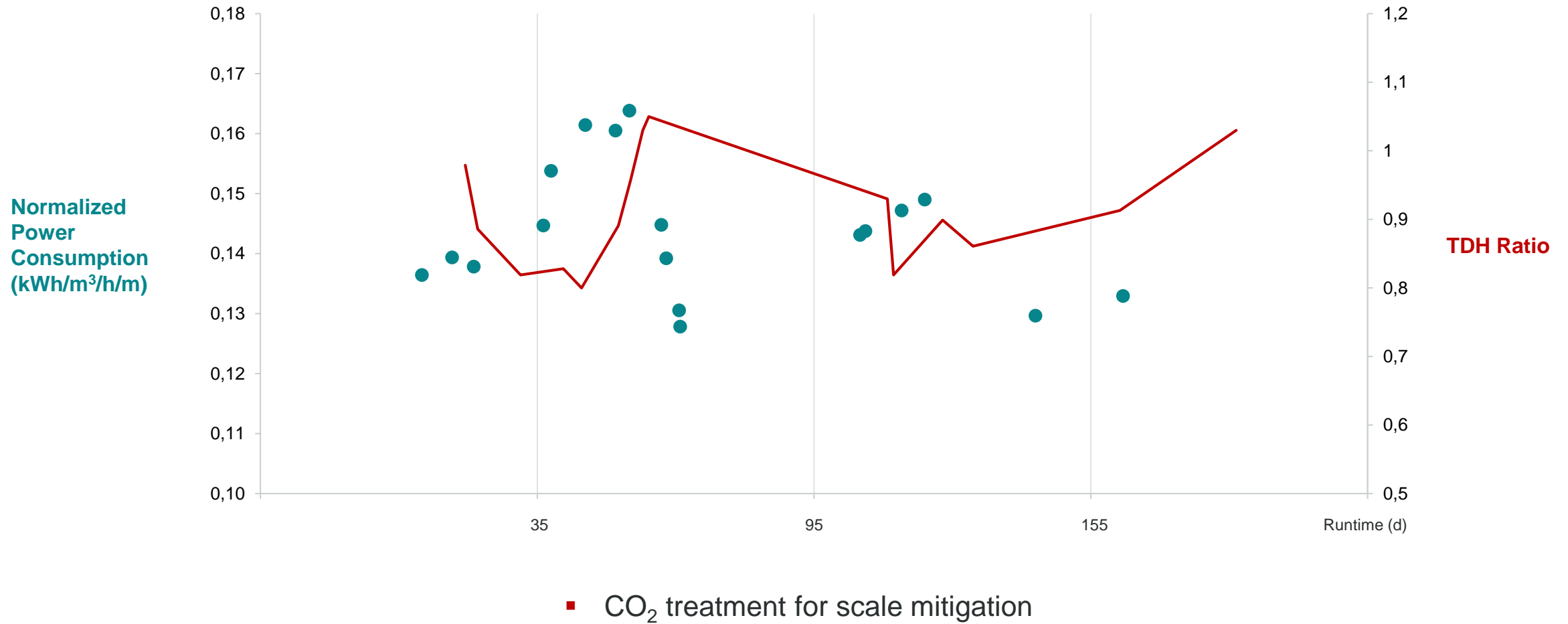
## Events detection: Surface backpressure



- Calibration with data from abnormal and normal events
- Cloud-based real-time application for automatizing event detection

# Results

## Normalized Power Consumption vs. TDH Ratio tracking



# Results

Increase **GeoESP®** run life with **real-time digitalization**



**01**

## Machine learning models

- PIP
- TDH
- Learning from patterns
- Events detection

**02**

## >3000 ESPs database

- Unconventional
- Conventional
- Geothermal



**03**

## Real-time GeoESP® status

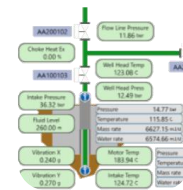
- Pump wear tracking
- Well performance
- Electric unbalance
- Vibration resonance



**04**

## Next steps

- Event forecasting



# Conclusion

## Solution



Scale:

- Machine Learning diagnostics



Power consumption:

- Real-time KPI tracking



Run life:

- Intelevate™ platform

>12 geothermal applications and  
>1700 days of run life



24/7/365 continuous monitoring



# Thank you

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