BayWa r.e.

r.e.think energy

From concept to reality

The world's largest offgrid mining hybrid power system at Fekola Gold Mine, Mali

AGENDA

1 Introduction

2 Feasibility study

3 Controls

4 Implementation

5 Q&A

1

Introduction

BayWa r.e.

Key figures

- Founded in 2009
- 2400 employees in 28 countries
- 2 bn € turnover (2019)

We have built more than 3.5 GW of wind and solar projects globally:

- Project development
- Turnkey construction
- Long-term operations

We r.e.think energy with future innovations:

- Hybrid farms, combining solar and wind
- Storage systems
- Floating PV, floating solar farms on water
- Agri PV, joint use of agricultural land
- Offshore wind

Development of the Fekola project started in 2019 and was quickly approved for implementation by B2Gold

2018
B2Gold inaugurates PV plant at Otjikoto mine in Namibia

Feb.-May 2019
Suntrace and BayWa r.e. carry out feasibility study for Fekola hybrid project

June 2019
The project is approved by B2Gold, forming a team with Suntrace and BayWa r.e. for implementation

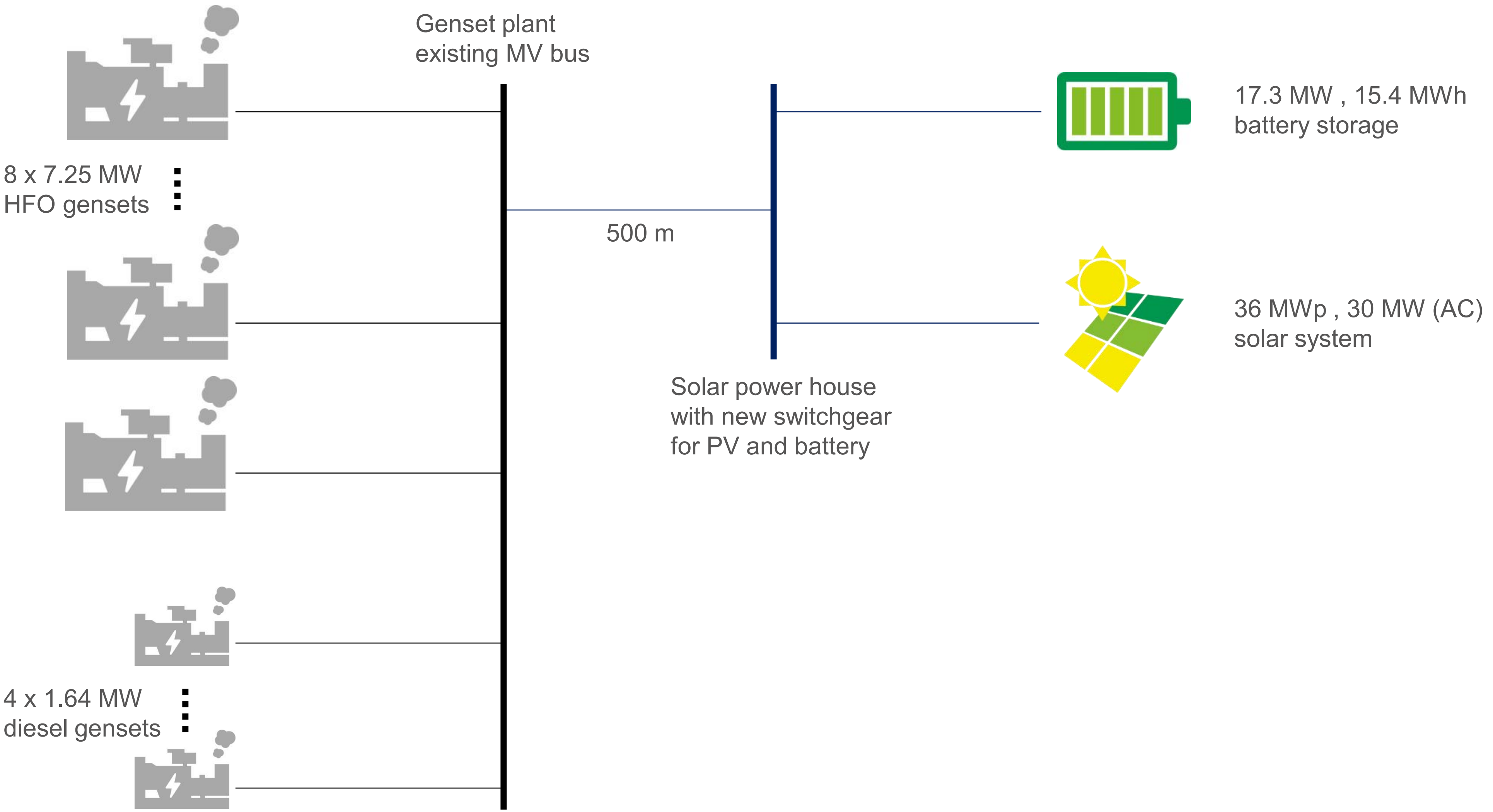
April 2021
The project is successfully commissioned

B2Gold Commissions World's Largest Off-Grid Solar Plant For The Mining Industry

B2Gold, a low-cost international senior gold producer headquartered in Vancouver, Canada, announced the commissioning of an off-grid hybrid solar-battery system at Fekola in southwest Mali, one of the world's biggest gold mines.

Jointly implemented with Suntrace GmbH and BayWa r.e., the 30 MW solar plant and 15.4 MWh battery storage together constitute the world's largest such hybrid system for the mining industry. (*Mining Global*)

30 MW solar plant and 15.4 MWh battery storage were added to the existing 64 MW thermal plant



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Feasibility study

With a 3-day site visit and solar resource assessment data was gathered as basis to develop the hybrid concept

Site visit investigation

- PV site assessment
  - Space and geology
  - Connection to existing system
- Resource assessment
  - Annual yield
  - Soiling
- Thermal power plant
  - Setup
  - Operational constraints
  - Control system
- Mine requirements
  - Expected RE share
  - Financial constraints/requirements

During the feasibility study the system configuration was determined and the control principles elaborated

01

Basic analysis of different integration scenarios

- PV without battery
- PV with small battery for stabilisation
- PV with large battery for energy shifting

02

Detailed modelling and finetuning

- Development of a customised control concept taking operating limitations of the thermal plant into account
- Detailed techno-economic evaluation

03

Key results

PV size (MWp / MWac)	36 / 30
Battery size (MW/MWh)	17.5 / 13.5
Solar production potential (MWh/year)	68,287
Solar utilization	93%
Renewable share	19%
Maximum renewable penetration	75%
Fuel savings (liters/year)	13.1m
CO_2 savings (tons/year)	39,000
Genset running hour reduction	17%

3

Control concept

The overall control philosophy can be broken down into six key functionalities

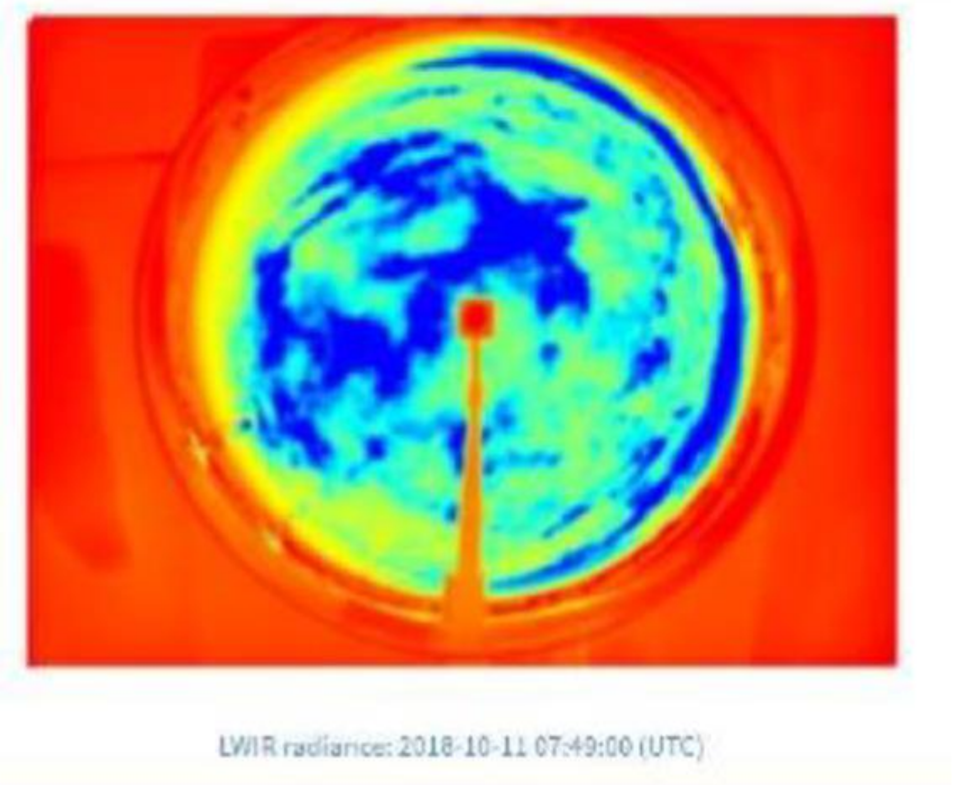
The hybrid controller needs to monitor genset operation and react according to engine limits:

- **Frequency and voltage stabilization**
  Stabilize the system as gensets are switched off especially during special events like trips or mill start-up
- **Overload prevention**
  Prevent HFO genset overload by discharging the battery
- **Low load prevention**
  Prevent HFO genset operation below their minimum load by charging the battery or curtailing the PV system
- **Solar output smoothing**
  Prevent strong ramps on the HFO gensets by smoothening the output of the solar system
- **Battery state of charge management**
  Make sure the battery is always filled with sufficient energy
- **Genset dispatch control**
  Recommend required number of gensets to be operated

A sky camera is used to predict impact of clouds on PV generation

Forecasting and dispatch control

- A sky camera monitors cloud movement in close vicinity to the solar field to predict short-term fluctuation
- For long-term PV forecasts additional input from satellite data and weather models is used
- Based on this information approximate timing of genset stops and starts can be estimated
- Short-term forecast and image help decide whether battery can be used to top up PV generation during intermittent cloud coverage or whether more gensets are required



Source: Reuniwatt

There are several security layers to keep the system safe in the event of generation loss

It shall always be possible to restart HFO gensets in time after they had been switched off

1. Solar forecasting makes operators aware of approaching drops of solar output to prepare and restart HFO gensets on time

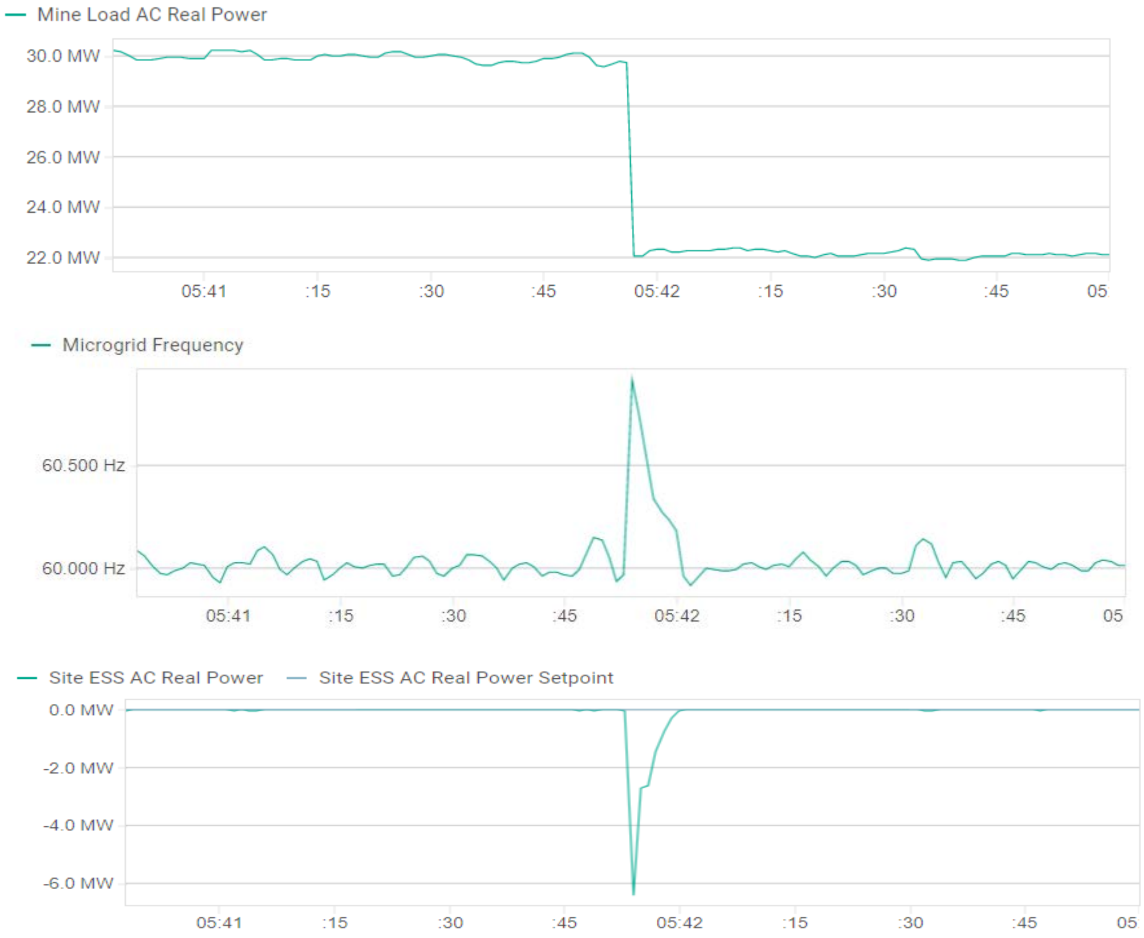
2. Should the forecasting system fail to predict a reduction of solar output or restart of HFO gensets be delayed the battery will be discharged to prevent overload of the running gensets

3. If the start of additional HFO gensets is further delayed and the battery is running low due to the constant discharging for overload prevention the diesel gensets can be started quickly and replace the output of one HFO genset

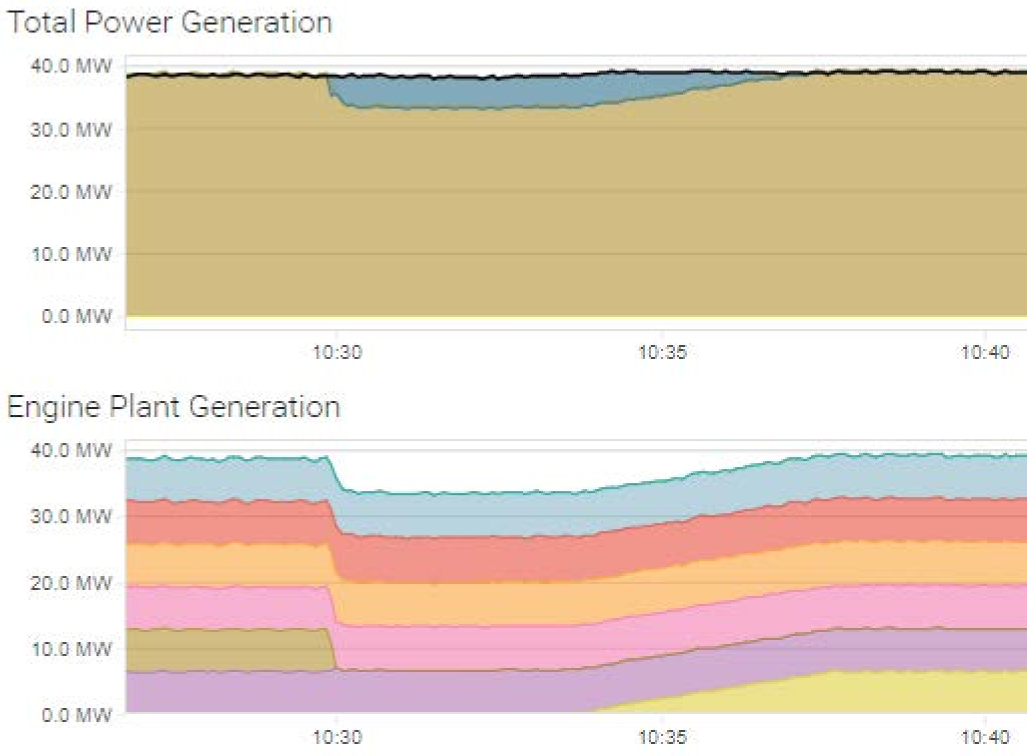
4. As a last resort load shedding must be initiated

Examples for control operation in critical situations

Mill trip (primary response)



Genset trip (primary response and load limiting)



The battery adds significant benefits to mining operations

High quality of electricity supply

- Primary control improving frequency and voltage stability
- N-1 security, battery supporting during engine trips

High efficiency

- Efficient engine operation as gensets can be safely switched off
- Primary response and smoothing during cloud coverage increase efficiency by reducing ramps
- Avoiding the start of additional engines during certain activities during mine outages
- Batteries support during start of large loads saves idling time of the engines

Optimised maintenance

- Reduced genset running hours prolongs maintenance intervals
- Silent powerhouse during maintenance as all engines in one hall can be shut down completely
- Possibility for no engine operation during mine shutdowns

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Implementation


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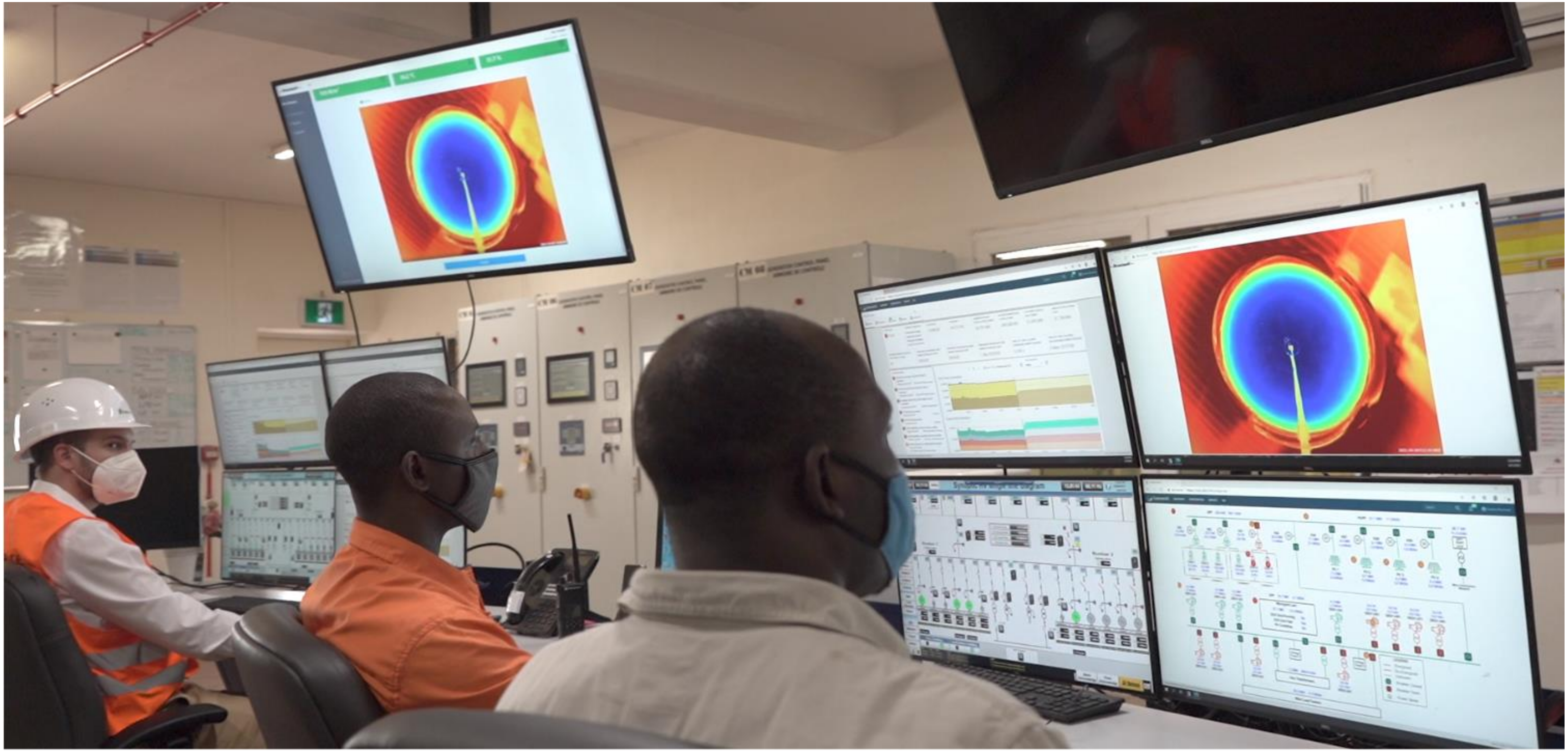

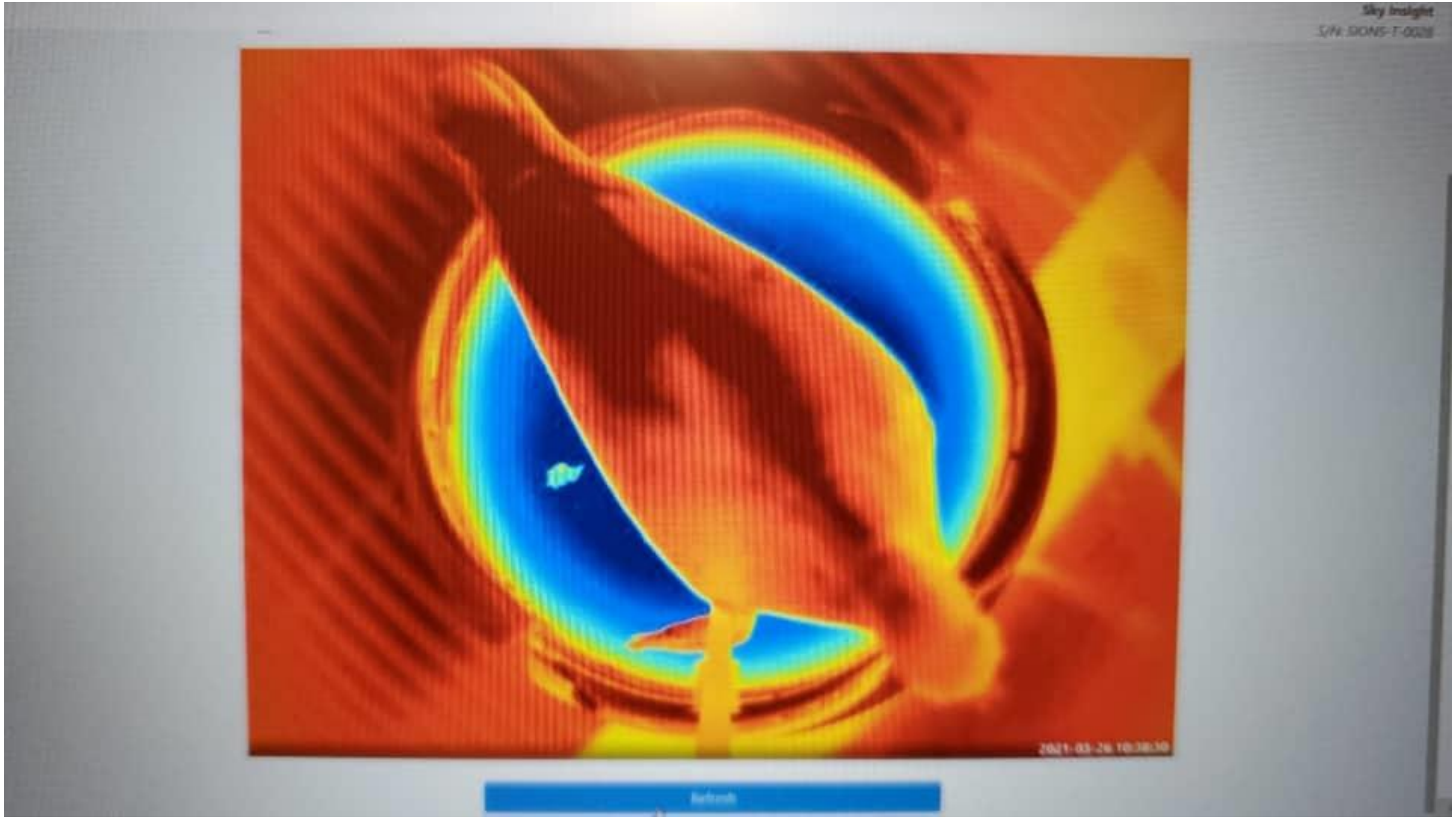
Sky Insight
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Q&A

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