

CSIR Centre for Robotics and Future Production

*Data observatory platforms, using big data for
carbon and resource monitoring*

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science & innovation

Department:
Science and Innovation
REPUBLIC OF SOUTH AFRICA



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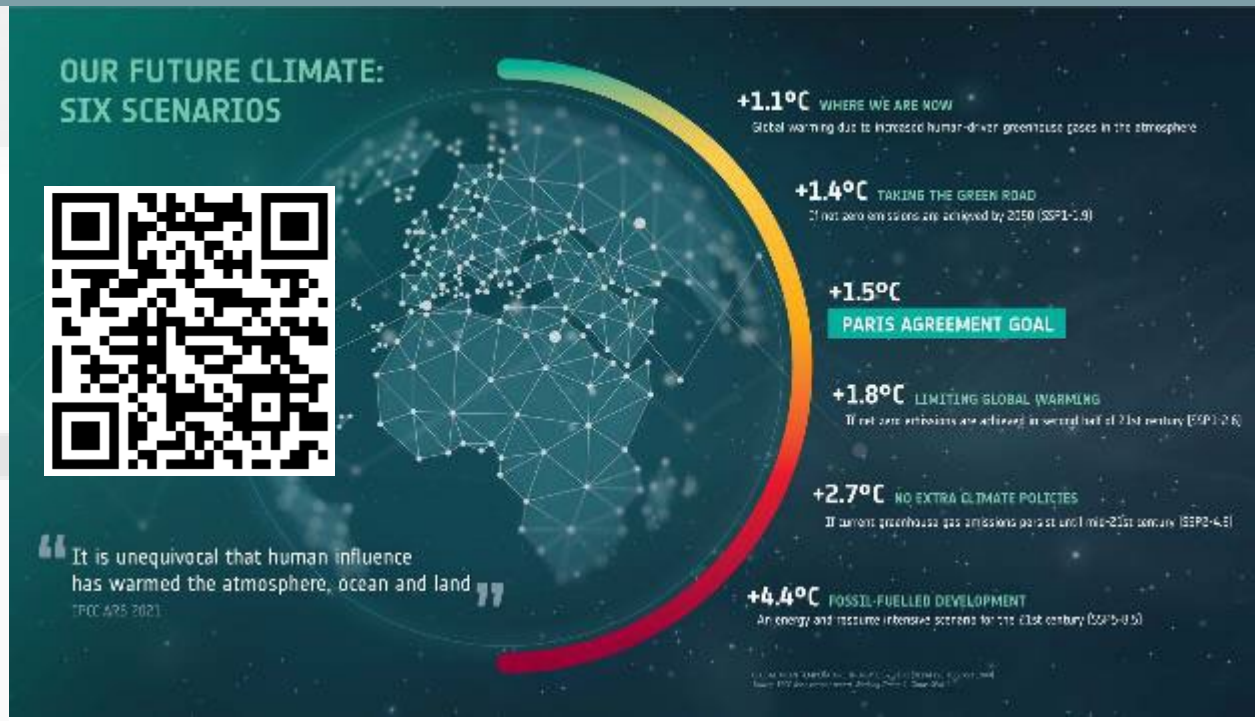
Data Observatories

Introduction

A **data observatory**, like a physical observatory, serves as a **monitoring and analysis hub**; however, instead of observing celestial phenomena, **it collects and analyzes large datasets** from various sources (e.g., sensors, satellites, and IoT devices) to **track trends** in areas like environmental changes and industrial emissions. It aims to provide **insights** from continuous observation, using **digital tools to understand real-world systems**.

Purpose: These platforms are essential for tracking long-term trends, forecasting, and supporting real-time decision-making in areas like environmental monitoring, urban planning, and industrial emissions.

Big Data Role: Through Big Data technologies, data observatories handle massive datasets in real-time, which is vital for accurate carbon and resource monitoring.



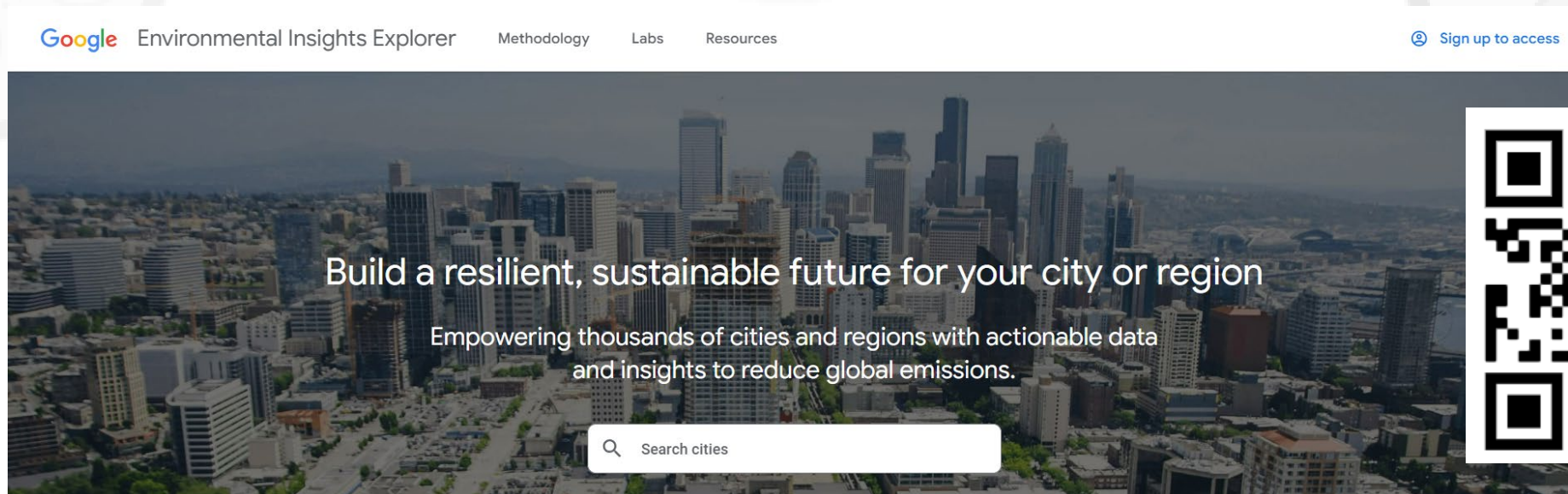
e.g. the **European Space Agency's Climate Change Initiative (CCI)** collects satellite data to monitor global greenhouse gas (GHG) emissions and temperature changes, helping inform climate policies.

Big Data and Carbon Monitoring

Big Data enables continuous and high-resolution tracking of carbon emissions, helping identify the carbon footprint of industries, cities, and ecosystems. It plays a crucial role in climate change mitigation by pinpointing areas for emission reduction.

Key Elements: IoT devices, smart meters, and satellite imagery provide real-time data, forming the basis of carbon tracking efforts.

Examples: Predictive analytics based on Big Data can model future emissions and identify where efficiency improvements can lead to carbon reductions.



e.g. **Google's Environmental Insights Explorer (EIE)** uses Big Data and machine learning to estimate carbon emissions for over 100 cities worldwide, helping cities plan for carbon reduction strategies.

City of Tshwane Metropolitan Municipality

Gauteng, South Africa

Size: 6,357 km²

Population (2020): 3,861,830

Google Environmental Insights Explorer

Methodology

Labs

Resources

Search cities



Sign up to access

Sample

Buildings data



% of total measured area



89% Residential 11% Non-residential

226,000,000 m² | 2,070,000 total buildings

Sample

Transportation activity



2023

% of total trips per mode



Tree canopy

Data isn't available yet

If you're a local government employee or consultant, you can request your city or region's data after signing up.

[View example data for Yokohama, Japan](#)

Rooftop solar potential

Data isn't available yet

If you're a local government employee or consultant, you can request your city or region's data after signing up.

[View example data for Yokohama, Japan](#)



Benefits of Data Observatories



Comprehensive Monitoring:

Data observatories provide 24/7 monitoring of emissions, resource usage, and energy consumption, delivering precise insights into carbon hotspots and trends.



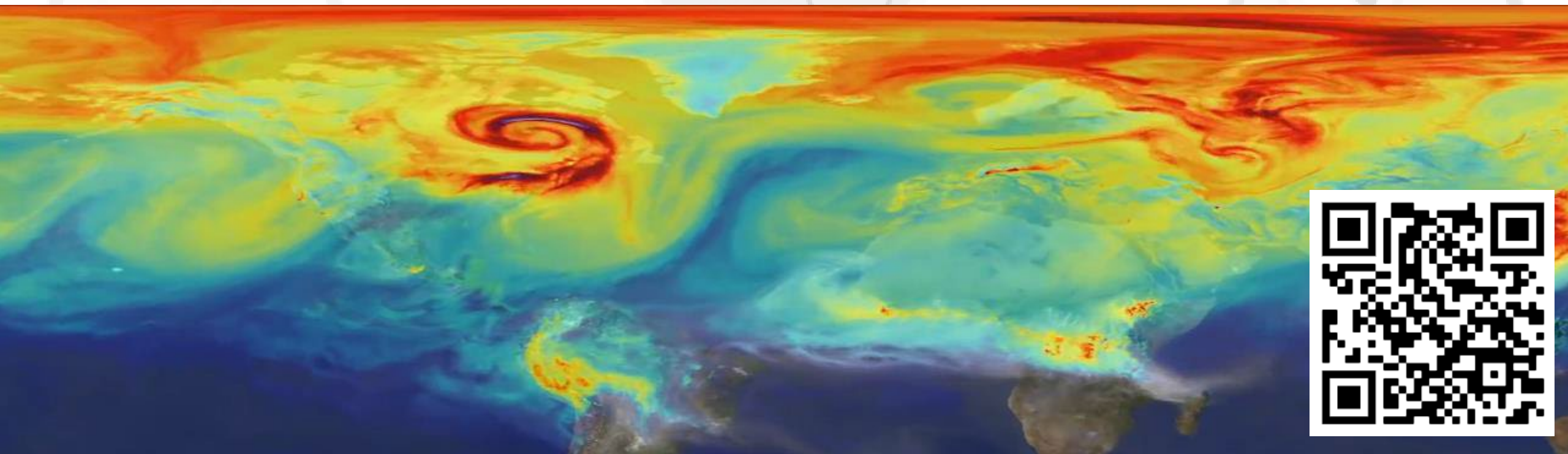
Regulatory Compliance:

Data observatories enable easier compliance with national and international climate regulations, helping companies stay aligned with environmental laws.



Improved Decision-Making:

Policymakers and industry leaders can use data-driven insights to make informed decisions about carbon reduction and resource optimization.



Challenges & Opportunities for Global Data Observatories

Challenges:

High costs of implementation, data integration across different platforms, and the complexity of handling large, real-time datasets. Additionally, there are technological barriers in ensuring accuracy and accessibility.

Leveraging 4IR technologies & processes:

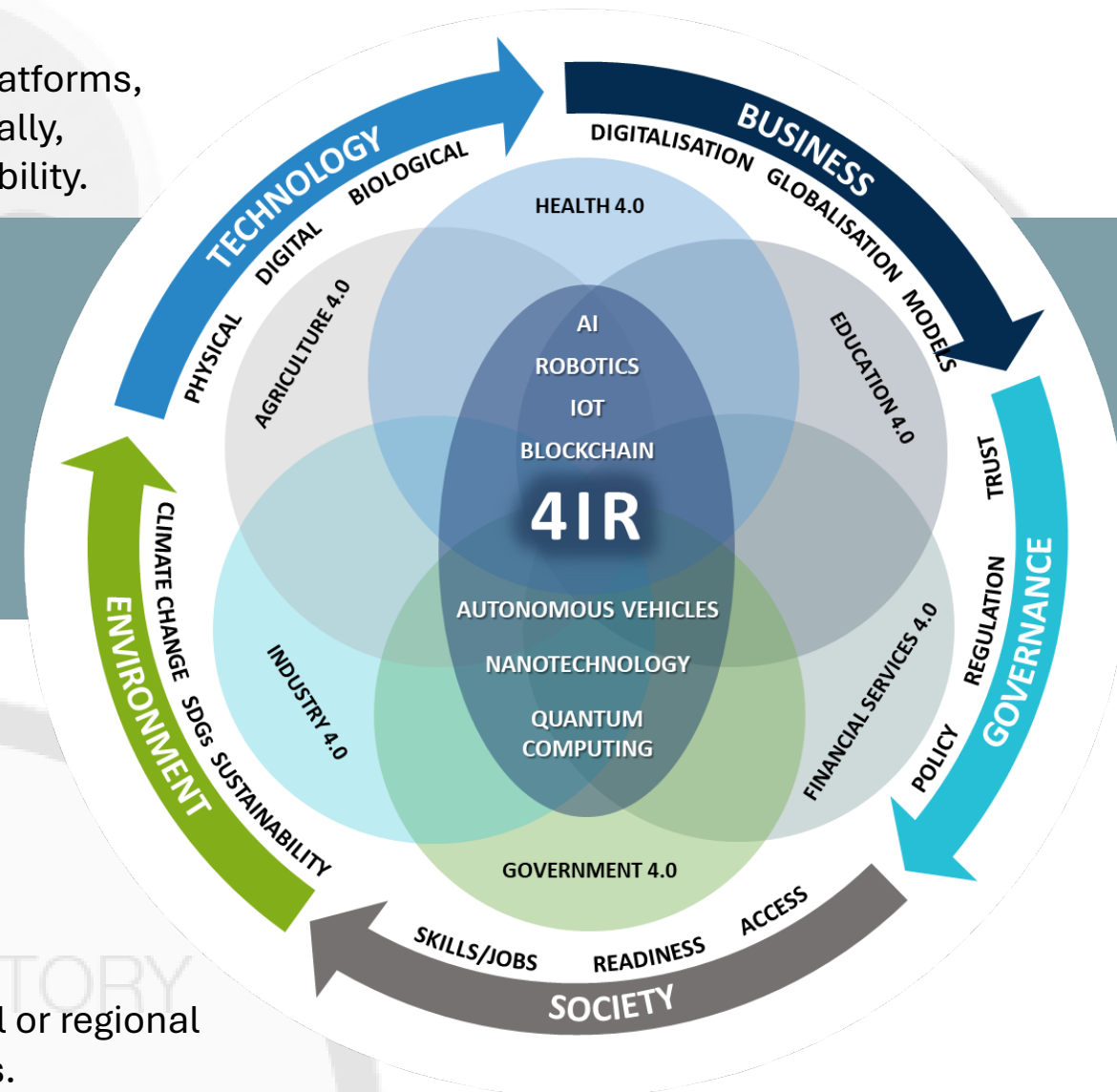
- Ability to do things that were impossible a few years ago;
- New approaches to solving problems via “new ways of doing”;
- Data as the new “oil”;
- AI, machine learning, data analytics making huge strides in the past couple of years;

Opportunities:

The adoption of these technologies can improve data accuracy, security, and integration. These tools also enable better forecasting and more detailed analysis of carbon data.

Scalability:

With advanced technology, observatories can be scaled for global or regional monitoring, enabling precise emissions tracking across industries.





Data Observatories in South Africa

Examples of Data Observatories in South Africa



NATIONAL POLICY DATA OBSERVATORY

Check our Dashboards



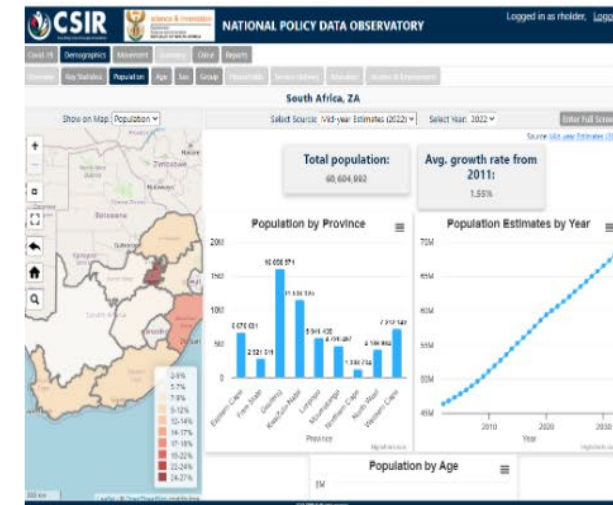
SA's Development Indicators Dashboard

Dashboard for tracking South Africa's Development Indicators published by the Department of Science and Innovation [read more...](#)



Logistics Observatory

The performance of the national logistics system is dependent on trustable, validated data [read more...](#)



NPDO Dashboard

Dashboard that contains Covid-19, Demographic, Mobility, Financial, Report data and more.

Background – GHG Monitoring in South Africa

South Africa's GHG monitoring framework includes national reporting requirements under NEMAQA, a national GHG inventory, voluntary initiatives like the Carbon Disclosure Project, and the carbon tax system.



National Reporting Requirements

South Africa enforces greenhouse gas (GHG) reporting through the National Environmental Management: Air Quality Act (NEMAQA), which mandates specific industries to monitor and report their GHG emissions. This is part of the country's commitment to environmental sustainability and climate change mitigation.



Carbon Tax

Introduced in 2019, South Africa's carbon tax applies to industries exceeding certain GHG thresholds. This tax incentivizes companies to reduce their emissions by providing a financial cost for their carbon footprint, necessitating accurate annual emissions monitoring and reporting.



National GHG Inventory

South Africa compiles and submits a National GHG Inventory to the United Nations Framework Convention on Climate Change (UNFCCC). This inventory tracks emissions from various sectors, such as energy, agriculture, industry, and waste, providing a national overview of GHG emissions.



Industry-Specific Efforts

Certain sectors, like mining and energy, participate in industry-led initiatives that encourage sustainable practices and GHG monitoring, but gaps remain in industries like the foundry sector, which lack dedicated GHG tracking systems.



Voluntary Initiatives

Companies also participate in voluntary GHG reporting initiatives like the Carbon Disclosure Project (CDP), which allows them to disclose emissions data, set reduction targets, and benchmark their environmental performance against peers.



South African Greenhouse Gas Emissions Reporting System (SAGERS)

The **South African Weather Service (SAWS)** manages emissions reporting under the **SAGERS** platform, helping industries comply with carbon tax and national regulations.

Challenges – GHG Monitoring in South Africa



Lack of Industry-Specific Inventories

Certain sectors, like the foundry industry, lack dedicated GHG inventories, limiting accurate emissions tracking.



Non-Compliance Among SMEs

Many small and medium-sized enterprises (SMEs) face technical and financial challenges in GHG reporting, resulting in unreported emissions.



High Costs of Monitoring Technologies

Continuous Emissions Monitoring Systems (CEMS) are expensive, particularly for smaller companies, limiting widespread adoption.



Limited Skills and Expertise

There is a shortage of technical knowledge and skills to effectively operate and manage emissions monitoring technologies.



Lack of Knowledge on Proxy Measurements

Limited understanding of how to apply proxy measurements (e.g., energy and fuel usage) as an alternative to costly CEMS.



Inconsistent Reporting and Data Quality

Reporting requirements vary across sectors, leading to inconsistencies in data quality and accuracy.

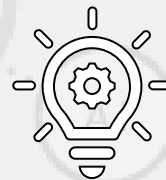
Addressing these challenges through **targeted interventions**, such as the **development of industry-specific GHG inventories**, **affordable monitoring solutions**, and **data observatory approaches** is essential for improving South Africa's overall emissions tracking and meeting its environmental obligations.

Foundries comprise highly energy intensive unit operations. The foundries sector in SA contributes to GHG emissions through both direct carbon dioxide (CO₂) emissions (scope 1) and indirect (e.g. electricity-related) GHG emissions (scope 2).



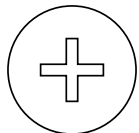
OPPORTUNITY 1: PROVIDE A TOOL FOR CBAM REPORTING FOR EXPORTERS

This is currently a huge challenge in the industry. Provide an affordable, accessible CBAM service for South African manufacturers.



OPPORTUNITY 2: KNOWLEDGE FOR DECISION-MAKING

Decarbonization is associated with **energy efficiency** and this will guarantee an **improvement in the bottom line** of a steadily declining foundry sector in the face of increasing energy prices, cheaper imports and a struggling economy. Digital transformation technologies and processes can be used to collect trusted data in order to support **decision-making by stakeholders** in this sector.



OPPORTUNITY 3: EXPANSION TO OTHER SECTORS

Once tested in the foundry sector, the technologies and processes can easily expanded to other industry sectors.



OPPORTUNITY 4: TRUSTED DIGITAL INVENTORY

There is currently **no GHG emission inventory for the South African foundry sector**. This means that there is a clean slate with no legacy systems to take into account. This area is rife for innovation. CSIR / NFTN / NCPC well-positioned to provide this service.

Objectives – GHG Observatory for Foundry sector



Development of a Foundry GHG Inventory

Create a dedicated GHG inventories, to enable accurate emissions tracking.



Support Compliance Among SMEs

Remove the technical and financial challenges regarding GHG reporting amongst small and medium-sized enterprises (SMEs), resulting full reporting of emissions.



Affordable Monitoring Technologies

Foundries still need to have annual once-off audits. However, using proxy monitoring approaches and access to other information sources, it becomes possible to enable continuous monitoring using cheaper sensors.



Deskill the process

By building a “plug-and-play” system, with automatic emissions reporting, dashboards, etc., it becomes possible to deskill the emissions monitoring process.



Use of Proxy Measurements

The system should apply proxy measurements (e.g., energy and fuel usage) as an alternative to costly CEMS.



Consistent Reporting and Data Quality

The system will adjust to reporting requirements that vary across sectors. In addition, the use of a blockchain backend will enable auditability and trust in the data and data quality.



OBSERVATORY

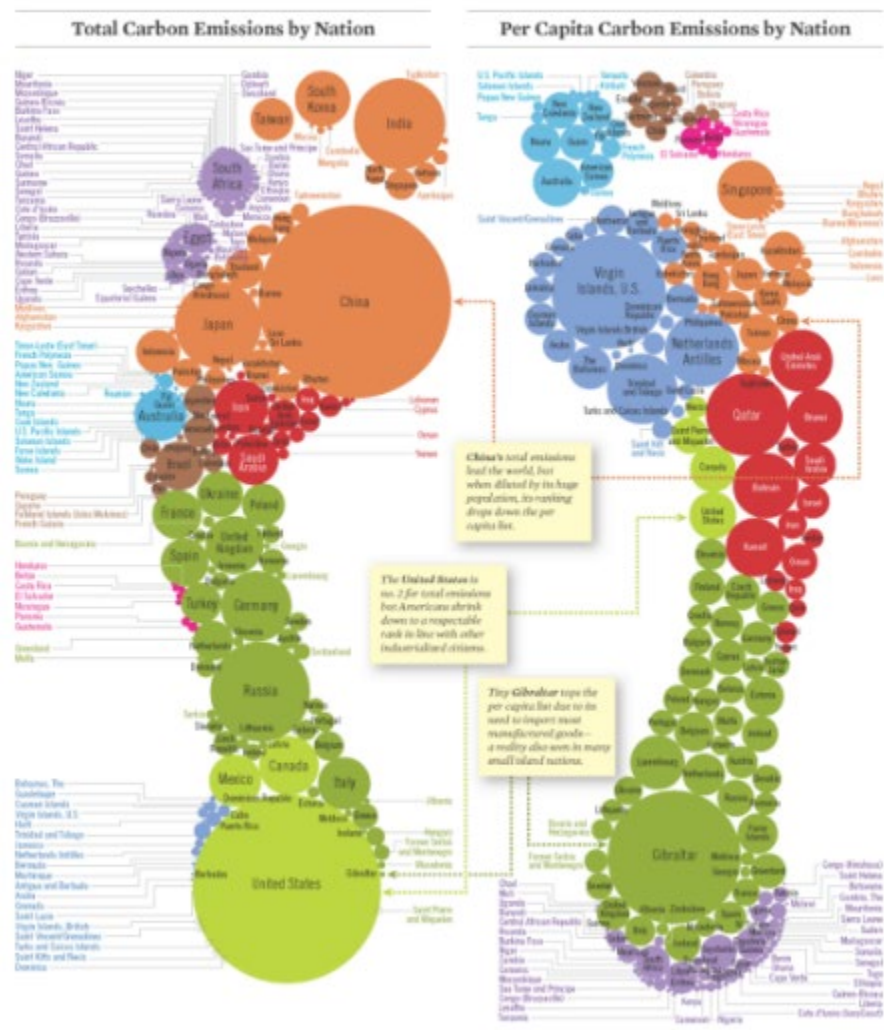
Aim & Future Expansion of the GHG Data Observatory



- **Objective 1:** Establish a sector-specific GHG emission inventory for the foundry industry, filling a critical data gap.
- **Objective 2:** Ensure compliance with international carbon regulations, providing standardized emissions data that can be used for global trade compliance.
- **Objective 3:** Promote energy efficiency and emissions reduction through the use of real-time data and analytics.
- **Future Expansion:** Expand the observatory to include other high-emission sectors in South Africa, broadening its impact.

Tracking Carbon Emissions

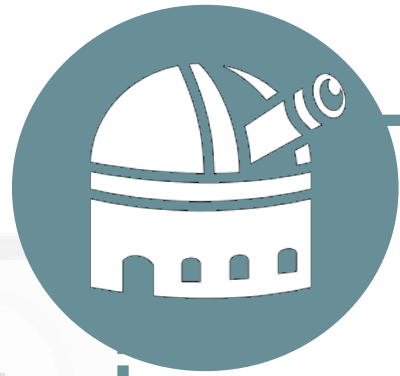
A footprint comparison of total carbon dioxide emissions by nation and per capita shows there's plenty of room for smaller countries to reduce their carbon footprints.
By Stanford Kay





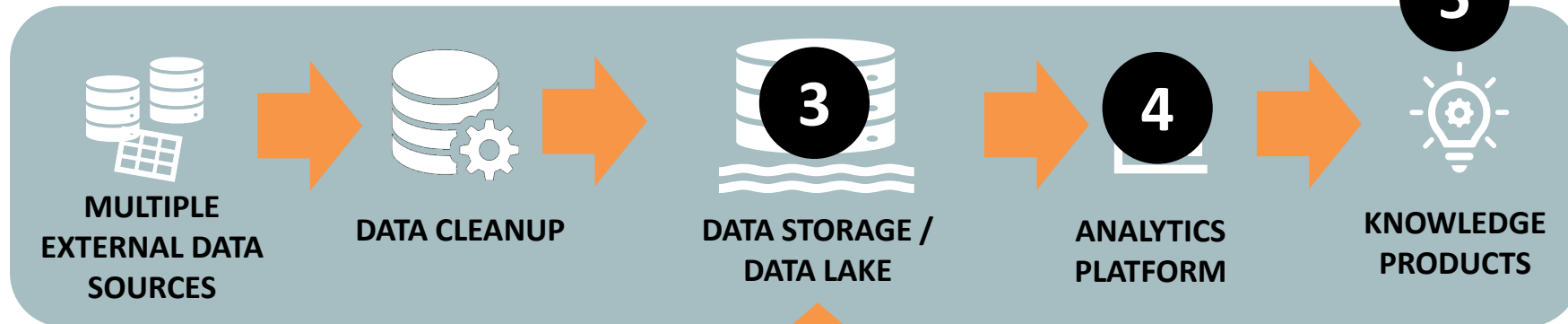
GHG Data Observatory Proof-of-Concept

Proof-of-Concept Solution

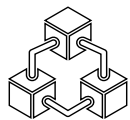


FOUNDRIES

DATA MANAGEMENT & ANALYTICS PLATFORM



2 BLOCKCHAIN-BASED DATA COLLECTION PLATFORM (REAL-TIME, AUTOMATED)


BLOCKCHAIN AS THE TRUST FOUNDATION

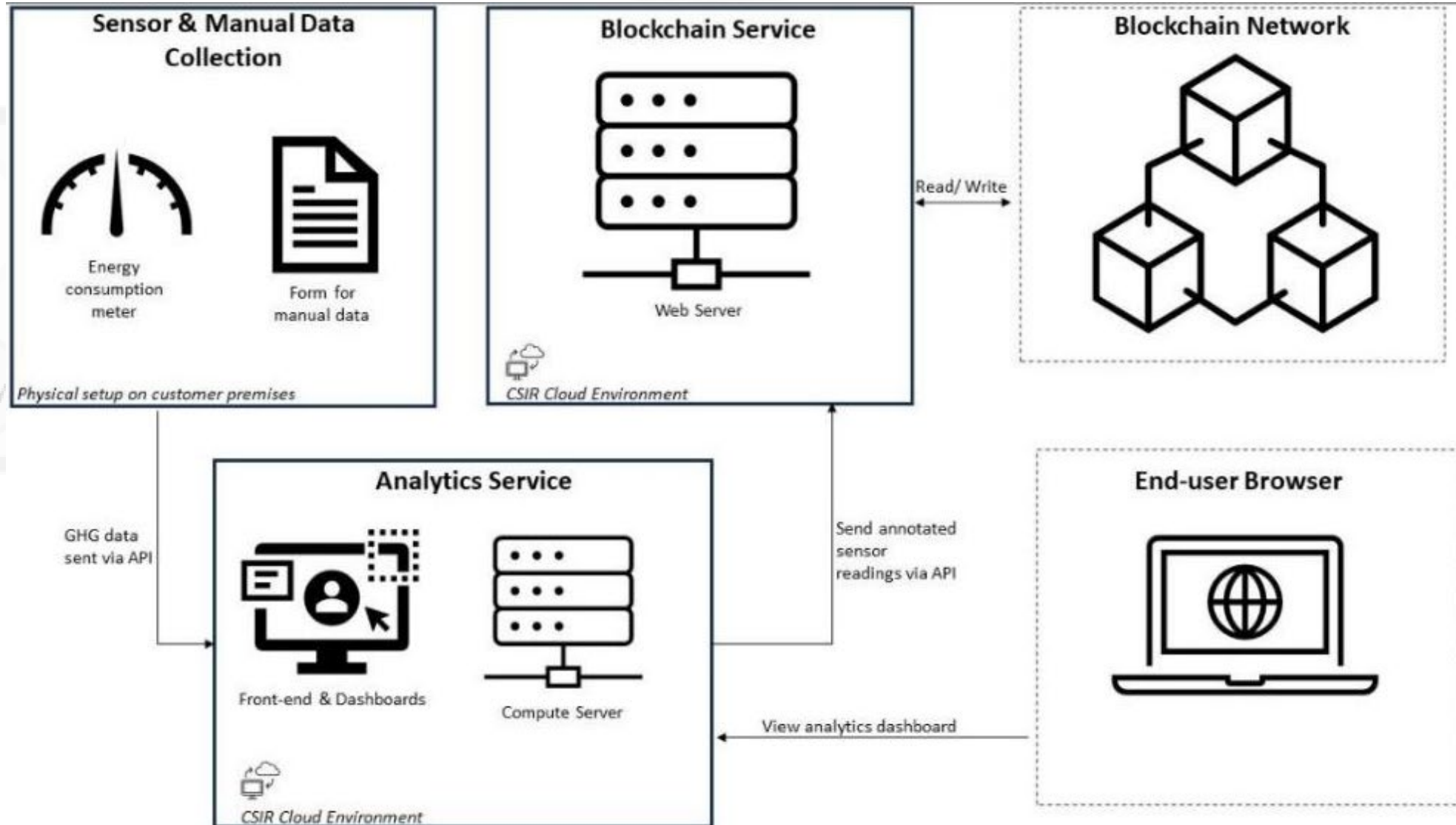
1 DATA COLLECTION "PLUG AND PLAY KIT", CONSISTING OF APPROPRIATE SENSORS FOR AUTOMATED DATA COLLECTION

Pilot at McWade Foundry

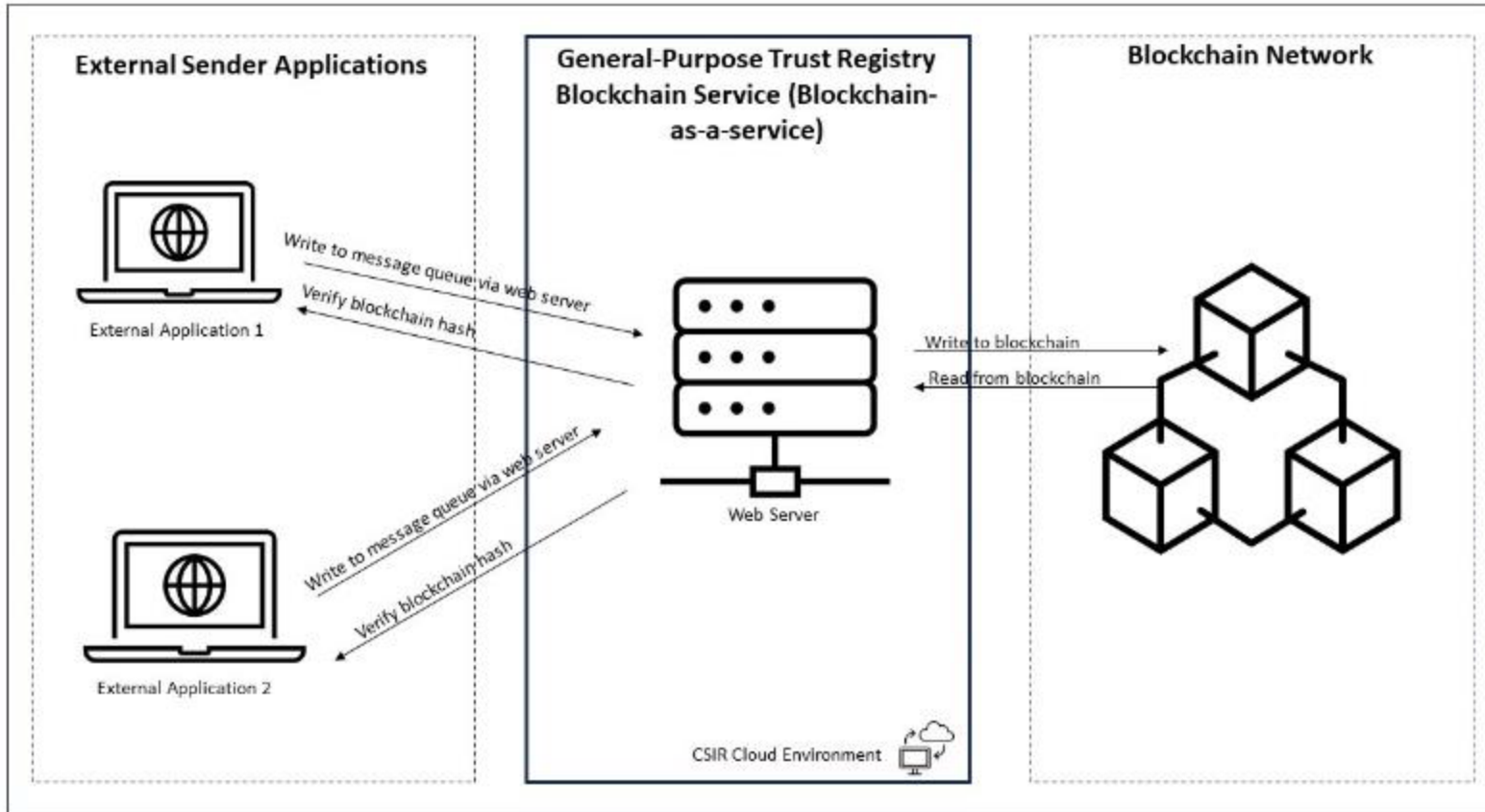
- McWade Productions is an aluminium foundry that supplies electrical components and accessory equipment for the electricity transmission and distribution industry.
- 3-month pilot (May – July 2024) of GHG Observatory deployed at McWade
- Automatic data: energy (office and production floor electricity consumption) – one measurement per hour
- Manual data: gas, petrol, diesel, mileage, aluminium, copper, lg2, zinc, die casting production & sand-casting production – once at month-end



Data Collection, Analytics and Integrity



Data Integrity – CSIR Blockchain-as-a-Service (BaaS)

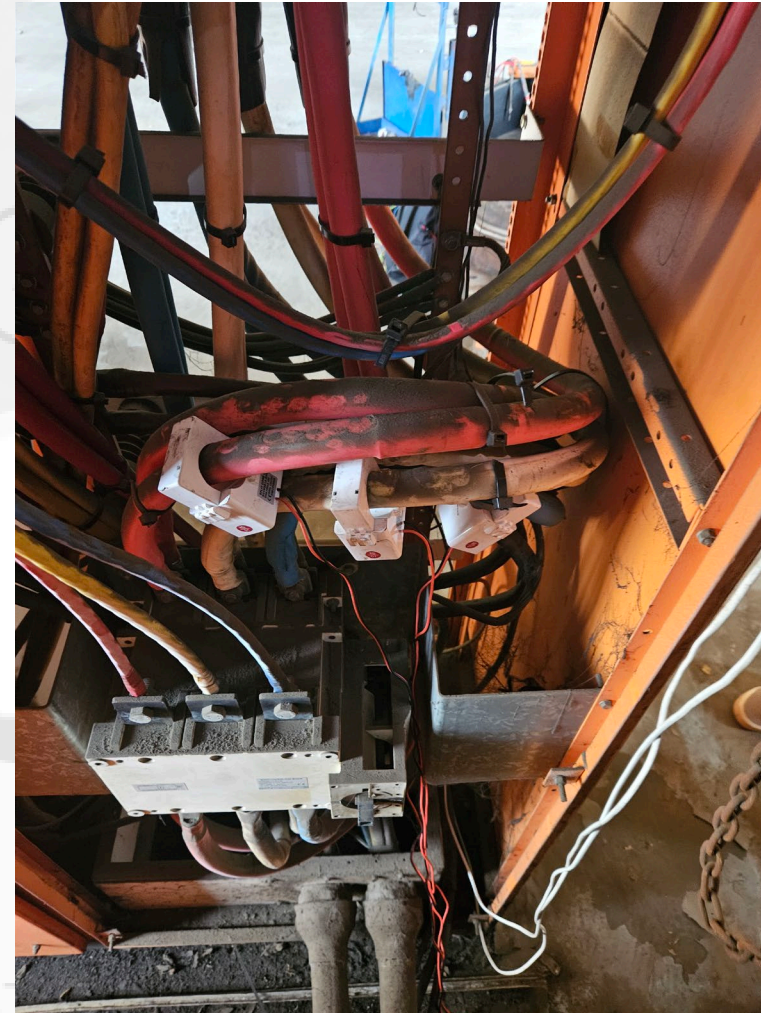


- The CSIR BaaS platform is a pluggable service that writes data to a blockchain platform to prove its integrity and provide traceability and transparency.
- It receives foundry data (energy, gas, fuel, mileage, aluminum, copper, lg2, zinc, die casting production, and sand-casting production) from the Analytics Service, and provides a trust foundation, i.e. proof that the data has not been tampered with.

Data Collection – Hardware Installations (I)

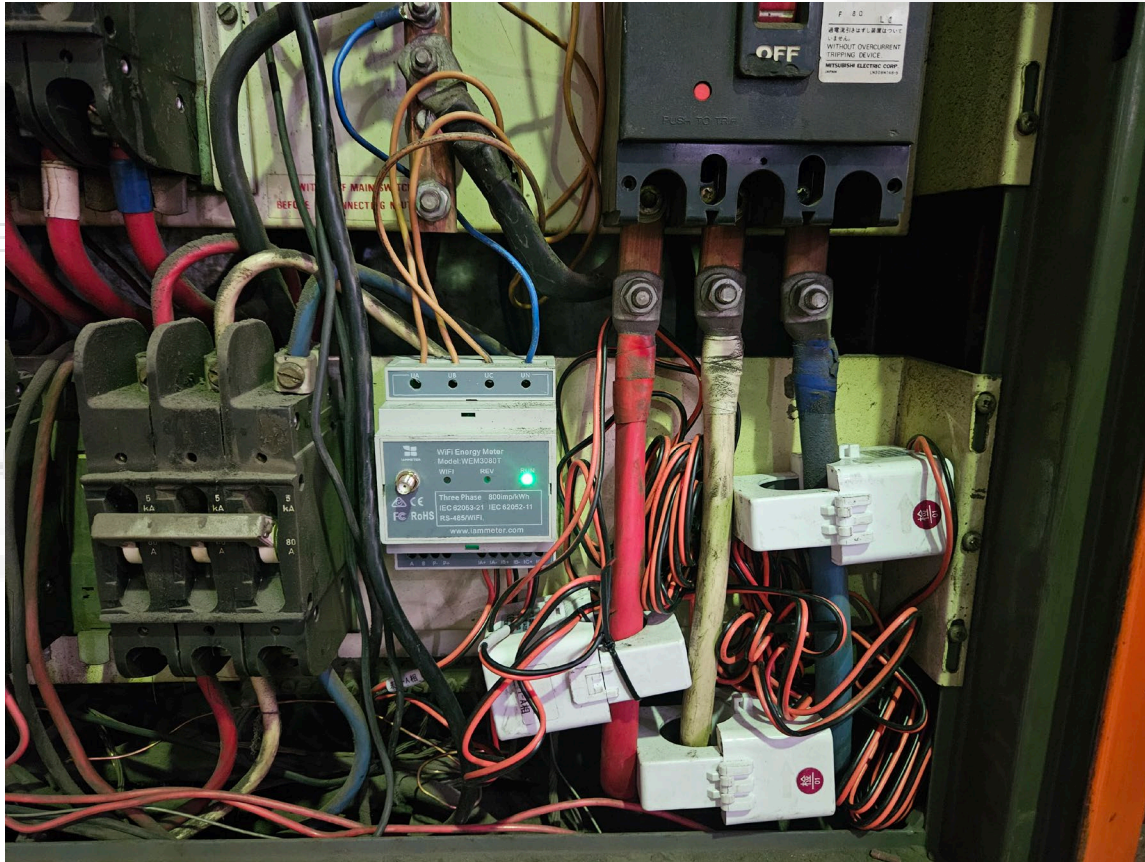


Factory distribution box



Energy meter installation

Data Collection – Hardware Installations (II)



Energy meter installation in office block distribution box



Raspberry Pi

Raspberry Pi installation

Data Collection – Software (I)

Bussiness Usage Information

Gas Usage

Gas reading (m³): Date:

Vehicle Usage

Fuel Type: Date:

Liters filled (L):

Mileage (km):

Raw Materials Usage

Aluminium (kg): Date:

Copper (kg):

LG2 (kg):

Zinc Alloy (kg):

Production Rates

Die casting (kg): Date:

Sand casting (kg):

Usage submission

Submit usage information

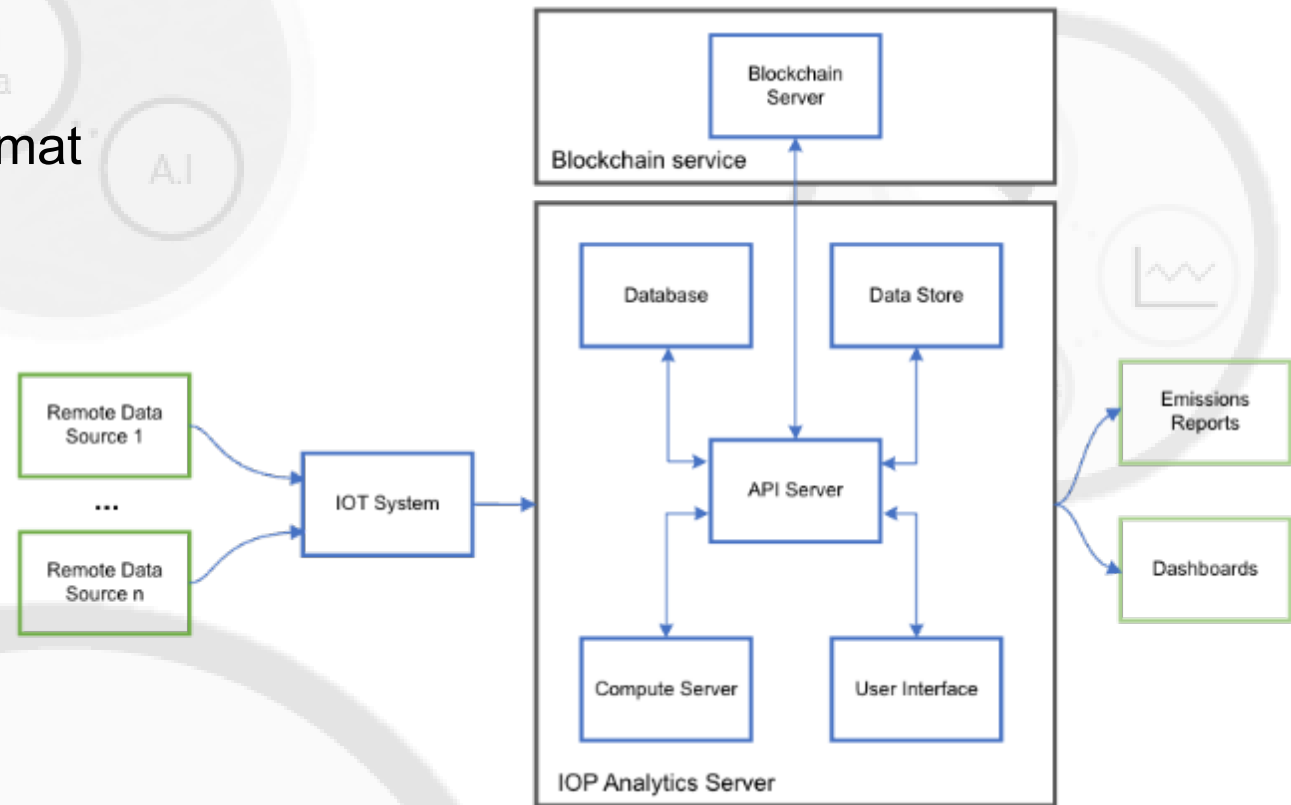
Email Address: *

Password: *

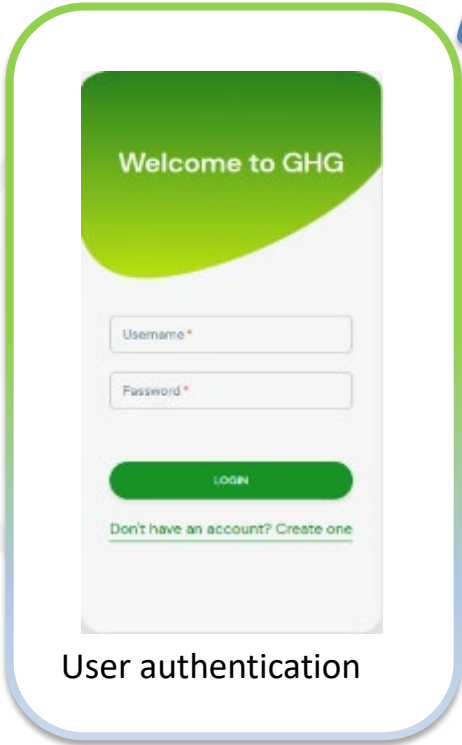
Node-RED dashboard for manual entry of usage data

Data Analytics - Architecture

- The analytics system consists of five interacting components
 - **API Server** - receives data in JSON format from the IOT System.
 - **User interface (UI) server** - serves a browser accessible GUI to the user.
 - **Compute server** - carries out more complex calculations and analysis.
 - **Database** - persists IOT data.
 - **Data store** - stores supplementary multimedia.
- All servers, managed databases, and datastores are hosted on cloud-based infrastructure.



Data Analytics - GUIs



Welcome to GHG

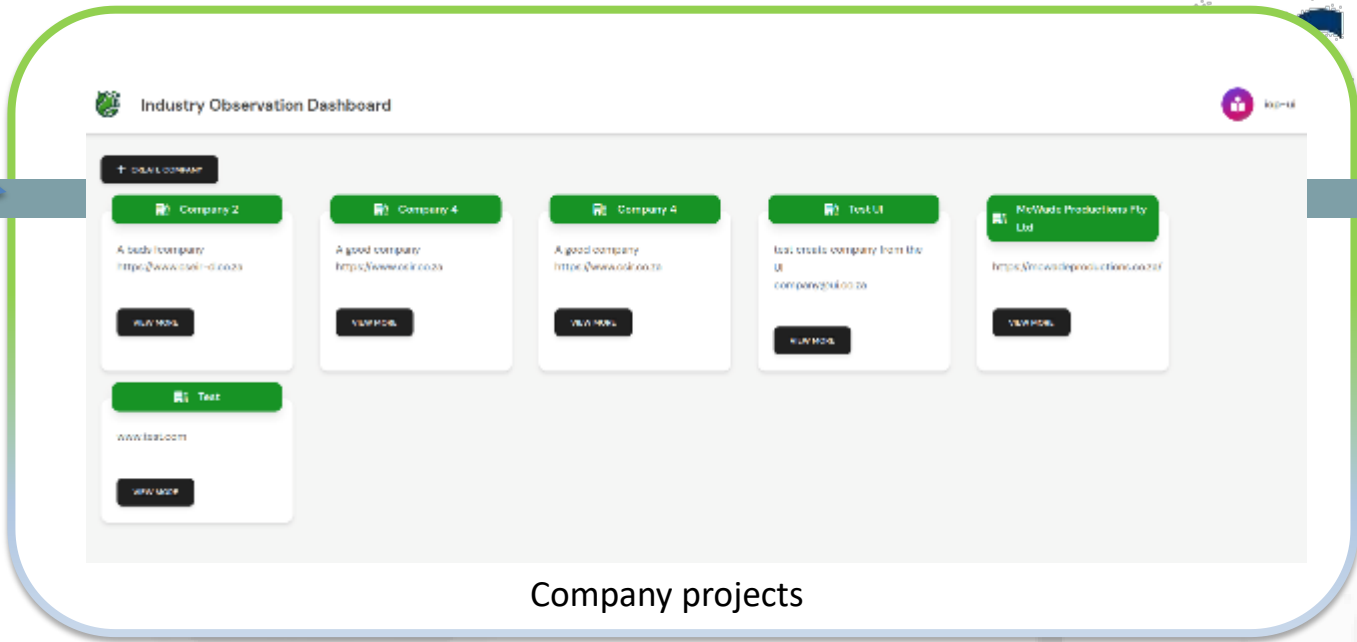
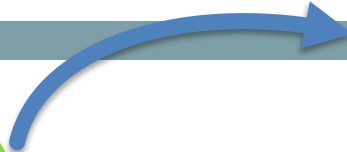
Username *

Password *

LOGIN

[Don't have an account? Create one](#)

User authentication

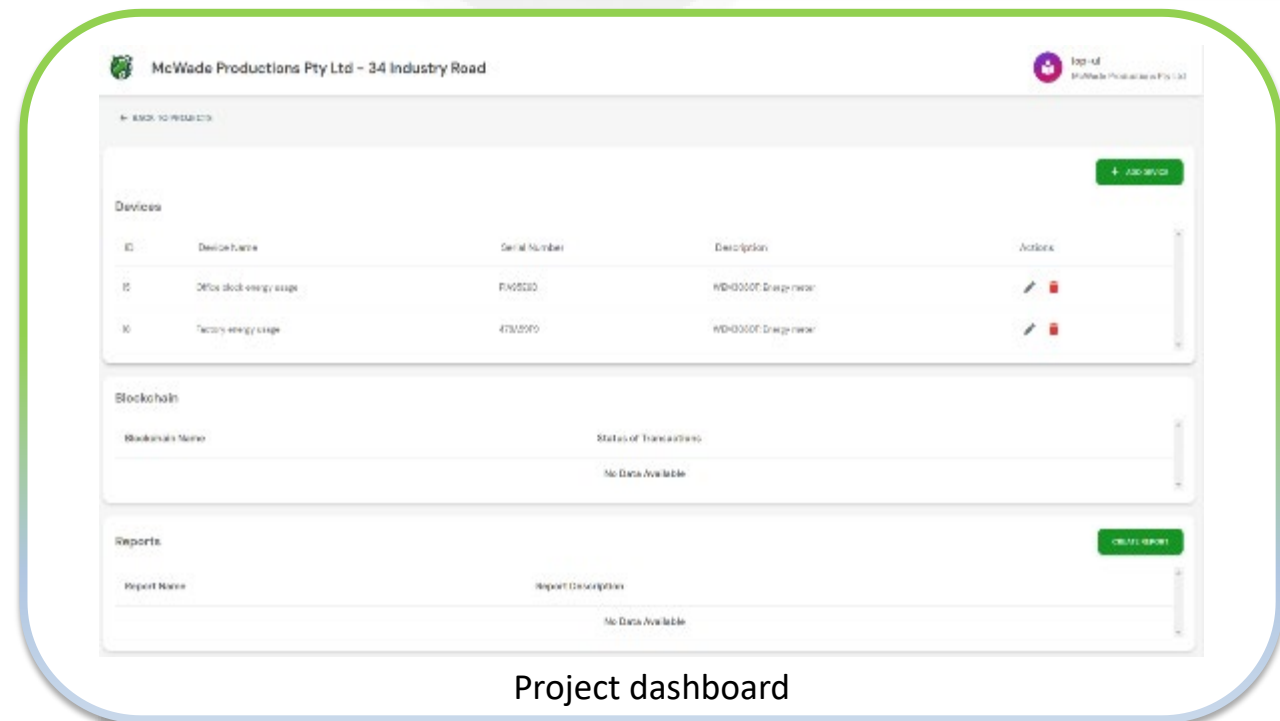


Industry Observation Dashboard

+ ADD COMPANY

- Company 2: A bad company: https://www.0000-0-0020. VIEW MORE
- Company 4: A good company: https://www.0000-0-0020. VIEW MORE
- Company 4: A good company: https://www.0000-0-0020. VIEW MORE
- Test Ltd: Test trials company from the UK: company2@00-00-00. VIEW MORE
- McWade Productions Pty Ltd: https://www.mcwadeproductions.co.za/00-00-00. VIEW MORE
- Test: www.0000.com. VIEW MORE

Company projects



McWade Productions Pty Ltd - 34 Industry Road

+ ADD PROJECT

Devices

ID	Device Name	Serial Number	Description	Actions
15	Office stock energy usage	F102520	WD-0000F: Drage power	[edit] [delete]
10	Factory energy usage	4731050	WD-0000F: Drage power	[edit] [delete]

Blockchain

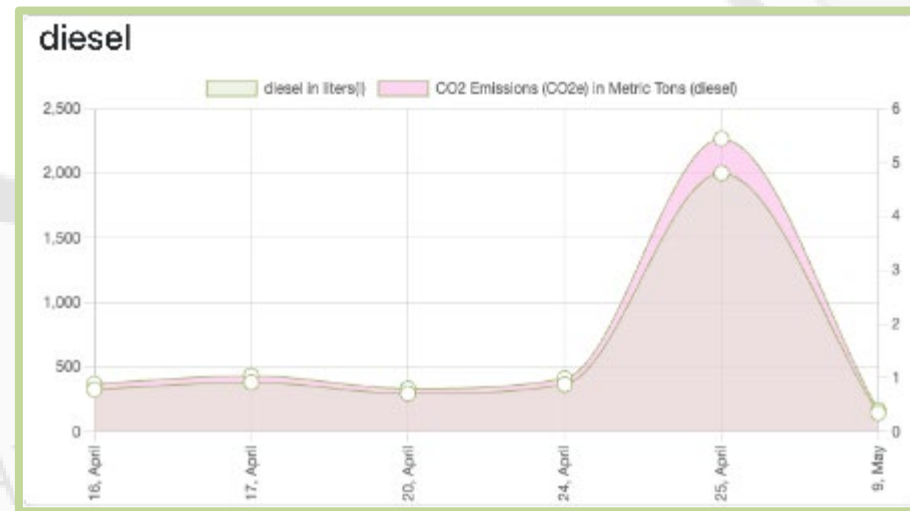
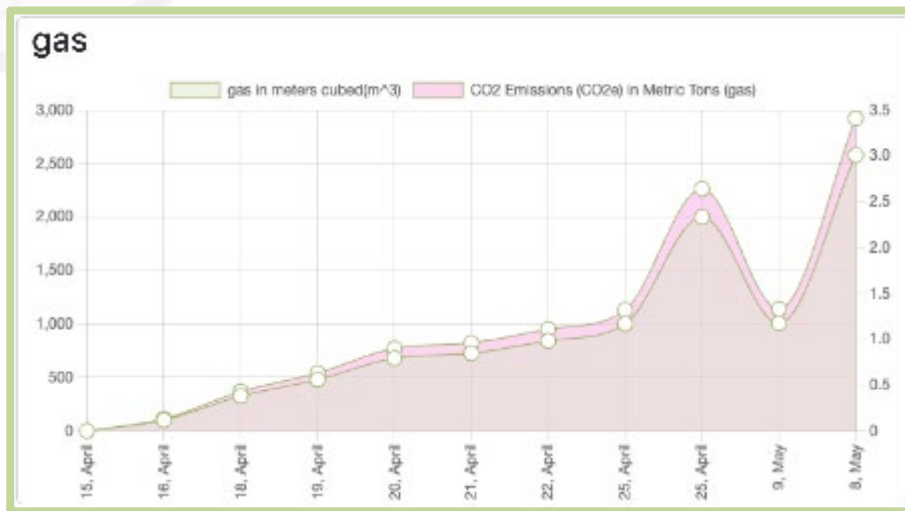
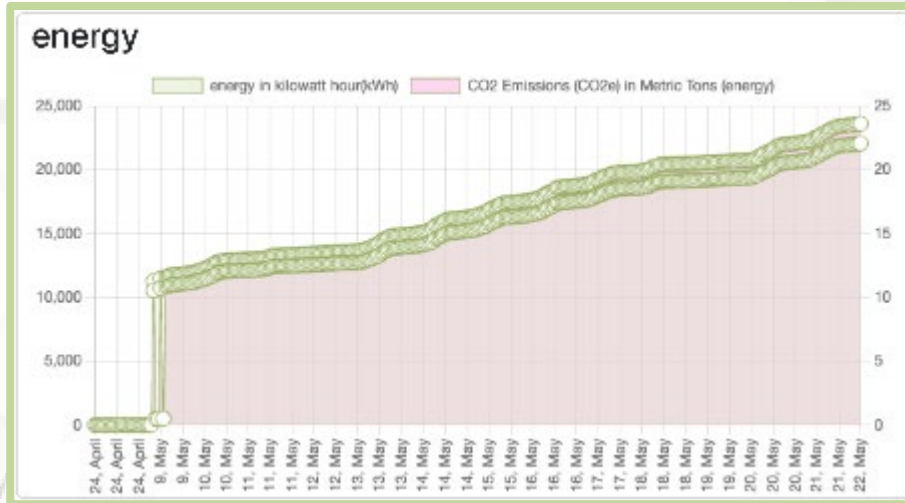
Blockchain Name: Status of Transactions: No Data Available

Reports

Report Name: Report Description: No Data Available

Project dashboard

Data Analytics - Reporting



CBAM Report



Emissions

Foundry Inf

Foundry Name: M

Location: 34 Indus

Contact Person: M

Email: madonah@r

Phone: +27 11 316

EU Importe

Importer Name: C

Location: Meiring P

Contact Person: M

Email: mford@csir

Phone: +27 12 841

Report Peri

Reporting Year: 15

1. Productio

Production Outputs:

- Aluminium: 3
- Copper: 4343.1
- LG2: 3160.41
- Zinc: 3188.30

2. Methodol

Calculation Protoc
emission calculation

Emission Factors: 1
Environmental Affa

3. Emissions Data

Total Carbon Emissi

- Direct Emissi
- Indirect Emiss
-

Per Source:

- Energy: 181.37
- Gas: 6152.23 n
- Petrol: 1623.22
- Diesel: 3368.62

Per Product Type:

- No data availab

4. Emission

Per Tonne of Alumir

- No data availab

5. Existing (

Carbon Costs Paid

Documentation of I
payments.

6. Data Inte

Integrity Statement
service platform whi
manual input forms

7. Third-Par

Verifier Name: Gre

Verification Statem
Solutions and confor

8. Compliar

CBAM Complianci
compliant with the C

Future Steps: Planning to insta
reduce emissions.

Appendices

Appendix A: Detaile

Energy

- Methodology: Calculator
- Data Used:
 - Energy Consumption
 - Emission Factor: 0.5
- Calculations:
 - Total CO2e = 181.37

Gas

- Methodology: Calculator
- Data Used:
 - Gas Consumption: ?
 - Emission Factor: 0.5
- Calculations:
 - Total CO2e = 1,500.0

Petrol

- Methodology: Calculator
- Data Used:
 - Petrol Consumption
 - Emission Factor: 0.5
- Calculations:
 - Total CO2e = 1,500.0

Diesel

- Methodology: Calculator
- Data Used:
 - Diesel Consumption
 - Emission Factor: 0.5
- Calculations:
 - Total CO2e = 1,500.0

Cumulative Calculation

- Output: 3,375 metric tons
- Emissions Per Tonne: 1,3
- Tonne: 600, 000 kg / 2,40

energy



petrol



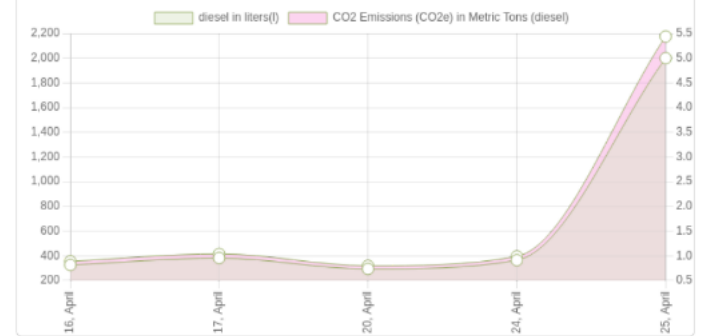
gas



mileage



diesel



Appendix C: Third-party Verification Report

NB: This is sample data.

Verification Agency: Green Audit Solutions Johannesburg

Summary:

- Objective:** To verify the accuracy and reliability of emissions data provided by McWade Productions.
- Scope:** Verification of emissions data calculations and methodologies for high-carbon and stainless steel production for the year 2024.
- Methodology:** On-site audits, review of production logs, energy usage records, and independent emissions testing.
- Findings:** Verification confirmed that the emissions calculations were accurate and consistent with international standards.
- Recommendations:** Recommendations for further improvements in data collection were provided to ensure continuous enhancement of reporting accuracy.
- Conclusion:** The emissions report from McWade Productions for 2024 meets all regulatory standards and reporting requirements for accuracy and compliance.

Verification Certificate: A formal certificate stating that Green Audit Solutions has verified the emissions data as accurate and compliant with the required standards. **NB - This is sample data.**

Appendix D: Receipts of Carbon Tax Payments

Summary:

Documented Evidence:

- Carbon Tax Receipts:** Copies of official receipts for carbon tax payments made to the South African Revenue Service for the fiscal year 2024.



Final Remarks



Ensure Global Competitiveness

To remain competitive in global markets, especially with the **EU's Carbon Border Adjustment Mechanism (CBAM)**, the **GHG Data Observatory** is essential for providing verified emissions data, preventing costly export tariffs, and ensuring continued access to international markets.



Take Control of Emissions

The foundry sector and other high-emission industries must take proactive steps to **accurately track and manage GHG emissions**. The observatory provides the tools to identify emission hotspots and drive **decarbonization efforts**.



Empower SMEs with Cost-Effective Solutions

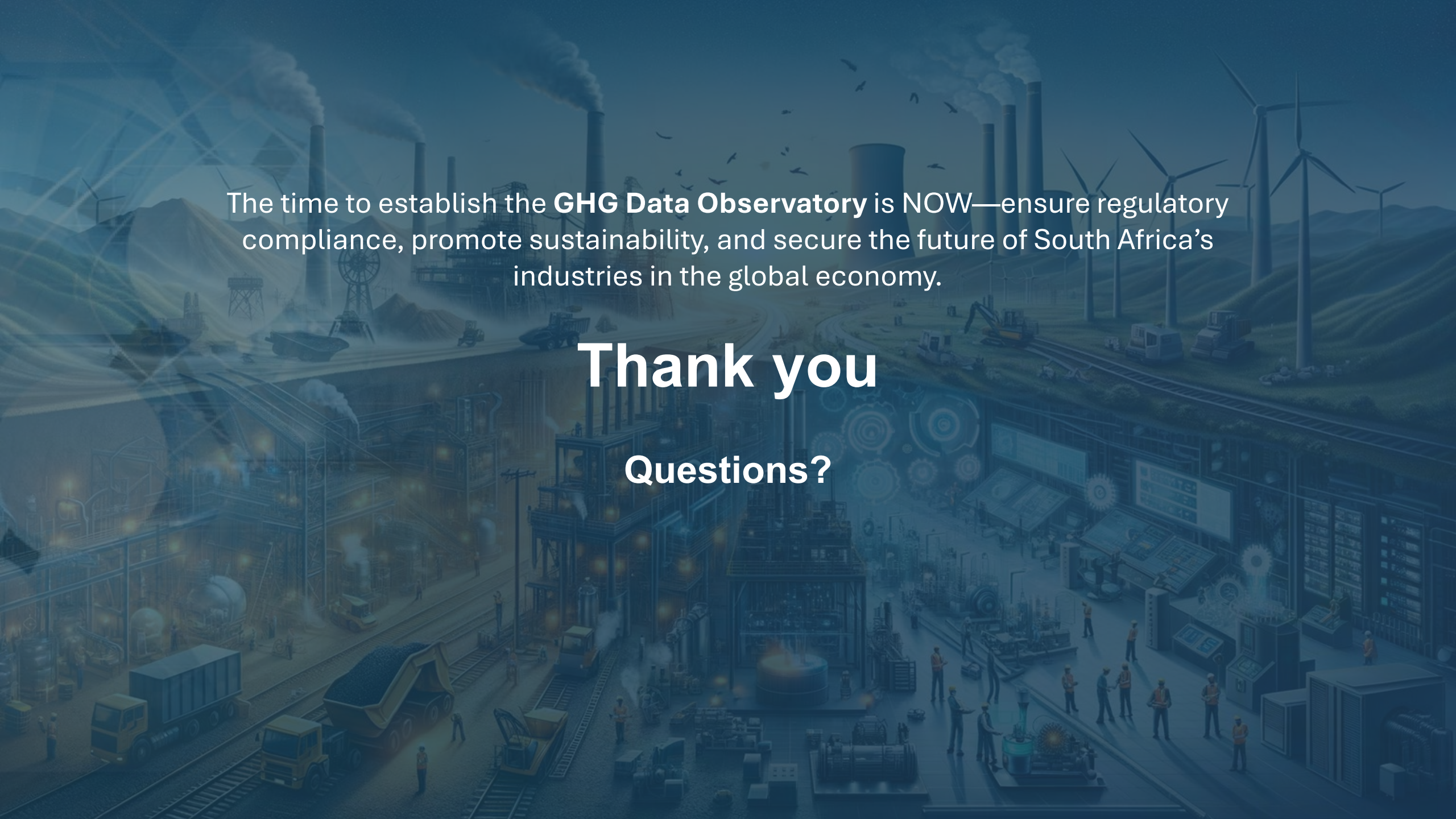
By adopting **proxy measurements** and affordable monitoring technologies, the observatory offers a solution that allows **smaller players** to meet compliance standards without the high costs of traditional CEMS.



Support a Sustainable Future

By implementing the **GHG Data Observatory**, we can build a more **sustainable and resilient industrial sector**, supporting energy efficiency, environmental stewardship, and long-term economic viability.





The time to establish the **GHG Data Observatory** is NOW—ensure regulatory compliance, promote sustainability, and secure the future of South Africa's industries in the global economy.

Thank you

Questions?