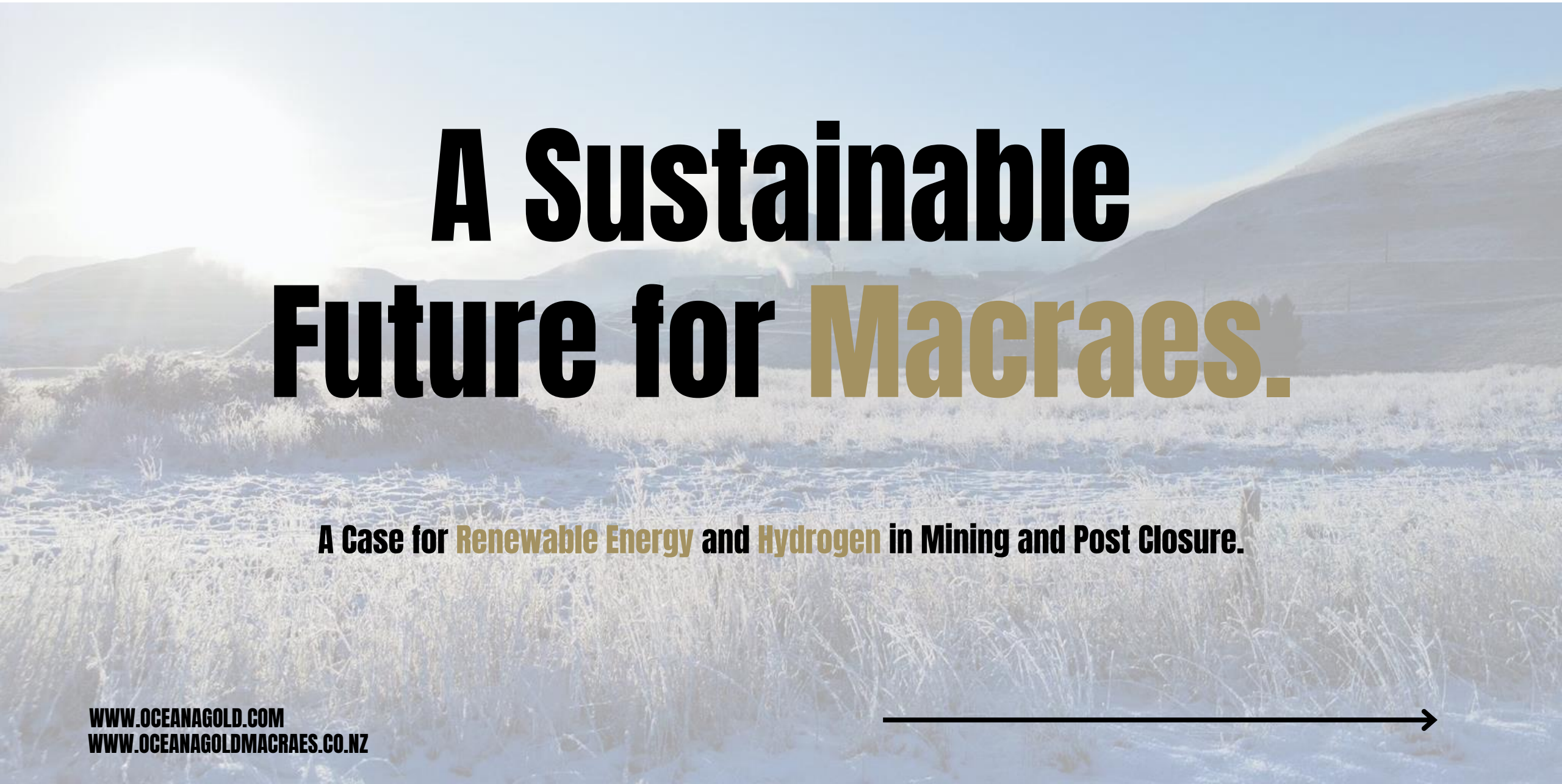


A Sustainable Future for Macraes.

A Case for Renewable Energy and Hydrogen in Mining and Post Closure.

WWW.OCEANAGOLD.COM
WWW.OCEANAGOLDMACRAES.CO.NZ

Contents.

01 Introduction to OceanaGold Macraes

02 Our Path to Lower Emissions

03 Unlocking Renewable Energy at Macraes

04 Potential to Accelerate Decarbonisation with Hydrogen

05 Sustainable Opportunities Post-Closure

06 Recommendations & Next Steps

INTRODUCTION.

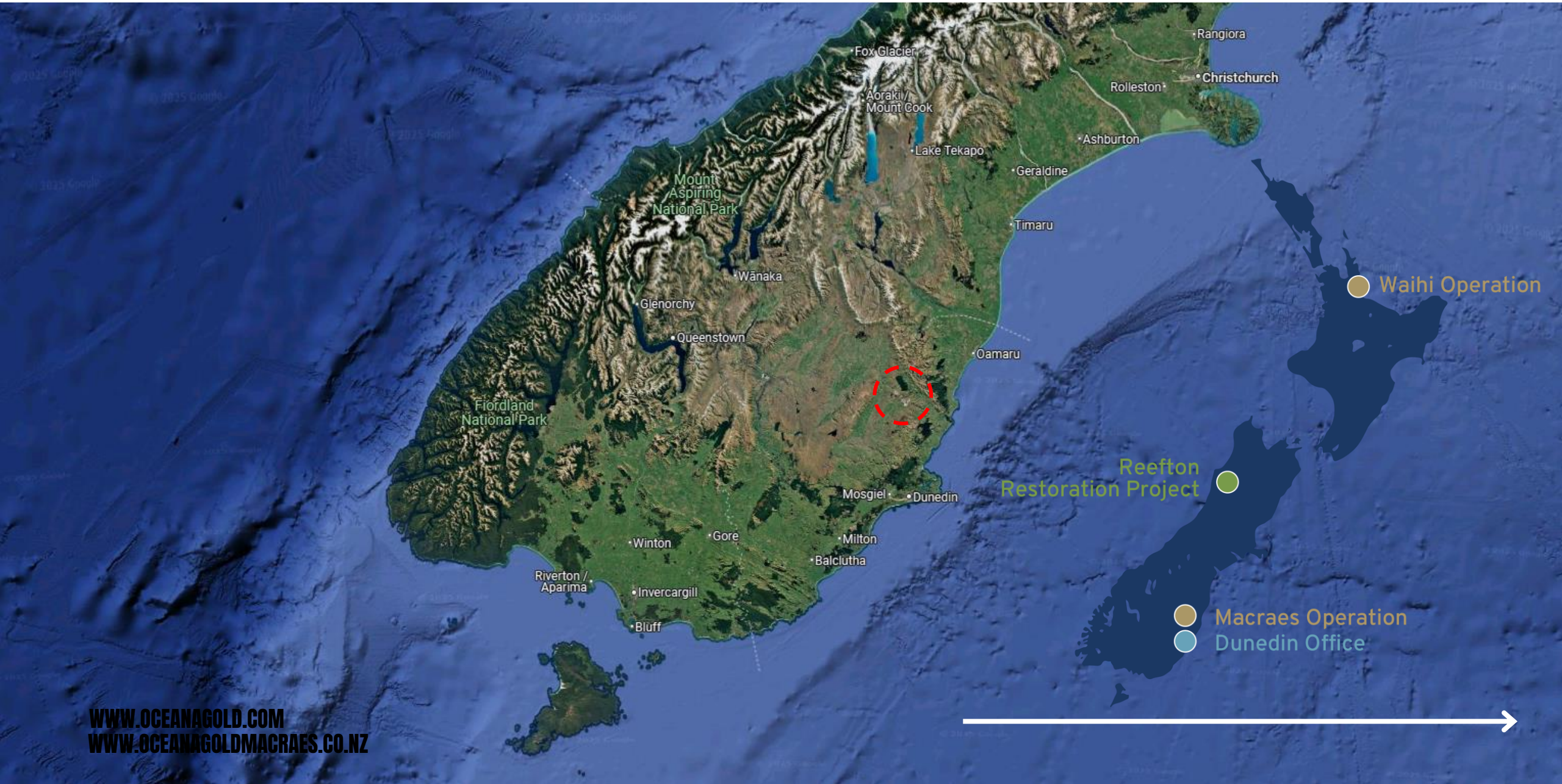
OceanaGold is a multinational gold mining company with operations in New Zealand, the Philippines, and the United States. The Macraes Operation in East Otago is New Zealand's largest gold mine, producing over 5 million ounces since 1990 through both open-pit and underground mining.

Macraes is a major economic contributor to the region and one of the South Island's largest industrial energy users—driven largely by diesel-powered equipment and grid electricity powered processing.

At OceanaGold, we pride ourself on environmental stewardship, responsible mining, and sustainable practices.

WWW.OCEANAGOLD.COM
WWW.OCEANAGOLDMACRAES.CO.NZ

OceanaGold Macraes Operation



WWW.OCEANAGOLD.COM
WWW.OCEANAGOLDMACRAES.CO.NZ

ABOUT ME.

Daniel Jelfs
Energy Engineer, OceanaGold New Zealand

- Joined OceanaGold nearly 3 years ago through the **EECA Energy Graduate Program**.
- **Chemical & Process Engineer** with a minor in **Sustainable Energy Engineering.**
- Based at the **Macraes processing plant**, leading **decarbonisation and energy efficiency projects**.
- The EECA program provided a strong foundation—**bridging technical skills with real-world impact**

MACRAES EMISSION PROFILE.

Diesel Consumption

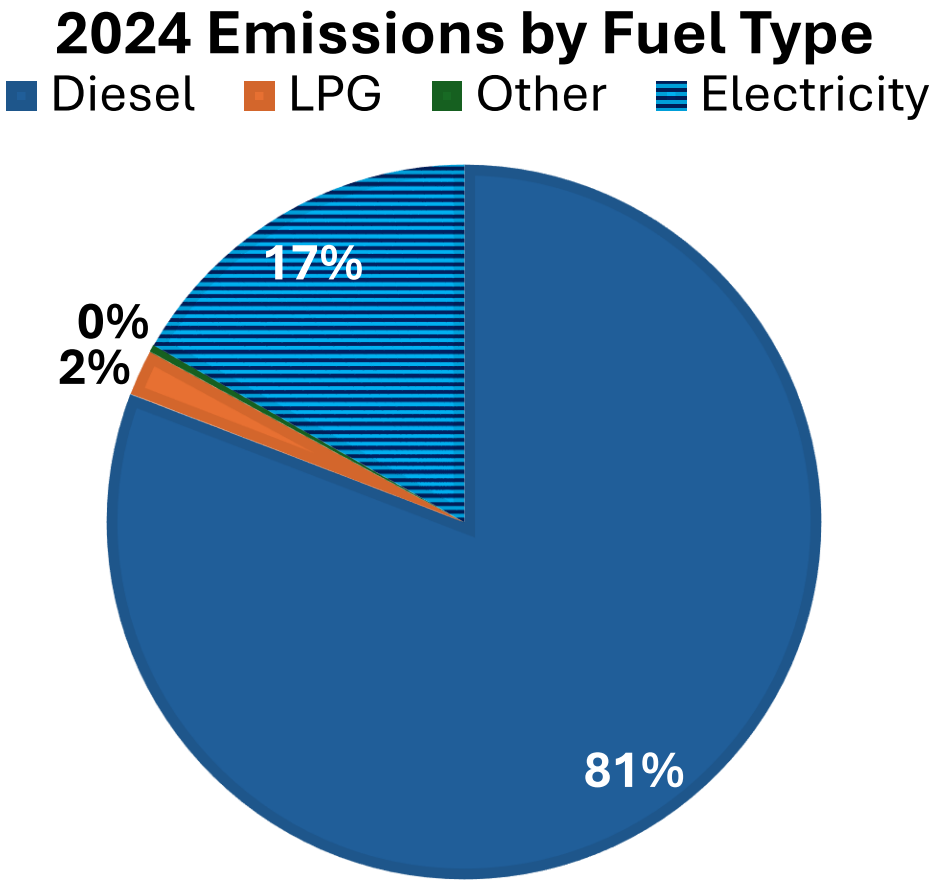
Powers heavy machinery, haul trucks, and backup generators. Macraes consumes on the order of 25 million L of diesel annually – Diesel dominates Macraes Emissions Profile.

Grid Electricity

Electricity at Macraes powers key systems including the processing plant, oxygen plant, underground ventilation, dewatering, and administration buildings. Between 2019 and 2024, annual electricity demand averaged 190 GWh, with peak site loads of around 25 MW.

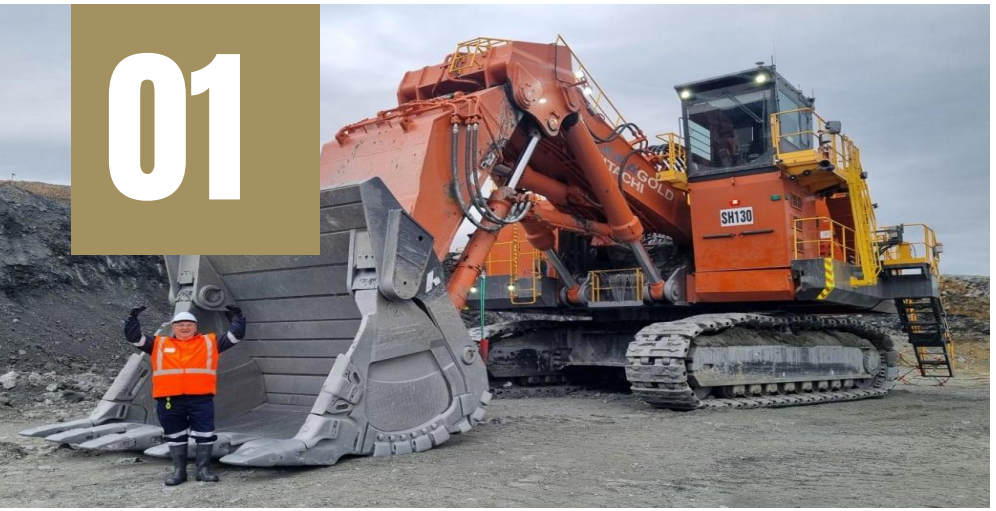
LPG Consumption

A smaller but notable contribution comes from LPG used in processing activities such as carbon regeneration, the elution circuit, and furnaces. Macraes consumes approximately 1.2 million L of LPG annually.



Market based electricity emissions are fully offset via Renewable Energy Certificates (REC's)

OUR PROJECTS.



1. New Zealand's first electric hydraulic mining shovel **(~2,200 tCO_2-e reduction[1])**
2. Electric Induction Furnace for the gold room **(~160 tCO_2-e reduction[2])**
3. Renewable Energy Certificates (REC'S) **(15,000 tCO_2-e reduction in market-based emissions since 2022)**

WWW.OCEANAGOLD.COM
WWW.OCEANAGOLDMACRAES.CO.NZ

[1] Based on 2024 operational data compared to the diesel excavators on-site
[2] Estimated annual reduction. Induction furnace was commissioned in December 2024

HOW DO WE COMPARE.

Macraes maintains a competitive emissions intensity of **0.55 to 0.65 tCO_2-e/oz** compared to other Australasian mid-tier gold producers averaging **0.7–0.8 tCO_2-e/oz**.

Strong Scope 2 performance due to:

- New Zealand's ~85% renewable electricity grid
- Full coverage through Renewable Energy Certificates (RECs)

Competitive advantage over Australian mines reliant on fossil-fuel electricity generation.

However, Scope 1 emissions remain a persistent challenge, driven by diesel use for material movement in open-pit mining and the processing of low-grade ore, which requires handling and transporting larger volumes of rock.

DIESEL HAUL FLEET.

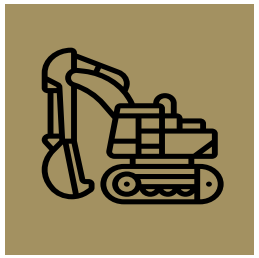
The Macraes Operation runs a fleet of **21 diesel-powered haul trucks** supporting open-pit mining operations.

These trucks are the single largest source of emissions on site, contributing to approximately **50% of total site greenhouse gas emissions.**

This is primarily due to:

- **High diesel consumption** due to the volumes of material that needs to be moved.
- **Long travel distances** and steep haul profiles.

CHALLENGES IN DECARBONIZING DIESEL.



Tech Availability

Emerging electric and hydrogen haul truck technologies are promising but not yet widely available at the scale required. Most options currently require full fleet replacement rather than retrofit solutions—raising both cost and implementation risk.

Electricity supply

Electrification requires significant increases in site electrical infrastructure. Peak loads from battery-electric fleets may exceed current capacity.

Life of Mine

Macraes' limited remaining life constrains the economic viability of large capital projects

Concept Study Objectives.

Renewable Integration

Assess the feasibility of integrating on-site renewable energy—primarily solar PV—into Macraes' operations. This includes evaluating resource potential, grid interactions, seasonal performance, and overall economic viability.

Hydrogen Utilisation

Explore opportunities for producing and using green hydrogen at Macraes, particularly as a transport fuel for heavy mining vehicles. The study will consider infrastructure needs, supply chain logistics, and decarbonisation impact.

Potential Post Mine Closure Concept

Develop a post-mining pathway where renewable and hydrogen infrastructure can be repurposed. The goal is to establish a clean energy hub that supports local communities and contributes to New Zealand's broader energy transition.

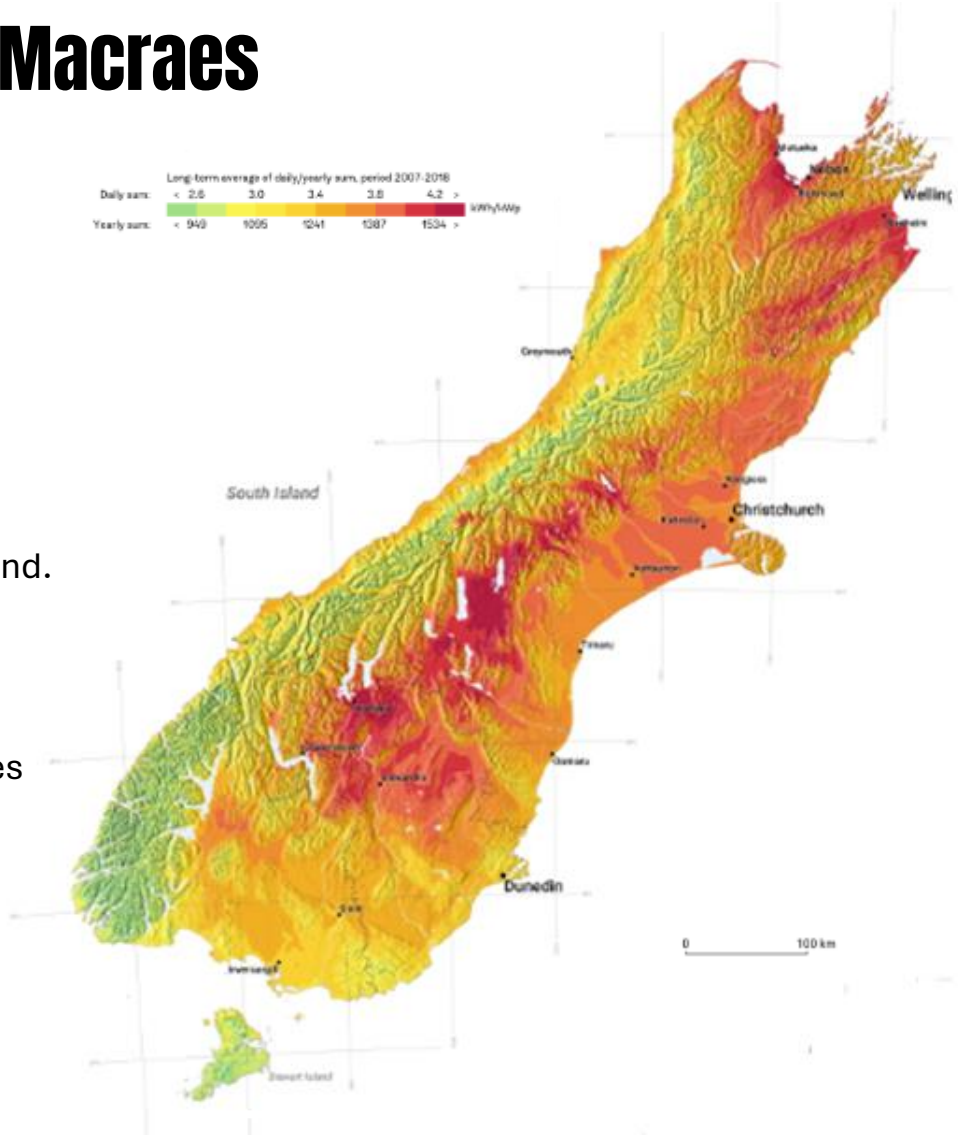
Potential for Renewable Energy Integration at Macraes

Macraes is one of NZs largest energy users and carbon emitters. With mine closure approaching there is a unique opportunity to deploy on-site solar to:

- Cut emissions and electricity costs immediately.
- Improve energy resilience in a remote location.
- Leave behind a large-scale renewable asset for regional benefit.

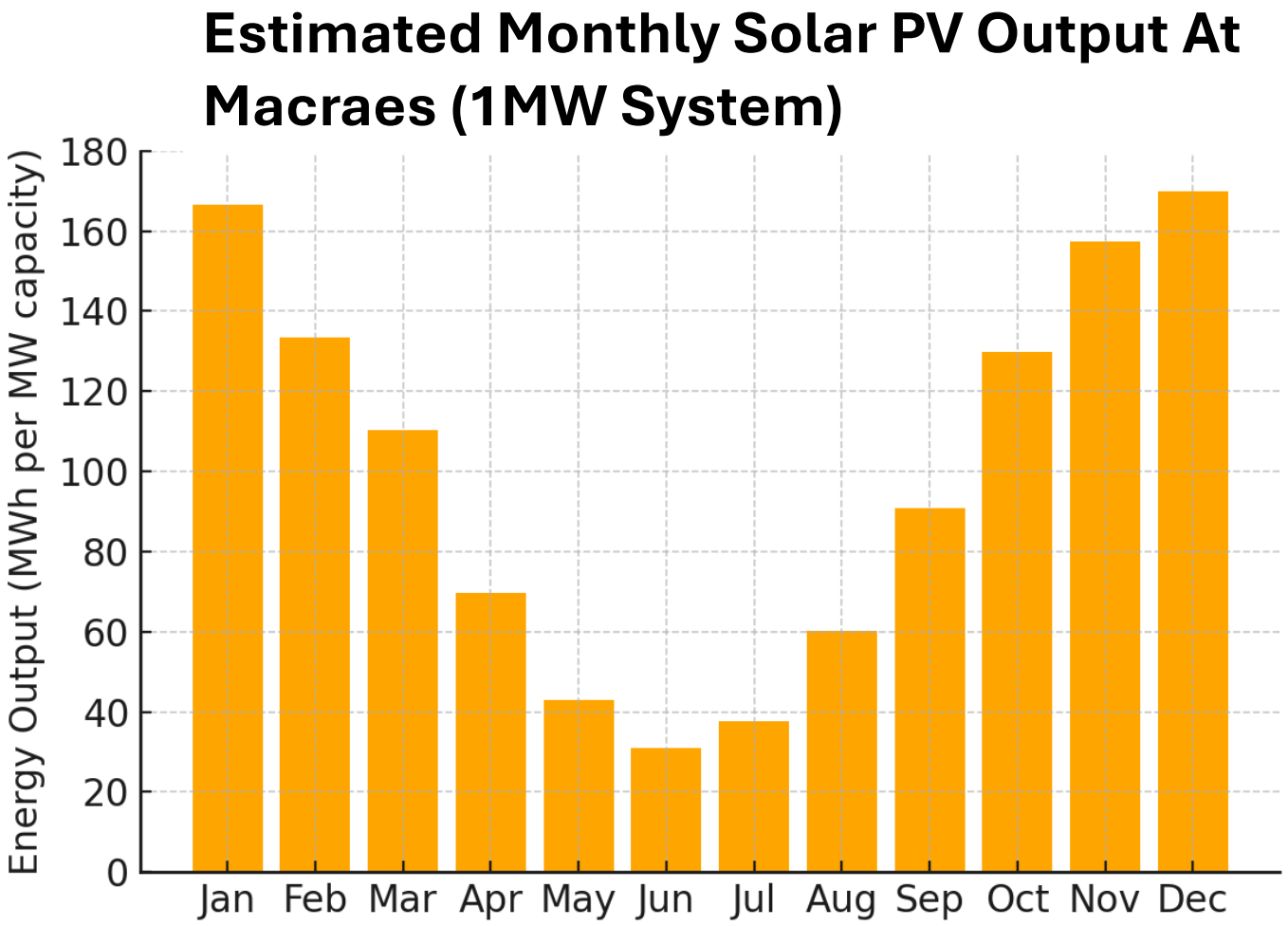
Why Macraes?

- Strong irradiance: 1,300–1,500 kWh/kWp/year, among the best in New Zealand.
- Inland site with frequent clear skies supports reliable solar generation.
- Flat, unused land near site infrastructure is ideal for large-scale PV.
- Solar helps reduce reliance on remote grid connection and associated losses (~7% for Macraes).



Seasonal Variation.

Seasonal variation: 5–6 kWh/m^2/day in summer, ~1–2 kWh/m^2/day in winter.



Potential Phased Deployment Strategy.

Phase 1 – Pilot (≈10 MW)

Initial solar installation on flat land near existing infrastructure, generating **12–16 GWh/year** (~6–10% of site demand).

- Designed for full on-site use with minimal grid upgrades.
- Allows OceanaGold to own and operate the system or partner under a PPA.

Phase 2 – Expansion (≈30 MW total)

Scale-up to 30 MW capacity, delivering **40–50 GWh/year** (~25% of demand).

- May introduce **20–50 MWh battery storage** to shift midday surplus.
- Likely requires upgrades to internal electrical network.
- Suited to third-party delivery under a PPA model.

Phase 3 – Full-Scale/Post-Mining (≈50-60 MW)

Final expansion to 50–60 MW as mine areas are rehabilitated, producing **75–90+ GWh/year** (~40–50% of demand).

- Enables grid export, large-scale storage, or curtailment strategies.
- Positions site for long-term renewable legacy use beyond mining.

Each phase allows evaluation of performance and economics before committing to the next stage, mitigating risk while aligning capital expenditure with the mine's production schedule. Designing the site layout in advance for the full capacity while installing in stages avoids redundant work and reduces costs in later phases.

Cost Benefit & Levelized Cost of Electricity (LCOE).

	NZ 2024 Average Spot Price	Phase 1 (~10MW)	Phase 2 (~30MW)	Phase 3 (~60MW+)
LCOE	NZ$178/MWh	NZ$115/MWh	NZ$100/MWh	NZ$85/MWh
Savings	-	35% savings	45% savings	50% savings

Key Points:

LCOE significantly reduces with increased scale:

- Pilot (10 MW): NZ$1.70/W
- Full-scale (60 MW): NZ$1.30/W

Grid electricity prices expected to rise (28–35% by 2025):

- Enhances solar's economic attractiveness.

Solar investment provides long-term hedge against market volatility.

Decarbonizing Mining: Haul Truck Technologies.

Mining haul trucks present unique decarbonization challenges. Several technologies offer different advantages and limitations.

Battery-Electric Vehicles

Zero emissions, limited range, heavy battery packs, extensive infrastructure.

Hydrogen Dual-Fuel

Reduces emissions by **~40%,** flexible operation, moderate infrastructure requirements.

Fuel-Cell-Electric

Zero emissions, longer range than BEVs, rapid refueling, technology still maturing.

Bio-Diesel

Lower emissions than traditional diesel, but **high costs** and **limited supply** in New Zealand.

Preferred Option for further assessment: Hydrogen dual-fuel technology provides the most immediate path to decarbonisation while utilising existing infrastructure.

Hydrogen Dual Fuel Technology - What Is It & How It Works.

What Is It?
Hydrogen dual-fuel systems blend hydrogen with diesel in modified engines, enabling both fuels to combust simultaneously. This **transitional decarbonisation technology** lowers emissions while keeping full diesel fallback.

How It Works:

- **Hydrogen is injected** into the intake of a standard diesel engine.
- Replaces up to **40% of diesel** during combustion.
- Engine reverts to **100% diesel** if hydrogen is unavailable — no downtime.
- **Each kg of hydrogen offsets ~3.6 L of diesel**, cutting emissions

Key Benefits:

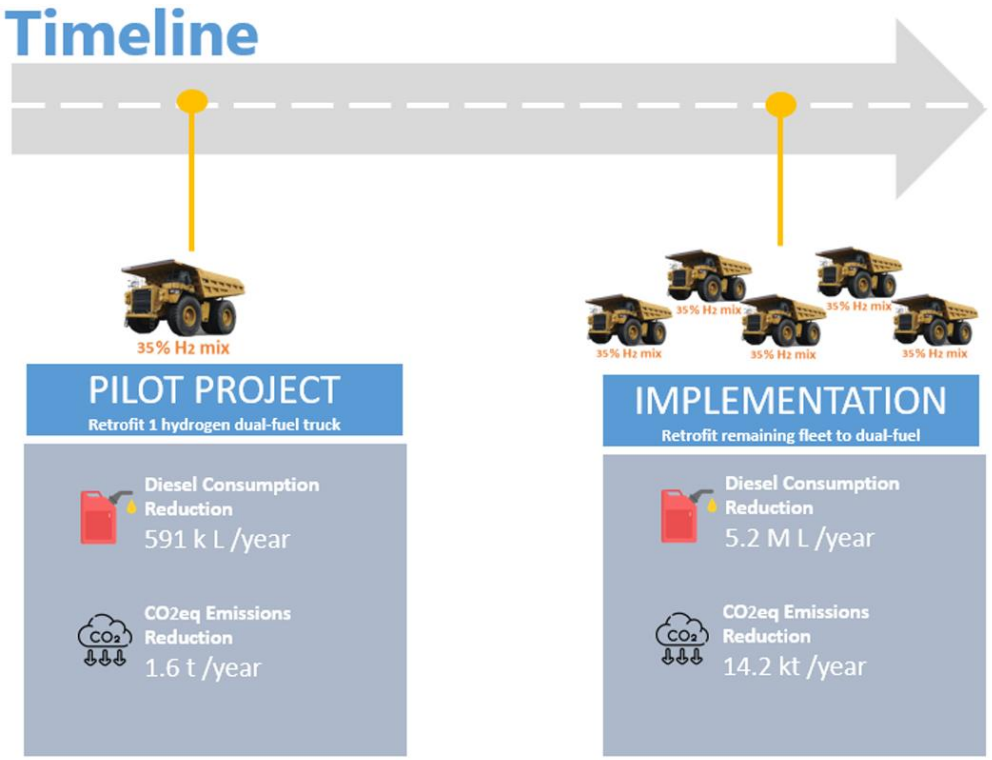
- **Up to 40% CO_2 reduction** per vehicle.
- **Retrofit-ready:** Works with existing haul trucks.
- **Lower infrastructure burden** than full electrification.
- **Extended range** vs battery-electric systems.
- **Resilient:** Hybrid system ensures uninterrupted operation

Potential Hydrogen Decarbonization Pathway

Phased rollout of hydrogen dual-fuel haul trucks, starting with a single-truck pilot and scaling to full fleet conversion. Each truck uses ~170 kg H_2/day.

Phase 1 – Pilot

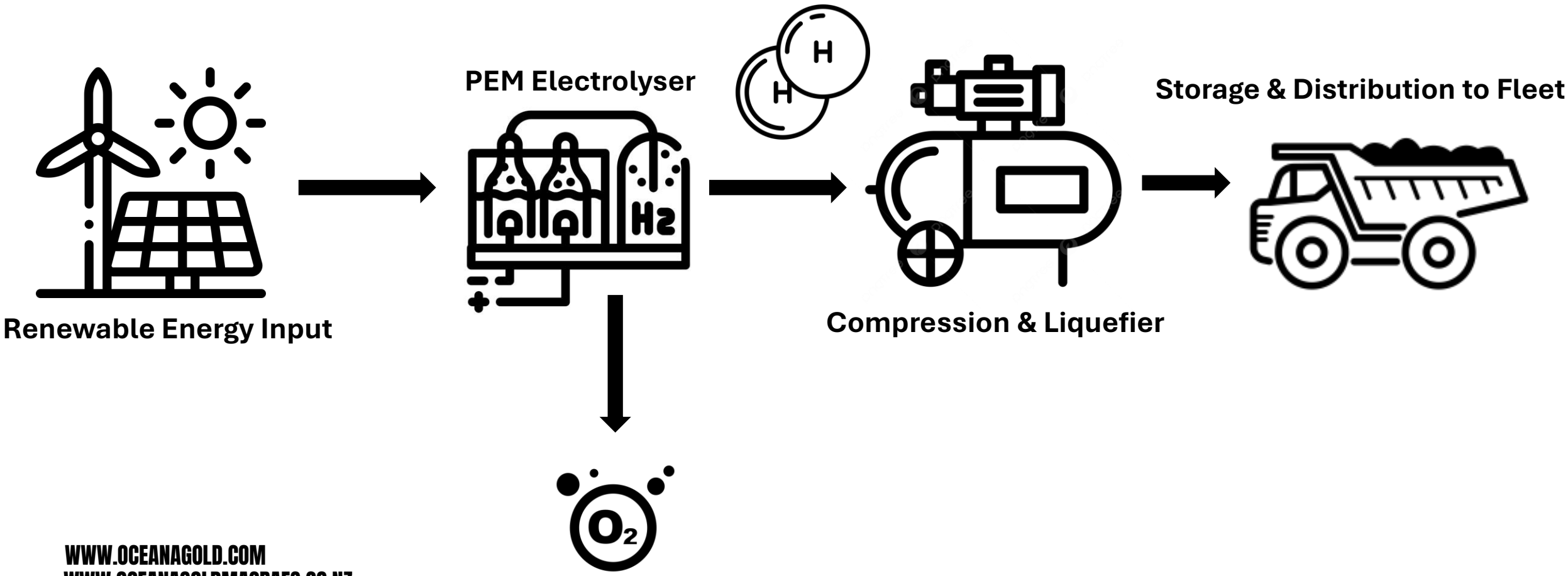
- Retrofit **1 truck** with dual-fuel (~35% H_2 blend)
- **Diesel saved:** 591 kL/year
- **CO_2 reduction:** 1.8 t/year
- **Supply:** On-site electrolyser and liquefier (imported H_2 uncertain)
- **Purpose:** De-risk tech and validate infrastructure



Full Implementation

- Retrofit entire fleet (**~21 trucks**)
- **Diesel saved:** 5.2 ML/year
- **CO_2 reduction:** 14 t/year (~20% fleet emissions)
- **Supply strategy:** On-site production preferred
  - Cuts cost, supply risk, and logistics
  - May require **strategic partnerships** for capital and operations

Onsite Production / Renewable Energy



Utilizing Oxygen Byproduct from Hydrogen Production.

Current Situation

- The onsite oxygen plant accounts for ~15–20% of site electricity consumption.
- Excess oxygen is often vented, leading to wasted energy and inefficiencies.

Opportunity from Green Hydrogen

- Electrolysis produces **oxygen as a byproduct**.
- Could **replace or downsize existing oxygen plant** needs.

Key Benefits

- **Offsetting oxygen supply** reduces associated cost.
- Associated cost savings equivalent to **10–15% of hydrogen plant OPEX.**
- Frees up **~15-20%** of sites electricity use for other uses (Hydrogen production).

Hydrogen Economic Analysis.

Economic analysis for full deployment of dual-fuel technology over the fleet of 21-haul truck. Hydrogen production estimated at ~3,600 kg/day.

Component	Metric / Range	Notes
CAPEX	NZ$65–75M total	Retrofits ~15%, Electrolyser+liquefaction ~75–80%, Refueller <5%
OPEX	15–20% of CAPEX per year	Hydrogen production, ~65 kWh/kg H_2
Annual Savings	20–25% of CAPEX/year	Diesel offset: 65–70% of OPEX, Carbon credits: 20–25%, Oxygen: 10–15%
CO_2e Reduction	~14,000 tonnes/year	Abatement cost: ~NZ$300/tonne
IRR (with 20% grant)	Low but positive	Improves with onsite solar integration

Project achieves breakeven over ~15 years with carbon savings, diesel offset, and oxygen byproduct value, so currently not economically feasible with limited Macraes mine life. Strategic grant funding or onsite solar generation can significantly improve financial returns.

Potential Post closure Opportunities: Macraes Energy Park.

Opportunity Beyond Mining

- Repurpose solar, wind, and hydrogen assets to create a regional energy park after mine closure.
- Transition Macraes from a gold mining site to a clean energy hub for the community and region.

Potential Benefits

Local Economy:

- Provides affordable, reliable green power to local businesses, farms, and households.
- Supports new industries (e.g., green hydrogen supply, advanced manufacturing, data centres).

Job Creation:

- Generates new employment opportunities in operations, maintenance, and green technology.

Energy Resilience:

- Reduces reliance on imported fuels, strengthening local and national energy security.

Long-Term Value:

- Ensures that decarbonisation investments continue delivering benefits long after mine closure.
- Positions Macraes as a model for sustainable mine closure and regional regeneration.

OUR PURPOSE

Mining gold for a better future

OUR VISION

A company people trust, want to work and partner with, supply and invest in, to create value

OUR VALUES

CARE

We care for the safety, health and well-being of our people, the environment and local communities

RESPECT

We respect and listen to each other, embracing different views and diversity in all its forms

INTEGRITY

We do the right thing and take accountability to deliver on our commitments

PERFORMANCE

We strive for excellence through learning, continuous improvement and innovating

TEAMWORK

We achieve great outcomes by everyone contributing and working together