ClarkeEnergy®
A KOHLER COMPANY

Engineer - Install - Maintain

Meeting Industrial Hydrogen Demand

Adam Wray-Summerson **MEng(Hons) CEng MIMechE**

Head of Sustainable Solutions

5th July 2023

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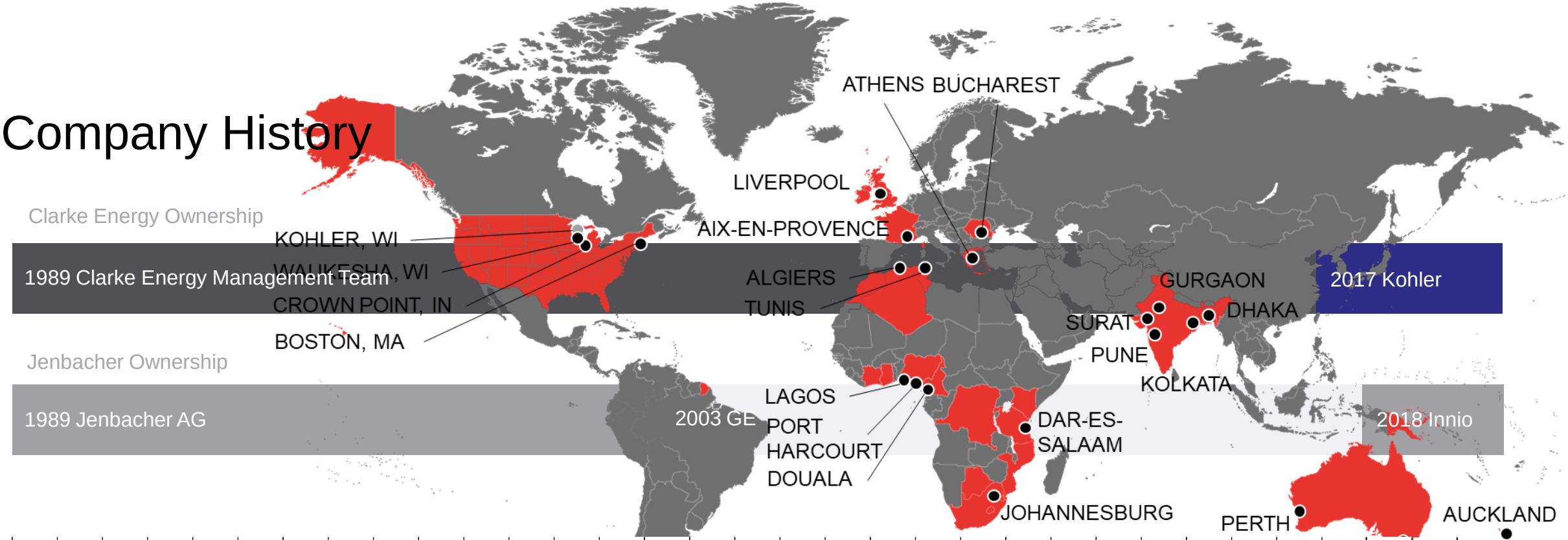
Company History



Clarke Energy Ownership

1989 Clarke Energy Management Team — 2017 Kohler

Jenbacher Ownership

1989 Jenbacher AG — 2003 GE — 2018 Innio

89	90	91	92	93	94	95	96	97	98	99	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21

- Established
- Appointed Jenbacher Distributor
- Australia New Zealand & Nigeria
- Acquired Cogen India
- Acquired Jenbacher France
- Ireland
- Tunisia
- Algeria
- Acquired Orient Energy Bangladesh, Agaricus Trading, GE's South Africa Jenbacher Service Business
- Cameroon
- USA, PNG, Morocco, Kenya, DRC, Rwanda, Ghana & Ivory Coast
- Romania, Greece, Acquired CoEnergy America
- Indonesia

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Company Introduction

Global

Operating in **28** countries with **8GW$_e$** of power generation and **10,000Nm^3/h** biomethane solutions deployed globally.

Our proven Local **Service-First** approach ensures satisfied customers.

Supporting net-zero

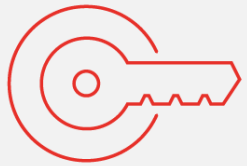
Our projects support the transition to a **net-zero** carbon economy.

Resilience

Installations supporting local and grid-level **resilience**.

Lower costs & carbon

Reduced operational costs and carbon emissions through **fuel efficient energy** delivery.



Turnkey EPC

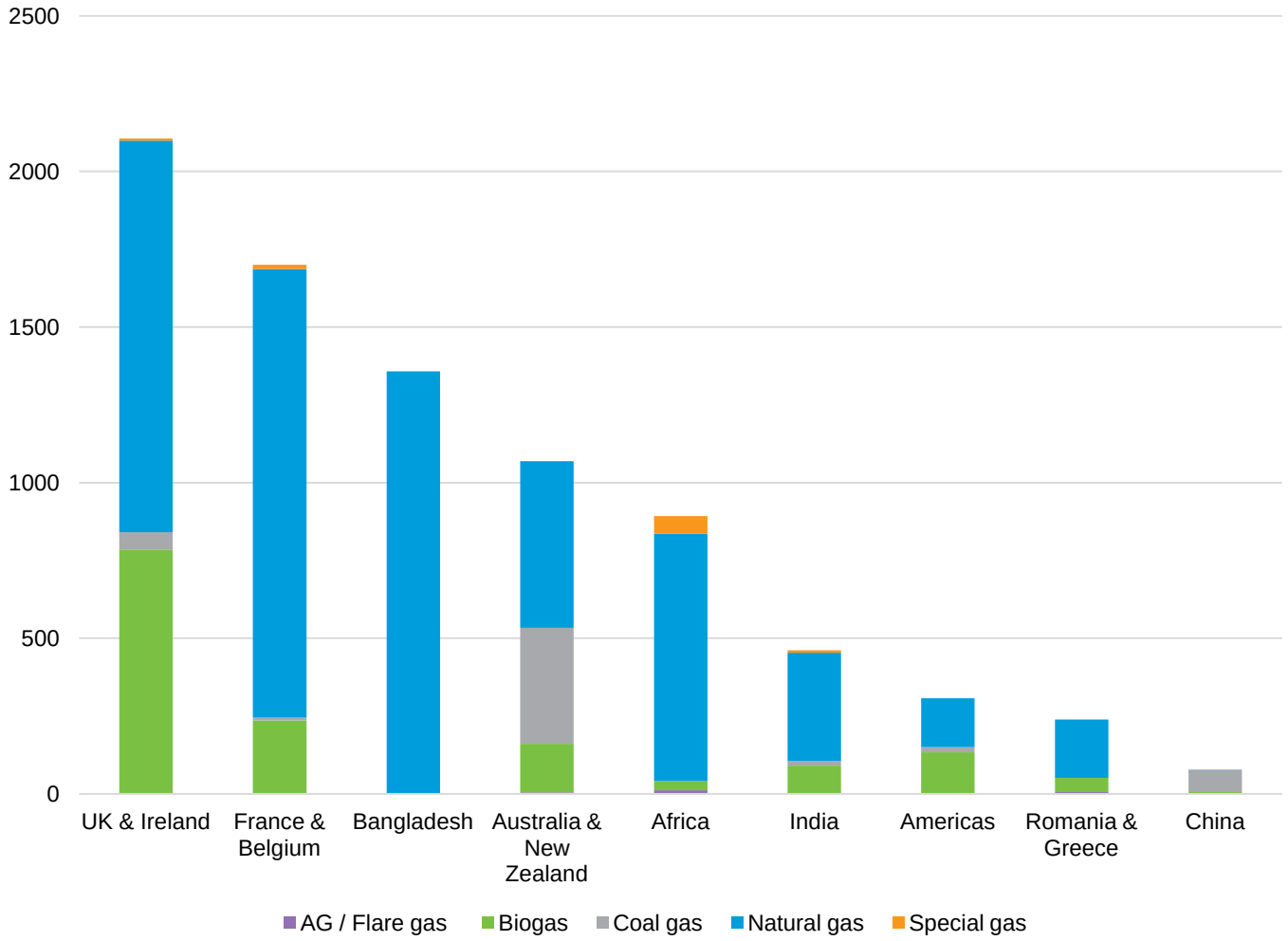
Single point of contact with, turnkey design, **engineering, procurement and construction** (EPC) services.

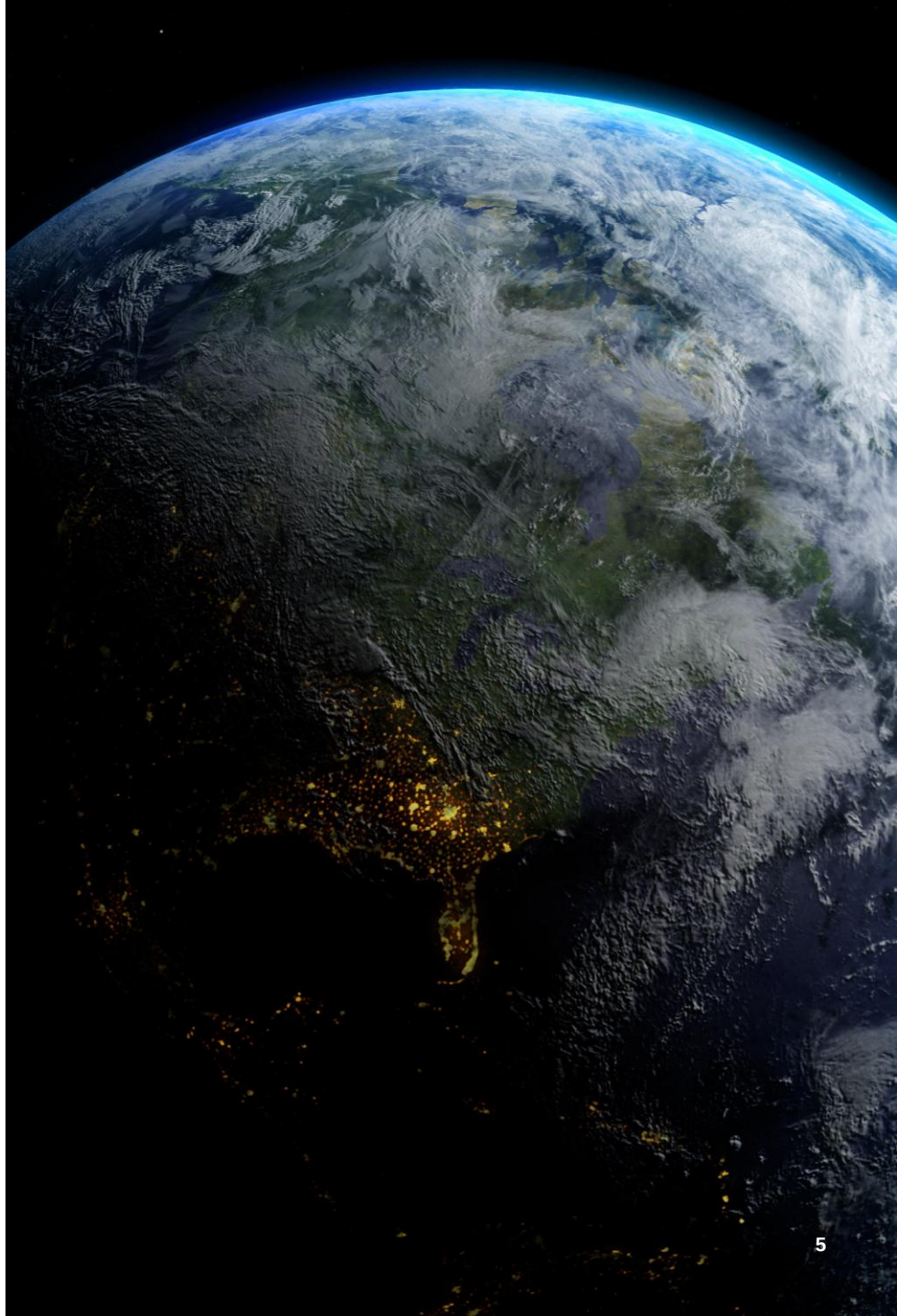
Continued Growth

Clarke Energy continues to recognise annual growth achieving revenues in 2022 of **£450m**

Coupled with an **enviable balance sheet**, provides confidence to our customers in Clarke Energy's ability to deliver on it's **contractual obligations**

Clarke Energy's Global Fleet





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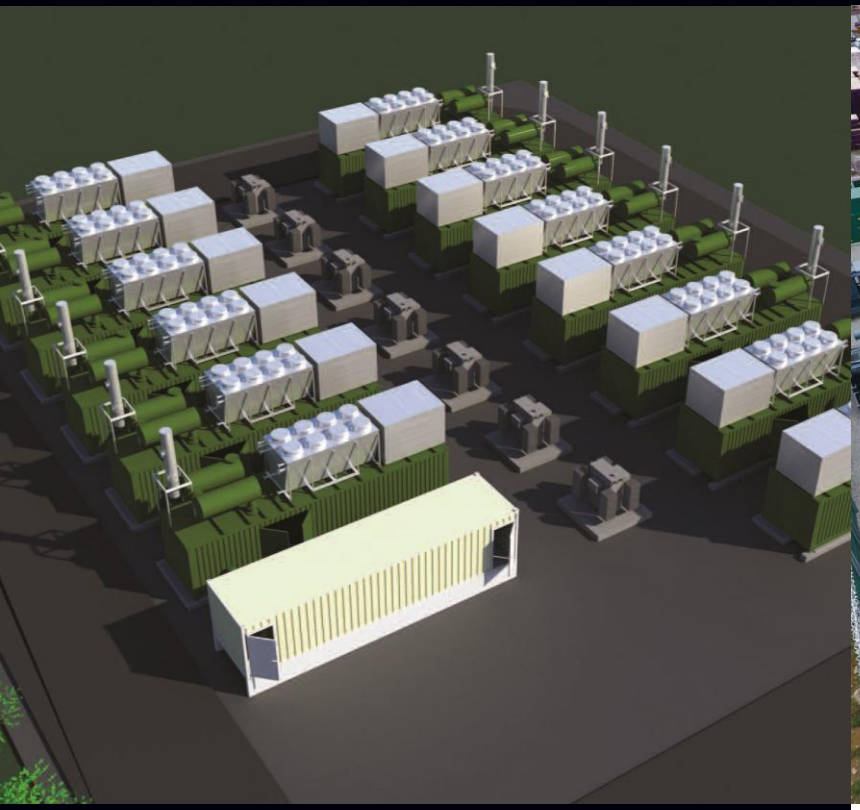
Turnkey Delivery of Energy Solutions



FACILITY ENGINEERING

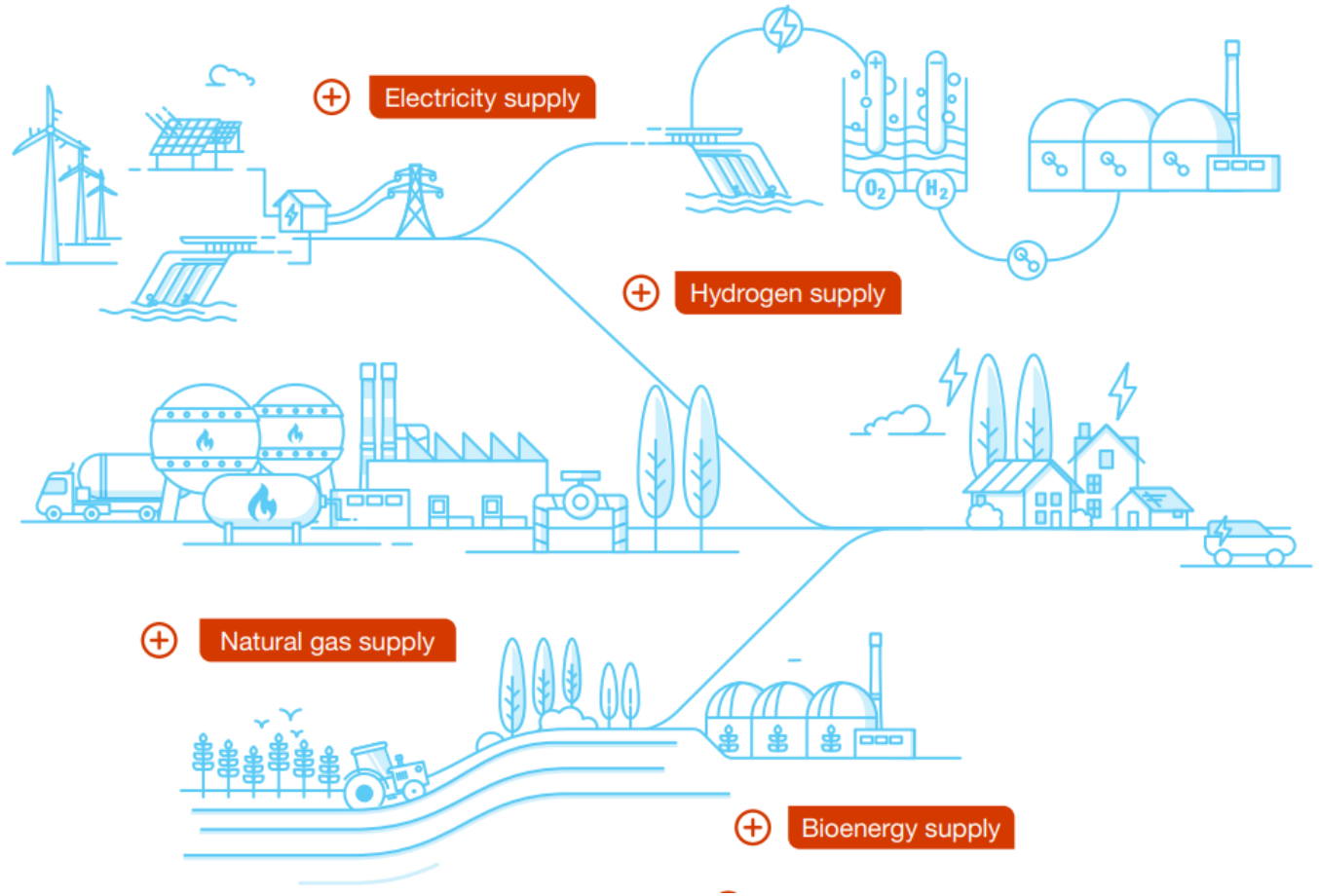
PROCUREMENT AND CONSTRUCTION

RELIABLE AFTERSALES SUPPORT

The Net Zero Challenge

Let’s assess the impact of changing supply & demand

National Grid – Future Energy Scenarios



Source: National Grid: Future Energy Scenarios 2022

FES headline messages:

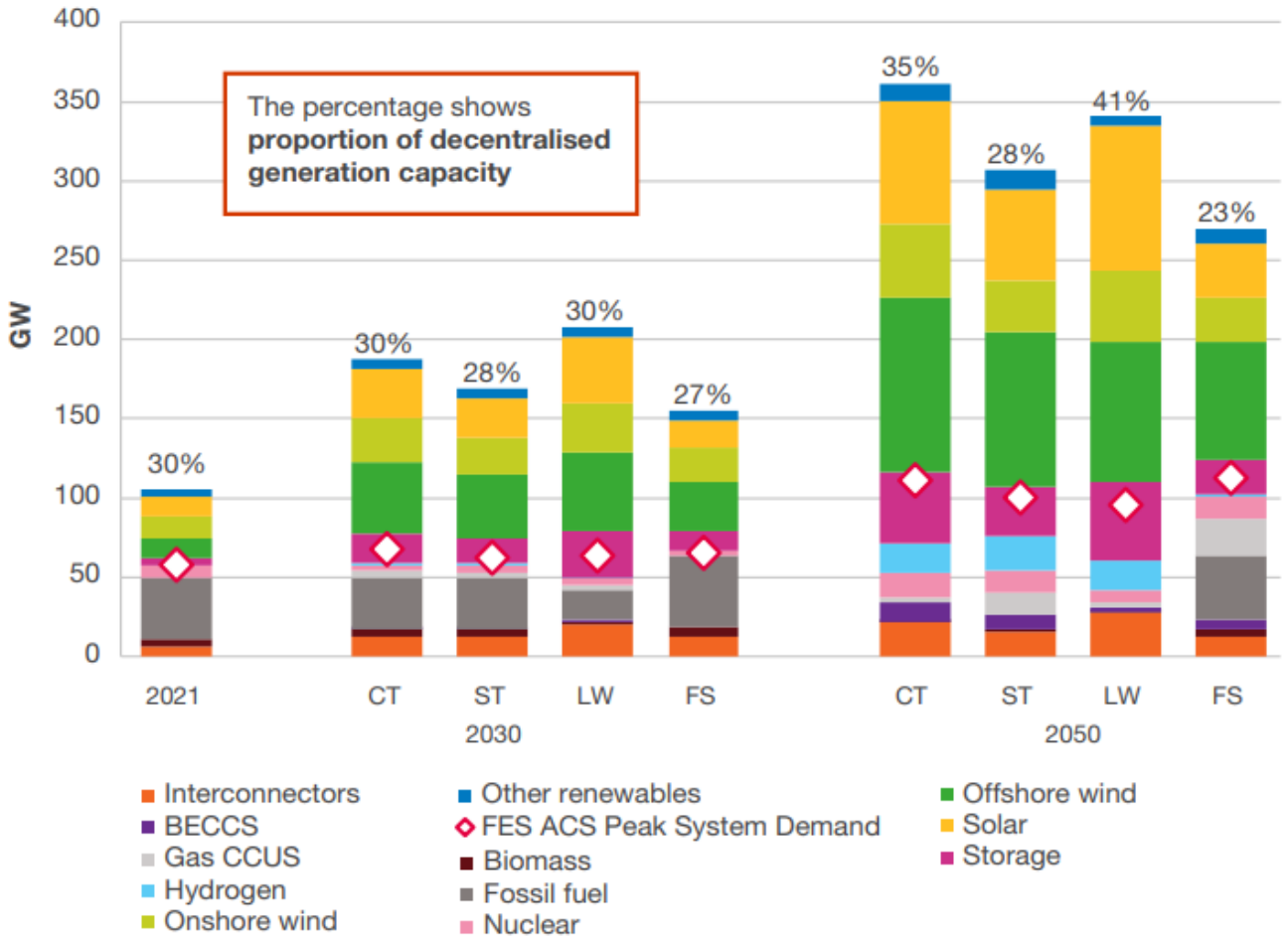
Net zero by 2050 is achievable with immediate action, but the window to act is closing.

Hydrogen and Carbon Capture & Storage must be deployed with demonstration project operational this decade.

Economics of energy supply and demand fundamentally shift in a net zero world. Market evolution, providing incentive for investment in flexible, zero carbon generation is key.

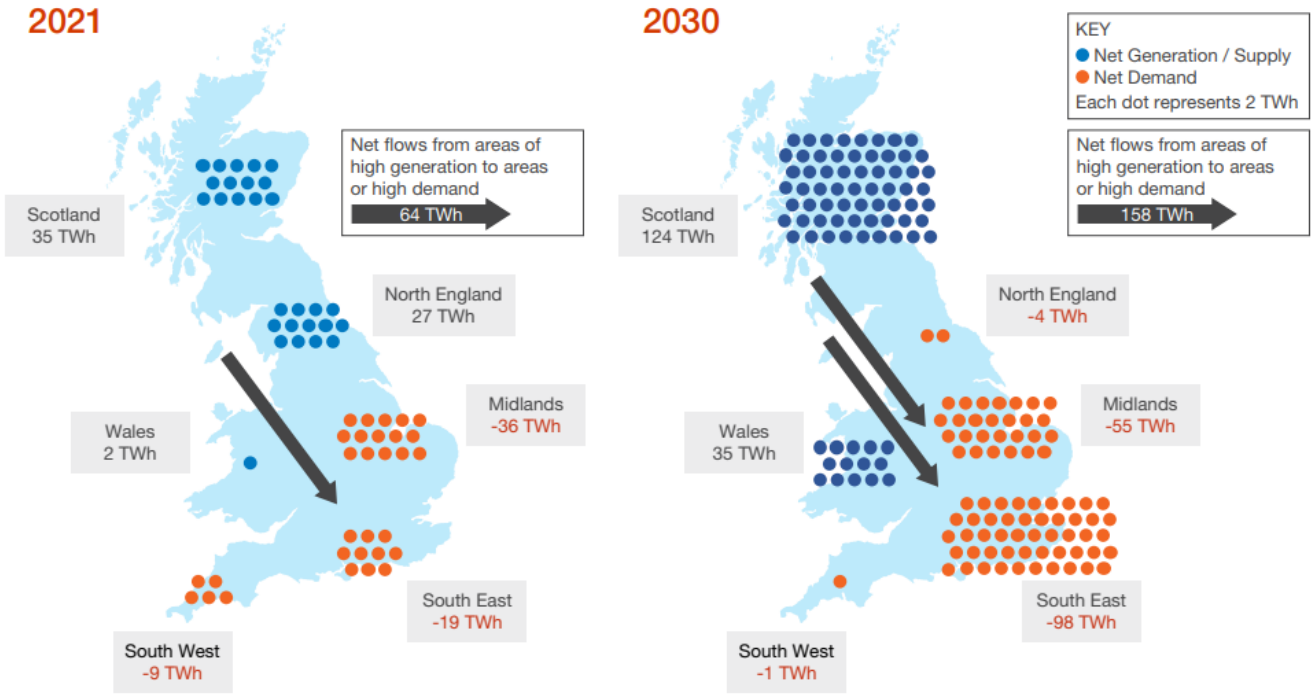
Open data and digitalisation underpin whole system thinking.

System Demand & Carbon Intensity in Net Zero Britain



Source: National Grid: Future Energy Scenarios 2022

Transforming our Electricity Networks



Source: National Grid: Future Energy Scenarios 2022

Balancing system demand with supplies, through a constrained system, will be critical to achieving Net Zero.

Approaching 2030, we see an increase in renewable generation in the North and significant increases in demand further South through electrification of heat and migration to electrified transport.

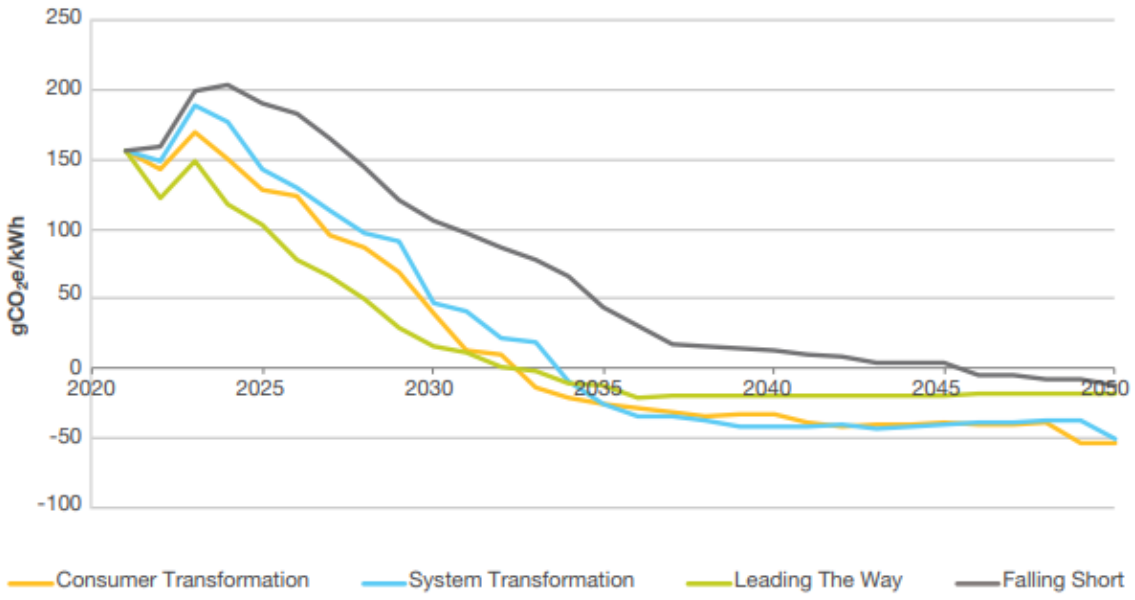
The risk is that existing System Constraints might limit our Net Zero future.

Scotland will become the UK's energy hub as we continue toward 2050 but system-wide transformation is required to ensure supply can be moved!

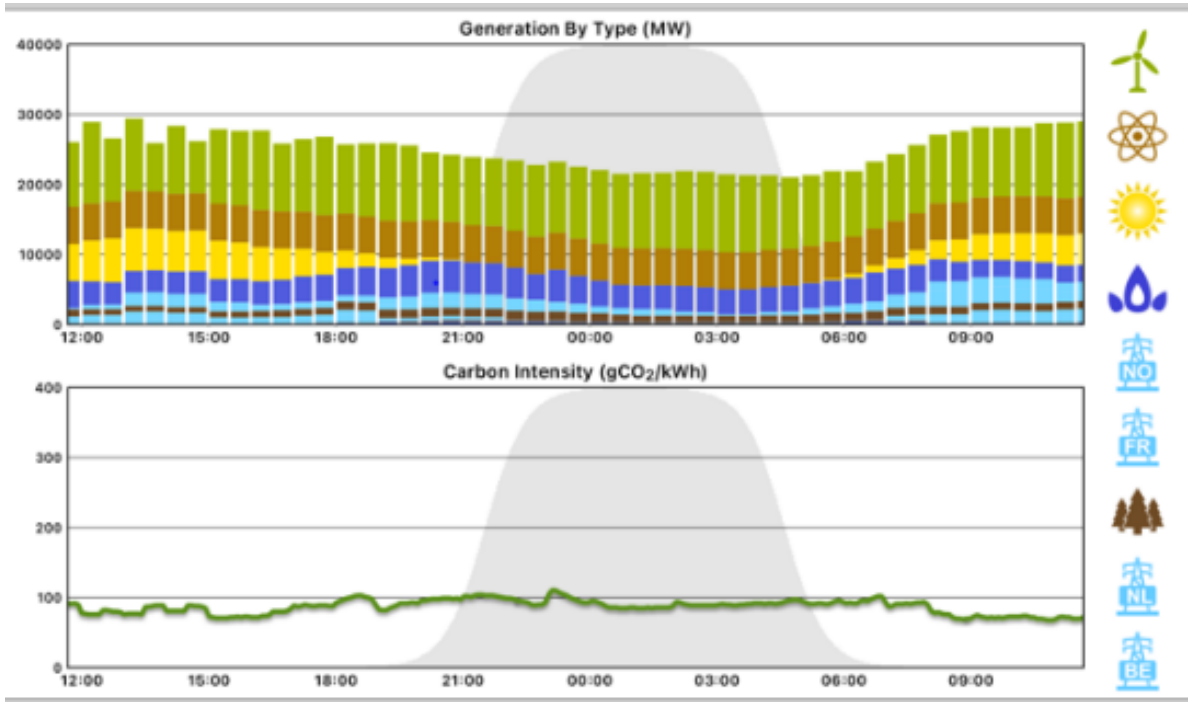
Decarbonising our Supply

Focus on an integrated network that offers maximum flexibility during operation is imperative

System Demand & Carbon Intensity in Net Zero Britain



Source: National Grid: Future Energy Scenarios 2022



Source: Grid Carbon UK

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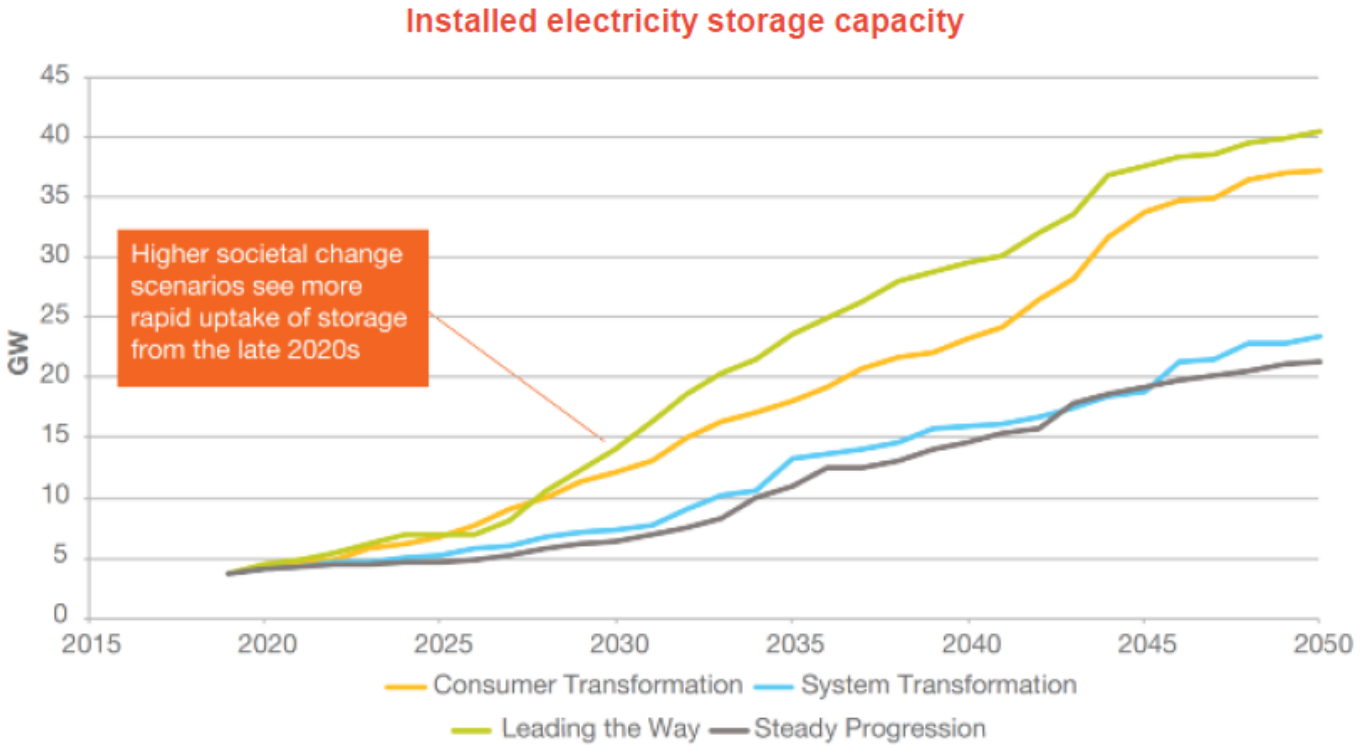
Electricity Storage saves the day?



Source: National Grid: Future Energy Scenarios 2022

Storage provides a key role in energy management, frequency response and grid-formation.

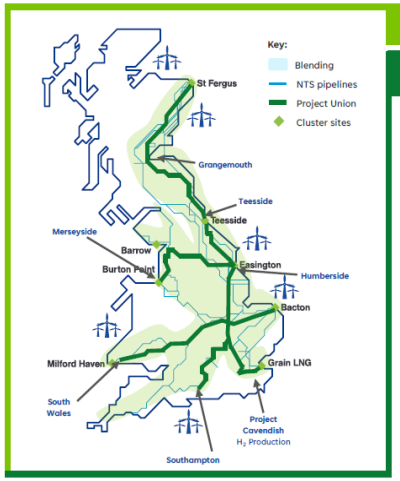
The challenge is matching potential growth with actual demand given varying focus of customers.

We're seeing huge investment in front-of-meter BESS

Should hydrogen be considered in the energy storage conversation?

Gas & Electric Network - Progression

Dual Pathway to a hydrogen NTS: hydrogen blending and rollout of 100% hydrogen pipelines



Rollout of **blending** across the NTS

Strategic rollout of **100% pipeline** connections

Delivering a Dual Pathway to transitioning the NTS to hydrogen:

- In 2024/5 low level hydrogen blending on will be facilitated on the transmission network
- From 2025 onwards blending could extend and increase up to 20% - more if deblending technology can be proven.
- In 2028/9 Project Union will deliver the first phases of 100% hydrogen transmission pipeline between the northern clusters
- By 2033 Project Union will have delivered a circa 2000km hydrogen backbone joining key production and use clusters
- Asset conversion continues to 2045 to deliver a complete 100% hydrogen network.

Net Zero 2050

Levelling up, Job Creation

Global Leader in Green Innovation

Providing flexibility and optionality

National Gas

Strategic Network Investment

- Clear holistic plan that balances, costs, operability, community and environmental impact
- Robust process that enabled the HND to inform the regulatory needs case
- Anticipatory Strategic Transmission Investment (ASTI) circa £20bn as part of £50bn upgrade programme
- Created the pathway for Centralised Strategic Network Planning (CSNP)
- Developing HND2 – further 15GW of Scotwind projects
- H2 electrolysis in the right areas can avoid network investment

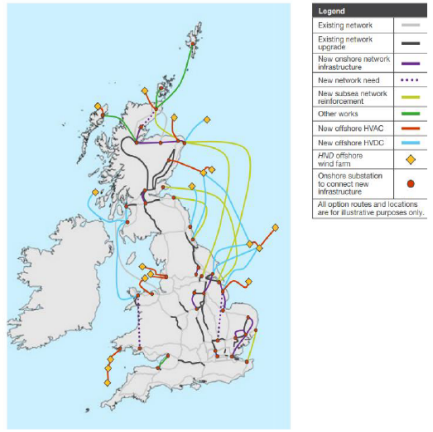


Figure 3: The full set of major network requirements recommended by the HND.

nationalgridESO

Gas & Electricity System Operator's strategies are aligned with government & regulator targets.
Strategic (efficient) use of hydrogen generated power (& heat) can avoid transmission network investment.
Hydrogen can be one source of Long Duration Energy Storage (LDES) to provide system resilience.

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Fuel Cells and Electrolysers

Initial overview of fuel cell and electrolyser opportunity in the UK market

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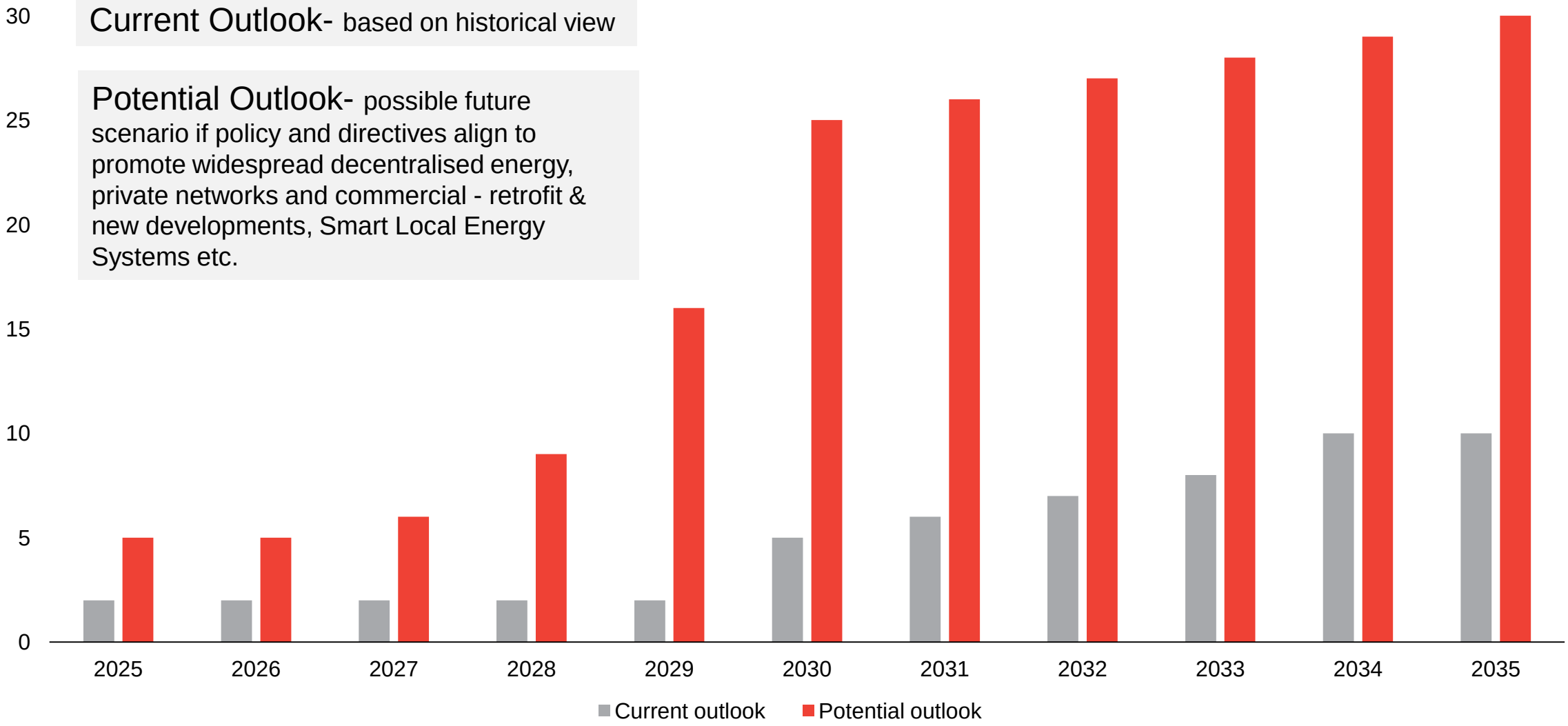
Fuel Cell Market Estimates UK (No. projects)

Current Outlook- based on historical view

Potential Outlook- possible future scenario if policy and directives align to promote widespread decentralised energy, private networks and commercial - retrofit & new developments, Smart Local Energy Systems etc.



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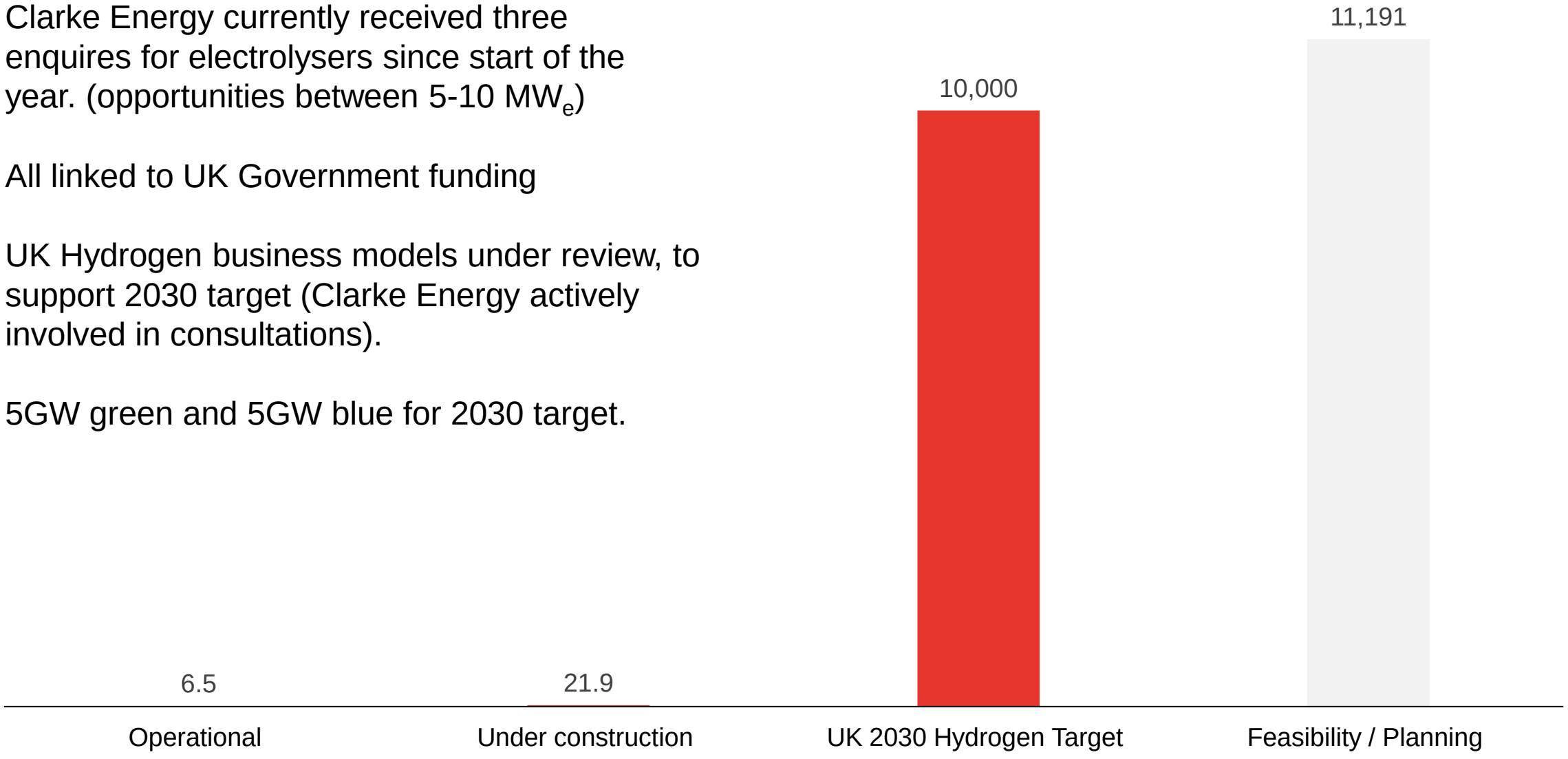
Electrolyser Market UK (MW_e)

Clarke Energy currently received three enquires for electrolysers since start of the year. (opportunities between 5-10 MW_e)

All linked to UK Government funding

UK Hydrogen business models under review, to support 2030 target (Clarke Energy actively involved in consultations).

5GW green and 5GW blue for 2030 target.



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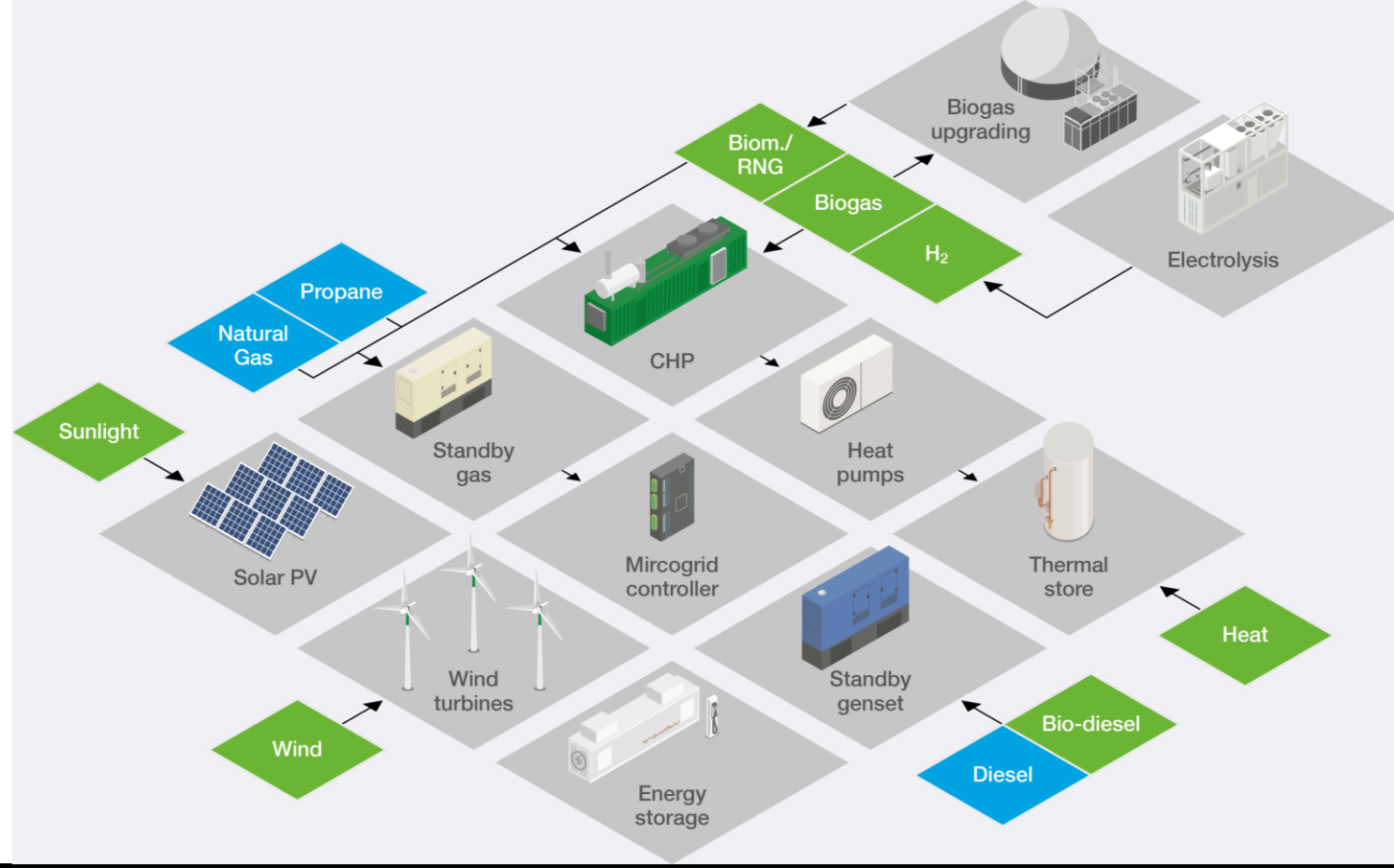
Clarke Energy Products and Applications



Gas engines, battery energy storage systems, biogas upgrading and electrolyser technologies for an integrated energy system

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Flexible Delivery Model

Innio Jenbacher Gas Engines

A Jenbacher gas engine module configured for electricity generation and/or recovery of both electricity and heat, utilising a range of renewable and non-renewable gaseous fuels

$0.25MW_e$ – $10.50MW_e$

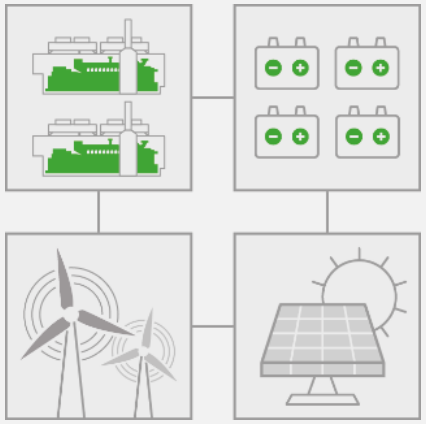
Battery Energy Storage Systems

Clarke Energy can offer either fully-wrapped or Balance of Plant style contracts for a range of BESS suppliers and integrators

10MW – 400MW

Hybrid Energy Solutions

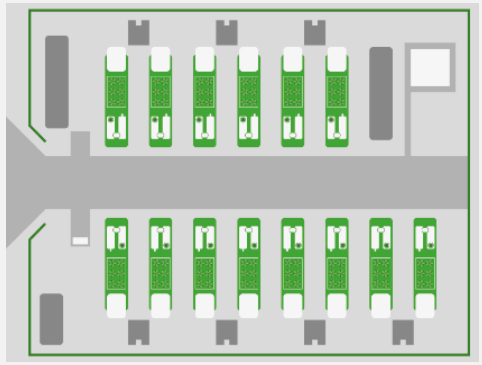
Clarke Energy can incorporate different power generation and storage technologies, alongside renewables and control software to optimise generation within a turn-key microgrid



Biomethane Upgrading / Electrolysis Plants

Clarke Energy can supply turn-key installation of renewable gas production plants.

Electrolyser plants up to 10MW range and biomethane upgrading up to 5,000Nm^3/h



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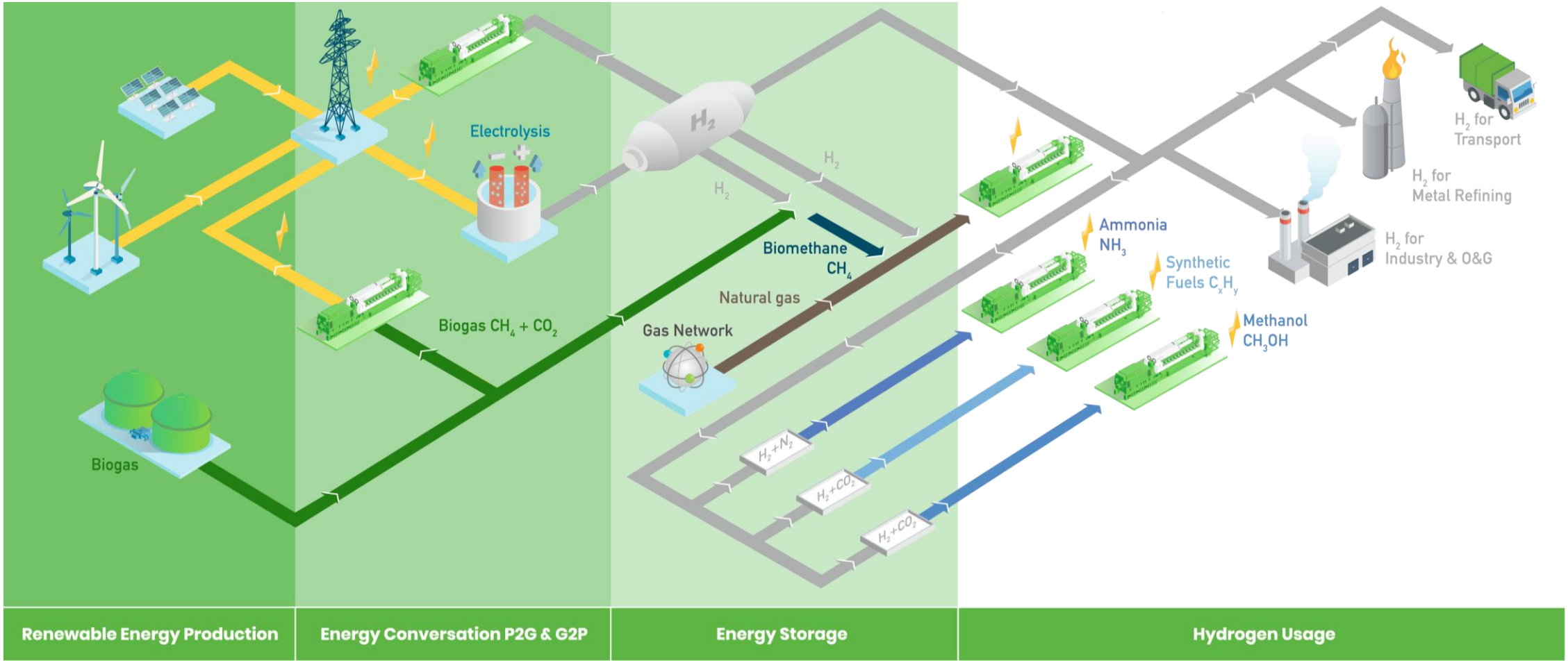
JENBACHER
INNIO
Distributor New Units & Services

Gas in a Renewable World



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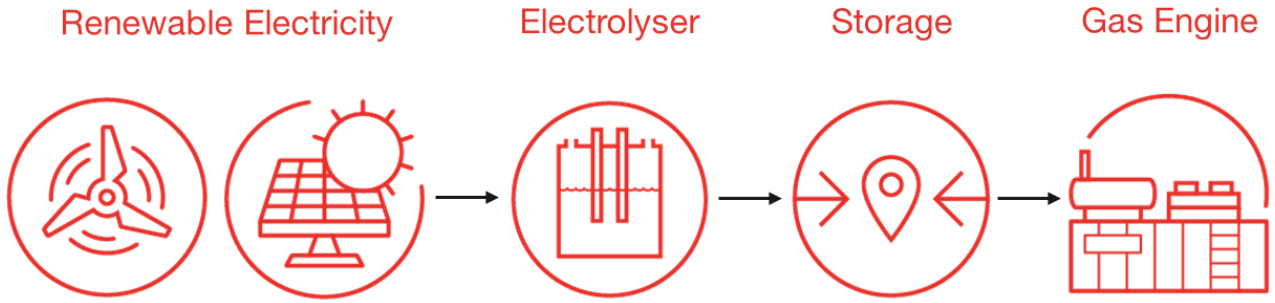
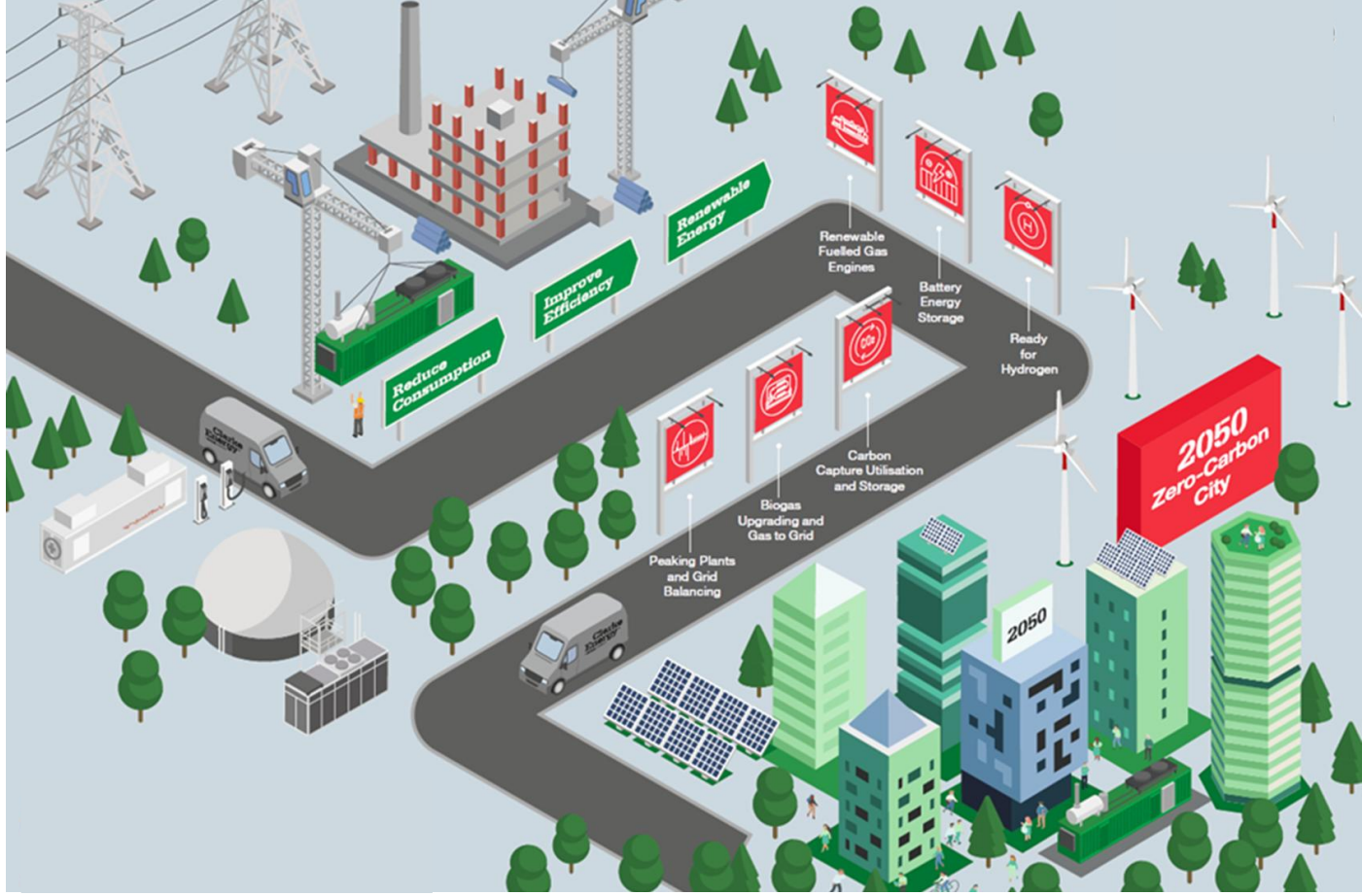
Hydrogen Operation



H_2 blend (%)	Renewable Electricity (MW_e)	Electrolyser (kg H_2 / hr)	Gas engine (/MW_e)	CO_2 saving vs 100% natural gas (%)
20%	0.25	5	1	7
50%	0.80	16	1	22
100%	3.75	75	1	100

Clarke Energy - Supporting Net Zero



Engineering sustainable, resilient and energy efficient installations, then servicing those assets through life – all whilst supporting the transition to net zero carbon

Supporting Net-Zero

Renewable Electricity Enablement

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