Cleanergi

Enabling renewables to power the world affordably, reliably and resiliently

Cleanergi

The Energy Transition: Electricity

Cleanergi

What It Is:

1. Replaces hydrocarbons with renewables
2. Replacing dispatchability with intermittency
   - Dispatchable: available on demand
   - Intermittent: when it wants, not when we want
3. Replacing synchronous with asynchronous
   - Synchronous: large AC-connected rotating machines
   - Asynchronous: DC-connected
4. Loss of Black Start capability
   - Re-starting the grid when all has failed

Challenges:

1. Technologies must be at the scale and duration of hydrocarbons
2. Balance the energy to make intermittency dispatchable
   - Balancing energy generation with demand, day & night
   - Providing for weather-related longer-duration shortfalls
3. Create synchronicity on the grid, in the locations needed
   - Grid stability, controllability, power quality
4. DC connected plant can't do Black Start
   - Proved by National Grid's Distributed ReStart project

Most storage on offer is the wrong scale, duration, cost and capabilities.

The Energy Transition: Hydrogen / Industry

Cleanergi

What It Is:

1. Replacing hydrocarbons with electricity, hydrogen & their products
2. Grids cannot be made big enough
3. Replacing infrastructure
   - Out: oil, gas, petrochemicals
   - In: hydrogen, synthetic fuels and chemicals, electricity
   - Extraction, refining, distribution, equipment mfr, projects
4. Replacing skills and capabilities
   - Synchronous: large AC-connected rotating machines
   - Asynchronous: DC-connected
5. Scale
   - Oil, gas and petrochemicals, $5 trn p.a. + distribution
   - User industries (e.g. engines, mfg) much larger

Challenges:

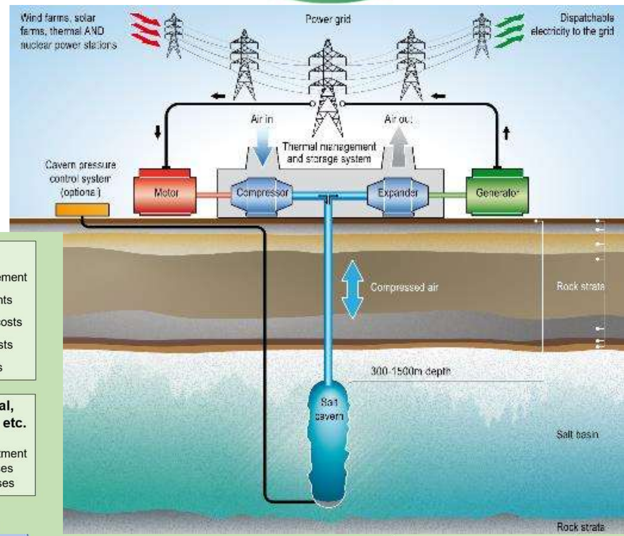
1. It is not a straight switch: different solutions for each challenge
   - Electricity likely to increase from ¼ to ½ of all energy
2. Take intermittency, H_2 etc. off-grid
3. Maximise conversion rather than replacement
   - Infrastructure, technologies, skills
4. Re-use / convert wherever possible
   - Engineering, project mgt, operations, finance, risk
5. Must be at hydrocarbon scale

Many of the technologies on offer are the wrong scale, duration, cost and capabilities.

Cleanergi's Solutions: Transformative Improvements

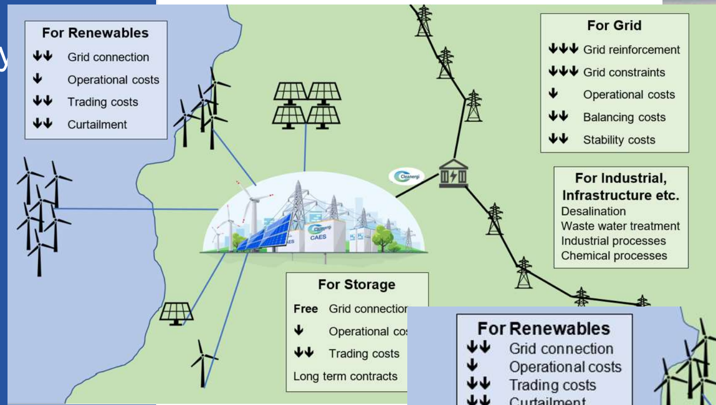
1. CleanCAES™

- The world's most efficient and cost-effective large-scale, long-duration electricity storage
- Uses existing technology, simple
- Patented, validated by multinationals
- CleanStart™: Black Start without reserving capacity



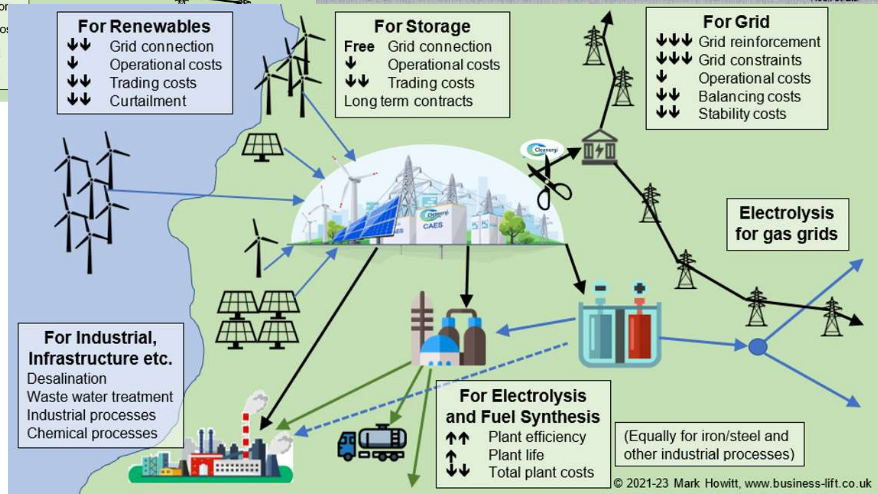
2. CleanGrid™

- Integrating renewable generation with grids
- Reduces grid connection size, delay and cost
  - Offshore wind by ½; onshore ⅔; solar UK >5/6
- Saving billions on grid reinforcement, operation and maintenance



3. CleanPark™ integration w. cleantech

- Making electrolysis, the hydrogen economy, clean industries, data and AI cheaper and more efficient
- Eliminates or reduces the biggest commercial and regulatory risks
- With massive bulk hydrogen storage
- Unique, patent pending methodology



Partners Sought for Two Projects

Modelling

A project to build on existing grid models a layer that shows the benefits and effects (to both project and whole system) of (a) connecting large-scale renewables to the grid THROUGH large-scale long-duration inertial storage; (b) powering large-scale off-takers directly from the {renewables+storage} with a reduced grid connection and (c) same as (b) but entirely off-grid.

Construction

Cleanergi seeks partners (large-scale renewable generation, tubo-equipment, off-takers, H2 economy, data/AI etc.) for a project to integrate all these, delivering 24/7 renewable energy and improving the capex and opex of the off-takers while reducing or eliminating (depending on configuration) its grid connection and associated commercial and regulatory risks. Saves billions in grid connection / reinforcement costs.

Competitor Analysis

Cleanergi

	Capex nth/MW	LCOS £/MWh	Efficiency whole system	Emissions	Plant Life	Lifetime Deterioration	Synergies w. Renewables	Locations	Inertia
Cleanergi CleanCAES ™		60.80	68-70%						
Hydrostor (estimated)		100-120	60-62%						
Chinese (estimated)		100-120	58-60%						
Traditional CAES		68-82	52-54%						
Pumped Hydro-Electric		117-152	75%						
LAES (Liquid Air)		294	55-58%						
Flow Batteries		241-531	55-65%						
Batteries (Lithium)		139-248	50-74%						

Data Sources Capex nth /MW: capital cost for the 5th plant onwards, per megawatt, >100MW, duration min. 4 hours

LCOS: Levelised Cost of Storage = sum of non-energy fixed and variable O&M costs + finance cost of plant, 35-year life, ignoring efficiency

- For Cleanergi, 1st large stand-alone plant (better with renewables), 1 x 5-hr cycle/day, 350d/yr
- For Cleanergi, expected for 5th plant, CleanCAES 30% cheaper capex, £45.06/MWh
- For LAES, source = University of Birmingham 2018; for traditional CAES and Pumped Hydro, Lazard 2.0 (2016) = their most recent data
- For batteries, Lazard 7.0 (2021), stand-alone 100MW 4-hour plant, noting that this reflects equipment (not whole plant) costs

Key

Best

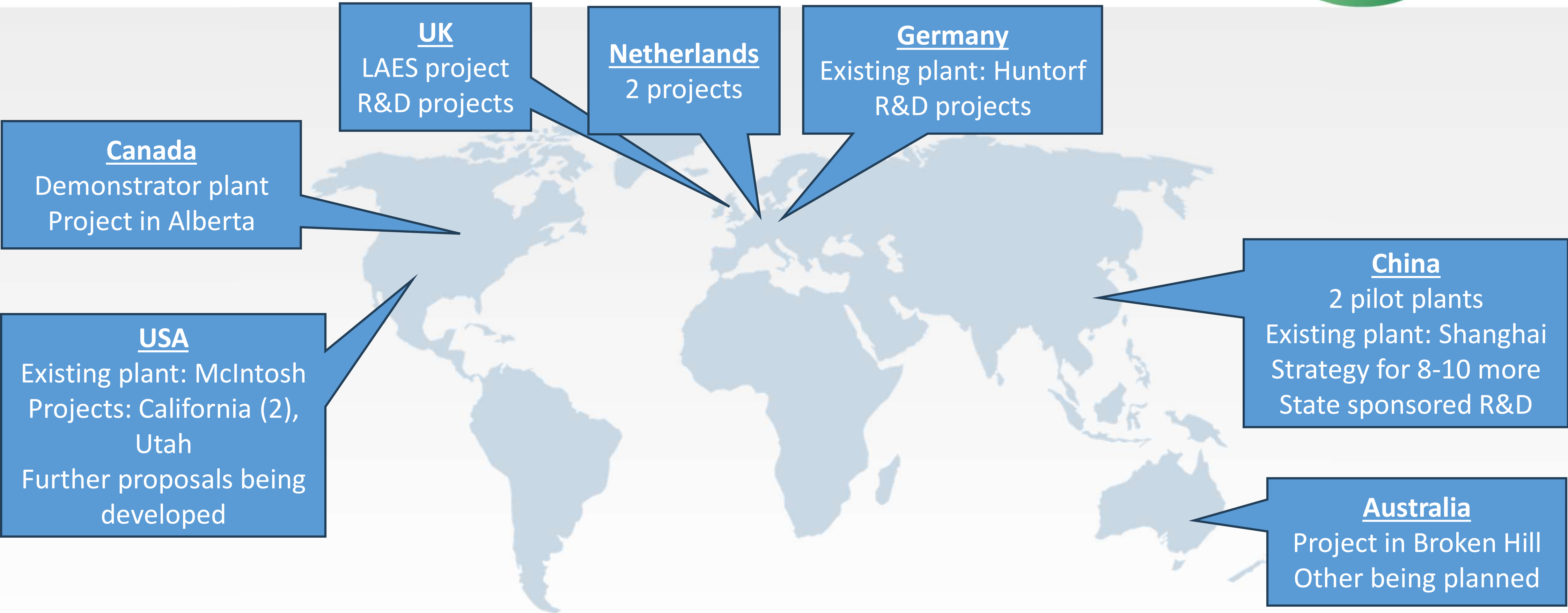
Worst

The world's most cost-effective large-scale long-duration electricity storage

Enabling renewables to power the world affordably

Table compiled 2019-2022

CAES Around the World



Cleanergi's are cheaper, more efficient, more flexible, better economics

Ready to build

Cleanergi

Technologically

1. Technically validated plants
   - Arup, Costain, Fortum, Mott MacDonald, Siemens, Mitsubishi and others
2. Proven geotechnically
   - Huntorf, McIntosh, Geostock, KBB DEEP
3. Can build from catalogue equipment
   - Mitsubishi and Siemens have said so; others can
4. World-leading technologies
   - Universities of Durham and Edinburgh
5. EPC guarantees offered
   - Mitsubishi, subject to agreement
6. Top quality team (see below)

Commercially

1. Commercially profitable stand-alone
   - Baringa
2. Business case stacks up
   - PwC
3. Essential part of the energy transition
   - Major Chinese build-out despite inferior technology
4. Best defrayal of regulatory risk
   - Tall revenue stack: re-configure commercially when markets and contracts change
5. Most cost-effective available
   - UK Energy Catapult
   - Comparisons with other technologies' LCOS
   - Greater flexibility and capability
6. Projects in discussion globally
   - UK, DK, UAE, US, DE, UKR…

Business Case

Revenue Streams

1. Construction investors buy into project, as well as investing dilutively
2. Project rents Cleanergi skills to oversee construction and possibly operation
3. Income from minority (20-40%) ownership of project (or can sell)
4. Income from royalties, 1% of t/o
   - T/o is typically 10 x capex per annum
5. Additional services
   - Refurbs, upgrades, trading, operation

The more we integrate, the more cost-effective and efficient it becomes

Potential energy transition savings:

From widespread roll-out of optimal solutions

1. £1-1.5 trillion capex, UK grid alone
   - Including grid savings on cleantech integration
   - \+ 10% of that per annum
   - \+ savings for Cleantech industry
2. Potential globally is 100 times this
   - The UK is 1% of global energy consumption
   - And 0.7% of global population
3. CAES profitable without subsidy in today's UK markets
   - Other developments have much better cost/benefits, though many benefits not currently remunerated – market dependent
   - Public funding would be a bonus

Financial Projections

Cleanergi

Business Model

1. First revenues year 4
2. Operating profit from year 6
3. Break even year 9
4. Costs thereafter = 10-20% of revenues
5. Construction funding of project SPVs will not dilute Cleanergi shareholdings

Financial projections are likely to differ greatly due to:

1. Size of CAES 40MW => multi-GW, 4-hour to multi-day duration
2. Stand-alone CAES or within a CleanPark energy park
3. Owned, leased or JV locations
4. Time and cost to secure locations and permits / planning

The above figures are based on a standardized project size / scope, and an assumed rate of roll-out – see Assumptions.

SEIS and EIS pre-approval granted

Assumptions

1. Assumed costs and revenues
2. Start one project p.a. from year 1, this rate not increasing over time
3. Each project costs £200k feasibility + £2m (+£1m borehole, 2 projects in every 3), 3 years total inc. permits
4. Cleanergi undertakes feasibility and pre-construction work itself
5. The plant SPV pays Cleanergi for professional services, use of networks and CleanPark system, (sub-)lease of land
6. Zero public funding

Team

Mark Howitt
Founder and Inventor
Physics with Electronics, 12 years world-wide management and innovation consultancy. Developed three profitable businesses within a multinational, one commercialising technology he'd developed and patented. In electronics manufacturing, developed 5 product ranges and took them to market, and helped 2 businesses grow strategically. Previously a management consultant in diverse industries

Richard Chamberlain
Business and Project Development
BSc Eng Imperial College, MBA Cranfield, BDEsS Real Estate Harvard Uni
International Business Development and Manufacturing Lead developing a business in solar ca parks and charging hubs.
Diligence Associate and Angel investor for the Green Angel Syndicate..
Ex principal in an international project development and client advisory.
Ex Senior Underwriter, Risk Management, GE Capital Real Estate.
Ex Business Development Director, Sensormatic (now Johnson Controls)
Holder of an American Green Card, 25 years working in America.

Mike Rimmer
Development Engineering
BEng Uni of Liverpool, MSc Mechanical Engineering at UCL Mechanical Group Lead for WSP. Ex Principal Consultant at Costain, in Decarbonisation, Hydrogen Economy and AI; leading Feasibility, Concept, FEED, EPC studies etc., who led Costain's validation of CleanCAES. Previously Lead Mechanical Engineer at MSE, working on developing entire field systems and removing bottlenecks in oil and gas.

Kashif Manan
Finance
MSc Business and Management at Uni of Hertfordshire; APMP in Project Management at the Association of Project Management; CIMA accounting; BA Accounting and Finance, Uni of Derby. Ex Country Manager for FedEx Express Saudi Arabia, leading strategic direction and operations of one of the largest express transportation companies in the region. Prior to that, their Senior Manager Finance - Controls & Customer Financial Services – MEISA Region. Formerly Finance Director for TNT.

Clive Howseman
System Engineering
Master of Engineering, Chemical engineering and fuel technology, University of Sheffield
Over 20 years of experience in the process design of oil and gas separation equipment
Over ten years of supervision and management experience
Principal Process Engineer, who led the validation of CleanCAES for Maloney Metalcraft Ltd / Avingtrans plc

Kathleen Brady, Project Management
BSc Eng Trinity College Dublin, MBA University College Dublin. Consultant in power plant development, both conventional and renewables, for 25 years internationally (UK, Ireland, Europe, USA, Singapore, Australia, the Middle East), highly in demand for large and complex energy industry projects. Ex Commercial & Technical Manager for GE Power Systems. Ex GE Energy Services International; previously Manager of Engineering Services S.America, Canada, Caribbean, for GE Power Systems

Steve Shakeshaft, Technical and Engineering Advisor
World authority in rotating machines and gas processing, former technical lead on multi-$billion LNG projects around the world, including the world's largest ever – wants to train up successors for us

Jake Payne, Project Development
Mechanical Eng. Novel Technology Project Manager at Engineurs; ex Director of Development (project dev., especially new technologies) at Innova Renewables; ex Head of Ops at Recycling Technologies

IT support: The Webhound https://thewebhound.uk/

HR support: Peninsula Business Services http://peninsulagrouplimited.com/

Current Status and Accomplishments

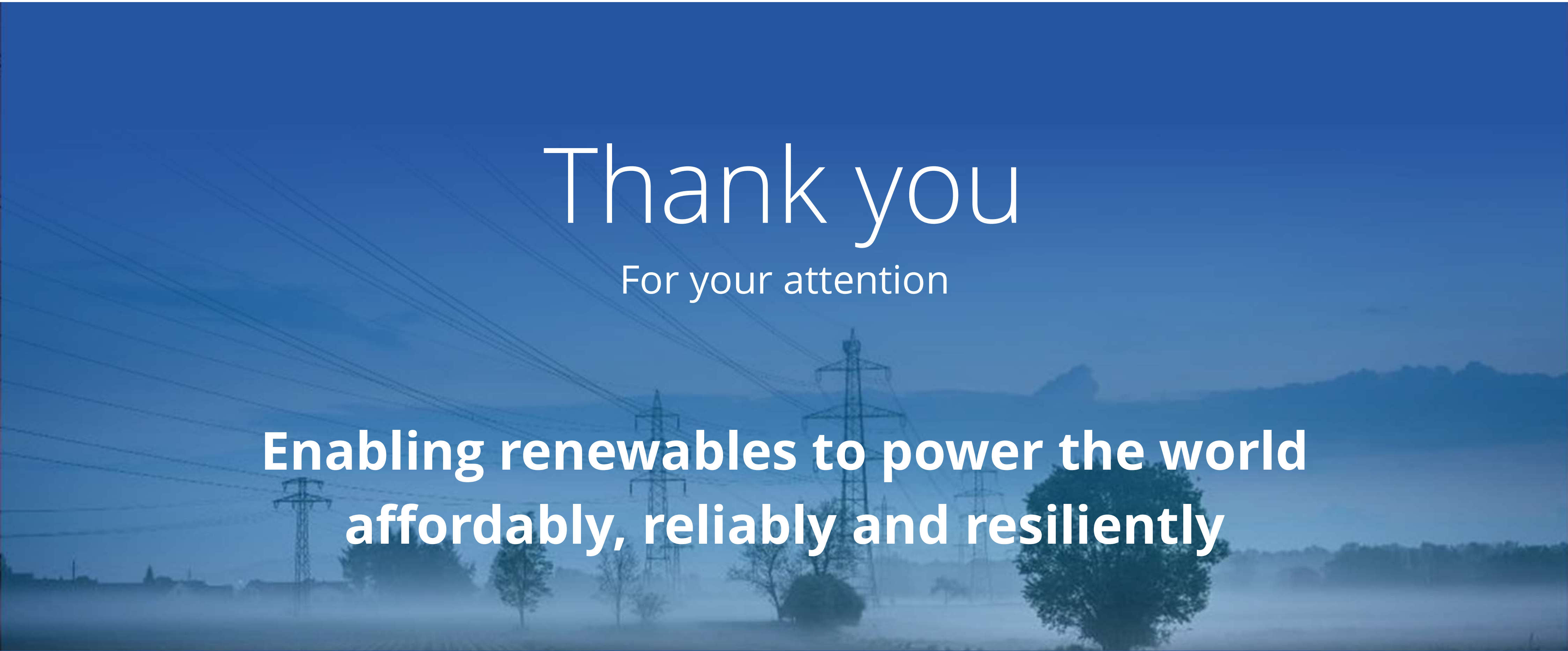
Cleanergi

Plants

1. Dorset: small (40MW) energy park discussions with keen land-owner and developer
2. Other UK opportunities identified
3. Denmark: local SME partner, medium / large energy park discussions with municipalities
4. Germany: willing cavern owner, need local partner to develop CAES
5. America, UAE & Ukraine: interest from local partner / developers
6. Previous verbal expressions of interest in follow-on plants globally

Company

1. CleanCAES
   - Patented, re-acquiring from previous company that has pivoted away
   - Technical validations
     - Costain, Fortum, Mott MacDonald, Arup, Siemens, Mitubishi, many others
2. CleanPark
   - Patent pending, next stage defined
   - Embodiment depends on knowing which plants to integrate, & their performance
3. Team: identified, willing, very knowledgeable and experienced
4. Funding: ~£4m invested to date



Mark Howitt
Founder and Inventor
+44 (0) 7910 020 686
mhowitt@Cleanergi.com

www.cleanergi.com

Cleanergi Ltd is registered
in England and Wales,
number 15818343