

Fighting Carbon with Carbon

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Ground-breaking technology
that accelerates the move to a
carbon free grid.

Institution of
**MECHANICAL
ENGINEERS**





TRACK RECORD

EXERGY

Developed the new Radial Outflow Turbine with **460+MW_e in operation in** Geothermal, WHR and CSP Power Plant applications.

SEBIGAS

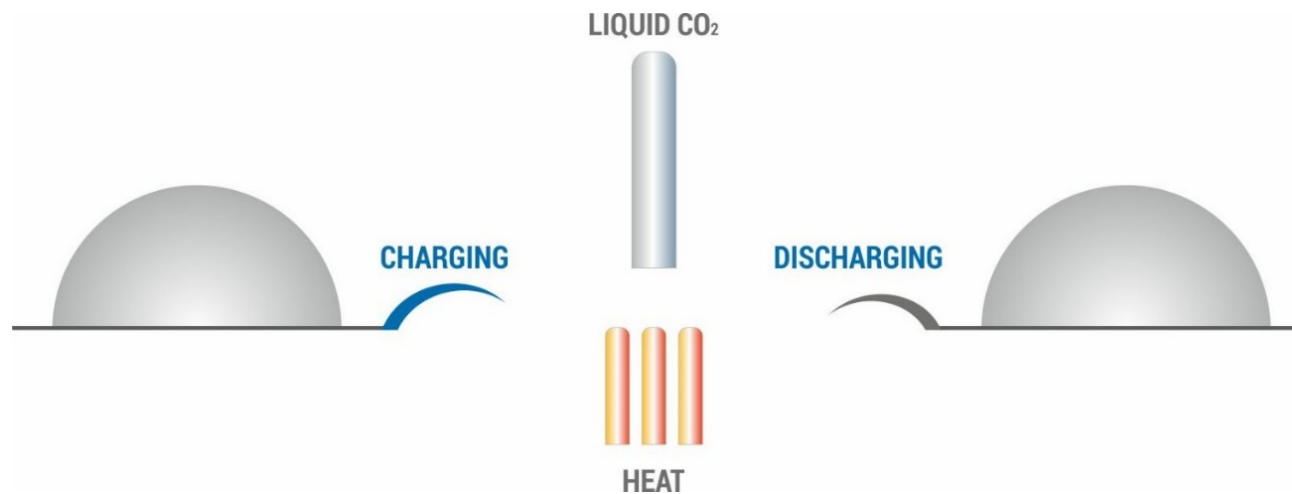
Designs, constructs and manages biogas plants worldwide with a reference list of over **+80 plants**.

DEEP IP EXPERTISE

Over 40 family patents filed and granted

OUR TECHNOLOGY

CO₂ Battery is an innovative **large scale long duration** energy storage solution based on manipulating and storing **CO₂** under different state conditions.

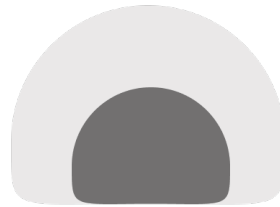


The **CO₂**Battery is covered by **wide and solid IP protection**, with multiple patents family filed

OUR TECHNOLOGY

The Principle

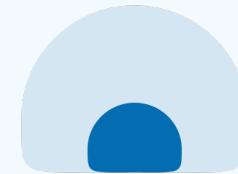
Capex and Efficiency are very much influenced by DENSITY and TEMPERATURE at storage condition



AA-CAES



LAES



CO₂ BATTERY

Starting	1 kg of Air	1 kg of Air	1 kg of CO ₂
Volume at ambient conditions	0.82 m ³	0.82 m ³	0.55m ³
Pressure in Storage conditions	High (70 bar)	15 bar	High (70 bar)
Temperature in storage conditions	Ambient	-190°C	CO ₂ = Ambient TES = 220 – 350C
Volume in Storage conditions	12 liters	1.1 litres	1.3 litres
Energy Storage Density	2-6 kWh/m ³	107 kWh/m ³	66.7 kWh/m ³

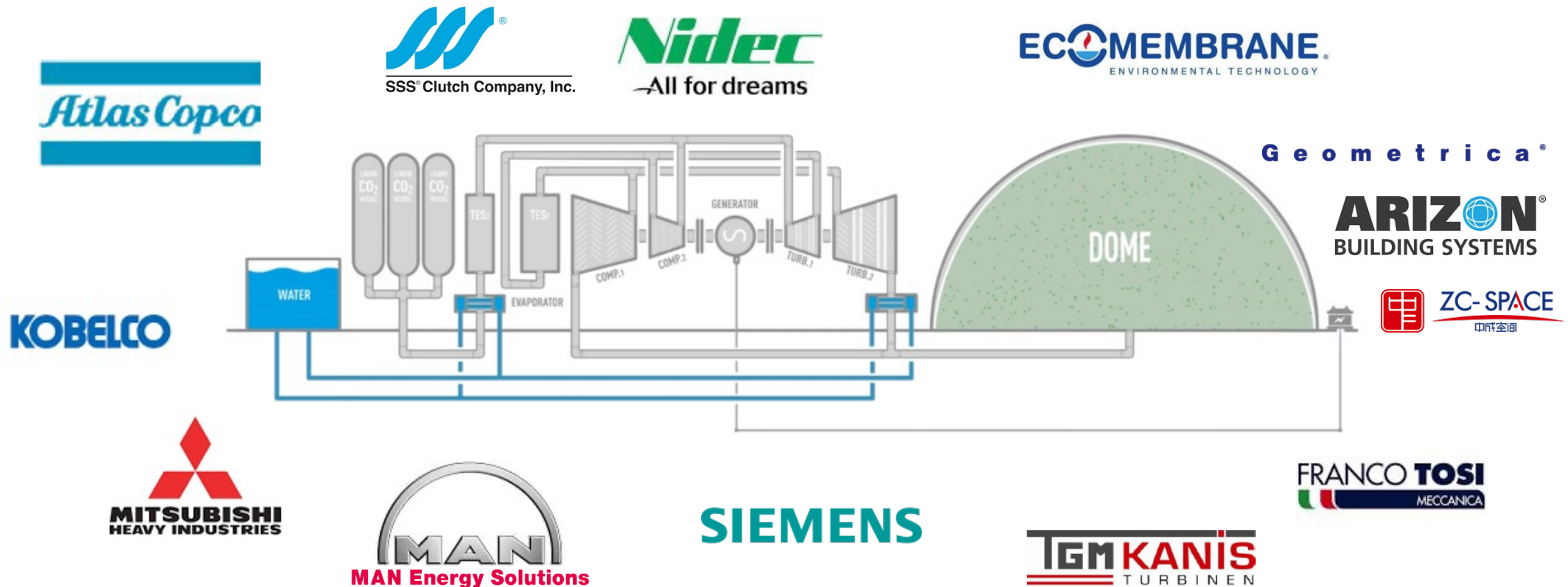
SMALL STORING VOLUME AT AMBIENT
TEMPERATURE
LEAD TO LOW CAPEX

The Process

[Click here for animation in pdf](#)

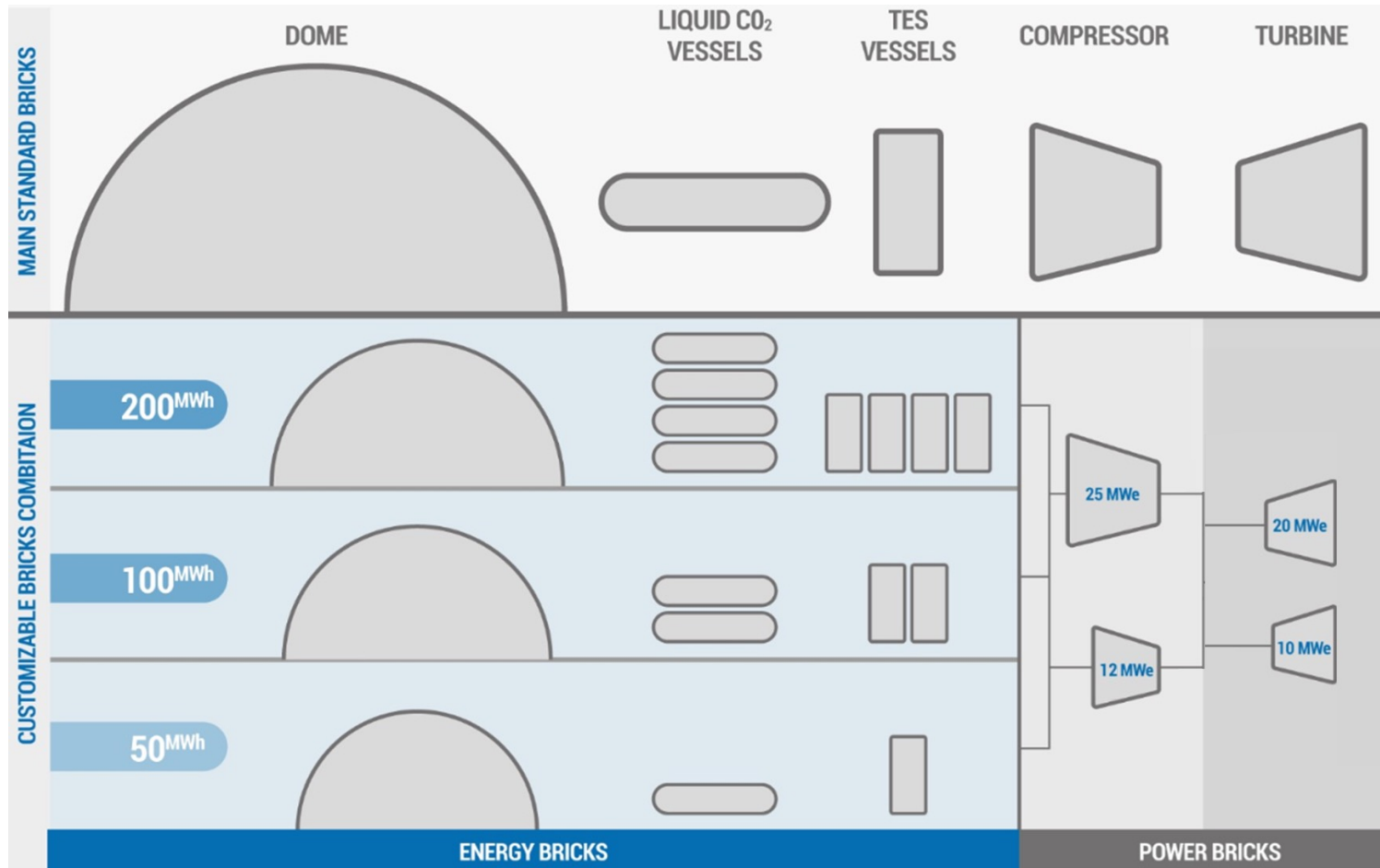
THE CO2 BATTERY

All readily available “off the shelf” equipment



THE CO2 BATTERY

Standardized bricks approach



ENERGYDOME'S TECHNOLOGY – THE C₂BATTERY

100 MW Solar PV Power + 200 MWh C₂ Battery
15 MW Baseload Renewable power plant 24h/7



100MWh = 2-2.5 Ha = 5-6 Acres
(4-5kWh/m²)

THE CO2 BATTERY

100MWh general arrangement



Rendering of a 100MWh CO2 Battery

GO TO MARKET

CO2 Battery | Product Development Path

	Lithium-Ion	
RTE	80-85% RTE - degradation over time	75% - no degradation over time
CAPEX *	\$300-400/kWh (Mass Scale)	\$200-250 kWh (for initial deliveries) \$150-200 kWh (when at mass scale)
LIFETIME	10 y	25 - 30 y
CAPACITY (Usable DOD range)	20-80% - degradation over time	0-100% - no degradation over time
EQUIPMENT TRL	TRL9	- TRL 9 - PPB TES: TRL6
PROOF OF CONCEPT		- Fichtner Report - Mini-Demo
PERFORMANCE VALIDATION		- Fichtner - Politecnico di Milano
- CAPEX of Li-Ion Battery for large scale projects 4h; - CAPEX of CO2 Battery calculated for 20 MW, 10h and inflatable dome;		

DEMONSTRATION PLANT

2.5MW-4MWh

Testing and start of
operation 1Q22.



CASE STUDIES



LDES-driven business case

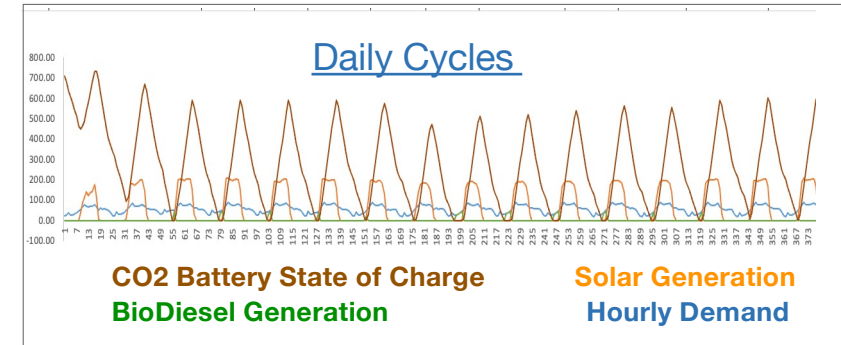
Application	Case example	Customer example	IRR (potential improvement)	Value drivers for LDES	Key unlocks
 Energy shifting, capacity provision, and T&D optimization	US-based utility	Integrated utilities with significant RE build-out and transmission bottlenecks between generation and demand	~3% (+11%)	T&D optimization	Market mechanisms enable remuneration of CO ₂ e bene-fits for LDES asset owners
 Stability services provision (eg, inertia)				Capacity provision CO ₂ e cost savings RE curtailment reduction	Regulatory options or incentives ensure WACC commensurate with RE development Sustained carbon price in line with NDCs ¹
 Firming for PPAs	RE developer in Australia	RE developers or owners looking to serve corporate RE PPAs with firming capacity	~7%	Firmed capacity RE PPA premiums	Increase certainty for LDES developers through long-term contracting
 Isolated island grid optimization	Isolated island integrated utility in the US	Integrated utilities serving isolated island power systems with decarbonization ambitions but limited interconnectivity	~7% (+5%)	Production cost savings CO ₂ e cost savings	Regulatory options or incentives ensure WACC commensurate with RES development
 Optimization of energy for industries with remote/ unreliable grids	Diesel-powered copper mine in Chile	Industrial customers looking to reduce the costs of energy supply and reduce carbon footprint of products	~15% (+4%)	Production cost savings CO ₂ e cost savings	Market mechanisms enable remuneration of CO ₂ e benefits for LDES asset owners
 On-demand RE peak power	RE developer in India	RE developer in India providing morning and evening peak supply as well as off-peak generation	~10% (+2%)	Peak and off-peak power supply	Increased electricity pricing spread and higher need for clean dispatchable peaking power

Source : LDES Council – McKinsey : [Net-Zero Power, Long Duration Energy Storage for a renewable grid](#)

Case Study 2 : Solar PV Power Remote Location

Generation & Load Profile						CO2 Battery				
		Load	Solar PV					Rating	No	Total
Annual Energy		538	777 GWh			Compressor		24.3	4	97
Max Power		99.6	248.3 MW			Turbine		18.3	4	73
Min Power		20.0	(0.3) MW			Storage		200	4	800
Hour	Total Load MW	Solar PV dispatch MWh	CO2B dispatch MWh	CO2B charge MWh	CO2B SOC MWh	Biodiesel Dispatch Capacity MWh	Biodiesel Dispatch Energy MWh	Total Solar 777 GWh	Total CO2B 230 GWh	Total Bio 16 GWh
1	24	(0)	(24)	-	776	-	-	(0)	-	-
2	27	(0)	(27)	-	748	-	-	(0)	-	-
3	41	(0)	(41)	-	707	-	-	(0)	-	-
4	28	(0)	(29)	-	678	-	-	(1)	-	-
5	29	(0)	(29)	-	649	-	-	(1)	-	-
6	32	(0)	(33)	-	617	-	-	(1)	-	-
7	38	(0)	(38)	-	579	-	-	(1)	-	-
8	48	1	(46)	-	533	-	-	(0)	-	-
9	55	40	(15)	-	518	-	-	40	-	-
10	66	85	-	14	531	-	-	125	-	-
11	80	115	-	26	557	-	-	240	-	-
12	71	140	-	50	608	-	-	380	-	-
13	68	120	-	38	646	-	-	501	-	-
14	69	138	-	50	696	-	-	639	-	-
15	71	140	-	50	746	-	-	779	-	-
16	79	177	-	71	800	-	-	956	17	17
17	66	111	-	33	800	-	-	1,067	33	50
18	53	9	(44)	-	756	-	-	1,076	-	50
19	62	(0)	(62)	-	694	-	-	1,075	-	50
20	54	(0)	(55)	-	639	-	-	1,075	-	50
21	58	(0)	(58)	-	581	-	-	1,075	-	50
22	56	(0)	(56)	-	524	-	-	1,075	-	50
23	52	(0)	(53)	-	472	-	-	1,074	-	50
24	39	(0)	(39)	-	433	-	-	1,074	-	50

Hourly Series



Customer Request

- Given 30 year fixed hourly load and solar PV profile, what is optimal storage configuration ?

Analysis

- CO2B sizing driven by
 - Required energy storage capacity (MWh)
 - Required max discharge capacity (MW)
- Capacity shortfalls can be managed by
 - More generator capacity
 - Provide standby Biodiesel for ... X ... % (resolved for 3%)
 - Limited demand management

Recommendation

- 4 X 200MWh CO2 Battery
- Reduce size of solar PV array
- Facilitate demand management

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NEWS

'CO2 Battery' startup Energy Dome gets US\$11m financing, first agreement to deploy 100MWh project

By Andy Colthorpe
December 1, 2021

Europe Grid Scale Business, Products, Technology

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NEW ENERGY FINANCE

Energy Dome named BNEF Pioneers 2022 Finalist

Energy Storage NEWS

Energy Dome scores first licensing agreement for CO2 battery

By Cameron Murray
March 11, 2022

World Industrial Reporter » Innovation » Energy Dome Unveils Disruptive CO2 Battery System

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CANARY MEDIA

Energy Dome is the rare long-duration storage firm that's moving fast

The Italian firm landed a deal for a 100MWh plant just two years after launch.
9 December 2021



POWER News & Technology for the Global Energy Industry

Energy Storage

Feb 1, 2022
by Darrell Proctor

Italian Group Taps CO2 for Energy Storage

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