gPAC Technology for Sequestration of Air Captured CO_2

Overview of the Technology and Invitation for EOI

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Sydney, Australia

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The Opportunity

Direct Air Capture with Storage (DACS) is now recognised by many jurisdictions as complimentary to carbon dioxide removal (CDR) to ensure effective decarbonisation for achieving net-zero emissions by 2050.

This dual strategy has been acknowledged globally as conceivably the only option to avoid a global climate crisis.

The challenges with current DACS approaches

In the absence of verifiable methodologies for permanent large-scale sequestration of captured CO_2 from current DAC systems, it is presently near-impossible to assess the potential climate benefit over the life cycle of the proposed DACS systems through integrated full lifecycle assessments (LCAs), techno-economic assessments (TEAs) and environmental impact assessments (EIAs).

It is broadly accepted that DACS will not be the primary mitigation process and cannot be a “cure for all”, with many decarbonisation technologies needed to achieve net zero outcomes. Regardless, the above shortcomings hamper the ability of the DACS solution providers to verify their net CO_2 removal potential with a reasonable level of confidence, as an effective near-term CDR tool.

Consequentially, the need for innovative technology-based solutions to address these shortcomings, which are essential for DACS public acceptance and securing social license for global deployment, is more than ever overwhelming.

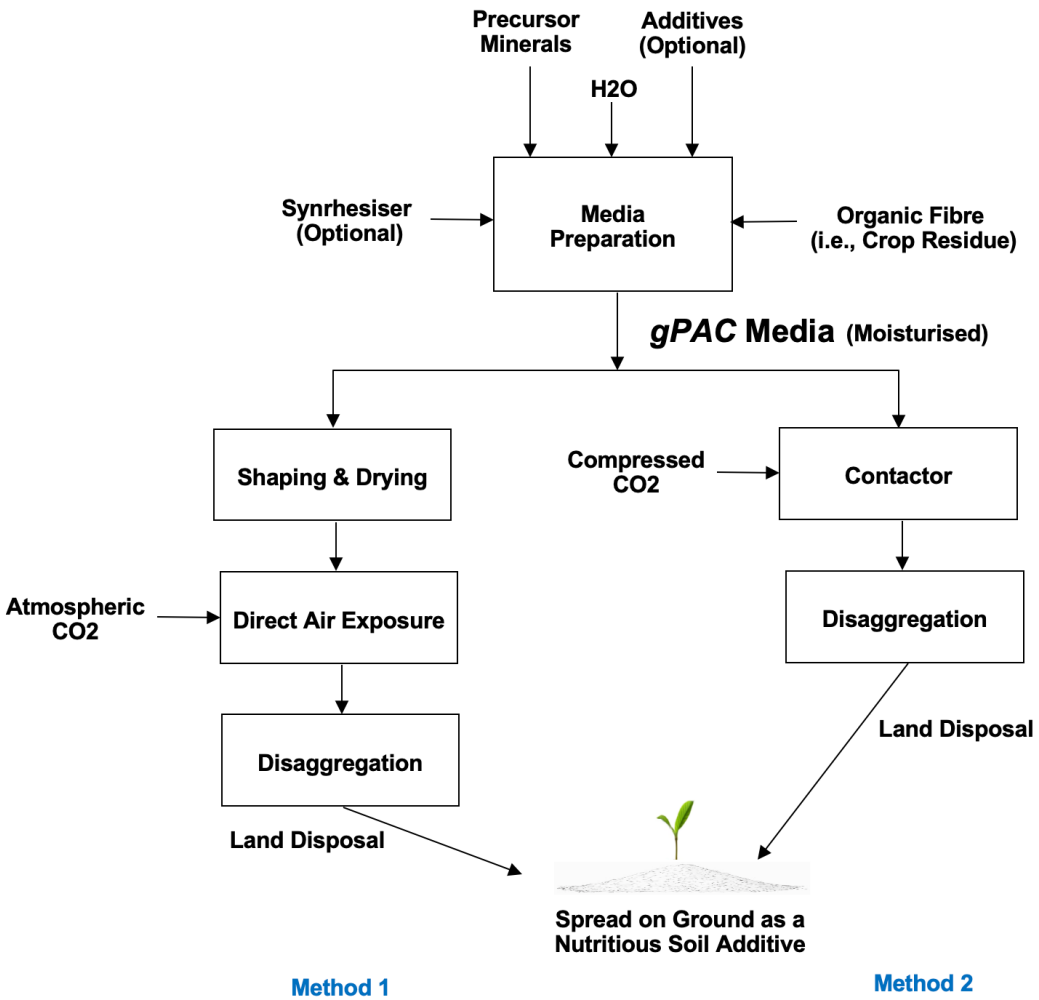
gPAC technology-based solution can help address these challenges

The technology's key attributes:

- Based on introducing pressurised CO_2 to contactors containing ***gPAC*** media and achieving baseline rates of carbonation in the order of a few days at efficiencies in excess of 80% carbonation. The carbonated media is disposed of safely and permanently by placing it on land to become a nutritious soil additive.
- ***gPAC*** media being mineral-based and soil degradable, are made from widely available crop residue and precursor minerals, including gypsum and minerals of magnesium and potassium. They are formulated to capture and permanently sequester air CO_2 and compressed CO_2 by mineral carbonation processes. The carbonated media is directly applied to land to naturally degrade as a nutritious soil additive.
- The precursor minerals for media formulations can be sourced opportunistically from the treatment of numerous waste streams, including reject brine originating from seawater desalination processes, mine tailings, leachates of flyash from waste-to-energy plants, and oil and gas operations, to name a few.
- Processes are based on well-known scientific principles and established carbonation reactions in ambient field conditions, which will enable the establishment of verifiable methodologies for determining the CO_2 throughput values.
- Modular units, either standalone or in cascades, requiring minimum moving parts to permanently sequester air CO_2 supplied in pressurised form.
- Zero waste with minimal leakage or residual emissions.

Methods for application of *gPAC* media for capture and permanent sequestration of air CO_2 either directly from atmosphere (Method 1) or compressed CO_2 from DAC processes (Method 2).

Note: only Method 2 is the subject of this invitation for EOI.

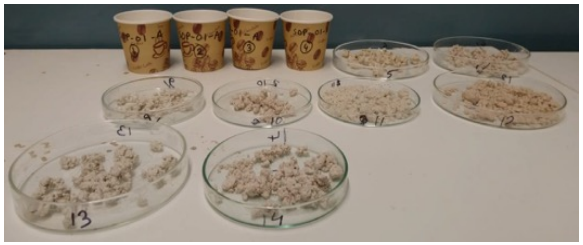


Examples of *gPAC* media before and after direct air CO_2 capture and carbonation (Method 1)

Close up view of the media before application

Carbonated media spread on the ground

Close up view of carbonated media



Differences with enhanced rock weathering (ERW) approaches

Our ***gPAC*** technology-based solution differs substantially from other CO_2 sequestration initiatives involving direct land application of CO_2 absorbing rocks, including ERW approaches, which involve spreading fresh pulverised volcanic rock on the ground.

In contrast to ERW initiatives, CO_2 sequestration by ***gPAC*** media is achieved by formation of non-reversible diagenetically formed carbonate minerals under controlled conditions in a contact vessel and subsequent transfer to land for natural degradation independent of the nature of the underlying soil types.

gPAC technology enables permanent CO_2 sequestration at a substantially more accelerated rate than the proposed ERW approaches with minimal spatial uncertainty which reduces the need for multiple proxies and hence the risk of introducing a new set of complexities associated with soil application of volcanic rocks, as is the case with the ERW approaches.

How *gPAC* technology can be a good fit for DAC processes to become DACS solutions in the near-term

By leveraging energetically favourable carbon mineralisation reactions within our mineral-based media at ambient temperature, our technology provides a sustainable solution for permanent on-site sequestration of pressurised CO_2 from existing and proposed DAC systems. This is achieved by:

- Obviating the need for energy use for CO_2 transportation and storage, which will be necessary for geological carbon storage,
- Combining a fast non-reversible carbonation rate with safe non-spatial land disposal, making the technology a unique tool for onsite linkage with existing and proposed DAC systems as an end-of-pipeline sequestration solution for multiple site application, at scale,
- Being largely independent of the need for renewable energy sources and low-carbon energy infrastructure which is required to meet the overall mechanical energy demand for DACS systems and will likely involve trade-offs between energy usage and capture efficiency,
- Providing a permanent CO_2 sequestration method that satisfies a number of matrices, namely, durability, safety, cost, resource usage and environmental impact - all of which are considered necessary for responsible and effective deployment of DACS at megaton and eventually gigaton scale, annual removal of atmospheric CO_2, whilst attracting community acceptance and achieving social license, and
- Supporting demand market development beyond voluntary carbon markets and corporate commitments by engaging additional industry stakeholders (such as forestry and food production), that are increasingly becoming committed to regenerative farming at scale, and waste generating industries (landfills, mining, composting, etc), that are seeking sustainable technologies for reduction of their carbon footprint.

Panels made from *gPAC* media, from experimental production to field trials (Method 1)

Earlier version of direct air CO_2 capture panels which were subjected to field performance trials in a horizontal setting.

Current project focus is on improving the microengineering and panel design aspects in tandem with field and laboratory-based CO_2 capture performance evaluations.

Close up views of vertically arranged direct air CO_2 capture panels showing lifecycle stages commencing from carbonation to degradation steps before panels are disaggregated and spread on land as a soil additive.

Field and laboratory evidence point to key role of both diurnal and longer-term wetting/drying events in alternative capture of air CO_2 and subsequent diagenetic precipitation of carbonate minerals.

DACS shields made from *gPAC* media for tree trunks (Method 1)

Close up views of tree trunk shields made from ***gPAC*** media that are currently being subjected to performance evaluation for direct capture and sequestration of atmospheric CO_2 in forested areas.

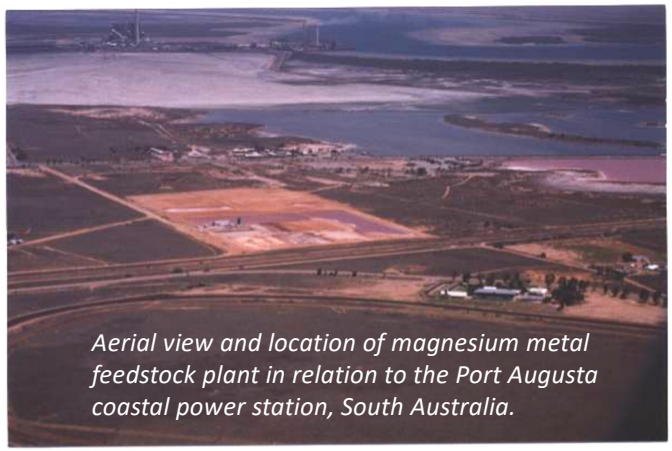
These shields can also act as effective barriers for protecting trees from the lower canopy fire fuel, commonly the first stage fire ignition during wildfire events.

About Pact Renewables

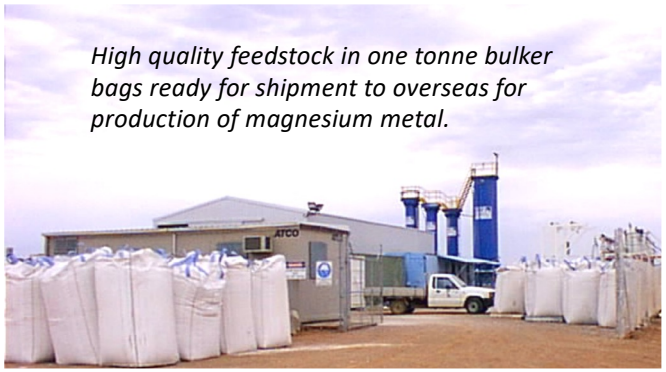
- A Sydney, Australia based private technology company established in 2011, directed by Dr. Aharon Arakel with a business focus on developing and commercialising a portfolio of clean technologies and low-footprint products.
- Aharon is a pioneer and global expert in the recovery of values from saline waters and wastewaters, with his first patent on the production of minerals from salt lake brines dating back 30 years. His first foray in developing air carbon capture processes dates back to the mid 2000s, following the implementation of the Kyoto Protocol and entering a partnership with a south-east Asian carbon and energy fund.
- The Company engages a highly qualified team of engineers, scientists, and product designers, whilst drawing from the skill base and deep experience of an advisory team located around the world and enjoying close links with EPCM providers and offtake contractors.
- Pact Renewables operates specialised in-house material testing facilities and offers expert advisory services through an affiliated company.

Snapshot of technology development and piloting leading to technology licensing

1996-99: A partnership project with Takata Corporation of Japan for semi-commercial scale production and demonstration of a high-purity Mg metal feedstock, using reject brine from seawater cooling system of a coal-fired power station in the city of Port Augusta, Australia. A fixed 23,000 tpa salt load removal capacity plant was successfully constructed and operated, leading to the granting of a technology license to Takata Corporation.



Aerial view and location of magnesium metal feedstock plant in relation to the Port Augusta coastal power station, South Australia.



High quality feedstock in one tonne bulker bags ready for shipment to overseas for production of magnesium metal.

Technology development & public demonstration

Pact Renewables is well-versed with the intricacies of new technology commercialisation processes, by drawing from the extensive global experience of Dr. Arakel in technology demonstration to investors, communities, governments, industry, product off takers, and trading companies.

Technology optimisation

Over the past few years, substantial focused efforts have been directed towards technology/process and product optimisation in parallel. The end outcome is massive technical and market information bases that will be available to technology licensees for their early market positioning.

Snapshot of test rig-scale production of media using ***gPAC*** Technology. The media includes both using gypsum and recycled gyprock (plasterboard) as part of the precursor minerals of the composites. The mineral-based media has been produced in bulk and subjected to comprehensive performance testing for industrial, GHG emission reduction, and other applications. More information is available on the Company's website.

Invitation of expression of interest and next steps

We believe that Method 2 of our ***gPAC*** technology-based solution for permanent sequestration of captured CO_2 by land application of the carbonated media, offers a unique opportunity for DACS projects to avoid falling at the tail end of broader global decarbonisation efforts because of reliance on pairing with future geological carbon storage facilities.

However, this method being currently at TRL of 4-5, needs further optimisation to improve its TRL through microcosm trials in regions of interest to better understand how the interaction between the air CO_2 capture and sequestration processes, local soil, and other parameters will work collectively to provide scalable solutions with measurable outcomes for individual DACS enterprises.

Accordingly, the owners of Pact Renewables invite expressions of interest, exclusively from DACS companies, for access to ***gPAC*** technology with the objective of proprietary IP development through contract R&D with Pact Renewables.

Further detailed information in the form of a confidential information memorandum and access to Pact Renewables' management will be provided to those selected parties who respond to this call and demonstrate a genuine intention to proceed.

The disclosure of confidential information will be subject to entering a confidentiality agreement with Pact Renewables.

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