The SPOCC Reactor

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OmnaGen

Who we are

Omnagen is a UK-based start-up. We were founded to make more sustainable use of hydrocarbon resources.

We use solid oxide fuel cells to convert hydrocarbons into chemical products, with electricity as a byproduct.

The SPOCC Reactor follows on naturally from this work, by incorporating solid oxide electrolysers.

'SPOCC' stands for 'Self-Powered CO_2 Converter'.

Omnagen owns a range of granted patents, and patent applicatons.

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Our Objective:

To provide the lowest energy route for converting carbon dioxide into syngas.

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Capturing CO_2:

Capturing from point sources of fossil fuel combustion:
- combustion in pure oxygen – condense the water.
- combustion in air – more energy for separation.

Direct air capture:
- CO_2 is very dilute, so more energy needed for separation.
- can locate anywhere.

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Converting CO_2 :

CO_2 is thermodynamically stable.

Carbonates are more stable - mineralisation.

CO_2 can be electrolysed – carbon monoxide plus oxygen.

CO_2 can combine with reactive molecules.

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Reacting CO_2 with natural gas/methane:

Dry reforming:

- direct reaction of CO_2 and methane – high temperature (>800^oC), endothermic and carbon deposition.

Electrolysis of CO_2 and methane:

- much lower electrical potential and energy than direct CO_2 electrolysis.
- lower temperature than dry reforming.

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CO_2 electrolysis:

Conventional CO_2 electrolysis:
- products are CO + oxygen
- solid oxide electrolysers are most efficient
- needs a relatively high voltage

Co-electrolysis of CO_2 and steam:
- product is syngas (CO + hydrogen)
- needs even more energy than direct CO_2 electrolysis

SPOCC - Electrolysis of CO_2 with methane:
- product is syngas (CO + hydrogen)
- needs a much lower voltage, therefore much less energy to consume a given amount of CO_2

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Reacting natural gas/methane with air:

Gas boiler in your home:
- outputs - CO_2 + water + heat

Solid oxide fuel cells in your home:
- outputs – CO_2 + water + heat + electricity

Clean Carbon Energy. No CO_2 is produced:
- outputs – syngas ($CO + H_2$) + heat + electricity
- syngas is a platform chemical which can be converted to a huge range of other chemicals

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SPOCC Reactor uses electrochemical reactions:

Fuel cell:

- self-sustaining reaction
- exothermic reaction which generates heat
- some energy removed as electricity

Electrolyser:

- reaction does not happen spontaneously
- electrical energy supplied through electrolysis
- endothermic reactions need heat

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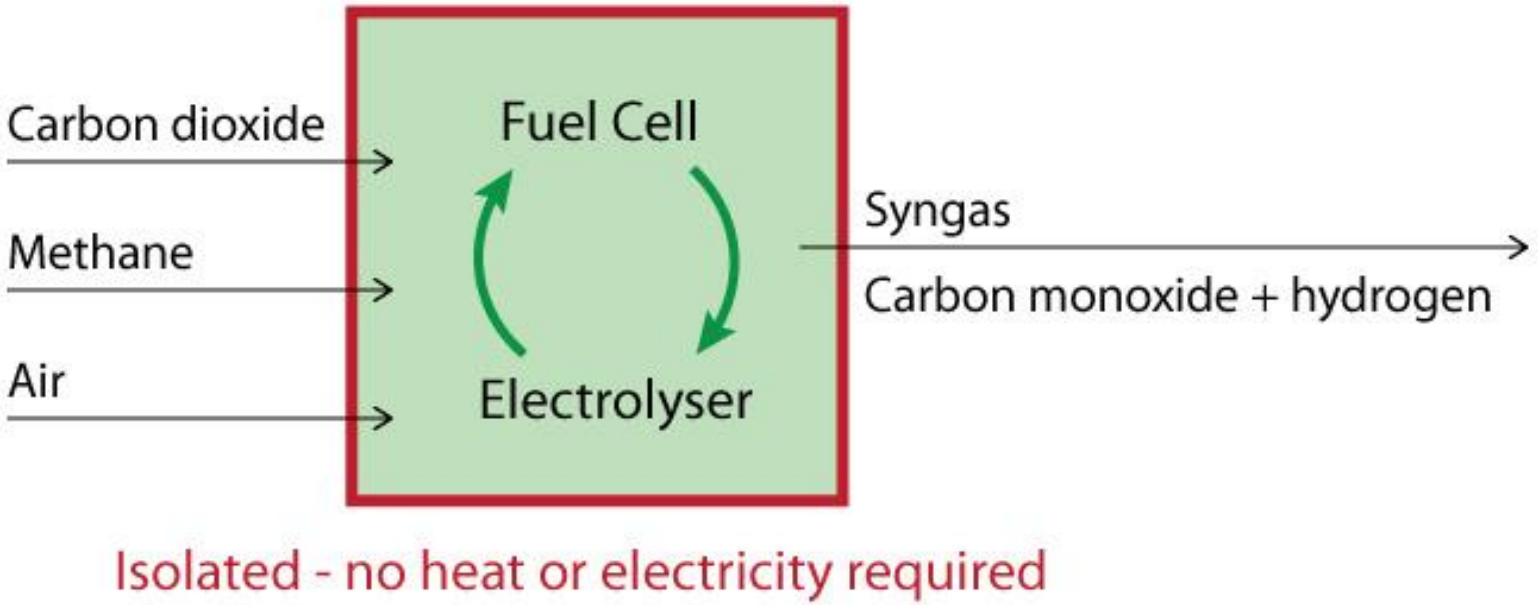
The SPOCC Reactor:



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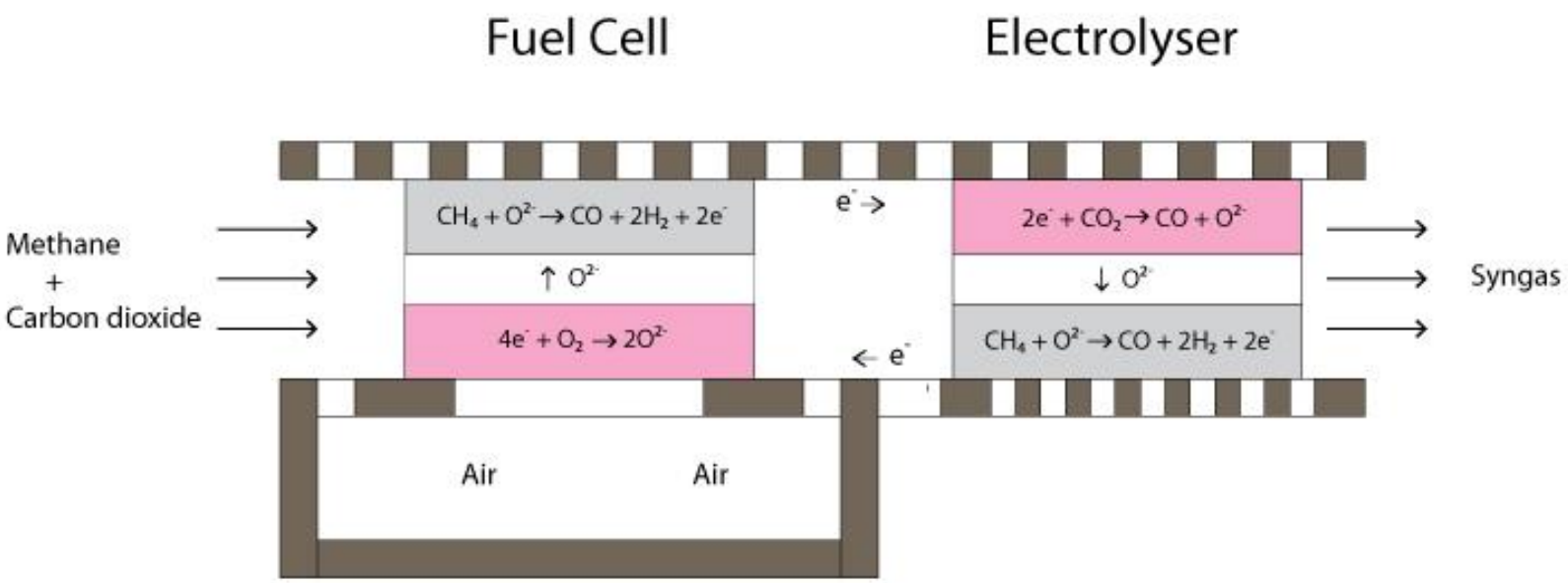
The SPOCC Reactor:



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The 2 reactions :

1. Fuel cell:- $2CH_4 + O_2 = 2CO + 4H_2$ + electricity + heat

2. Electrolyser:- electricity + heat + $CH_4 + CO_2 = 2CO + 2H_2$

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Overall reaction:

$2CH_4 + CO_2 + ½O_2 = 3CO + 4H_2$

This reaction is very endothermic. It needs a large heat input if it is done chemically.

If it is done electrochemically, the reactions are self-sustaining at elevated temperature, and no external energy is required.

The SPOCC Reactor takes advantage of the big entropy increase. **This makes it stand out as a low energy route for re-using CO_2.**

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What Omnagen can offer:

1. A carbon dioxide reactor where the reactions are self-sustaining.

2. Very scalable.

3. Converts the CO_2 to syngas.

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Sustainable applications:

1. Anaerobic digester
 - biogas is the perfect mix of methane and carbon dioxide as an input to the SPOCC Reactor.

2. Direct air capture (DAC) of CO_2 plus a supply of methane.
 - DAC units can be located where supplies of methane are also available. The SPOCC Reactor can convert them into syngas.

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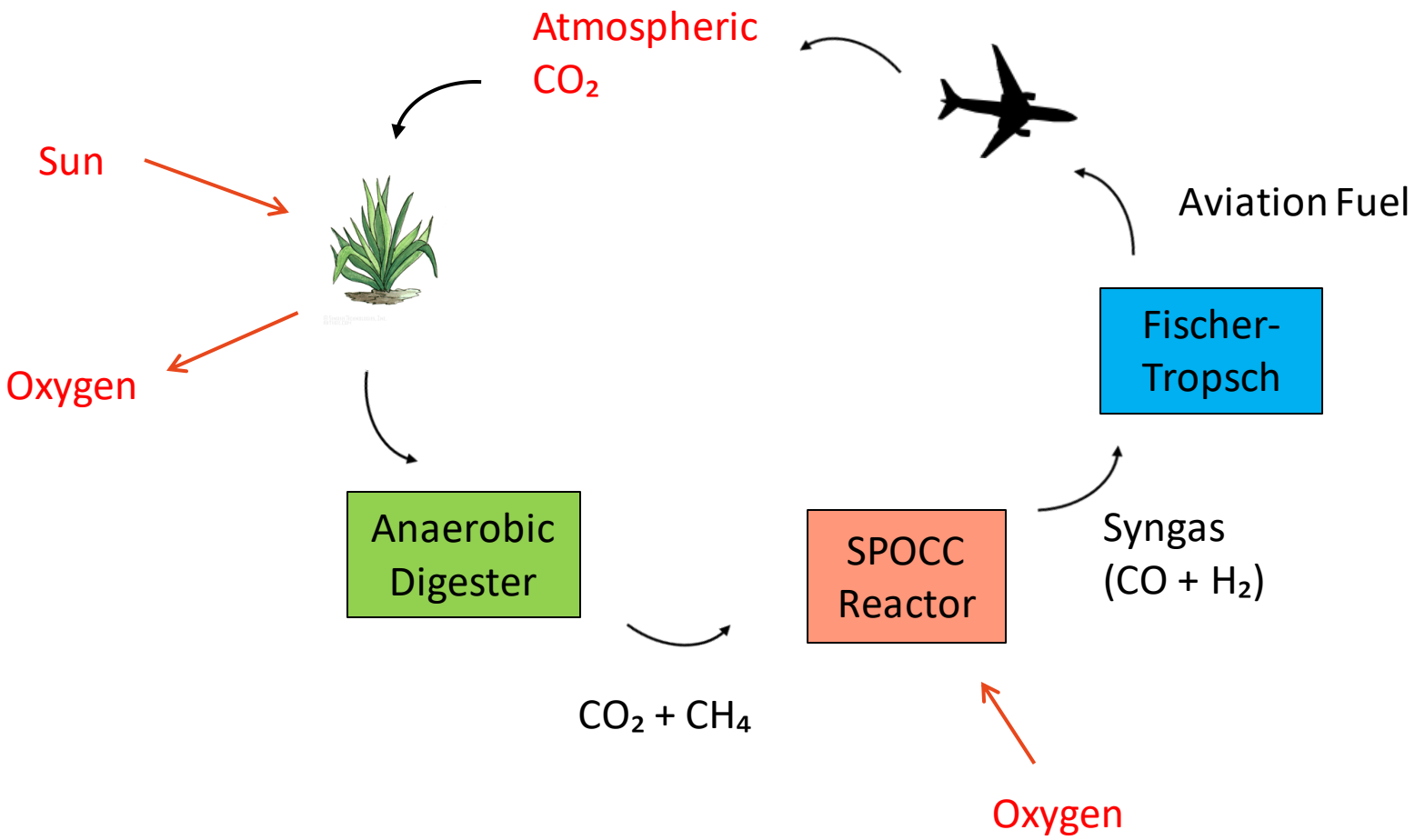
Alternative Carbon Cycle for Sustainable Aviation Fuel:



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Processes which release CO_2, and could benefit from the SPOCC Reactor:-

1. **Steam Methane Reforming** – produces hydrogen and CO_2: add more methane to the CO_2, and produce syngas

2. **Natural gas extraction** - CO_2 contained in the natural gas is usually vented to the atmosphere. React the CO_2 with methane to produce syngas. Process further to a liquid for transportation.

3. **Natural gas power stations** – separate CO_2 from the exhaust gases: add more methane and produce syngas.

4. **Cement production** - CO_2 is released during the heating and decomposition of calcium carbonate. Capture that CO_2, add methane, and produce syngas.

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Summary

1. Technology which allows carbon dioxide to be reused rather than buried, or released to the atmosphere.

2. Technology which uses self-sustaining reactions.

3. All of the carbon in the carbon dioxide and methane is converted into useful products.

4. Syngas produced by the SPOCC Reactor is carbon negative.

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What stage has the development reached?

What Omnagen is looking for:

We would like to work with companies and institutions which could help to fund and develop the SPOCC Reactor.

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Omnagen is a limited liability company registered in England and Wales with registered number 04372721.

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