
Carbon
Engineering

Carbon Engineering

Management Team

Adrian Corless

CEO

David Keith

Exec Chair / Founder

Susan Koch

CFO

Investors / Partners

- Bill Gates
- Murray Edwards

$18 M

Canada

$15+ M

SPX DHV STT Technip UBC

Intellectual Property

8 patents + 22 pending:

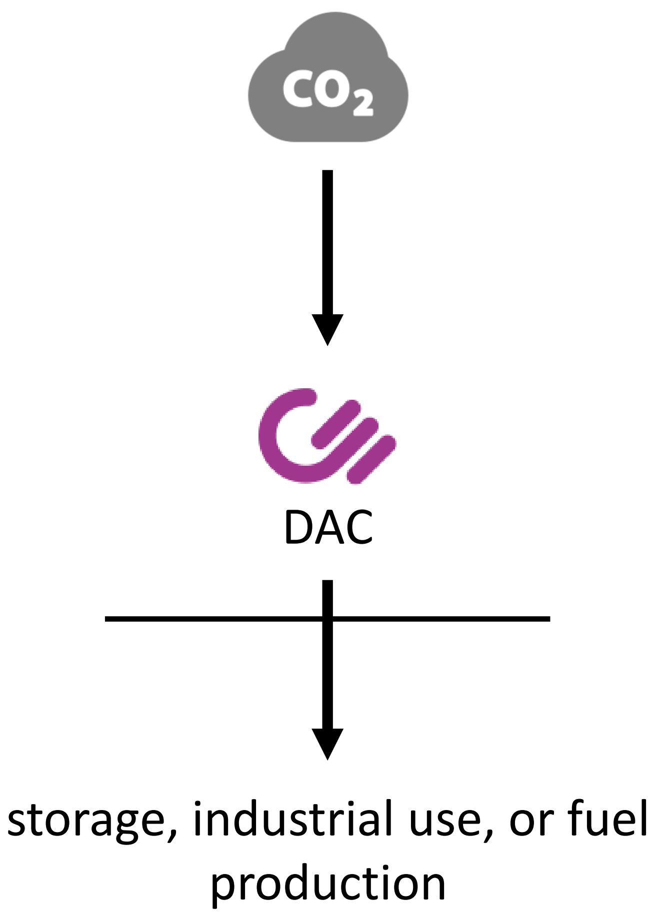
- P-Ca process
- Air Contactor
- low-CI fuel manufacture

Recognition

Virgin

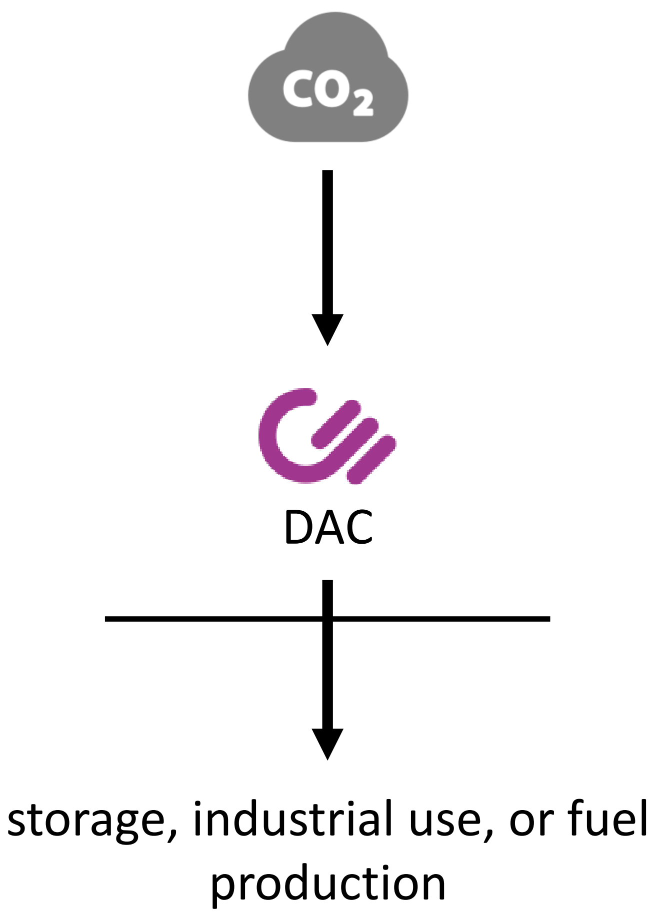
$25 M
Virgin Earth Challenge
Finalist

DAC - Direct Air Capture of CO_2



- Compared to CCS:
  - Higher thermodynamic barrier.
  - Larger air volume to be processed.

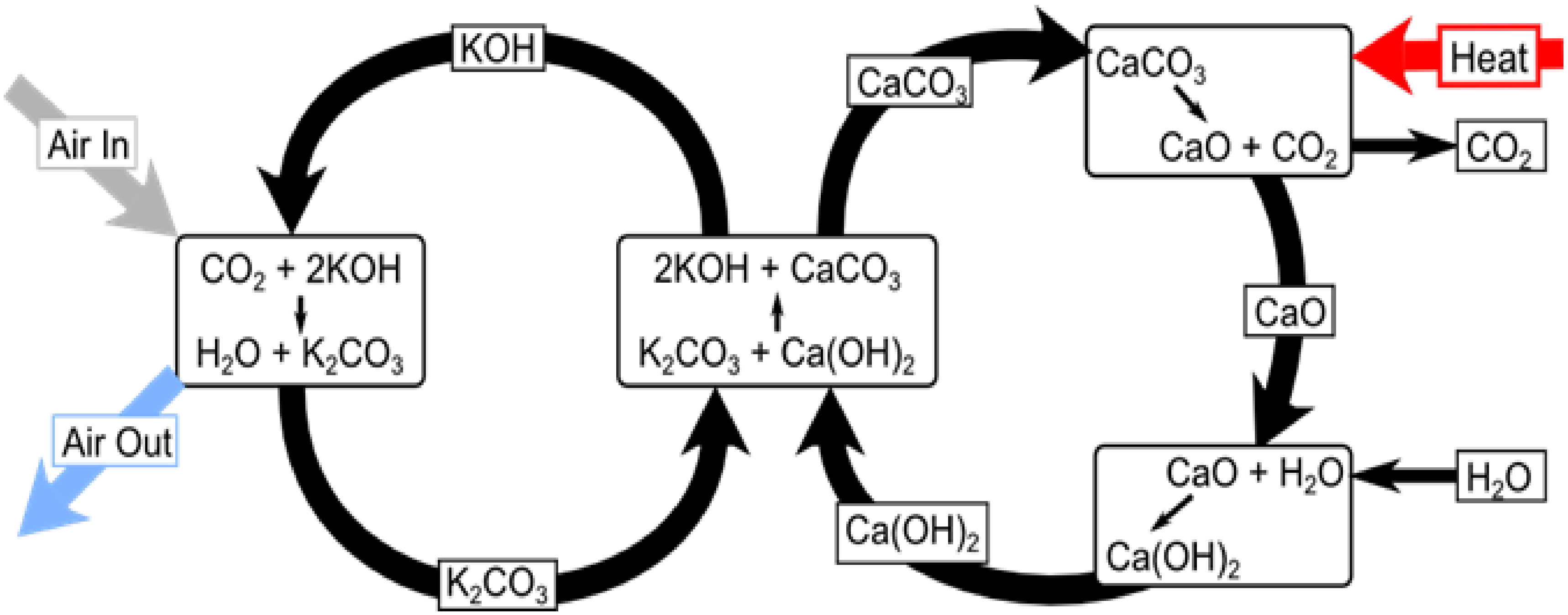
DAC - Direct Air Capture of CO_2



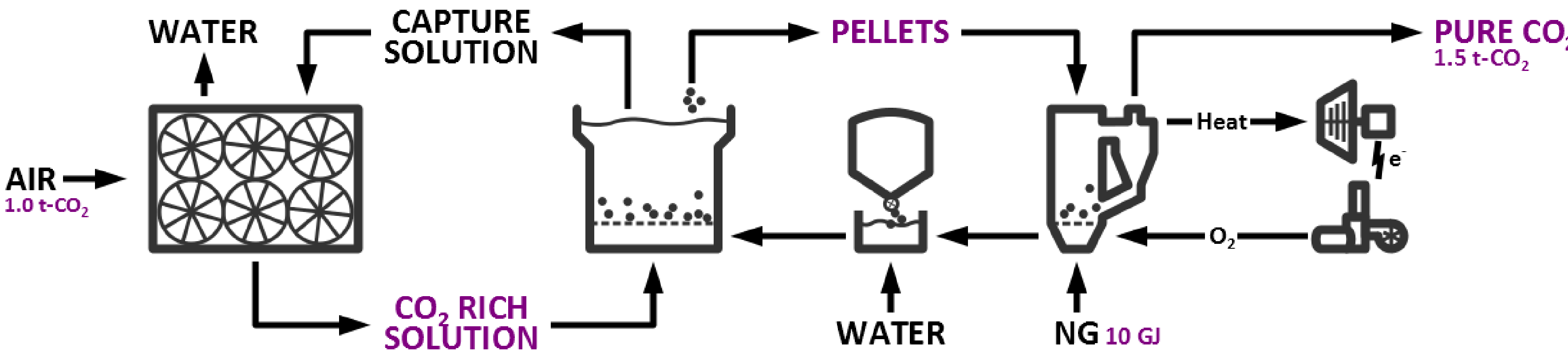
- Freedom of location.
  - Greenfield builds.
  - Locate at point of storage/demand.
- Manages emissions from any source.
  - Targets those not amenable to CCS.
- Enables negative emissions.
  - Physical carbon offsets.
- Closed carbon-cycle fuels.

Technology

CE's DAC Technology - Chemistry



CE's DAC Technology - Partnerships



SPX

Leading global cooling tower supplier.

Key technical similarities with CE air contactor.

Supplying CE air contactor.

Joint engineering and development.

DHV

Pelletization technology holders for wastewater.

3 years collaboration on CE's pellet reactor unit.

Supplying CE pellet reactor.

Continued joint development.

Technip

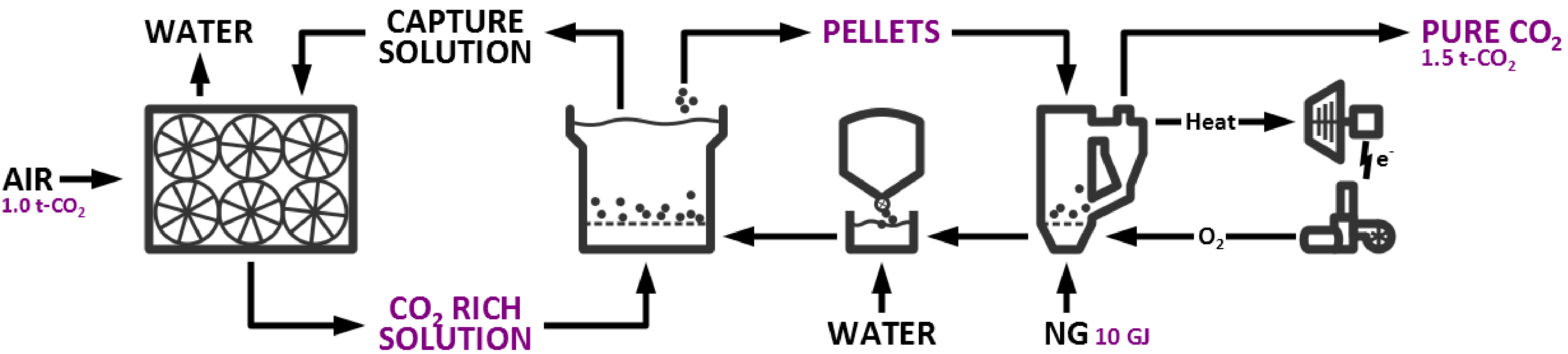
Global EPC, plus ore roasters and kilns.

Joint development of CE's CFB kiln.

Technical oversight for CE pilot calciner.

Calciner technology provider.

CE's DAC Technology – Process Basics



Inputs: Air, water, natural gas.

Electricity produced on-site.

Output: High pressure CO_2:

1 ton-CO_2 from air **+**

0.5 ton-CO_2 from natural gas

1.5 ton-CO_2 delivered

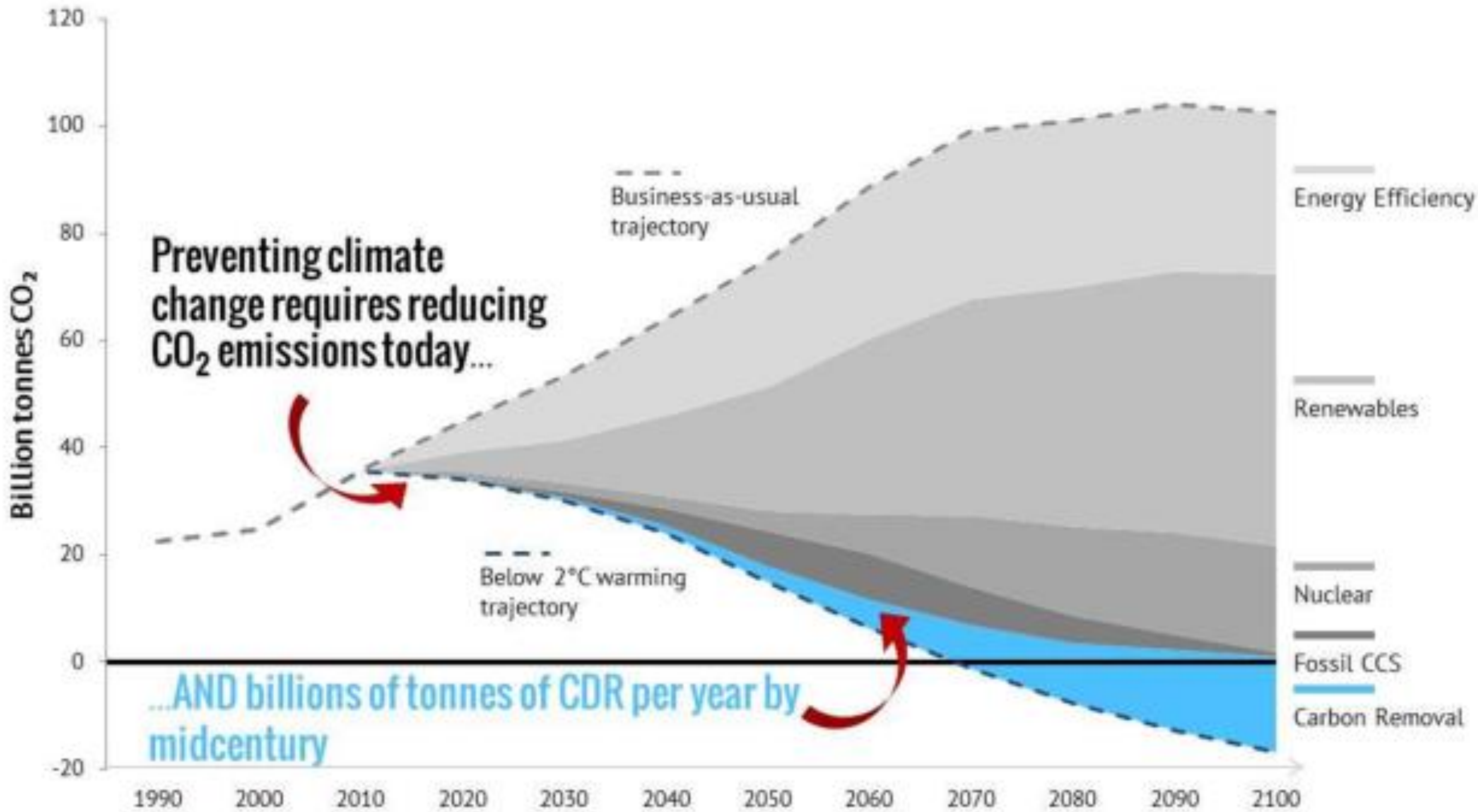
- Nth plant costs:
  - \$100-120/ton-CO_2-captured.
  - \$70-80/ton-CO_2-delivered.

Adaptation for fuel synthesis:

- Partial replacement of natural gas with renewable electricity.
- O_2 integration with electrolysis.
- Low pressure output.

Markets and Commercialization

Global CO_2 Emissions



- IPCC-5 and NAS both recognize CO_2 removal as necessary part of avoiding catastrophic climate change.
- Direct air capture → Fuels (Renewables) → Sequestration (Carbon Removal)

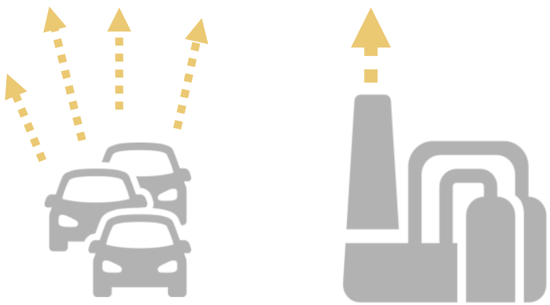
Market Opportunities - Offsets

“Platinum quality” CO_2 offsets are generated and sold to industrial emitters

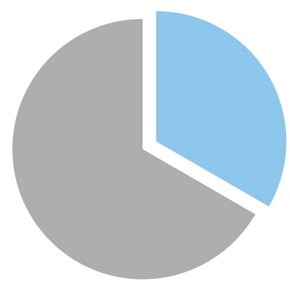
DAC can offer verifiable offsets based on physical mass flows, for sectors where reduction at source is too difficult or costly.

Future opportunity.

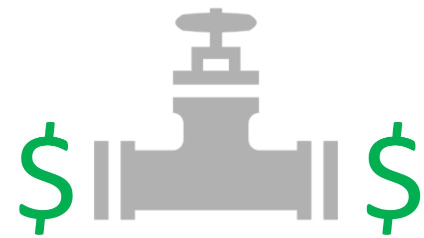
How to decarbonize transportation?



it’s harder to eliminate carbon from transportation than from stationary sources



transportation is 1/3 of CO_2 emissions



$ trillions in global infrastructure used to distribute high energy density fuels

How to decarbonize transportation

electrification

- no local pollution
- battery energy density 3% of liquid fuels
- electricity source determines carbon intensity

biofuels

- niche opportunities
- high land footprint
- competes with agriculture

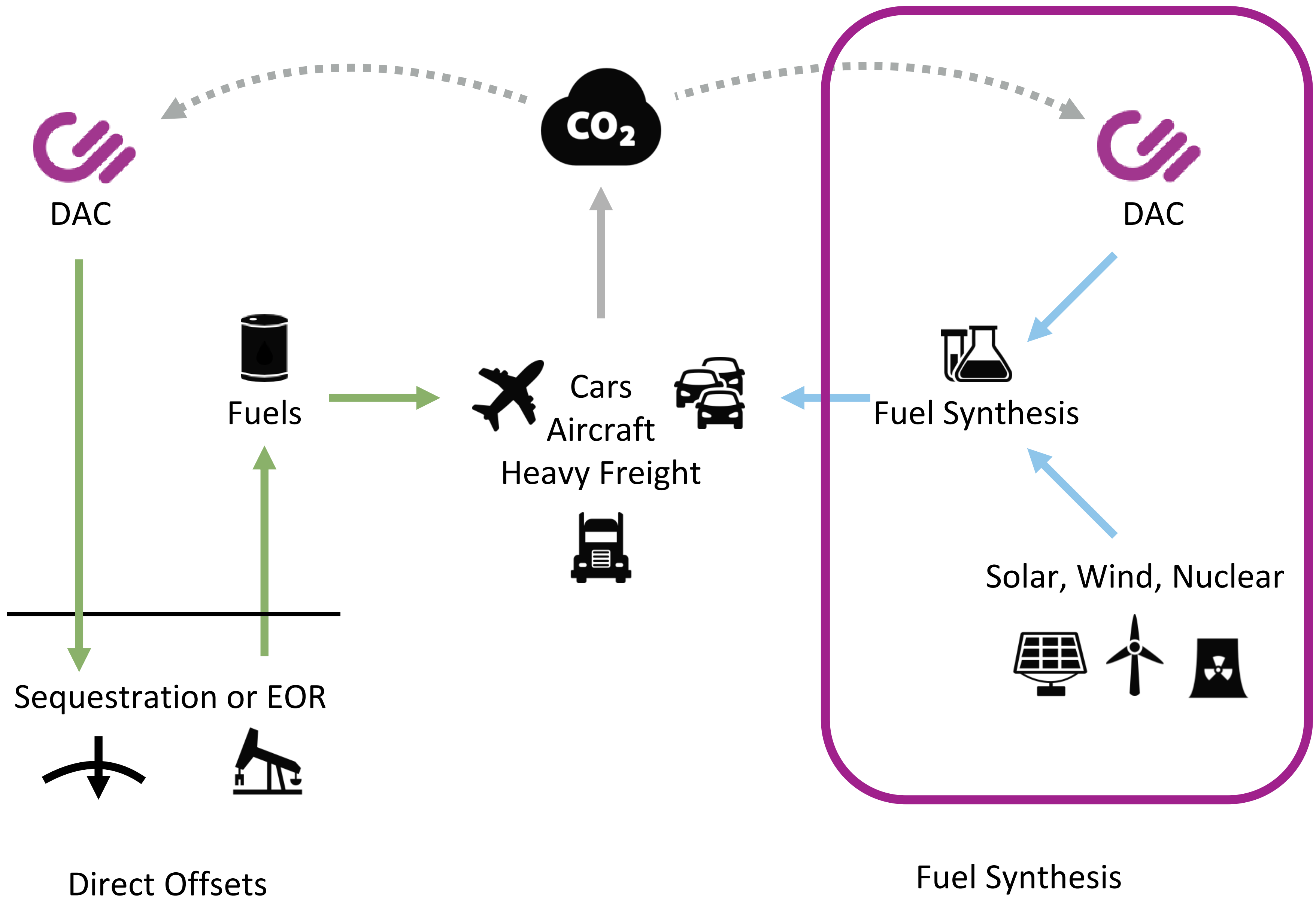
hydrogen

- high energy unit per mass
- difficult to transport
- requires total infrastructure turnover

carbon-neutral hydrocarbons

- high energy density
- compatible with $ trillions of global infrastructure
- low land-use footprint
- enabled by direct air capture of CO_2

Carbon-Neutral Hydrocarbons with DAC



Air-to-Fuel: Why at all? Why now?

Why at all?

1. Compatible with today's infrastructure and engines.
2. Globally scalable, avoids land use and food security issues of biofuels.
3. High energy density allows use in air and heavy transport sectors.
4. Can be blended with conventional fuels in increasing amounts over time.
   - Enables progressive transition.

Why now?

Convergence of major advancements:

1. Direct Air Capture of CO2 at industrial scale developed by CE
2. Dramatic drop (3x) in cost of large scale solar PV over last 5 years.
3. Multiple vendors now delivering MW and greater PEM Electrolyzers
4. Availability of fuel synthesis technology with high conversion efficiencies from multiple sources.

~$1.00/L liquid fuels with low carbon intensity.

Technology Precedent

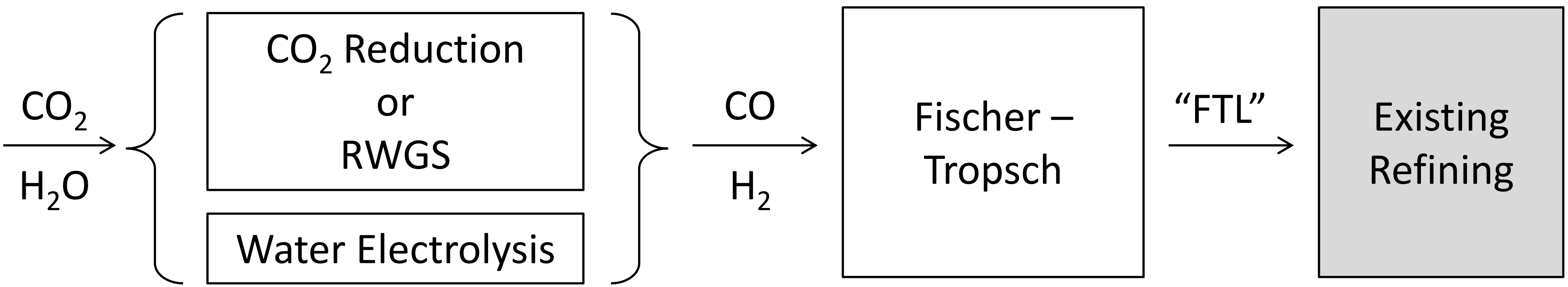
CRI, Iceland. CO_2 to MeOH.

Hydrogenics, ON. Grid e^- to H2.

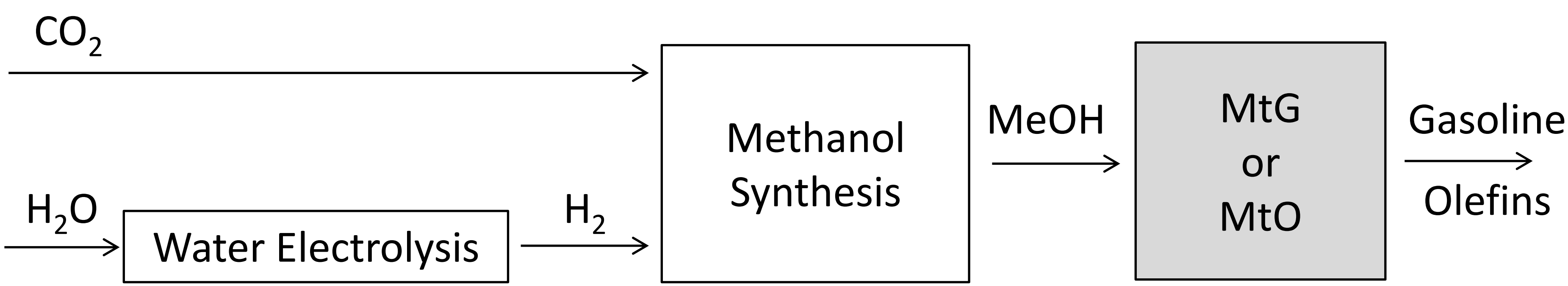
Sunfire, Dresden. CO_2 to FTL.

Shell Pearl, Qatar. GtL (140,000 bpd).

Fischer-Tropsch Pathways



Methanol Synthesis



This is an integration/optimization play. Modest technical risk.

CE Squamish Demonstration Plant

Hardware Development History

2005: Spray Tower

2008: Packed Tower

2010: Lab air contactor

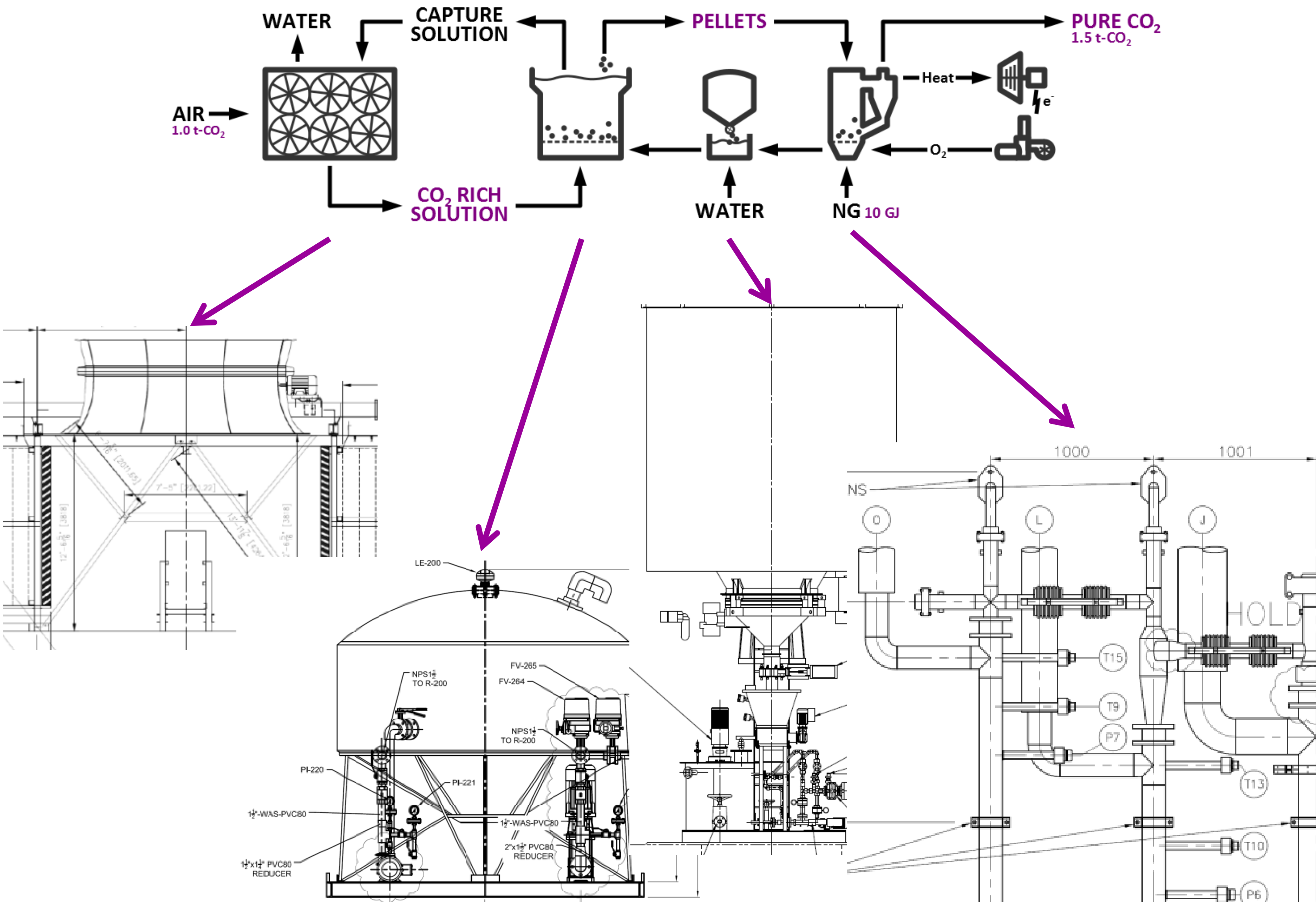
2011: Pellet Reactor Tests

2011-2012: Air Contactor Prototype

2013: Calciner Tests

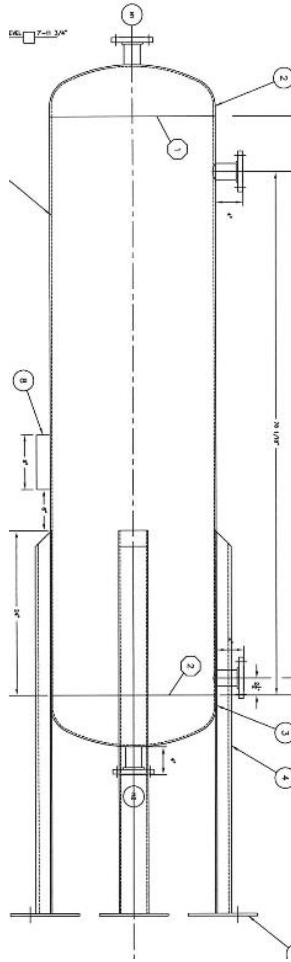
2014-2015: Full end-to-end pilot plant

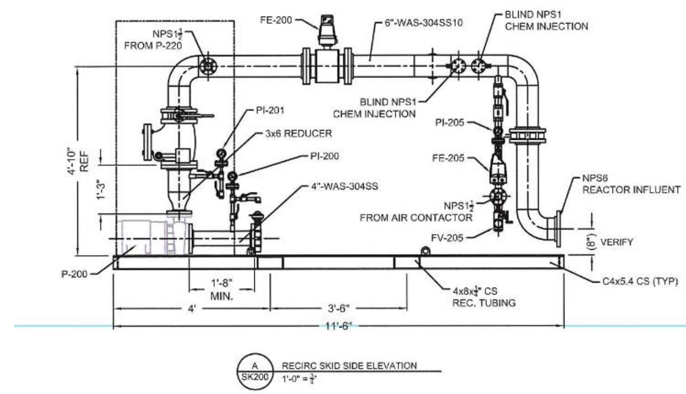
Demonstration Plant - Design



Demonstration Plant - Site

Demonstration Plant - Equipment









MERIDIAN


MERIDIAN

Demo Plant Operating Data

Plant data slides cut for distribution.

Conclusions and Next Steps

DAC Pilot:

- Core performance targets achieved.
- Operations will continue 2016-2017.
- Continued optimization on Pellet Reactor and Calciner.

Air to Fuels Demo Plant:

- Engineering a 1 bbl/day fuel demo (CO2, water, and elec).
- Goal is to demonstrate a pathway that has commercial scale costs of ~$1.00 /L
- 2016-2018

First Commercial plant:

- Targeting ~2018 kick-off for 100,000 ton-CO2/yr (~700 bbl/day) commercial plant.

N^{th} Plants:

- Scale up to 1 Mt/yr (~7,000 bbl/day).

Policy Requirements

First Plant:

- Targeted support.
- End user premium.

For wide-spread adoption, continued policy evolution is needed:

- Carbon tax (or fee-bate) is helpful.
    - But higher prices needed for transportation sector, and “residual” emissions.
- LCFS in more jurisdictions, or Nation-wide.
    - Emphasis on performance metrics:
        - Carbon intensity, land use, etc.
    - Double crediting sub-program for “advanced fuels” to help transformative technologies into the market.

Thank you.

Questions?