



**Industrial
Climate
Solutions Inc**
Innovation for Impact



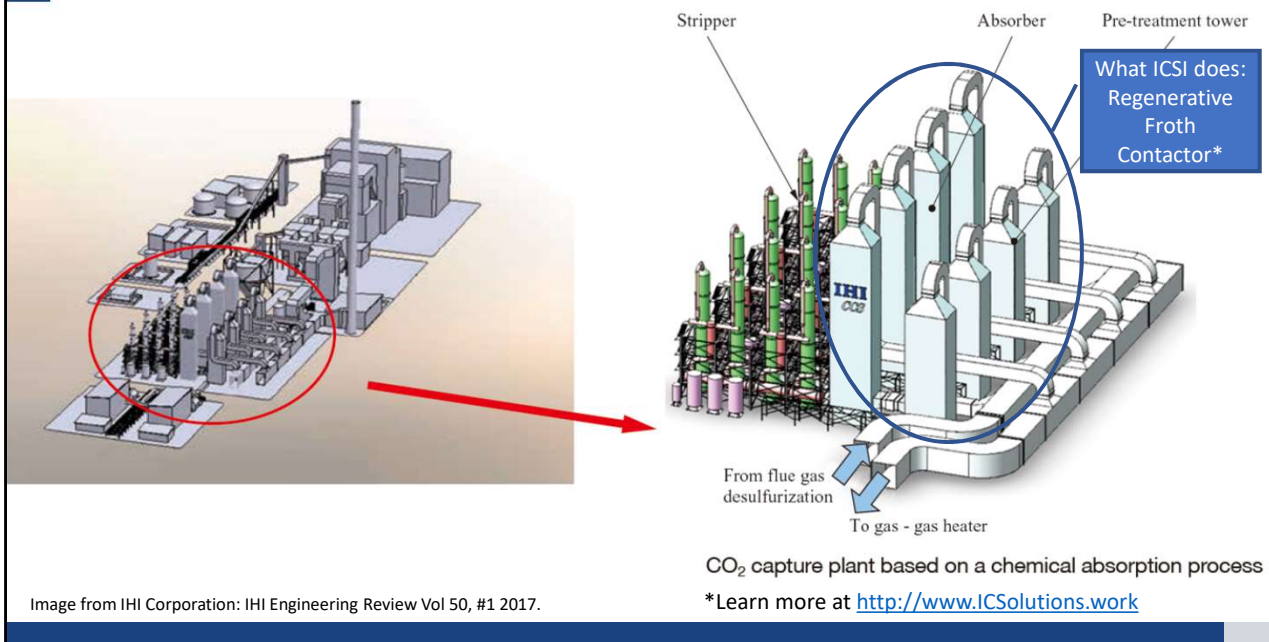
Industrial Carbon Emissions: It's a jungle in here!

June 2018

This presentation was developed to frame the Industrial Climate Solutions Emissions Management Conversation held on 2018-06-14 at the Bank & Baron in Calgary, Canada. The objective was to stimulate an exploratory discussion around how carbon management might become a cornerstone of developing a diversified, low-GHG-emission industrial economy in Alberta.

Inspired by the Rainforest initiative (see <https://www.rainforestab.ca/>) this conversation is meant to explore whether there is sufficient organic support to achieve breakthrough velocity in carbon management in Alberta.

Solvent-based CO₂ Capture Plant



To frame context – ICSI has a specific interest in gas/liquid contactors or absorber column technology. The ICSI technology demonstrates 4x to 5x increase in process intensity over incumbent technologies. This means that SO_x scrubbers and CO₂ absorber columns may be reduced by up to half in area and up to 60% in absorption bed height.

Important in very large point-source emissions capture plants, it may be a game-changer for distributed, multiple-source, intermediate-scale CO₂ capture arrangements. This may form the basis of a future presentation.

(For more information about the ICSI Regenerative Froth Contactor, see <https://www.icsolutions.work/notes-n-pubs>).

The larger point here is that ICSI provides a part of an overall solution. In order to succeed as a business we need to engage with, systems integrators, Engineering-Procurement-Constructors (EPCs), end users and many others.

Even a global scale systems integrator like IHI Corporation needs to integrate with the customer/host site and will work with EPCs to complete a project.

We need to work together to create the conditions for success.

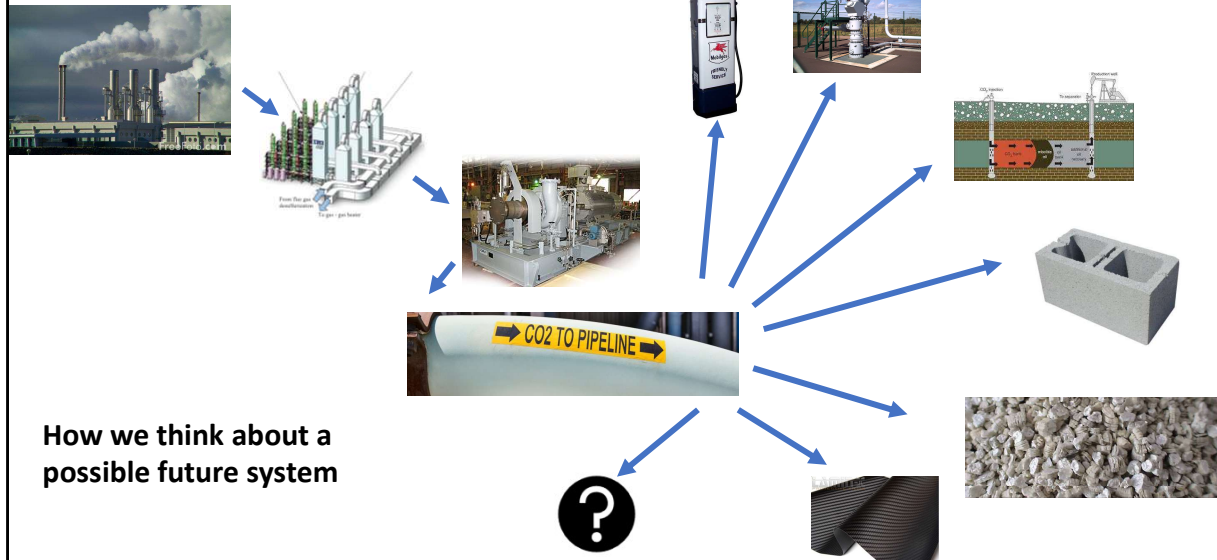
Technologies → Solutions

Many innovative companies, each with a piece of a solution.

Connect or die. But how?

In particular in Canada and in Alberta we have many small, innovative companies working on different aspects of the issue. If we insist that we each have “the” answer then we are unlikely to succeed. To have a successful industrial GHG innovation sector we need to seek synergies and opportunities to leverage each others’ strengths.

Step back and look at the system



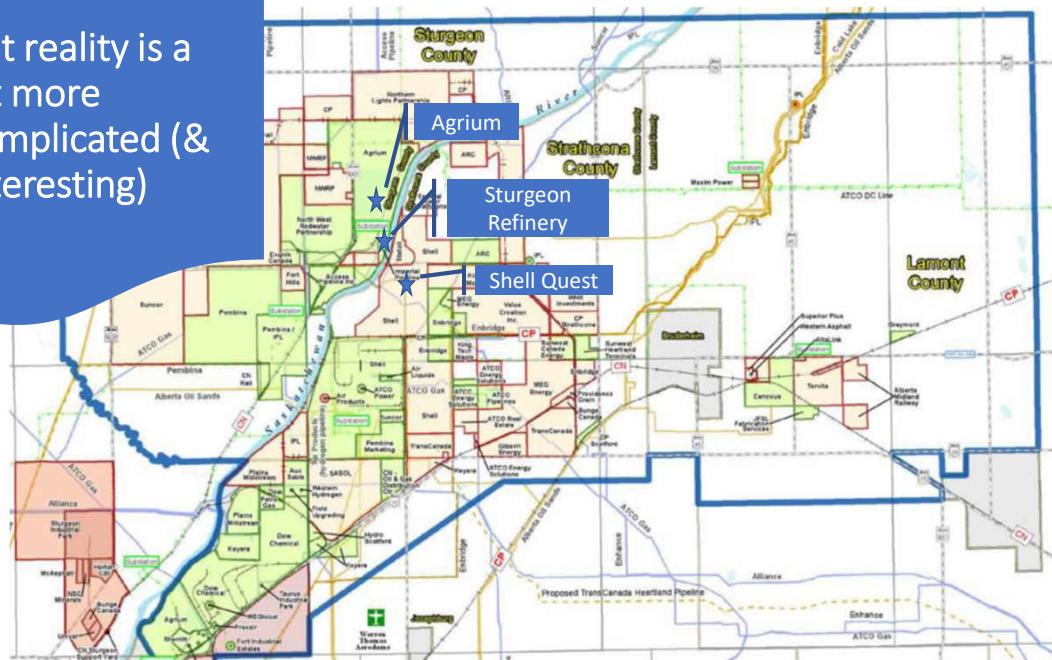
This is a hugely simplified framework, but when we step back from the capture plant to see it as a link in the chain between emission source, capture, drying and compression, transport and many diverse destinations for CO2 we see that the network gets more complex.

There are groups around the world working to convert CO2 to fuels, precast and cast-in-place cement, mineralized to create aggregate, convert to carbon materials including carbon fiber and nanotubes and many other outputs. The CO2 can also be used for enhanced oil recovery (EOR) and can be injected into deep formations for long-term sequestration.

The issue is that none of these are likely to be steady-state. Rather than thinking in terms of point-to-point projects, we need to think in terms of interconnected networks that can:

- Handle multiple sources
- Use deep storage as a means of dealing with startup and periods when production of CO2 exceeds demand (and may even return CO2 if demand exceeds supply at times)
- Allow for bringing on-board new conversion technologies, additional sources, and improving economic conditions (reduced capture cost or more competitive conversion technologies or changes in regulations and market incentives).

But reality is a lot more complicated (& interesting)

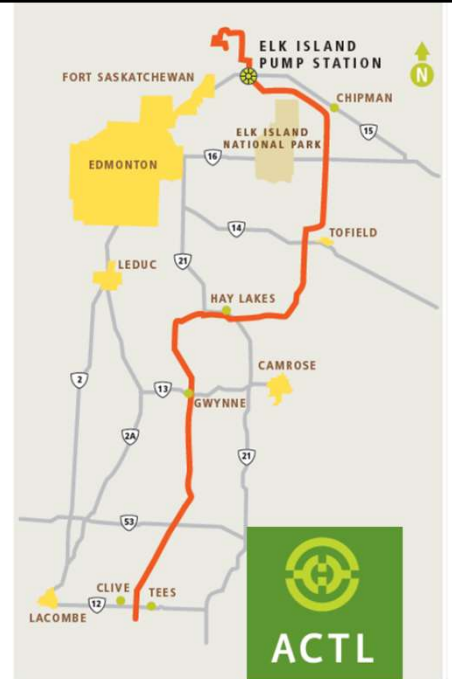


Alberta has already built many of the elements of this network in the Industrial Heartland. The Shell Quest project was designed as a point-to-point deep sequestration project with capture at the Shell Scotford Refinery and injection into wells to the North. While more wells were evaluated, three were completed for injection and only two are used. The capacity and injectivity of the target formation far outstripped original projections, so the entire project only uses one wellhead at a time.

Right next door, the Sturgeon Refinery connects to the Alberta Carbon Trunkline, designed to connect to an EOR project in Clive Alberta. Emissions from the Agrium (now Nutrien) fertilizer plant was to also feed the ACTL project, but these two emitters only would fill a fraction of the pipeline capacity.

Yet the Shell project and the Sturgeon/Nutrien/ACTL projects are not connected, (and there does not seem to be a mention of ACTL on the new Nutrien website.)

CO₂ Infrastructure



Alberta has two CO₂ pipelines, with origins adjacent to each other, and no mention of how they might become part of a larger system.

Projects → Systems

Full scale industrial demonstration projects – got ‘em.

What would it take to integrate into systems?

We need to move from point-to-point projects and demonstrations to developing integrated systems that are robust and can support expansion and innovation. Can we build on our existing investments, at least in policies and regulations that were put in place to enable these earlier projects? But also incorporate some of the capital investments to use them as a springboard for diversification in a world that is increasingly sensitive to investment risk associated with costly, long-term industrial developments?

Innovation Infrastructure



Alberta continues to invest in innovation infrastructure. Facilities, people and programs are great.

The newest ACCTC raises our profile globally and attracts some of the leading innovative entrepreneurs into the city.

How can we connect these things together to make a compelling argument to attract developers, investors and users of these technologies to set up shop here?

Innovation resources → Ecosystem

Terrific initiatives, programs, facilities, expertise, ...

How do we maximize impact?

How is impact measured?

The key is to establish an ecosystem.

But an ecosystem is not hierarchical and is not going to be about following one person's vision. It will be about developing a process by which a broad range of stakeholders can engage, participate, and achieve extraordinary outcomes.

What outcomes would indicate success to you?

Innovation Sprouts

- ERA Grand Challenge (CO₂ conversion)
- NRG COSIA Carbon XPrize
- Growing number of Alberta innovators:
 - Process components
 - Process design innovations
 - Conversion technologies (carbon fiber etc.)
 - Algae pathways
 - Solid sorbents
 - Molten Carbonate Fuel Cells for capture
 - Regenerative fuel cells
 - Methane decarbonization
 - CO₂ hydrates storage
 - Bio-char etc.
 - Measurement, monitoring & verification
 - Who else?
- Canadian innovators:
 - Capture solvents
 - Membranes
 - Process innovations
 - Conversion processes (cement)
 - Fuels from
 - Direct Air Capture
 - Bio-conversion
 - Photo-catalytic conversion
 - Electro-catalytic conversion
 - Mineralization
 - EPCs
- International players
 - EPCs
 - Process innovations
 - Conversion technologies
 - Novel solvents (precipitating etc.)
 - Direct Air Capture
 - BECCS
 - Research institutions
 - Global investors
 - ???

There are a lot of initiatives and innovative startup ventures originating here, but Alberta is too small to do it on our own.

We need to leverage attractors like the ERA (former CCEMC) Grand Challenge and NRG COSIA Carbon XPrize to attract innovators from around the world.

“Us” = Alberta → “Us” =

Need stronger & better combinations.

How do we improve richness of connections in a
global ecosystem?



But we need to reach hard beyond that. We need to attract innovators and partners from across Canada and around the world, to create a sense of urgency.

If you work in the industrial climate space “You gotta be here.”

Can we open our initiatives so we see it as a positive if a startup from the US or EU or Asia establishes in Alberta to ‘take advantage of our programs’?

Can we see that as a success?

Summary:

Technologies → Solutions : Connect or die

Projects → Systems : How?

Innovation Resources → Ecosystem : Maximize impact. How?

“Us” = Alberta → “Us” = World

In summary,

We need to emphasize connection and synergies between companies and organizations to see how together we can increase our ambition.

How can we think in terms of systems rather than single ‘inside-the-fence’ demonstration projects?

How can we take the terrific components we have in Alberta and in Canada and leverage them for maximum impact?

And how can we eliminate the tendency to think we need to defend ourselves against ‘competitors’ around the world. We have potentially important global partners. Can we invite them to come and play in our sandbox?

Industrial GHG Management Leadership – What might it mean for Alberta?

Low-risk investment environment for traditionally high-emitting industries.

Domestic markets for fossil resources.

Economic development building on the capacity legacy of the fossil boom.

What else?


Globally investors in large-scale industrial plants are concerned about access to resources, but looming large in their decision process is how to mitigate risk associated with GHG emissions from plants with lives that extend over decades.

Alberta has:

- Abundant natural resources, including fossil resources;
- World-class Engineering, Geosciences, fabrication, trades and large-scale project development expertise;
- World-class educational institutions and a well-educated existing population
- A policy regime that makes geological storage of CO₂ a low-risk, well-understood prospect;
- Technical capability for CO₂ storage, EOR, and increasingly CO₂ conversion;
- Access to global markets (well, could be improved!)

If you were trying to decide where to locate a major industrial facility, where would you locate it?

Don't want to become a CO₂ project developer? If only Alberta had CO₂ management systems in place ...



How can we make Alberta
a major 'watering hole' in
the global CO₂
management jungle?

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