Super-Cheap Hydrogen From Free Oil Heralds Big Change: BNEF Q&A

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Where some may see aging oil reservoirs as a problem needing to be fixed – and cleaned up -- Calgary-based Proton Technologies Inc. sees an almost limitless opportunity.

The Western Canadian company has developed a process to extract hydrogen from mature oil fields – by injecting oxygen into the ground to induce a reaction that heats up the oil and releases hydrogen. The reservoir's natural cap rock provides a barrier to trap any released carbon dioxide, meaning there are no greenhouse gas emissions to the atmosphere.

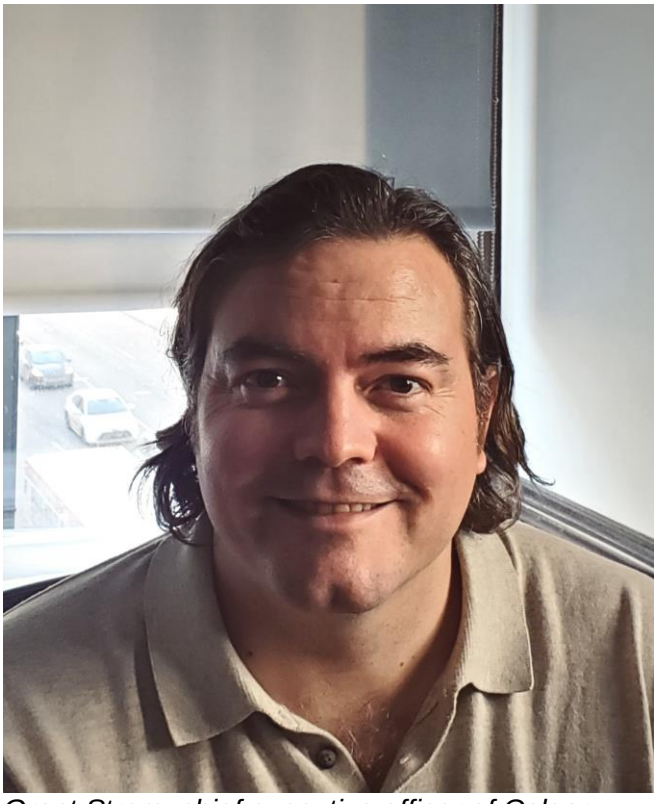
"It's incredibly wide-ranging in what kind of geological settings and environments this can apply to," Grant Strem, Proton's chief executive officer, told BloombergNEF in an interview. "Pure oxygen will react with any type of hydrocarbon. It doesn't need a certain grade of oil quality."

Tapping old oil fields, which Proton reckons they'll be able to access at essentially no cost, means the Canadian company expects to produce hydrogen at a cost far below existing market prices, and with no CO2 emissions. Proton's Strem said the company's economic modeling has shown it should be able to produce hydrogen in high volumes at a levelized cost below 30 cents per kilogram. Proton estimates almost all hydrogen is currently produced by steam methane reformers at a cost of $2 to $3 a kilogram.

As a step to prove its process, Proton is piloting a test at an aging oil field in the Canadian province of Saskatchewan. As of February, the company was separating hydrogen from the oil field; hydrogen truck-loading is expected later this year. Proton says it has already secured licensing deals with other companies in 11 countries.

"If the technology is proven on a large scale under multiple conditions, and its zero-carbon credentials are fully verified, it could revolutionize hydrogen production," said Martin Tengler, a senior associate at BNEF covering hydrogen. "Hydrogen costs could fall lower than we had ever thought possible. The next couple of years will therefore be essential."

Strem spoke to BNEF in mid March. The following transcript has been edited for brevity and clarity.



Grant Strem, chief executive officer of Calgary-based Proton Technologies Inc.

Q: Hydrogen is all the rage at the moment. Where does Proton Technologies fit?

A: Proton Technologies is a company set up to

produce the lowest-cost and cleanest hydrogen of all. We're calling our product 'clear hydrogen' because nobody else has a lower carbon intensity that we've seen according to lifecycle analysis, and that includes wind and solar to electrolysis.

Q: Talk me through your hydrogen production process. My understanding is you inject oxygen into a mature oil or gas reserve.

A: An oil field exists where it is because there's already sufficient cap rock to hold it in and that's why it accumulated and held there for millions of years. When wells can no longer get enough oil to surface, they get abandoned or in many cases they don't, which causes an abandonment liability problem. These are the wells that we can repurpose either by injecting oxygen or producing hydrogen from an existing oil system.

Our process begins with an air separation unit that removes the nitrogen so we can inject pure oxygen, or oxygen with carbon dioxide. On the production side, we have wells with a filter down inside the reservoir that allows only hydrogen to pass through up to the surface.

Q: So you're deriving hydrogen from old oilfields that would otherwise be abandoned?

A: We're using the existing disturbances. We're not using a new land footprint. By leveraging all of this and powering our process with a portion of the hydrogen we make, that's what gives us the very low carbon intensity but it also gives us an extreme cost efficiency.

Q: Is this a new process? Does it require new technology?

A: There's been more than 500 projects that oxidized oil in place, always with the goal to heat it up so that the viscosity lowers and flows more easily. All of those projects had unintended production of hydrogen as a byproduct. Our downhole filters were developed in the early days of the steam methane reforming industry. They're technologically proven. They're just tied together in this new pathway, which gives us a unique ability to be successful in patents all around the world.

We're giving away very interesting early-adopter deals to companies that want to move quickly toward this process. So far we've signed licenses in 11 countries and there's a lot more interest. Some of these are within Canada, a few of them are oil companies but we're actually getting the most interest from wind and solar companies trying to solve their intermittency problem because our hydrogen through a turbine provides reliable baseload power they can dial up or down, similar to natural gas.

Q: Why has this not been done before?

A: It's like wheels on a suitcase. As soon as people put wheels on a suitcase, people asked why they'd been carrying suitcases around for so long. That's very analogous to what we're doing. It's a simple concept that should have been discovered and used 50, 70 years ago. It seems strange to me that it hasn't been put together, but sometimes hindsight is 20/20.

Q: What happens to the oxygen after the process begins and how do you control the combustion?

A: It gets trapped within carbonate rock. In some places like Iceland the type of rock fairly quickly turns CO2 into carbonate and that does happen on some timescale in every rock system but we can accelerate it and we have some patents for doing that inexpensively. This won't just benefit our projects but also other carbon sequestration projects.

Q: Is the amount of hydrogen you produce controlled by the amount of oxygen injected?

A: Yes. It's our main limitation and our main cost factor. The more oxygen that we get in and the faster that we get it in, the more hydrogen we can get out faster.

Q: Again, why does this produce no carbon dioxide?

A: Carbon dioxide is formed within the oilfield when reactions happen but it very quickly can become carbonate rock. Some of it dissolves and

becomes carbonic acid within the waters of the system and that reacts with various chemicals that are down there or that are introduced, like oilfield waste water, and that triggers a reaction that causes the formation of solid carbonate.

Q: Will your process work only at certain oilfields based on their geological structures?

A: It's incredibly wide-ranging in what kind of geological settings and environments this can apply to. Pure oxygen will react with any type of hydrocarbon. It doesn't need a certain grade of oil quality. There are a few things that we predict are better than others. For example, if you have greater porosity in the rock it means that less energy goes to heating up the rock. With a tighter rock you'll expend more of the thermal energy warming up the container. We require projects that never leak to surface so there must be some sort of a competent cap rock so there's no chance of carbon dioxide breaching and making its way up. Typically, this is already true of oilfields that have demonstrated holding in oil and gas for millions of years.

Q: Is this suitable for Canada's oil sands?

A: It is suitable. We have more than 2 trillion barrels of oil in Alberta alone. For us, it's an enormous target. Using roughly one tenth of the resource remaining in Western Canada, we can supply 10% of the world's energy by 2040 assuming a 50-year project life. Canada can be a significant clean energy export superpower at a cost that's lower than hydrocarbons.

Q: What are the markets you're looking at?

A: Our biggest primary market is baseload power – so making electricity and selling it through the existing infrastructure to the existing market. People would prefer to pay less for electricity and they would rather it be clean. Interest in that trajectory has only accelerated since the Canadian carbon tax was introduced. There's an enormous push to decarbonize the energy system here. To put in a hydrogen-capable turbine and make electricity – we see that as a very large market to step into. Meanwhile there are other demonstrations we'll be involved in like selling hydrogen by truck. As fuel cells become more common, transportation becomes a trajectory as well.

Q: What kind of company will you be in five years? Will you be a producer of hydrogen yourself or will you license the technology?

A: I imagine we'll be more focused on doing it ourselves five years from now. Right now we're trying to get early adopters to implement it and we want to leave the door open for people to do it themselves. This is a technology that we hope to see proliferate as fast as possible. Prices will escalate over time for license fees and royalties.

Q: You're operating a test site at the moment in Saskatchewan?

A: Right now we're producing hydrogen but it's getting burned in our incinerator. We need to start separating it for sale. Our plan is to start trucking in liquid oxygen as a near-term demo within the next few months and that will give us the interesting data that takes us to the next level in terms of investment toward large-scale air separation units.

Q: You've said your production cost is below 30 cents per kilogram. Is that right?

A: We anticipate handily beating that target at full scale. We're not there today. That's on a standalone basis, and not including any other revenue streams from nitrogen production. Hydrogen on a standalone basis, we expect to see a levelized cost below 30 cents per kilogram. There's potential to be below even 10 cents.

Q: Is your cost assumption based on the oil in the ground being free?

A: Yes it is. The smallest component to our entire input is taking over someone's abandonment liability. Right now it exists on the wrong side of someone's balance sheet and the government from wherever has a gun to their heads saying `abandon these wells or else.' They look at the cost of abandonment and they are super eager to dump those projects. So there's no shortage of them. No one can corner the market on low-

quality oil fields. They're endless. They're everywhere.

Q: Are there other benefits you haven't discussed?

A: Whenever I talk about our technology, one of the things I always come back to is air pollution. It kills millions of people per year and I think it behooves us to evaluate how we spend our efforts in terms of buying energy and energy use systems. It's worth closely considering the issue of air pollution. Greenhouse gases and climate change have grabbed the environmental narrative but air pollution is an unsung crisis that needs a lot more attention and it's a big part of my motivation in wanting to scale up Proton Technologies as fast as I can.

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