**Comments on *Ontario Low-Carbon Hydrogen Strategy - discussion paper***

***Vision***

* 1. Do you support Ontario’s efforts to create a hydrogen strategy?

**Yes, absolutely, provided that the intended final outcome is the establishment of a “green” hydrogen-based infrastructure, i.e., for which the energy for electrolysis will ultimately come from renewable sources. A strategy is essential in order to ensure that foundational aspects are addressed early on as these steps will then facilitate further activities, leading to fast and broader implementation and an incremental use of green, sustainable energy sources.**

**I accept that a transitional period will be essential, and so at the outset we will almost certainly have to rely on the use of so-called “grey hydrogen” and “blue hydrogen” while a “green hydrogen” infrastructure is developed.**

**I fully expect that a very effective and robust communications strategy will be required for implementation to be successful.**

* 1. How would you refine the vision statement

**I find the current preliminary vision not to be focused enough. I would suggest key action- and outcome-based vision statement components such as:**

***Support development of a province-wide hydrogen-based infrastructure that will be an integral component of sustainable, renewable, de-carbonized energy basis for the province’s industry and commercial sectors, and for all citizens. In doing so, promote investment in green hydrogen ventures, providing long term economic benefits for the province and reducing, and ultimately eliminating, dependencies on external energy suppliers.***

* 1. What should be the key outcomes of Ontario’s hydrogen strategy

**Sector-specific strategies should be developed for more effective implementation, e.g., for haulage/trucking, energy for commercial industry, rail networks, home heating, urban supply for vehicles, public transport, etc.**

**Developing sector-by-sector strategies will allow for very focused approaches which will be more manageable and attainable. Trying to develop one broad strategy for all sectors risks making things over-complex and unwieldy.**

**The strategies should identify what the key foundational elements are for the sector to build upon, e.g., number and location of green electrolyzers (identification of transport corridors, fueling hub locations), sources of clean energy for electrolysis, storage, availability. The strategy should plan to capitalize on key infrastructure that already exists, such as the network of gasoline stations which can be converted to include hydrogen pumps.**

**Having worked on developing strategies for other purposes, in my experience it is absolutely vital that at least some of those involved in developing the strategy are also involved in its implementation. Ideally, an implementation team (or teams focused on different sectoral strategy implementation) would be built from the group(s) that developed the strategy/ies. These groups will have in-depth understanding of what the strategy is intended to entail and achieve, will understand viewpoints and concerns of stakeholders, and will not misinterpret key components. Assembling implementation groups without any linkages to the developers of the strategy risks misunderstandings, misinterpretations and delays as new people will potentially need time to grasp the key concepts and needs.**

* 1. How should the hydrogen strategy define and measure success?

**I think that different performance measures should be applied to different phases of implementation.**

**A different target may be required in early years as, while the initial infrastructure is being established, there may be no or very little hydrogen production, yet this would not imply a lack of success as long as it is part of the strategy. In the early years, perhaps capacity number of MWs via green electrolyzers in the plan/build/install stage.**

**Therefore, initially, measures-of-success should be based on uptake of hydrogen as an energy carrier, whatever the source of the hydrogen (i.e., whether green or not at the outset), therefore perhaps simply the proportion/percentage of energy conveyed through hydrogen. Building that base, which may initially rely on blue or grey hydrogen, will allow for green hydrogen to be incrementally substituted as more electrolyzers are built/installed.**

**Over the longer term, a series of targets for the proportion of overall energy that is provided through green hydrogen would become more suitable. This should be relatively easy to measure and would provide meaningful information.**

***Reducing greenhouse gas emissions***

* 1. What are Ontario’s key technology, regulatory and business opportunities in developing low-carbon hydrogen?

**Perhaps the possibility to discontinue any subsidies for fossil fuel production and use the savings to offer tax reduction incentives to adopters of green hydrogen. Possibility to subsidise installation of hydrogen filling stations, beginning at key hub points.**

* 1. What is the potential for hydrogen to contribute to Ontario’s 2030 greenhouse gas emission reduction target?

**Hydrogen (if produced from renewable resources) should be considered a fundamental part of Ontario’s 2030 greenhouse gas emission reduction target. As it represents an energy storage approach for renewable energy, it can be used to ensure continuity of supply whether or not the sun is shining, or the wind is blowing. It is clear that green hydrogen production can occur and can be scaled up (e.g., some of Shell’s, Linde’s and Snam’s activities based on ITM Power electrolyzers).**

* 1. What additional environmental benefits should be considered in the development of the strategy (for example during hydrogen production)?

**Localized/regional energy capture and supply through green electrolysis means avoidance of energy usage in transporting the energy to Ontario from external sources. This is being demonstrated in parts of the U.K. and Europe (Shell, Snam, Linde, ITM Power).**

**It should also be recognized that the hydrogen infrastructure for filling stations for cars, trucks, and buses partially exists at present to the same extent that the recharging infrastructure exists for mass adoption of batteries. For recharging of batteries, extensive (and environmentally-negative) construction of grids and recharging stations is required. For hydrogen, filling stations are required, but all of the current gasoline and diesel filling stations could be converted, presumably at no more of an environmental impact.**

**The manufacture of large numbers of batteries for cars and trucks would have significant environmental impacts (mining). Fuel cell vehicles do have batteries too, but they are much smaller and so the broad scale deployment of H2 fuel cell transport would require fewer scarce resources to be mined. Also the avoidance of having to recycle lots and lots of large batteries would be reduced.**

**Using electrified rail lines, overhead power cables (also known as catenary cables) for trains, buses, trams and even road-going trucks have often been proposed, but do not seem logical from a cost or effectiveness basis, as the installation costs are much larger than for filling stations, and significant maintenance is required. Such power lines are more vulnerable to weather or physical damage which could knock out an entire transport grid, whereas if one hydrogen station became unserviceable for a period, as long as others were available there would be no real impact and only localized inconveniences.**

* 1. What role can hydrogen play in various regions and sectors?

**It has potential beneficial applications in any sector that uses electricity as an energy carrier, and many that use natural gas. For transport, the early applications in which early advances and gains might be made most easily include the heavy road transport, municipal bus and rail sectors as, in each of these, hydrogen refueling can be cited at key hubs (e.g., for trucking, along key transport corridors, for bus depots at the central refueling site, and for rail at key rail depots).**

* 1. What actions can Ontario take to help Ontario companies get ready to meet expected international demand (for example research and development, innovation, procurement)?

**Since hydrogen can be produced anywhere, and there are already very advanced technologies (e.g., ITM Power for green electrolysis, Ballard Power for fuel cells, I would suggest that this is an occasion in which the government should focus on developing the infrastructure for its own population, enjoying the environmental benefits, but not necessarily trying to develop something new that must compete internationally. I would rather see us compete on how quickly we can implement an infrastructure and how quickly we can reduce our carbon emissions.**

* 1. What are the training needs for the workforce to support the economy across Ontario?

**Safe hydrogen gas handling training will be required from both a safety perspective and a public opinion viewpoint. Note that a communications strategy will be required as several people immediately seem to equate hydrogen with danger and raise the spectre of a the Hindenburg (when of course the hydrogen was being used for buoyancy in that airship, not for propulsion, it is not clear what caused the fire, and gas handling technology has evolved massively in 100 years).**

**Also, as part of a communications strategy, the non-carbon-related benefits must be highlighted as some citizens may not be interested in that aspect or may be focused more on best use of public funds, etc. So, for example, cost comparisons of electrifying rail lines with hydrogen locomotives that are fueled at hubs; benefits for reducing air pollution; avoidance of having to build a charging infrastucture**

***Promoting energy resilience***

* 1. How can hydrogen support a reliable and affordable energy system, including energy storage?

**Since hydrogen represents a form of energy storage, it offers continuity of supply when energy sources might be temporarily unavailable or in localized emergencies (e.g., Plug Power applications during recent hurricanes in the U.S.). It solves the problem of effective energy supply form intermittent sources such as wind and solar in a more environmentally and cist-effective way than can batteries.**

* 1. What are the barriers and opportunities for hydrogen in the energy system**?**

**Intentional spread of misinformation and/or unintentional misunderstanding of the use of hydrogen may represent a barrier. Because of this, the hydrogen strategy must include a communications strategy. For example, many people appear to comment on the efficiency of battery storage in comparison to hydrogen fuel cells, but this leaves out the convenience aspect. The ability for hundreds of cars to refuel quickly and conveniently at a refueling station (based on a conversion of a existing gasoline station facility) compared to the prospect of one battery vehicle taking much longer and tying up one recharging station, and the inconvenience of cables, e.g., handling them in bad weather or trying to use them in situations without off-street parking (possible tripping danger for pedestrians) means that in many cases the convenience of a fuel cell vehicle outweighs efficiency considerations, particularly if the energy source for the hydrogen is green. In addition, in larger applications such as trucking, maritime transport and air travel, weight is at a premium as each conveyance must have the ability to maximize payloads when needed.**

**A communications strategy must also address safety concerns. We already drive vehicles with explosive fuels, and gasoline appears to be more dangerous than hydrogen in an explosion and is certainly more environmentally damaging in a simple leakage situation.**

***Reducing barriers and enabling action***

* 1. How can the provincial government best support partnerships with the private sector, academia and other government / levels of government?

**Discontinue subsidies for any fossil fuel activities and provide grants, subsidies, tax breaks for green hydrogen activities.**

* 1. Are you aware of regulatory barriers that need to be addressed or regulatory enabling mechanisms that need to be put in place? Please explain.

**It would be nice to have the ability to apply interprovincial tariffs to products coming into Ontario that could used green hydrogen but do not.**

* 1. What are the best opportunities to cost-effectively support hydrogen across Ontario while respecting tax payers?

**Tax breaks for installing hydrogen furnaces, installing hydrogen filling stations at gas stations, for purchasing hydrogen fuel cell vehicles.**

***Using hydrogen where and when it makes sense***

16. What potential feedstocks and stages of the hydrogen supply chain (production, storage and distribution, and end-use) do you think Ontario is best-positioned to develop and lead in and which uses have the greatest potential for cost reduction?

**Probably wind, solar and hydro sources linked to electrolyzers (e.g., as ITM Power can provide)**

17. What are the main risks of hydrogen use in Ontario and are there opportunities for the government to decrease these risks?

**People will cite fire and explosion risks. However, gasoline is also flammable and explosive and hydrogen in fact appears to be safer. A robust communications approach on this will be required.**

**I note that the public hydrogen station in Quebec City has had some problems with the nozzle freezing to the filling receptacle in cold weather. It must be possible to overcome this (slightly warmed nozzle?). But reliable and easy filling will be vital if hydrogen is to be deployed in the transport sector.**

18. Considering that low-carbon hydrogen is expected to be more competitive over time, what should be the timeframe for Ontario’s hydrogen strategy?

**We are already extremely late in comparison to the provinces of Quebec, and B.C., and also internationally, e.g., looking at progress in Europe, the U.K., certain U.S. states (California), Australia, Japan, China, Chile and others, they are miles ahead. But I don’t see the need to compete on technology with other jurisdictions. Good technology already exists, as above, and some of it is Canadian. I would instead focus on rapid deployment of this technology for the sake of the environment.**