

# Evaluation of Atmospheric Vortex Engine

## Submitted by Louis Michaud

- Attached is the ProGrid Evaluation Report of the above Energy Pathway, undertaken at the request of Louis Michaud.
- The evaluation was based upon the methodology used by the Canadian Academy of Engineering in a recent Energy Pathways Study, which is described in CAE Energy Pathways Task Force, Phase 1 Final Report, May 2007. However this evaluation is not part of the CAE energy project and has not been authorized or conducted by the Academy.
- Eight individuals experienced in the energy field agreed to participate in the evaluation on a voluntary unpaid basis, to assist the inventor in identifying strengths and weaknesses in the concept and in defining potential next steps. Chart 3 compares the grid position with the energy pathways that were investigated in the Academy report. The Atmospheric Engine concept is in the middle of the pack with respect to Expected Impact but is at a low level with respect to Pathway Assets due to its unproven status. The comments on Pages 3 and 4, and on Pages 6 through 10, are inserted directly into the evaluation software by the evaluators, with no opportunity to edit or to adjust spelling or grammar. Had the evaluators met as a group and shared their experiences, as is often the case in ProGrid evaluation processes, the variation in results would likely have been reduced.
- All evaluators noted the novelty of this early stage concept. None stated that the underlying principles violated any known laws of science. Many major advances in science have arisen from ideas that were clearly “out-of -the-box” at the time of initial introduction.

# ProGrid® Evaluation Report

**Opportunity No:** 36  
**Category:** R  
**Proponent:** Louis Michaud  
**Organization:** Vortex Engine  
**Opportunity Title:** Atmospheric Vortex Engine

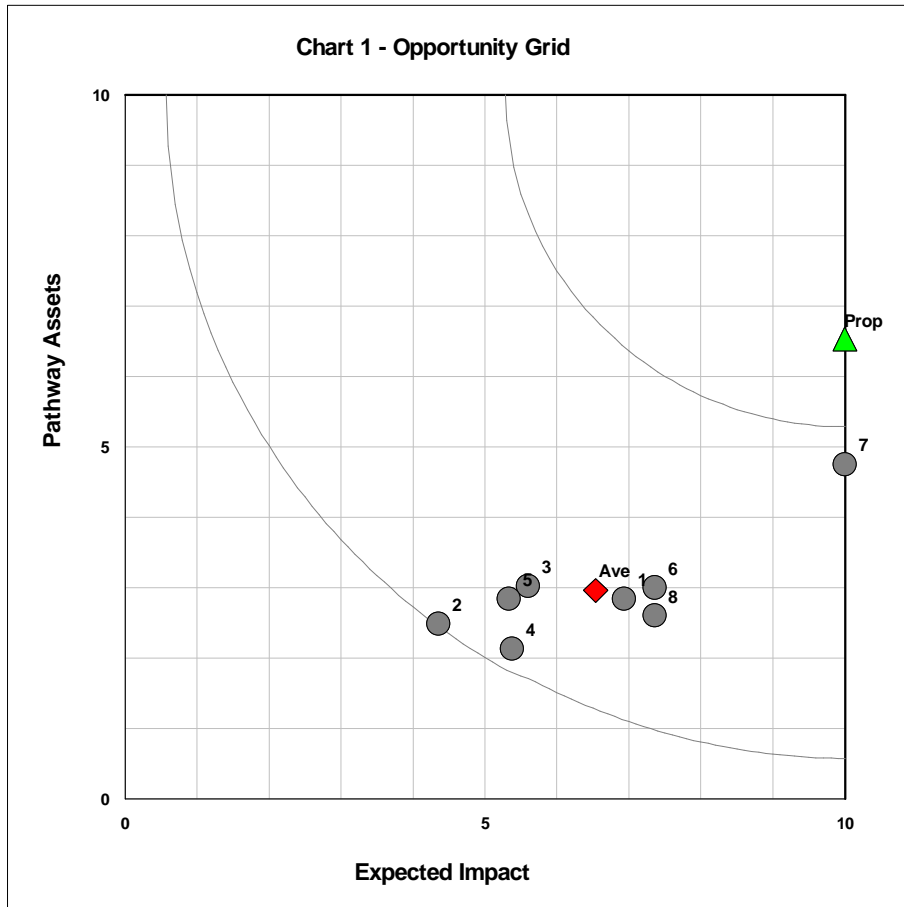
**Date Received:**  
**Type 1 \$:**  
**Type 2 \$:**  
**Date Start:**  
**Duration:** Years

**Summary:** An Atmospheric Vortex Engine (AVE) uses a tethered tornado-like vortex to capture the energy produced when heat is carried upward by convection in the atmosphere. A vortex engine consists of a cylindrical wall open at the top and with tangential air entries around its base. The heat can be the natural heat content of the warm or humid air or can be provided in heat exchangers. The heat source can be industrial waste heat or warm seawater. The intensity of the vortex is regulated by restricting the air flow. The electrical energy is produced peripheral turbo-generators.

The Opportunity was evaluated according to the following Performance Criteria by: 8 Evaluators.

Pathway Assets	Connectors	Expected Impact
Scientific Principles	Corporate Capacity	Economic
Technology Validation	Competitive Advantage	Environmental (ex GHG)
Commercial Readiness	Sustainability	GHG Emissions
Societal Acceptability	Enabler/Other Pathway	Energy Efficiency
National Initiative Fit	Infrastructure Issues	Value-Added

**Chart 1 - Opportunity Grid:** shows the current grid position as determined by the Proponent, each Evaluator, and the Evaluator Average, with respect to the two Overarching Objectives: Pathway Assets and Expected Impact.



The Opportunity ratings have the following characteristics:

**Pathway Assets = 3.0**

**Expected Impact = 6.5**

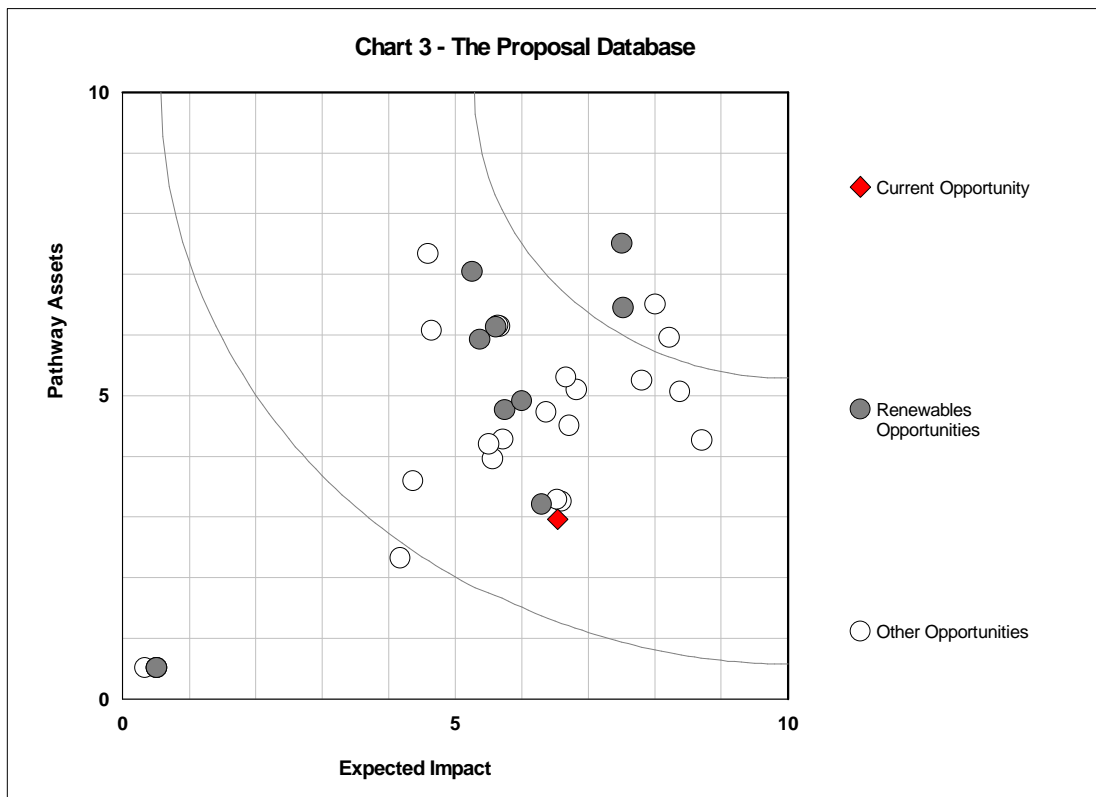
**R Value = 45%**

(the R Value is a measure of the distance of the grid position for the proposed opportunity from the point X=10 and Y=10, with the point 10,10 representing 100% and the point 0,0 representing 0%)

**Chart 2 - The Opportunity Profile:** shows the ratings for each of the performance criteria, comparing the Proponent's rating with the average rating of the Evaluators. This chart is useful in identifying strengths and weaknesses of the Opportunity and for tracking progress.



**Chart 3 - The Database:** shows the position of the current opportunity compared to all other opportunities in the database and those in the same category based on the Evaluator Average. This permits an assessment of how well the current Opportunity compares to other Opportunities, with respect to the two Overarching Objectives: Pathway Assets and Expected Impact.



## **Overall Comments on the Opportunity:**

### **Evaluator 1**

#### **Pathway Assets**

A very interesting technology but at a very early stage. Certainly worthy of a staged development project. A small demo unit would be relatively low cost and provide good data on worthiness of scale up tests.

#### **Expected Impact**

If this works, it could have a large effect on any distributed electricity generating system. It is no better, or worse than solar or wind, but at an earlier stage

### **Evaluator 2**

#### **Pathway Assets**

At this stage, it is a dream with minimum scientific or engineering validation. But mankind keeps hoping for a silver bullet. New ideas are precious and should get some air time.

#### **Expected Impact**

The impact, if any, would be felt by mankind for eternity, not for an individual country or region.

### **Evaluator 3**

#### **Pathway Assets**

This feels a lot like tidal power and solar thermal dynamic conversion - theoretically sound, able to be demonstrated, capable of producing power - but really difficult to conceive in a large enough scale to justify the time and \$. The Australian project is using 40 square kilometers of solar collector in what I would image to be a remote and very sunny area. In Canada, I would think the ONLY practical feed source would be waste heat and getting the equivalent amount of heat per unit would obviously require lots and lots of infrastructure (proponent talks about 20 AVEs around and existing heat source) to say nothing of land, space, etc. Starting from a blank sheet or on new installations, maybe this would all work - adding it into our existing infrastructure???????? On the other hand, if it could be made to work and if the net energy/cost equations worked - then - why not.

#### **Expected Impact**

Over 40% of Canada's energy in 20 years? And all largely from waste heat? That says that basically every major source of waste heat in the country would have an AVE (given that all the sources of waste heat today added together produce enough energy to equal total energy demand in the country and that those sources would double in output in twenty years). There would have to be some very careful system modelling to back this all up otherwise it is a little like saying that as long as we had 10 million wide turbines in Canada, then we would be just fine, thank you. Find a way to watch with interest??????

### **Evaluator 4**

#### **Pathway Assets**

This is an interesting new technology that can be developed into a new energy pathway. It is at a very early stage and a demonstration unit that actually produces electricity will be needed to verify the claims made for the technology. In some cases I was confused by the proponent talking about this technology as a natural phenomena and then about using waste heat from natural circulations, chimneys, cooling towers boilers etc. What will be the main source of heat to drive the engine?

#### **Expected Impact**

The economics for this technology may or may not work. There also may be societal concerns. It is another one of the "alternative" energy sources and will have to catch up to solar and wind energy in terms of know benefits before the real impact can be understood. The potential is there but, will it work?

### **Evaluator 5**

#### **Pathway Assets**

This proposal is certainly interesting. It clearly rests on the observation that natural vortices exist in nature provided that conditions allow them to do so. However, it appears that little has been achieved beyond the laboratory bench scale. The technology is in very early days: how vortices can be controlled, how the energy of such vortices can be tapped into effectively, how to do so reliably and sustainably in a safe industrial setting has yet to be demonstrated. A great deal of investment in technological development remains to be achieved successfully. The issue of cohabitation of such a technology with densely populated areas will eventually need to be addressed convincingly before it can ever be deployed.

#### **Expected Impact**

This proposal may have its place eventually in a basket of new energy technologies. However, as mentioned above, we are in very early days.

### **Evaluator 6**

#### **Pathway Assets**

The vortex engine concept does not defy known physics. It will take time and perseverance to develop knowledge relating to the creation of an artificial atmospheric vortex such that it can be repeatedly created and controlled. Further, the concept does not require any new or novel technology.

#### **Expected Impact**

The impact upon society world wide of successful development of the vortex engine will be enormous. Without an energy source which is non-polluting, all nations developed or otherwise face the necessity of social adjustment greater than the adjustment to the industrial revolution of the

## **Evaluator 6 (continued)**

18th century; and far greater in magnitude than any adjustment in the history of mankind.

## **Evaluator 7**

### **Pathway Assets**

The atmospheric vortex engine is a radically new invention for generating electricity. It represents a paradigm shift in how to extract electrical energy from heat available at ambient atmospheric conditions, by creating a thermodynamic engine that rejects heat in to the upper atmosphere. The atmospheric principles on which it is based are well borne out by the existence of tornados. The thermodynamic principles on which it is based are long established and well understood. Significant development effort is still required to commercialize this invention. However, given the promise of the technology it should be strongly supported.

### **Expected Impact**

If successfully commercialized the expected impact of this invention is almost unimaginable. This technology promises to allow electricity generation by extracting energy from ambient air, directing this air to the cooler upper atmosphere through an atmospheric vortex. It can be applied to increase the efficiency of existing power plants to generate electricity from the waste heat. It may also be applied to oil refineries and petrochemical plants allowing electrical power generation from waste heat and possibly allowing more production through increased cooling capacity. Because Canadian resource industries are particularly energy intensive, the availability of renewable electricity would contribute to the continued growth of the Canadian economy.

## **Evaluator 8**

### **Pathway Assets**

This pathway is absolutely unique and I strongly recommend it for R&D. It produces no GHG, it cools the atmosphere, and allows the recovery of a significant fraction of the waste heat produced at any large installation. If it can be proven to work with a large body of water as the heat source, it would produce seasonally unlimited amounts of energy. This pathway can also be expected to be even better in tropical regions. I recommend that it be funded at the highest possible level that your agency can afford.

### **Expected Impact**

## Chart 4 - Analysis of Ratings

The following table provides the criterion evaluations made by the Proponent and the Evaluators

Performance Criteria	A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	C1	C2	C3	C4	C5
<b>Proponent</b>	C	A	A	C	D	D	D	D	D	D	D	D	D	D	D
Evaluator 1	AB	A	A	D	A	A	B	D	B	A	C	D	D	D	C
Evaluator 2	B	A	A	C	A	BC	A	B	B	B	AB	C	C	B	C
Evaluator 3	C	A	A	B	A	B	D	B	B	B	C	B	D	D	A
Evaluator 4	AB	A	A	BC	AB	A	B	C	B	A	B	C	CD	CD	C
Evaluator 5	B	A	A	A	A	C	D	B	B	D	B	B	C	C	B
Evaluator 6	A	B	A	B	B	B	C	D	B	A	D	B	D	D	D
Evaluator 7	B	A	A	B	B	D	D	D	D	D	D	D	D	D	D
Evaluator 8	A	A	A	B	B	C	A	D	B	B	C	D	D	D	C
Evaluator 9															
Evaluator 10															
<b>Evaluator Average</b>	26%	7%	3%	44%	16%	45%	55%	71%	42%	39%	60%	67%	90%	85%	63%

The flags below are based on the standard deviation of the assessments, and on missing evaluations.

Standard Deviation Flag	**	*	*	***	*	***	****	***	**	****	***	***	*	**	***
<b>Proponent Rating Missing</b>															
<b>Evaluator Rating Missing</b>															

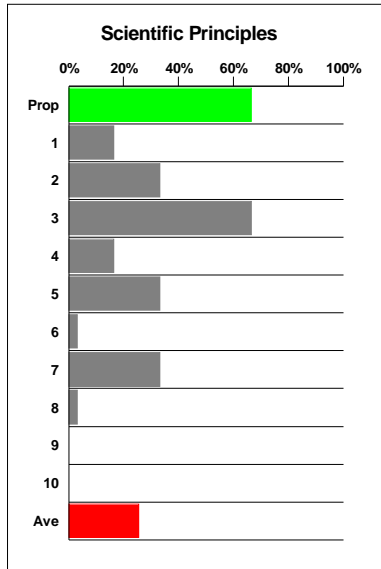
### Standard Deviation Flags:

- \*\*\*\* Variation is unusually high.
- \*\*\* Variation is beyond what would normally be desired and should be discussed further.
- \*\* Variation is within normal expectations and would not usually require any further attention.
- \* A high level of consensus

### Missing Ratings (N) Flags:

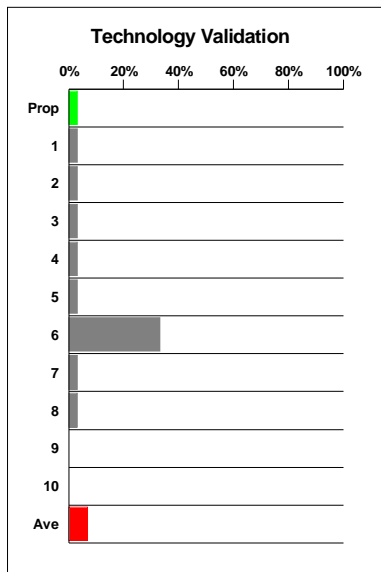
- # One or more of the Evaluators did not record a rating for this performance criteria.
- ! The Proponent did not record a rating for this performance criteria.

**Chart 5 - Evaluation Bar Graphs:**



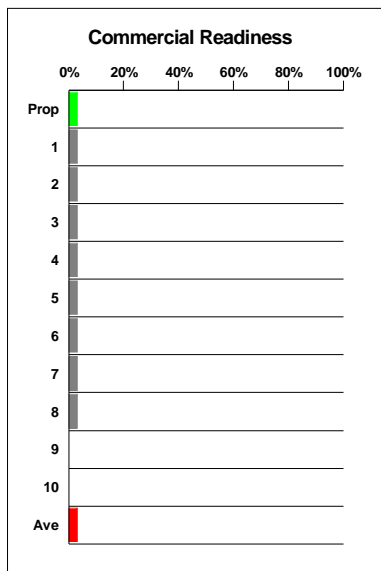
**Comments:**

1	Interesting idea, but all evidenc is bench scale at best
2	The scientific principles on the fluid flow around the cooling cell and turbo generators may be well known, but the fluid and energy dynamics of a controlled tethered vortex are probably not known.
3	
4	The scientific principles of vortexes may be well understood but the Vortex engine is still in the idea stage and the principles behind the Vortex engine are still being developed, but has it been disseminated to the scientific community?
5	
6	The underlying physics is well understood. The precise physics of creating an artificial atmospheric vortex is not understood, even though this writer and others have created artificial atmospheric vortices.
7	The scientific principles are well established principles of thermodynamics. Louis Michaud has published these in peer reviewed atmospheric science journals. The full scale vortex engine remains to be demonstrated.
8	The scientific principles are well understood and disseminated. It is assumed that the technical problems will be addressed with the R&D program proposed.
9	
10	



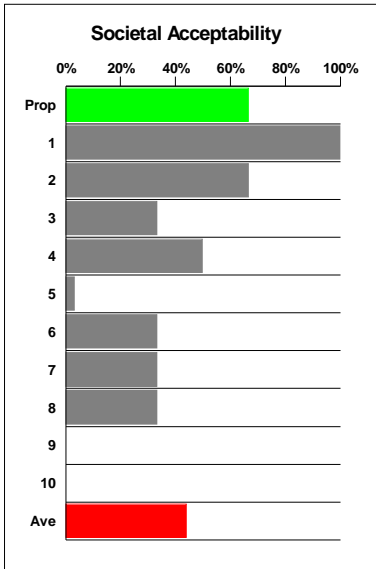
**Comments:**

1	See above
2	Not tested beyond the bench.
3	There are two key technologies - 1. Actually producing large stable vortices and 2. Getting harward in place to harness the power. Both are just ideas at the present
4	Very early stage
5	
6	The creation of an artificial vortex, if repeatedly demonstrable, does not require new and unique technology for either creation or practical utilization.
7	Small scale models demonstrating the fundamental prinpeples of the method have been created. Computational fluid dynamic modelling has also been done. Significant pilot scale development remains to be done to prove and refine the technology.
8	
9	
10	



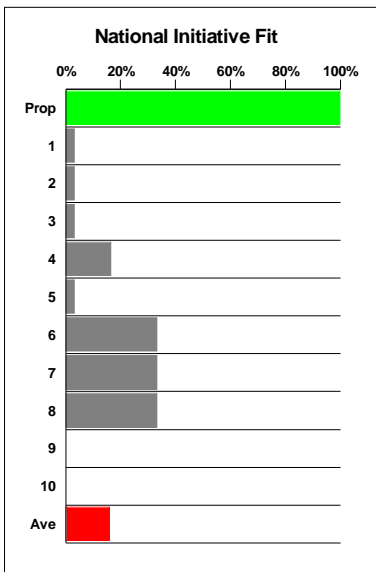
**Comments:**

1	
2	No integration of the steps involved have yet been attempted.
3	
4	Still mainly in theory
5	This assessment reflects numerous uncertainties related to this technology.
6	This is still a matter of gaining knowledge of the physics of artificial vortex creation. Once that knowledge is gained the technologies of an integrated process are straightforward.
7	The principles and components of the technology are well understood. However, refining these principles into a working prototype which can be commercialized still requires significant development effort.
8	
9	
10	



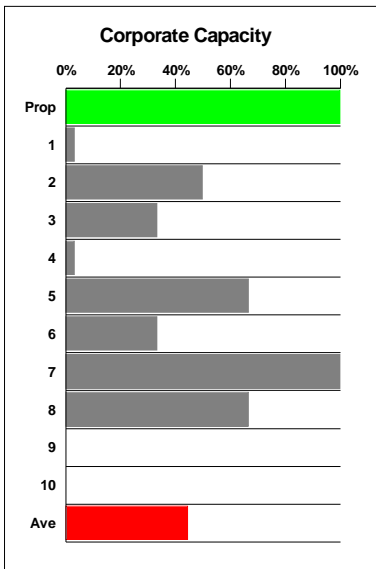
**Comments:**

- 1
- 2 I would expect that society would eagerly embrace the concept if it was proven attainable and controllable, with likely many backyard attempts to create a vortex!
- 3 At best. Built in the middle of the desert, OK. But tell someone that there will be a "tame hurricane" sitting on top of their local power generation facility - watch out. Also - serious concern with things that need to go to the troposphere to work.
- 4 I think societal concerns will arise when someone wants to build an artificial tornado, especially if it is close to civilization. Ask the people in the mid-west US where natural tornadoes are common.
- 5
- 6 Significant societal concern would arise from sensationalist common media reporting. It would be necessary that media releases are carefully worded and 'out of context' reporting promptly neutralized.
- 7 The stabilization of the induced tornado needs to be proven. The vortex of a full scale plant would extend up to a kilometre into the atmosphere, and the effects on commercial and recreational aviation would need to be mitigated.
- 8 Fears about runaway tornadoes and interference with airplanes would have to be overcome. These fears will be mostly addressed by the R&D program
- 9
- 10



**Comments:**

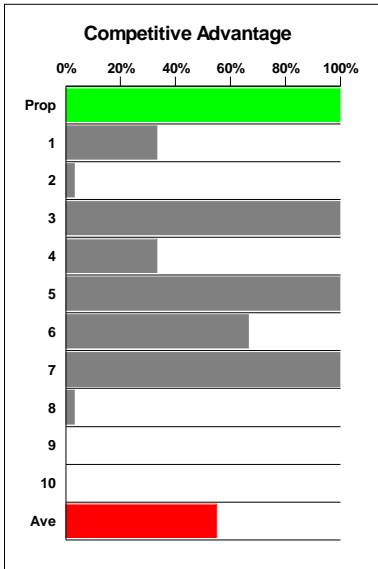
- 1 Very distributed application
- 2 Like cold fusion, this would never be a uniquely Canadian initiative.
- 3 Practically unknown at this point and so no support at all from the public
- 4 The pathway has the potential, but the magnitude of that potential is unknown at this time.
- 5 This assessment reflects numerous uncertainties related to this technology at the present time.
- 6 The same applies for Australia
- 7 This technology is an excellent fit with Canada's nuclear power leadership. It was invented in Canada and so offers the country a leadership position. The vortex engine is nascent technology and has not yet had an opportunity to garner broad support.
- 8 This pathway has great potential.
- 9
- 10



**Comments:**

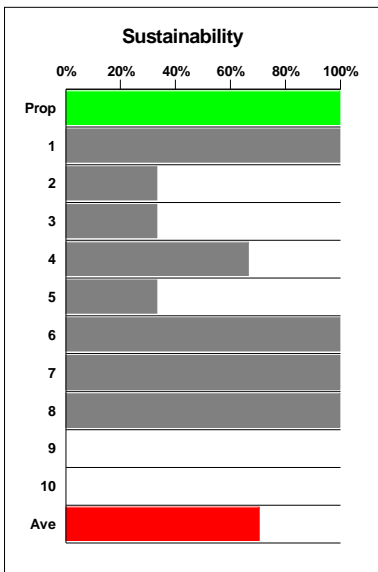
- 1 Early stage technology
- 2 Yes we have firms that have the capacity to participate in the development of the technology.
- 3 There MAY be companies who would see this as an opportunity and IF it worked there could be many and yes we have a lot of strength in power generation but.....
- 4 The proponent provides no evidence that any Canadian companies are even involved in the development of this technology. The technology is very early stage and has not proceeded beyond a garage model.
- 5
- 6 A & B use different language. "leaders in development" has a different meaning to "Commercialization"
- 7 Canada has excellent engineering infrastructure corporations and experience in the design and operation of conventional and nuclear power plants. These corporations would easily be able to fully commercialize the vortex engine.
- 8 Commercialization of this pathway would be particularly simple.
- 9
- 10





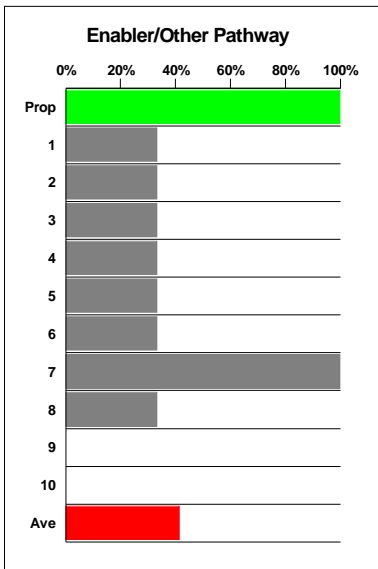
**Comments:**

- 1
- 2 There would be minimum opportunity for Canadian leadership.
- 3 IF it all worked, then yes it could be.
- 4 If the technology can be commercialized, Canada has the capability to develop it.
- 5
- 6 I have chosen C but it is possible that in the long term D would apply
- 7 The huge volume of electric power which could be generated through this renewable energy source would strengthen Canada's positions in all energy intensive sectors; for example, providing electricity for energy intensive mineral and oil sands exploitation.
- 8 This pathway will be most efficient at tropical latitudes or near large sources of waste heat.
- 9
- 10



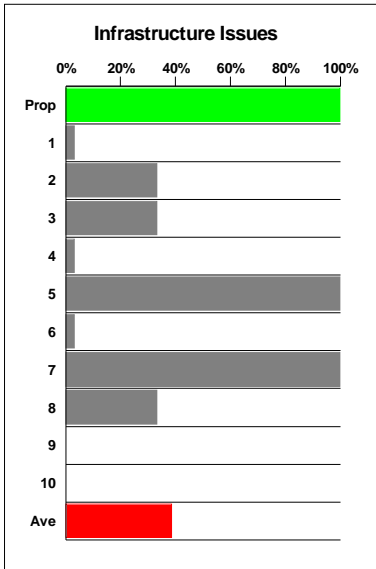
**Comments:**

- 1
- 2 If it worked, it would be a new energy source that would be sustainable as long as our solar system existed.
- 3 Having one of these going could be possible. Having thousands and thousands going (ie: a 'D') across Canada is a bit scary to imagine. I would also really like to see the net energy equation
- 4 If the technology relies on natural heat then it may be unlimited but if it relies on being an add-on to existing cooling towers or power plant stacks then it will not be an unlimited supply
- 5 This assessment reflects numerous uncertainties related to the technology at the present time.
- 6 It is probable that the fully developed vortex engine would be the source of unlimited energy for those countries having the required atmospheric conditions/space & demography.
- 7 This energy pathway would provide an almost limitless supply of renewable energy with an unlimited long term potential. It also can be coupled with existing technologies to enhance their efficiency and commercial life span.
- 8 It is noted that this pathway might be applicable to only a limited number of sites (near refineries or power plants, and near the oceans). It is, however, essentially limitless
- 9
- 10



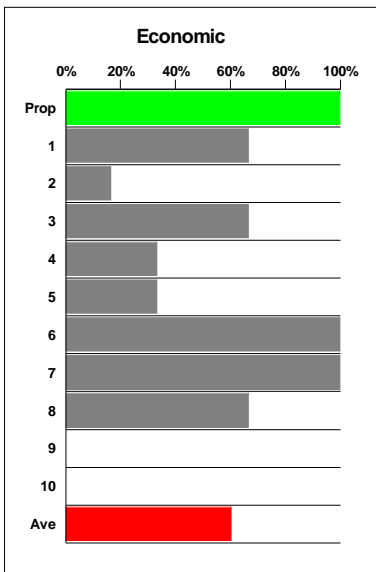
**Comments:**

- 1
- 2 It is really one of a kind, other than the spill over into other energy operations.
- 3 This would be a largely independent energy source (but I think from the description would depend on being part of the use of waste heat from other sources?)
- 4 This technology is not dependant on another pathway, it may contribute to other energy sources by producing electricity and thereby possibly replacing another energy source.
- 5
- 6 The vortex engine concept is a 'stand-alone' system. It has no probable improvement capability to existing power generation systems; indeed may benefit from improvements in existing systems.
- 7 Because this pathway can be coupled with existing nuclear and thermal power generation capability, it will enhance the commercialization of those pathways.
- 8 This pathway only needs some source of low heat
- 9
- 10



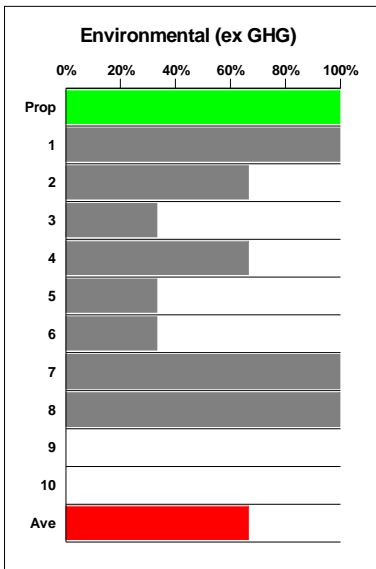
**Comments:**

- 1
- 2 There are likely to be specific regional locations where there would be a best fit, which would affect the delivery infrastructure.
- 3 If these are all in locations currently hooked to the grid - OK. If not, the same issues as small scale hydro will prevail.
- 4 This technology is a generator of another energy source, i.e. electricity. However, no infrastructure exists for this technology which is a generator of an energy source
- 5
- 6 The main infrastructure requirement would be proximity to the electricity grid; unlikely in the required areas remote from a populated area.
- 7 This pathway generates electricity for which there is already a well developed infrastructure.
- 8 Possible site limitation might preclude its use over the entire Canadian territory
- 9
- 10



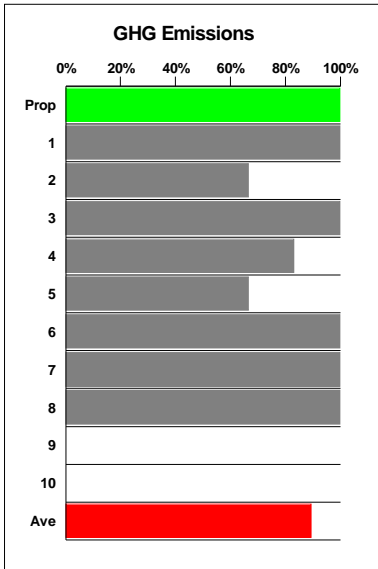
**Comments:**

- 1
- 2 Maybe there would be regions with preferred weather conditions (temperature and/or wind)
- 3 Maybe - but scale, location issues, net energy/cost balance, etc would determine if it might in fact be an 'A' or a 'D'
- 4 Is all of Canada potential recipient and does all of Canada have the natural heat sources to drive this engine? There is no evidence presented for this.
- 5 This assessment reflects the numerous uncertainties related to this technology at the present time.
- 6 Potentially greater than the pipeline in the long term but C in the shorter term
- 7 Successful development of the Vortex engine would have a transformative effect on the Canadian economy by providing plentiful electricity for the strong but energy intensive oil sands extraction, oil refining, aluminum, and steel manufacturing industries
- 8 Although I mentioned that the number of sites might be limited, there are existing power and petrochemical plants all over Canada
- 9
- 10



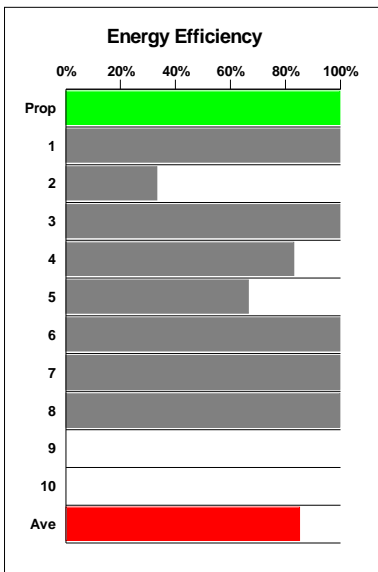
**Comments:**

- 1
- 2 Would depend on extent of impact.
- 3 Local and global weather systems react badly to large thermal vortices. My mind boggles in trying to think of the effect of thousands (millions?) of these all working at once
- 4 The environmental impact of this early stage, experimental technology is unknown. If it increases power plant efficiency then there will be a positive environmental impact. The impact of sucking up heat and creating vortices in natural areas is unknown.
- 5 Numerous uncertainties related to migratory bird patterns, airplane routes, etc.
- 6 In the necessary remote area for locating the vortex engine, it is a slight possibility that some resident would have to be relocated
- 7 The pathway provides a clean renewable source of electricity. The pathway also contributes to reducing global warming by conveying warm gas from the earth's surface to the upper atmosphere where it can radiate out into space.
- 8 This pathway is unique in that it would facilitate atmospheric cooling
- 9
- 10



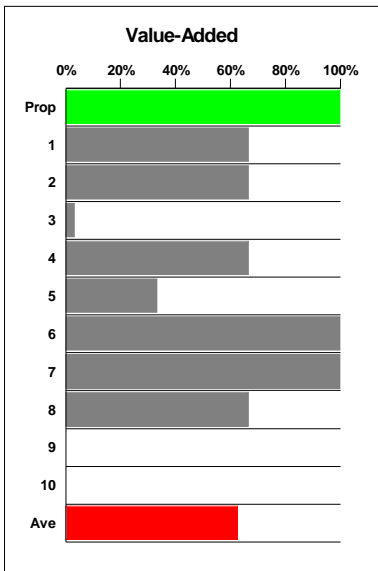
**Comments:**

1	
2	Would depend on extent of impact.
3	
4	There should be major reductions if the technology reduces the need for power plant electricity generation, but we don't know yet how much.
5	This assessment reflects the numerous uncertainties related to this technology at the present time.
6	
7	This technology can increase the efficiency of existing thermal generating stations reducing GHGs, and can be used to generate electricity directly with no GHG emissions. It would result in a significant decrease in Canada's total GHG emissions.
8	This pathway is carbon-free
9	
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**Comments:**

1	
2	Not sure that the overall efficiency would be changed.
3	If this is related to current thermal outputs AND there is a 20% increase in efficiency - then yes. But - the net system design would drive the reality of this
4	The technology is still in a very early stage and we don't yet know how much improvement there will be in energy production and use.
5	
6	
7	Because this pathway can generate electricity with no fuel requirements, it promises to greatly enhance the efficiency of energy production in Canada.
8	Even assuming no waste heat collection from the oceans, only from power and petrochemical plants, and only 10% energy recovery through AVE, one would get a 30% energy efficiency improvement
9	
10	



**Comments:**

1	
2	Could add another energy source, and some value-added manufacturing.
3	This might displace the need for other energy sources but would do nothing to create value added.
4	This technology has the potential to increase the yield or value of resources used in the generation of energy in Canada but whether it will be transformational is not know and is speculative.
5	This assessment again reflects the numerous uncertainties in this technology at the present time.
6	
7	Canada's resource industries are very energy intensive, so the plentiful cheap energy which could be provided by the commercialization of the atmospheric vortex engine would result in a major transformation of these industries.
8	I am not sure that this is applicable. The current energy pathway of this type is wind farms. The AVE is a more reliable type of atmospheric energy recovery, which should be more continuous in time, with probably lower failure rates.
9	
10	