RAA
RECREATIONAL AIRCRAFT ASSOCIATION
RÉSEAU AÉRONEFS AMATEUR CANADA

The Leading Edge

Monthly Newsletter of the Kitchener-Waterloo RAA

- April 2017 -

Gary Walsh and I were lucky enough to be invited to a pancake breakfast at Ken Chute's place on Puslinch Lake on Sunday. What a great event to start off another year of fly-ins, breakfast fly-outs and hundred dollar hamburger flights in 2017. Ken celebrated his 82nd birthday this week and is still flying fairly regularly in his Piper Cub.

President's Message

Well it sure is good to be flying again. As members of KWRAA we are fortunate to have the opportunity to attend four chapter sponsored fly-ins each summer. A number of other chapters are down to just one or two fly-ins due to lack of interest or inability to get enough involvement in the organization of these events.

Our chapter is fortunate to have an executive that recognizes the importance of these events and directors, like Mac, who put the effort into making sure all the plans are in place well in advance so I can keep reminding our members of the dates to keep free in our calendars. There is a fair bit of work involved in planning and running these events, so please take the time to attend at least a couple of them this year. Also, please don't forget to thank Mac for his work and Mike, who works behind the scene (and barbeque) to make sure everyone leaves happy and not hungry. Thanks guys!

If you remember, we had a fairly good turnout for the last fly-in of 2016 up in Teviotdale at CPR3. Let's try to make every fly-in event this year more like that one. The more members and guests that show up, generally the better the event ends up being. I'm already looking forward to Cam's fly-in on June 10th. Hopefully the weather will be more cooperative than last year when we had high winds that day.

For the members who fly regularly, you will appreciate when I say that the conditions lately have started to look much better, although we seem to be in a pattern where the weather craps out a bit on the weekends. For those of you still building… keep up the good work. It seems to drag on at times, but before you know it you'll be leaving the car keys behind and flying to our summer fly-in events!

2017 is going to be a great year for KWRAA!

\- Dan

If You Think Wind Turbines are a Problem for Pilots and Small Aircraft Read On…

There is a scary new development on the wind energy front for pilots! Airborne wind energy conversion systems could be more of a threat to small aircraft than ground-based wind turbines currently are.

What is an airborne wind energy conversion system? (AWECS) So far there are three main options for airborne wind generators. The first involves a shrouded turbine that work similar to conventional wind turbines but makes use of wind at altitude.[1]

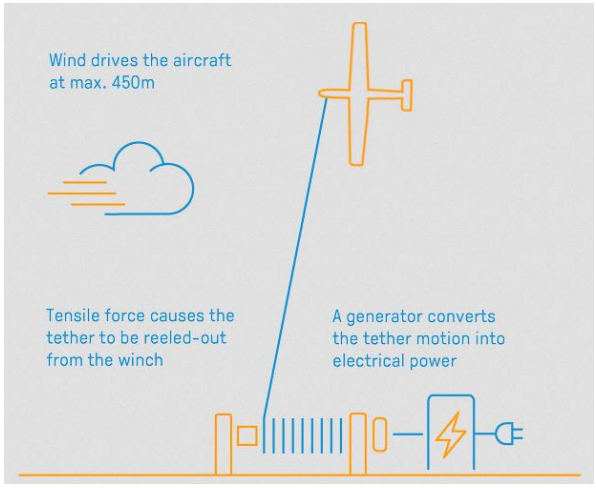
This option is ideal for remote locations when temporary power and quick set-up is required, such as an expedition into wilderness areas.
The second method uses a tethered kite or aircraft that is reeled in and allowed to be pulled out by the wind to turn a generator.[2]

This is a more permanent installation requiring more advanced mounting and control mechanisms on the ground.

The third option is a fast motion tethered system that uses the cross-wind action of the wind to generate power. This is the one I will focus on in this article as it could present the highest risk to pilots of small aircraft in the near future.

This form of airborne wind generator uses a tethered aircraft that moves in a large swept area at an altitude of up to 450 meters, where the wind is much stronger and more consistent.

Here's a basic illustration[3]:



Here is a photo of an actual airborne wind energy conversion system (AWECS) known as the PowerPlane[4]:

To see this concept in action check out this video link… https://youtu.be/5azHRiZyC4U

Here's another one in the EU…
https://www.youtube.com/watch?v=30iQG9nYDWk
The ground foot print is very small for these installations, but the volume of space occupied by these devices is massive compared to ground based wind turbines. Imagine a dome of sky almost one kilometer across and almost one half kilometer high that has a steel cable and unmanned aircraft darting back and forth across it. Now imagine a whole wind farm made up of several of these things darting around the skies …YIKES!!! I don't know about you, but I don't want to get anywhere near those things while I'm flying my small plane around!

In 2013, Leo Goldstein wrote a paper, *Theoretical Analysis of an Airborne Wind Energy Conversion System with a Ground Generator and Fast Motion Transfer*.

The abstract reads;
"A novel airborne wind energy conversion concept is presented, in which the wind power, which is harvested by the crosswind motion of a tethered wing, is transferred to a ground-based generator by a belt with a high speed close to the speed of the wing. The belt trails behind the wing. The high speed of the motion transferring belt results in a low belt tension, a high rotational speed and a low torque on the shaft connected to the rotor. The theoretical analysis and numeric calculations, which consider the drag of the tether and the weight of both the tether and the wing, demonstrate the practical feasibility of the concept. Two practical constructions are described, one with a single wing and one with two wings in counter phase. The economic analysis shows that the proposed system is 10 times less expensive than a conventional wind turbine with a comparable average power output." [5]

Just four years later, working prototypes have demonstrated that this device can actually generate more power than a conventional wind turbine and use 90% less material to build. This will be a game changer for utility companies trying to generate low cost electricity; in fact it could allow generation of electricity at a lower cost than natural gas, mostly because of the low installation and maintenance costs.

High altitude wind energy can be captured by kites, balloons, kite/balloon combinations, tethered gliders, tethered sailplanes, bladed turbines, airfoils, airfoil matrices, drogues, variable drogues, spiral airfoils, vertical axis turbines, spinning cylinders, multiple-rotor complexes, fabric para foil kites, piezoelectric materials and many more designs. But the design that seems most likely to get funding and perform the best appears to be tethered gliders or sailplanes.

Not only was that analysis proven sound, this 'theoretical analysis' is now reality with several working prototypes. Imagine where wind energy will be in another four years. I expect that we will see the first airborne wind systems sending electricity to the grid by then.

To illustrate my point, there are no less than two dozen companies cultivating this technology now, but many will require outside funding in order to speed up the research and development processes. However, some of the companies working on airborne wind energy are heavyweights with almost limitless funding, including Google. This article from 2015 illustrates this fact.
http://www.theverge.com/2015/3/17/8236723/google-x-makani-project-wind-turbine-planes

The Verge reports; *"Makani has developed and tested a 8m, 20kW demonstrator, called 'Wing 7' that showed the capability of fully automatic operations and power production. After these results, in early 2013 Makani was acquired by Google. Makani is currently developing a 600 kW prototype, 'the M600'. The M600 AWT has eight turbines, each with five propeller blades, and has a wingspan of 28 m. The prototype is now undergoing testing. After M600, Makani plans to produce an offshore commercial version of AWT with a nominal power of 5 MW featuring 6 turbines and a wingspan of 65 m".* [6]

Development of this technology is unstoppable at this point. These things will be flying en-mass in the not-to-distant future as part of a worldwide move toward low cost renewable energy sources. The questions of where they will be deployed and how they will impact aviation have yet to be answered.

Mark Moore of NASA said in an interview in December of 2010, *"Offshore deployment of these airborne systems probably makes the most sense in terms of both airspace and land use, because there is little to no demand for low altitude flight over oceans 12 miles (19 to 20 km) offshore. Also, unlike ground-based turbines, there is almost no additional cost for airborne systems offshore because huge platforms are not required to support the structure or resist large tower bending moments".*[7]

Let's hope that the opinion of the experts at NASA influences the US decision on where to position these devices. Maybe the Canadian government will follow their lead and put these things offshore where they will not create a significant hazard to aviation. Governments around the world are under increasing pressure to meet the Kyoto Protocol by moving away from dirtier technologies and this has the potential to deliver large amounts of clean renewable energy at as little as $.02/kwhr.[8]

Although this will be a game changer for energy generation, improperly placed on the terrestrial landscape it will create havoc for pilots of small aircraft operating in the vicinity of these wind generating devices. If you think the large spinning disk of a wind turbine is a hazard to aviation, just imagine what hazards these new tethered aircraft operating up to 1500 ft. AGL will create. It will be interesting to see how this unfolds and how organizations like AOPA and COPA deal with the potential hazards created by this new technology.

We already know that the government's track record at adopting new legislation to deal with these risks is lagging behind by many years and in some cases it seems decades. A search of the Transport Canada and NavCan websites reveals that airborne wind power systems are not even on their radar yet. If they are, it appears neither one is commenting on them.

I suspect that when these new airborne tethered wind generators are deployed, there will be a lot of confusion about safety issues surrounding them. We are just starting to get an understanding of the vortices that trail behind wind turbines, but I doubt we will have much information about the wind shear created by the moving vortices behind tethered devices for some time yet as the technology develops.

I am as much in favour of low cost sustainable energy as the next guy, but I truly hope they are deployed in a responsible manner, unlike the ground-based wind turbines in Ontario that almost shut down airports and created on-going hazards for several other smaller airstrips. Our only hope as pilots is that these things don't proliferate uninhibited even faster than wind turbines and drones have over the last decade, but given their relatively low cost of manufacture and deployment, I'm not hopeful on that front. Our provincial governments are so hungry for revenue and clean energy solutions at lower cost than presently available, I am concerned that unchecked these things could render much of our skies un-flyable within a decade or two.

To learn more about the technology go to: https://www.ampyxpower.com/technology

Note that Ampyx has started the design of its first commercial product: a 35m wingspan AP-4 PowerPlane (scaled up version of the one in the earlier photo) with a 'wind turbine equivalent' power of 2 Mega Watts. There is no doubt about it… this technology will be deployed somewhere soon![9]

Check out:
http://www.nearzero.org/reports/airbornewind/pdf
to see what the industry experts have to say about this technology.[10]

Also check out: http://www.sciencedirect.com/science/article/pii/S1364032115007005 for a great overview of the technology and key players in the airborne wind generation industry.[11]

As for the impact on general aviation, time will tell! In the meantime… keep an eye out for all the other hazards we already face and fly safe!

- Dan Oldridge

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Notice: This article is intended to generate discussion among pilots and aircraft owners regarding AWECS and their potential impact to aviation general aviation if this technology is not deployed in a responsible manner. Opinions expressed are those of the writer and may not reflect those of all parties involved in any discussion regarding this topic.

References:

1. **Inhabitat.com** Altaeros Energies' Floating Wind Turbines Tap Into Strong High Altitude Winds, 03/28/2012, Environment, News, Wind Power.

2. **Inhabitat.com** Giant Energy-Generating Kites Could Serve as an Alternative to Wind Turbines, 07/10/2013, Environment, Renewable Energy, Wind Power

3. **Illustrative Diagram** from Ampyx (modified slightly to fit on page) , https://www.ampyxpower.com

4. **PowerPlane** is a trademark of Ampyx

5. **Goldstein, L.**, Theoretical Analysis of an Airborne Wind Energy Conversion System with a Ground Generator and Fast Motion Transfer, Science Direct - Green Energy and Technology Volume 55, June 2013, Pages 987–995

6. **Arielle Duhaime-Ross**, Google will fly a crazy, plane-like, 84-foot wind turbine next month, TheVerge.com, Mar 17, 2015

7. **Mark Moore**, NASA, An Answer to Green Energy Could Be in the Air, October 2012 https://www.nasa.gov/topics/technology/features/capturingwind.html

8. **Roland Schmehl**, TU Delft, The Guardian, Flying a kite for aerial wind power, July 10, 2013, Technology article written by Lou Del Bello

9. **Ampyx** Power Airborne Wind Energy System, https://www.ampyxpower.com

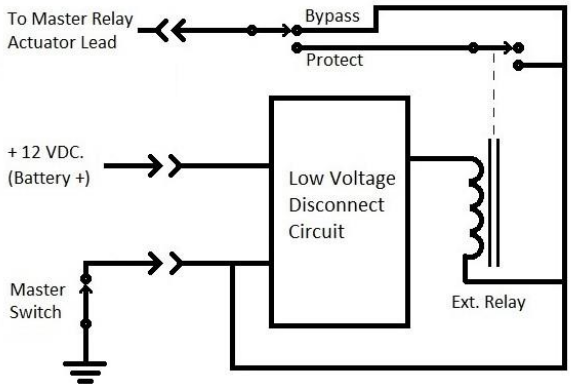
10. **Near Zero**, Energy High in the Sky: Expert Perspectives on Airborne Wind Energy Systems, ed. Mason Inman, 9 September 2012

11. **Antonello Cherubini, Andrea Papini, Rocco Vertechy, Marco Fontana ,** Airborne Wind Energy Systems: A Review of the Technologies, Science Direct - Renewable and Sustainable Energy Reviews, Volume 51, November 2015, Pages 1461–1476

Lithium Battery Protection Circuit (Revised)

In February, I wrote an article about an under-voltage protection circuit I was building and trying in my Highlander. I have since revised the circuit design … here's why and how.

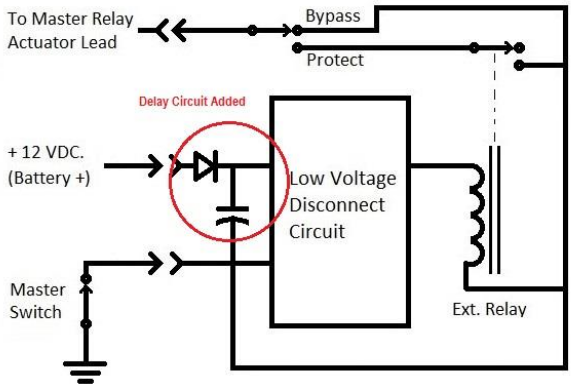
This circuit monitors battery voltage and I forgot to take into account that the voltage drops suddenly as the starter tries to turn the engine over. The drop is significant enough to trip the relay, cutting off the voltage to the relays intended to protect the battery. The result is a circuit that acts like a buzzer turning on and off hundreds of times per second.



Switching the circuit to bypass during starting will eliminate this problem, but that defeats the purpose of having a system that works automatically, so a modification is in order.

As I see it there are two options; the first would slow the reaction of the circuit down so it doesn't see a quick drop in voltage, only a slow one. The second option bypasses the low voltage protection circuit while the 'engine start' button is being depressed.

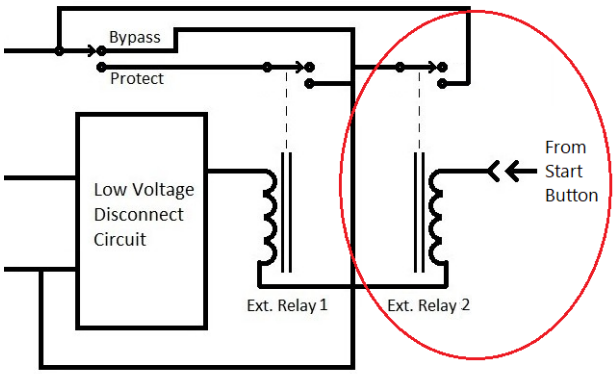
The first option would require the addition of a diode and large capacitor. The capacitor would charge to the battery voltage (minus 0.6 volts because of the voltage drop across the diode). The diode would isolate the input of the circuit from a surge of lower voltage during the time the capacitor was slowly discharging the higher battery voltage. The amount of time it would take for this to happen is determined by the current draw of the circuit and the size of the capacitor.



This option would likely require a bit of trial and error to find the right value of capacitor to keep the circuit on long enough to prevent the low voltage circuit from oscillating like it is now without oversizing it, which could prevent it from reacting as it should to protect the battery.

The second option would bypass the entire circuit while the 'engine start' button is being depressed. This would either require the installation of a DPDT push button in place of the SPST button that I currently use, or the installation of another relay to bypass the low voltage protection circuit while the start button is being depressed.

That circuit modification would look like this:



Given the options available, it makes the most sense to go with the second option, so I will let you know how it works out in next month's newsletter. In the meantime, I'm glad I installed a bypass function into the initial design.

- Dan

Very Interesting…
With the acceptance of the low cost Dynon D10 in some certified aircraft now it is interesting to note that the long required vacuum pump may go the way of the dodo bird. Check this out…
http://airfactsjournal.com/2017/04/death-knell-vacuum-pump

Upcoming Events in 2017: (Highlighted lines are KWRAA Events*)

May 8	-	May Meeting at 7:30 in the Cadet building at CYKF
June 10	-	KWRAA Fly-In at Cam Wood's in West Montrose
June 23-24	-	COPA National Convention in Kelowna, BC
July 15	-	KWRAA Fly-In at Tom Shupe's in Mount Forest
July 24-30	-	Air Venture Oshkosh in Wisconsin
July 29	-	KWRAA Fly-In at CPR3 near Teviotdale/Palmerston
August 5	-	Gathering of the Classics in Edenvale, ON
August 12	-	KWRAA Fly-In at CMZ2 – Metz/MacPat Field in Arthur
August 18-20	-	UPAC Convention – Lubitz Field, Plattsville ON
August 26	-	Aviation Fun Day at CYKF
August 30	-	Rotary Charity Airshow in Brantford, ON
Sept 2-4	-	Canadian International Air Show – CNE Grounds
September 11	-	September Meeting at 7:30 in the Cadet building at CYKF
September 16-17	-	Air Power Demonstration at London International Airshow
October 16	-	October Meeting at 7:30 in the Cadet building at CYKF
November 13	-	November Meeting at 7:30 in the Cadet building at CYKF
November 24 (TBA)	-	KWRAA Christmas Party in lieu of a December meeting

* KWRAA events are fly-in and/or drive-in (Please advise the host in advance if you plan to attend whenever possible.)

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Hangar for Sale in Roseville:

- 8' high at the back, 9 '2" at the front (39' x 24' overall)
- Asking $7000 for the hangar
- Land rent is about $400/yr

Contact: Allen Mattice at *allenjmattice@hotmail.com*

Rotax Heat Monitor Strips:
Mac has a number of Rotax Heat Monitor Strips that can be applied to sensitive areas to monitor for extreme heat readings. They are presently being recommended by Rotax to monitor the ignition modules. He is offering them individually for $15 each incl. HST. or two for $28 incl. HST.
Contact: Mac McCulloch at macpat@live.ca

Be sure to check out the KWRAA for more information at: www.KWRAA.net