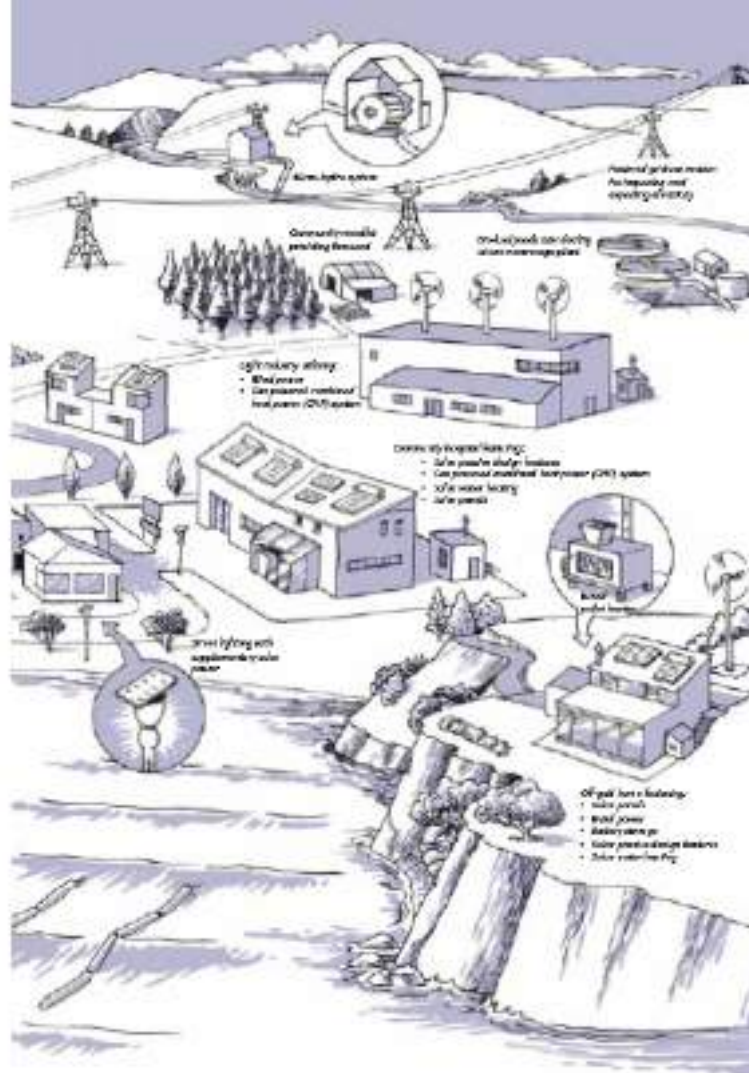


Small scale distributed wind: The Thinair turbine as a case study of the technical and commercial challenges of introducing an innovative renewable generation option.





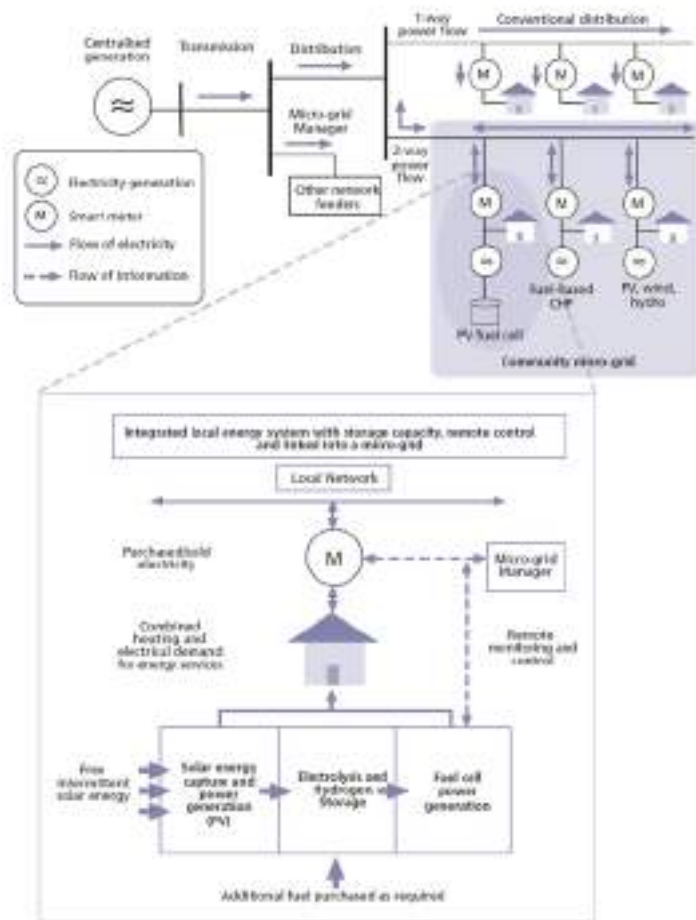


Figure 2.3 A micro-grid within an existing electricity network

Source: Adapted from Gerding, 2005



- We have designed a domestic scale wind turbine providing exceptional performance, reliability and potential for economic manufacture.
- Our aim is to give customers a viable complement to PV with the goal of facilitating houses and remote sites becoming net zero energy in all seasons and weathers.

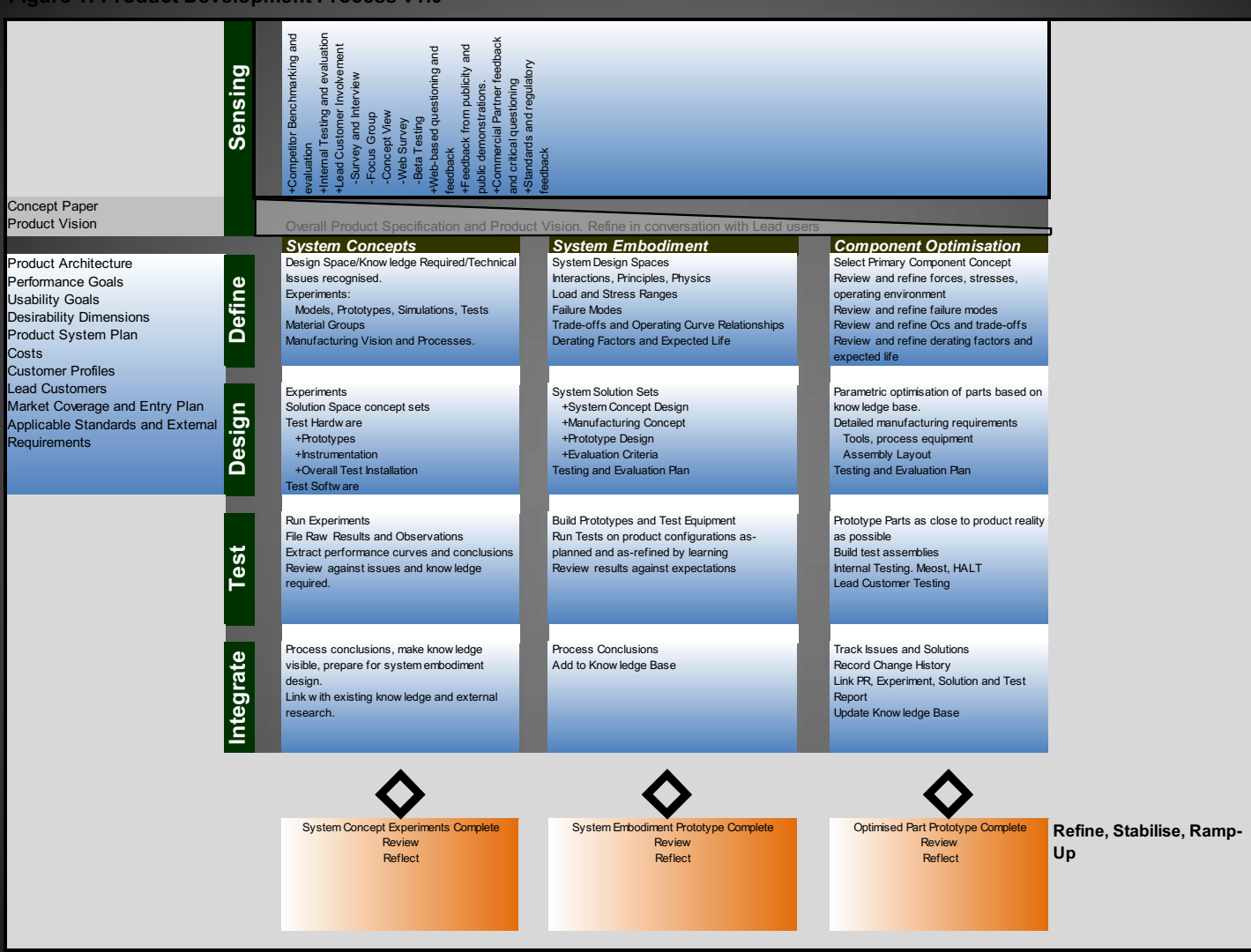


The turbine combines a high performance state of the art single blade rotor, a modular axial flux alternator and a proprietary control system – all carefully matched and designed for manufacturing and scaling.

We have set the company up with methodical systems which should facilitate scaling:

- Solidworks for mechanical design with all parts modelled and stored in a pdm database.
- Pspice for the electronic design
- Sage for product BOMs and ERP functions.
- Careful problem solving for all issues from the field.
- ANSYS CFD modelling work done by the University of Otago to fill in our understanding of the flow and especially post stall flow behavior of the wing.





File Home Insert Page Layout Formulas Data Review View Add-Ins

Font Paragraph Styles

Conditional Formatting Tables

Normal Bold Italic Underline Text Background Color

Decrease Indent Increase Indent

AutoFill

Sort Filter

Clear

Editing

Review

Comments

Track Changes

Protect Sheet

Protect Workbook

Print

Page Setup

Print Range

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Print Range

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Print Contents

	A	B	C	D	E	F	G	H	I	J	K		
					Define				Design				
					Issue	System/Component	Description	Issue	Expenses	Effect	Priority	Design Space Indication	Proposed Solution
41	Done		208002	Turbine assembly	Unreliable starting with loading edge first in moderate and strong winds.		Winds above about 6 m/s invert the stack while starting, and make it hard to get a good start.		Lost time getting started in productive winds. Running backwards also loses production time.	1	Spring performance	Raise spring preload? Any other ideas welcome!	
41	Done		208002	Turbine assembly	Unreliable starting with loading edge first in moderate and strong winds.		Winds above about 6 m/s invert the stack while starting, and make it hard to get a good start.		Lost time getting started in productive winds. Running backwards also loses production time.	1	Software development to detect condition	Add parametrised test so backwards running can be detected, and the machine stopped to try restarting.	
41	Done		208002	Turbine assembly	Unreliable starting with loading edge first in moderate and strong winds.		Winds above about 6 m/s invert the stack while starting, and make it hard to get a good start.		Lost time getting started in productive winds. Running backwards also loses production time.	1	Start parameter optimisation	Aim for much faster start to avoid situation where blade 'blows through' centre while starting from the correct side.	
43	Done		Electronics/Software	High Power Control	Control optimisation, especially in speed control region.		More work required on the control issues, but mostly above the cubic threshold.			2			
44	Done		Inverter	Inverter operation and connection	Unreliable syncing of inverter		Apparently due to attempting no-load connection		lots of failed sync attempts	1			
45	Done		Controller	Controller resets and stops machine apparently randomly.	Controller resets and stops machine apparently randomly.		Could be a communication issue. Needs investigation.		Lost production due to restart time, especially in strong wind.	1			
46	Done		Controller	Current sense resistor blown.	Current sense resistors and some of the back have been blown in inverter installations.		May possibly be associated with turning on the dc motor to the inverter under load.		Control lost, machine cannot operate with current sense. Not unsafe though.	2			
47	Done		Class 6 job	Well failure.	Apparently insufficient penetration in the tube to flange weld.		On know. It's opportunity got the best answer to this weld. Clark machine separated the flange from the well.		Ultimately loss of the turbine if the weld fails completely.	1	Weld improvement	Sequentially replace all clark 6 jobs with electrode welded replacements. Machine shaft back on inside of flange to allow space for full penetration weld inside of well.	
48	Done		Controller	Power supply failed	The power supplies have now failed.		The main board power supplies have now failed in apparently low stress situations.		Shutdown of the machine and maintenance visit to replace board.	2			
49	Done		Controller	Q8 failure	Wilson, Brookmeyer, Gajjar, Clark Q8 PCTs have failed. Plus Clark (paper), Sealed Hill, Otis Gladly.		One inverter and one battery charger controller have had Q8 failures. One possible indication is that there is a software fault where the controller can attempt to connect with the wrong speed target. The PCT should really handle this though.		Turbine won't start. Load to dump is too high for the rotor to get away.	2			
50	Done		Software	Wrong target loaded for inverter sync operation	Turbine attempts to sync at high speed, and high power flows to the dump load.		Apparently randomly, the software loads the wrong speed target and sets the R2 target for syncing. Only ever seen on Polystach machines.		Stresses dump load system and heats test sink. Will cause the machine to shudder or heat sink overtemp.	3			
51	Done		Rotor assembly	Controlling and taking	In sufficient protection for rotor		The hub takes are not sealed, and water has		Flaking of the bearings, which	1	A review of the control rotor bearing	To review the inner bearing, get someone to design to fit a	

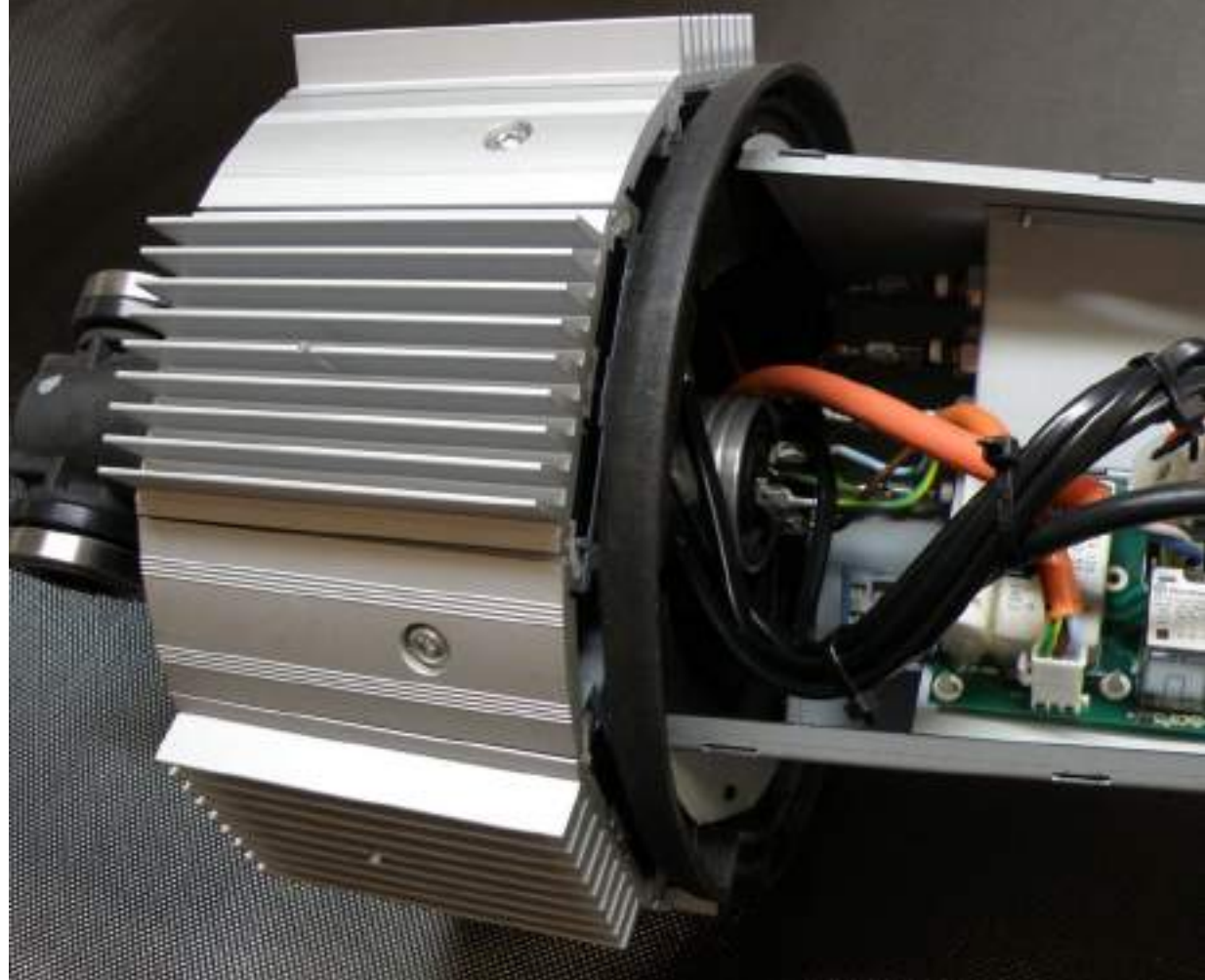
A lean approach to design results in a low parts count. The lightweight, single blade concept gives good material utilization. High voltage generation saves cable costs.

Potential to use high volume processes to manufacture major parts.

Potential to use common parts across a range of different sized machines.

Potential to adopt a distributed manufacturing model, where regional assembly sites produce turbines from a mix of local and centrally manufactured parts.

Potential to provide a 'mass customised' product range where a chassis frame size and blade wind speed rating can be closely matched to a customer's requirements.



Another interesting benefit of the single blade design is that the tower top unit can be packed and shipped fully assembled.



The simple mechanical design combined with sophisticated electronics and software create a system that once installed can be left to self manage by the customer or host.

Systems and components are designed for simple field replacement, with many examples of plug replaceable systems for fast repair with limited skills.

IP connectivity means problems can be remotely identified and alerted. Good for service plan managed installations.



screen → gallery

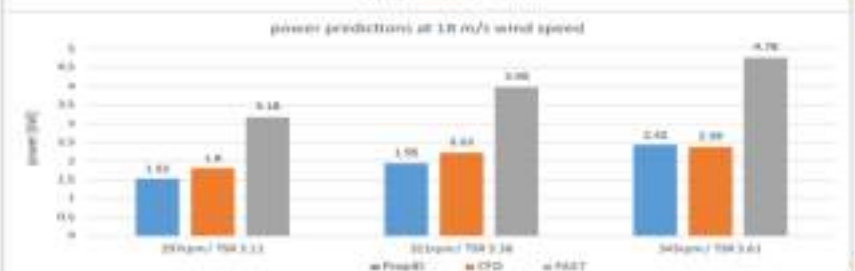
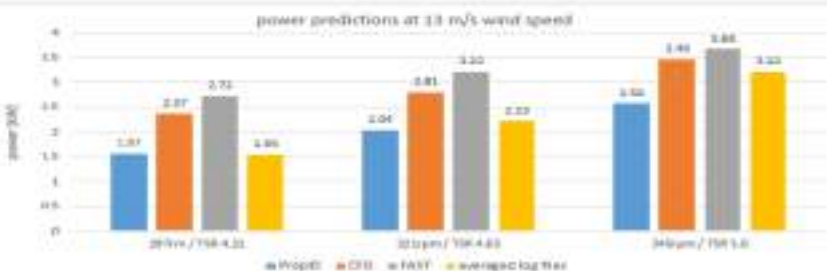
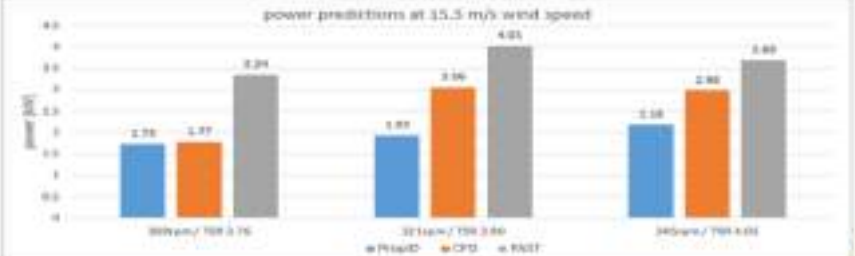
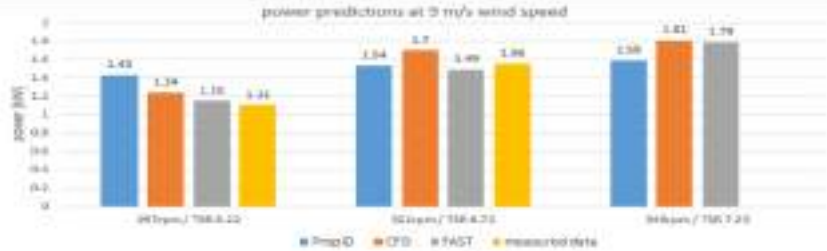
A World First

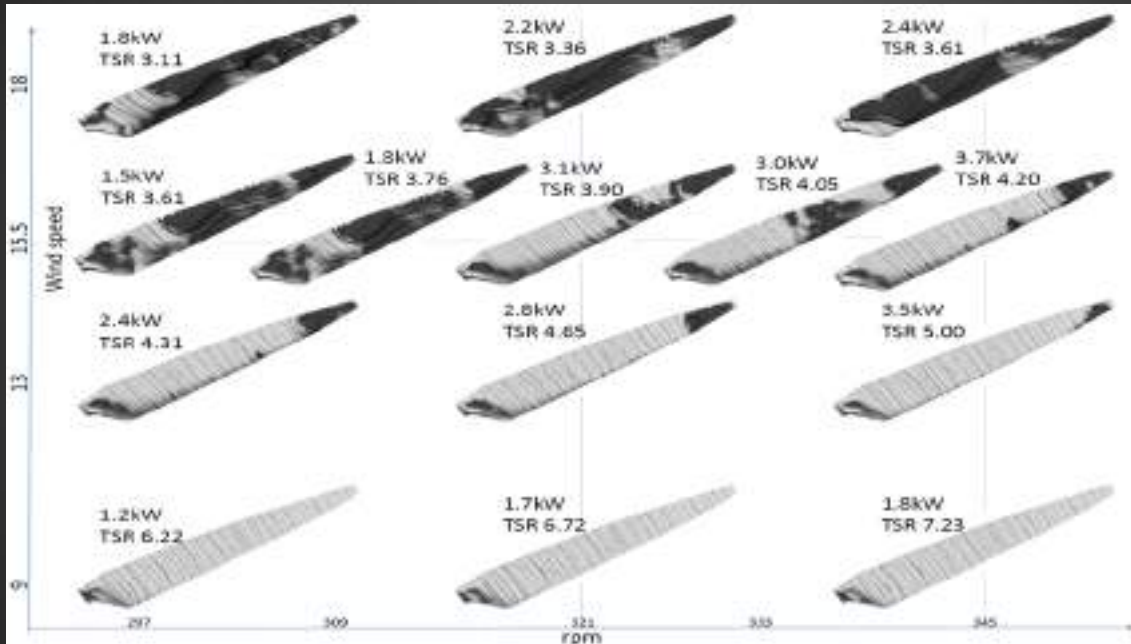
Keeping Performance

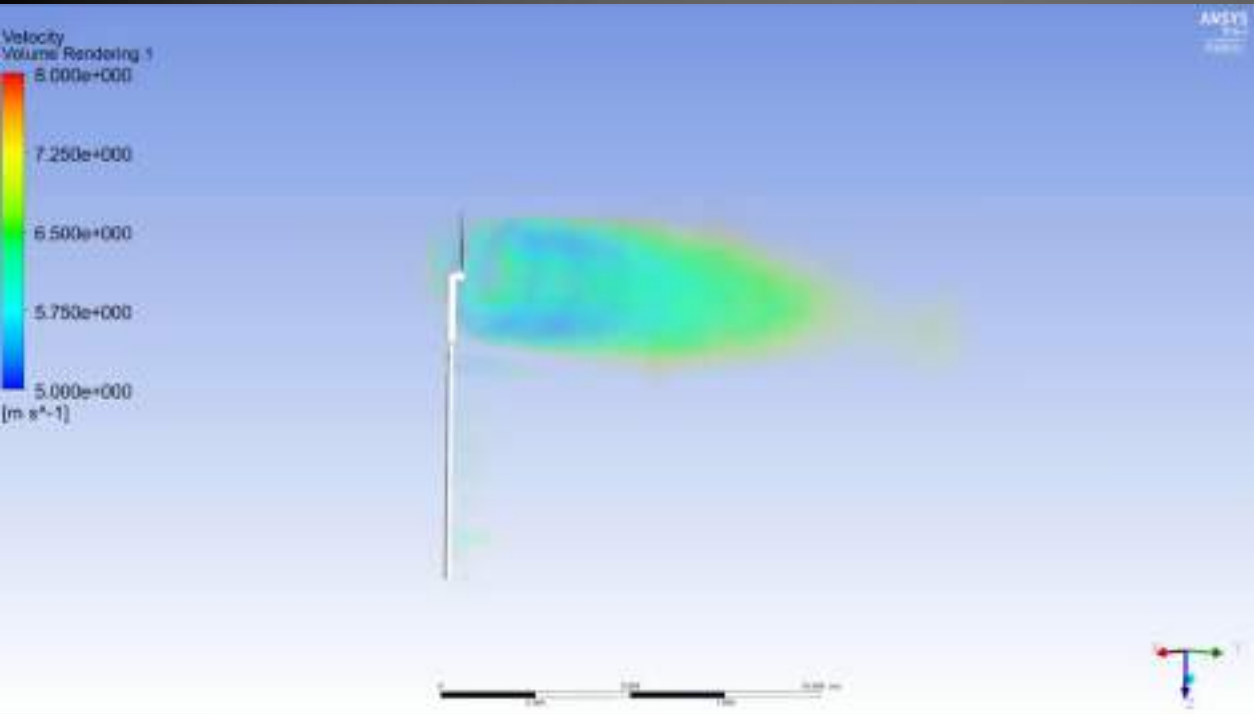
Lights in The Sky



Verification and Validation







This clip shows the extreme lack of interference possible with a single blade.



enaSOLAR

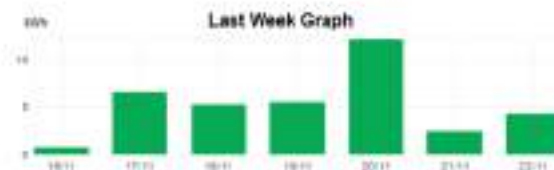
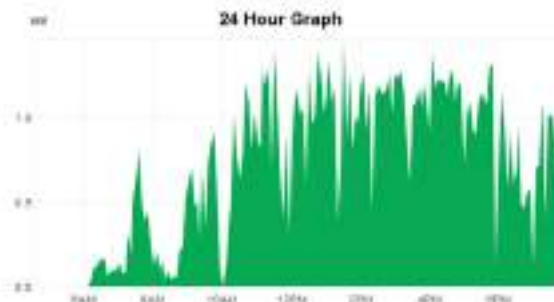


Yealands Est Thinair

- Home
- Charts
- Settings

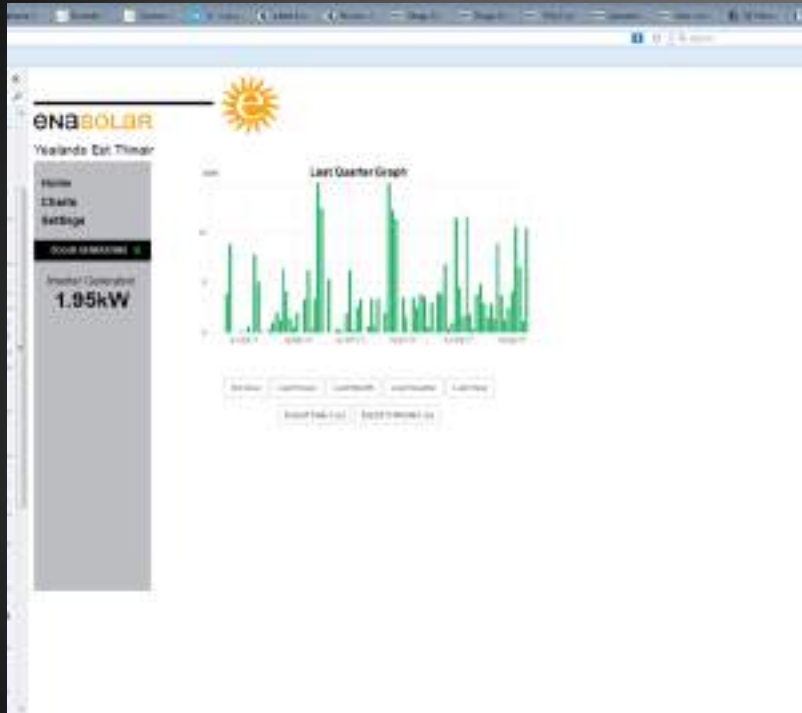
SOLAR GENERATING

Inverter Generation
2.71kW



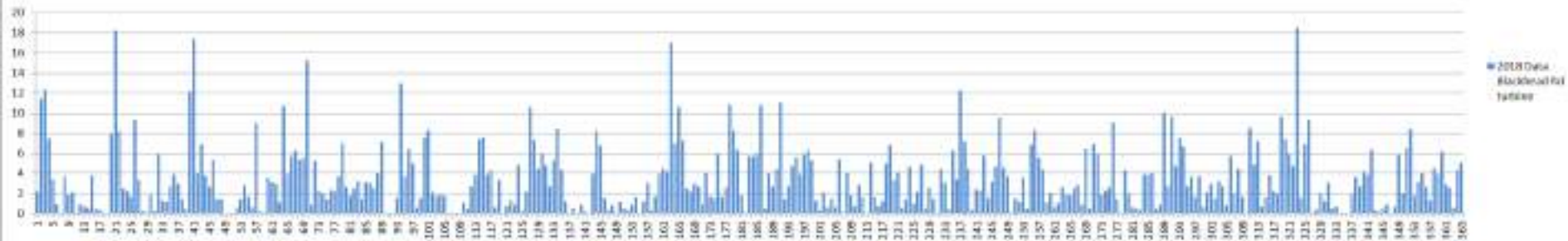
Total kWhs

	Today	Yesterday	Average	Lifetime
Inverter Generation	10.58	4.35	3.58	1023



This screenshot shows the machine at 1.95 kW- and the daily record for the last 3 months.

2018 Data Blackhead Rd turbine



Oct-19



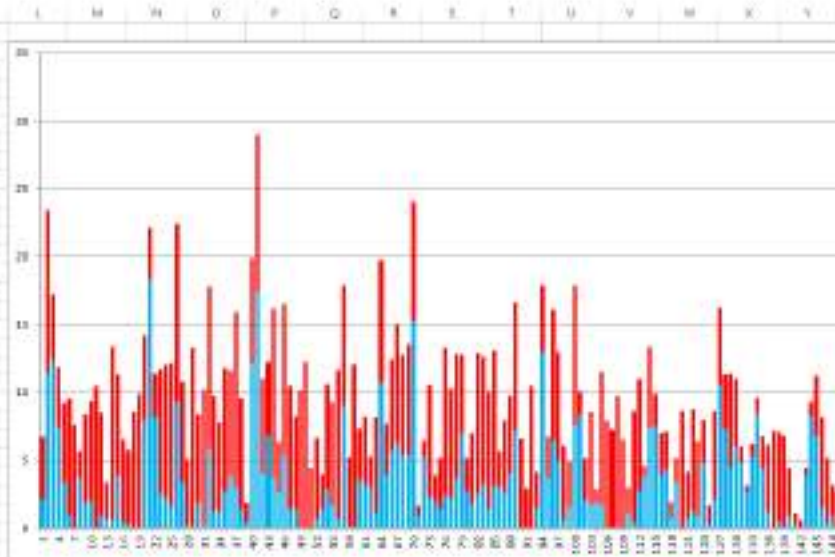
10.8 square m PV daily



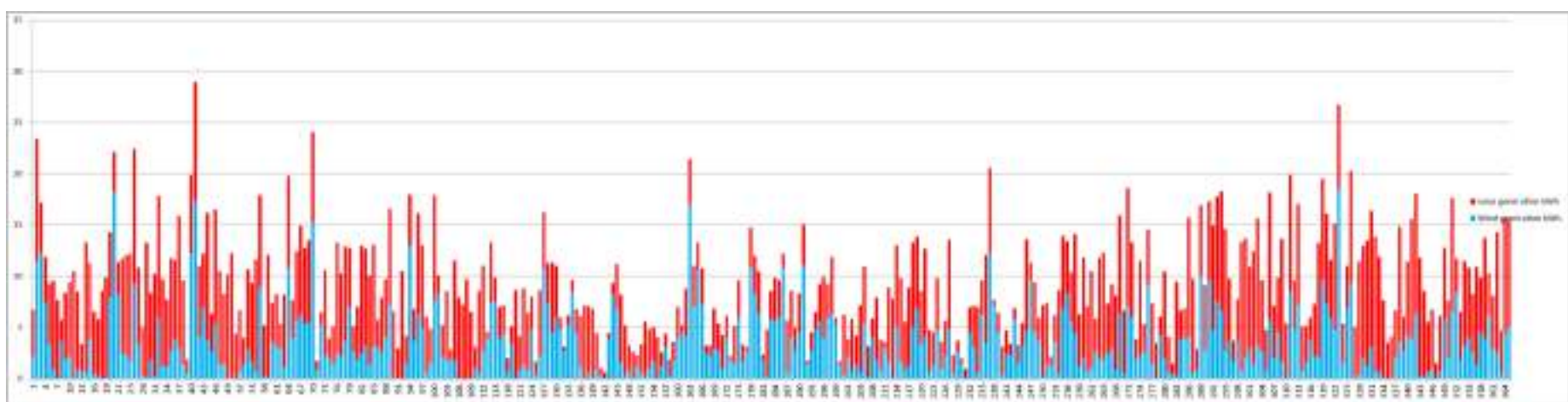
- Musselburgh data
- Typical days not a specific year
- Assumed 6 x 280 W panels, 46 degree tilt, bearing 0 degrees, ground albedo 0.1

Microsoft Excel ribbon: Font (Calibri 11), Home (Clipboard, Font, Paragraph, Styles), Insert (Tables, Charts, Links, Pages), References (Tables, Subtotal, Sort & Filter, Conditional Formatting, Tables), Review (Comments, Changes, Protection), View (Task Pane, Background Images, Show/Hide, Macros, Windows, Ribbon, Ribbon Tab), Help (Microsoft Support, Tell me what you want to do).

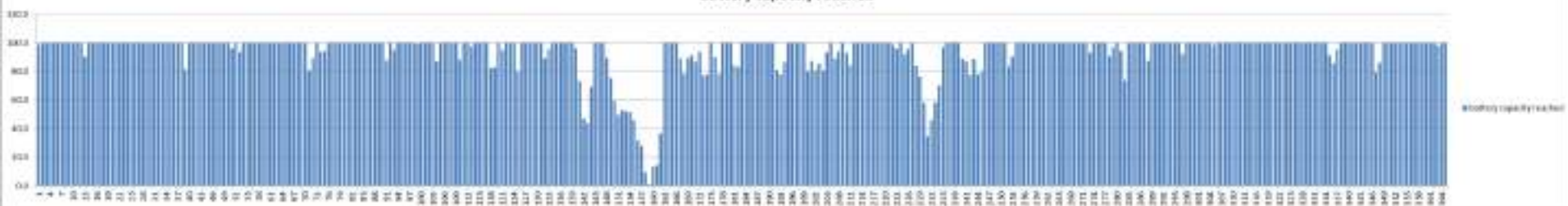
Day	Wind kWh	Solar kWh	Combined kWh	Battery kWh	25%	Surplus kWh	Deficit kWh	Hours/Day
1	2.18	4.509598	6.729597	16.7296	98.0	0	0	0
2	11.43	11.38343	23.21183	27	100.0	18.2183	80.2183	194.8021
3	12.18	4.81038	17.21183	27	100.0	12.2118	85.7882	151.5118
4	7.45	4.409598	11.81919	27	100.0	4.81919	21.8192	75.1819
5	3.18	5.76638	9.266379	27	100.0	4.26638	14.2638	45.7563
6	8.06	5.73037	9.530369	27	100.0	4.53037	25.1213	48.0703
7	0.06	7.55817	7.618173	27	100.0	2.61817	8.70718	18.0915
8	1.08	1.094478	5.704479	27	100.0	0.704478	1.41451	1.77181
9	1.06	4.528478	6.388477	27	100.0	3.88478	11.2848	14.1578
10	2.12	7.279437	5.359437	27	100.0	4.35943	14.0847	47.2843
11	8.04	30.49832	18.498318	27	100.0	5.498318	16.5230	16.5730
12	8.93	7.56817	6.498173	27	100.0	3.49817	11.6972	17.5581
13	0.68	2.698278	5.780279	15.57806	98.5	0	0	0
14	8.57	12.7983	15.308278	27	100.0	8.80254	21.2951	71.7134
15	3.83	7.40837	15.208373	27	100.0	6.20837	20.5079	87.4483
16	8.84	6.388478	6.438478	27	100.0	1.388478	1.33848	16.3384
17	8.12	3.48188	3.771883	27	100.0	0.771883	2.27188	8.27188
18	0	8.58117	8.631168	27	100.0	2.63117	11.8817	17.9817
19	8.03	8.82988	9.8578829	27	100.0	4.85788	16.1813	52.1383
20	7.88	6.77228	14.212273	27	100.0	5.25228	10.9479	18.2728
21	18.25	1.87578	22.125786	27	100.0	17.12578	17.0858	181.758
22	8.17	1.88658	15.208373	27	100.0	5.20838	21.1896	68.2073
23	2.88	5.20517	11.678187	27	100.0	6.67818	12.2587	71.0518
24	2.24	5.78857	12.028582	27	100.0	7.82857	25.4218	73.4228
25	1.62	30.54784	12.187882	27	100.0	7.68788	15.8911	78.8911
26	9.3	15.1148	22.418783	27	100.0	17.41878	30.0852	188.888
27	3.38	7.48037	19.841873	27	100.0	5.84187	19.4711	62.6727
28	9.24	4.85858	5.6758827	27	100.0	0.675882	0.24828	0.75788
29	8.12	11.1282	14.261881	27	100.0	8.26188	27.8712	88.3618
30	1.83	4.88178	3.881788	27	100.0	3.88178	11.1288	15.7818
31	0.18	8.89828	12.217884	27	100.0	5.21788	17.4218	38.0818
32	1.93	11.9228	17.942873	27	100.0	12.84288	42.6928	147.791
33	1.07	8.49827	6.708278	27	100.0	0.708278	11.4718	18.1718



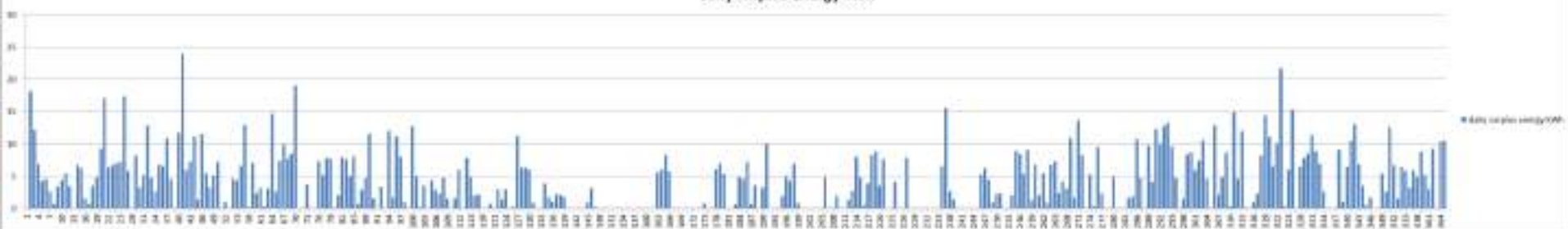




battery capacity reached



daily surplus energy kWh

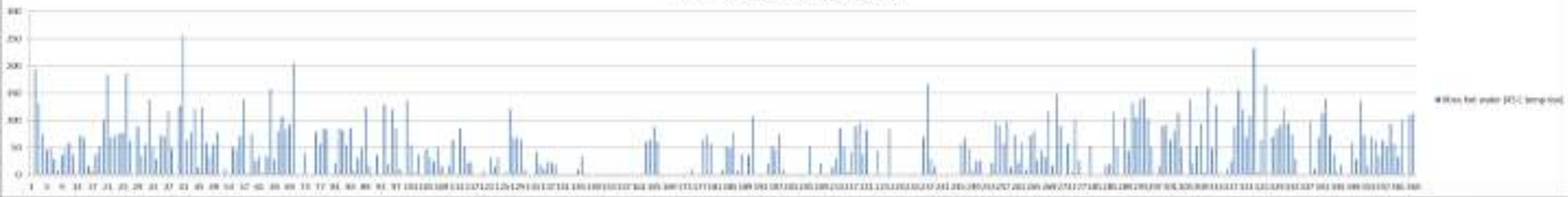


Daily surplus shown split 50:50 into charging an EV and heating hot water (45 C rise)

EV km (at 15 kWh/100km)



litres hot water (45 C temp rise)





Scaling strategy:

- Engage industry partners
- Sell machines directly
- Locate and engage reselling/installation agents
- Look for Pacific opportunities potentially with development agencies.
- Be open to good ideas from anywhere.

