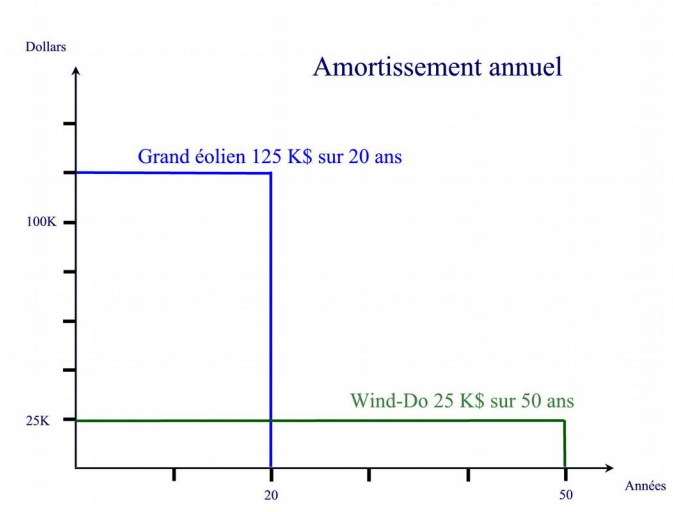
Wind-Do wind farms electricity cost

Those numbers are important as our business model is base on it.

Note : All the costs presented are expected averages. Each project is different and may present significative variations from the numbers shows.

Our modular wind farms may be optimized in diverse ways for different purposes. A one-megawatt Wind-Do wind farm may count from 50 to 125 wind turbines, with installation cost from $800K to $1.5M. There is also options on giant wind turbines that make installation cost vary from $2.2 to $3.0M per MW.



This first graph shows that amortization of an installation over a longer period have also a significative impact on operation cost.

In this example, a $2.5M giant wind turbine amortizes over 20 years cost $125K per year for dampening. Beside that, a $1.25M Wind-Do farm amortize over 50 years cost $25K.

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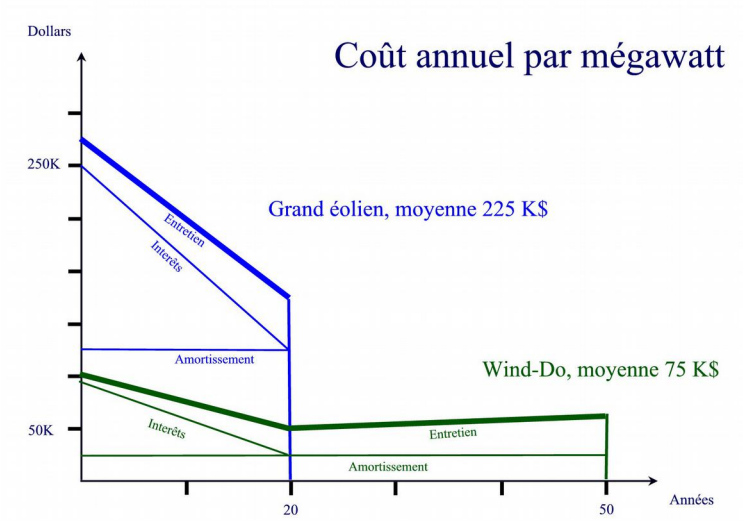
We have an overall cost representation with this second image.



We can resume the overall operation cost of wind energy as this: Dampening + Cost of capital + Operation and maintenance expenses.

Base on those two average projects, the operation cost of a Wind-Do wind farm is one third of a giants one.

As our wind turbines are much closer to the ground, cost comparison must count the difference in energy available from the harness wind. The following table show wind quality for different sites, the data's come from the Canadian Wind Energy Atlas.

At our level from the ground, we can see a significative drop of 30 to 60% in average kinetic energy, which is a 2 for 1 advantage for the large wind turbines.

Exemple d'énergie éolienne moyenne

Hauteur	Iles de la Madeleine	Baie James	St-Rémi	Montréal-Est
	Watts par mètre carré			
80 mètres	1133	467	289	221
30 mètre	685	323	132	99
Résiduel 30 vs 80 m.	**60,5%**	**69,2%**	**45,7%**	**44,8%**

We will see further on how the modular wind turbine work. For now lest mention that the larger the turbine was, the sooner its needs to be stopped with wind increase.

The very large turbines of 120 Sq.m. needs to be stop with wind above 9 m/s. If those engines are parts of a wind farm where wind above 9 m/s appear 15% or 20% of the time, this means that those specific engines will has a low efficiency per Sq.m. in regards of wind quality, maybe 25 or 30%. On reverse, if the site have a very low

average wind speed, the wind farm will be made only of those large turbines, and they will work 98% of the time with an overall efficiency of 45% or more.

The following table present few different situations:

Exemple de rendement

Profil de vent de St-Rémi

Moyenne sur 1 mégawatt

	Surface de vent	Puissance du vent	Rendement estimé	Production annuelle	Coût d'opération annuel	Coût par KW*h	Rendement vs puiss. nominale
	Mètres carrés	Watts par mètre-2	% puissance du vent	Millions KW*h	K$	$	%
Géantes							
Standard	2500	289	40	2,5	200	0,08	28,5%
Surdimensionné	4000	289	36	3,7	250	0,068	42,2%
Wind-Do							
Ferme modulaire	9000	132	36	3,7	75	0,020	42,2%
Éoliennes bimode	12000	132	33	4,6	90	0,020	52,5%

We can see here that for the same one megawatt of power facilities, Wind-Do wind farms will harness three to four times more surface of wind.

Altogether, the advantage of the Wind-Do wind farm over the giant one is: 3 for the annual cost x 3 for de surface of wind harness / 2 for the energy in the wind = 4.5 time cheaper for Wind-Do.

Not counting land rent, local community dividends and difficult public relations, giant wind turbine electricity cost 7 to 9 cents per KWh to produce, which lead to an equivalent of 2 cents or less per KWh for Wind-Do.

Second cost demonstration

As it is important to clearly state which cost of electricity production we will reach, here is the direct calculation of it.

Raw energy, the wind, is free. The calculation of the production cost of the electricity is then:

The annual operation cost ($/year) / Number of Kilowatt*hour produce per year (KWh/year)

= Production cost per Kilowatt*hour ($/KWh)

Thus:

Average production cost of electricity for a 10 KW wind turbine

Annual operation cost	KWh produce per annum	20 000	25 000	30 000	35 000	45 000	55 000
350		0,018	0,014	0,012	0,010	0,008	0,006
500		0,025	0,020	0,017	0,014	0,011	0,009
750		0,038	0,030	0,025	0,021	0,017	0,014
1 000		0,050	0,040	0,033	0,029	0,022	0,018
1 250		0,063	0,050	0,042	0,036	0,028	0,023

The average electricity production of a wind turbine depends on his size, his efficiency, and the average wind available on install site. As our modular wind farms use several sizes of specialize wind turbines, we must use an average. Our simulations and tests show high efficiency, but average efficiency already reach by Darius wind turbines also fit our modular system:

Average annual electricity production (KWh)		**4,5 m/sec** Low	**5 m/sec** Average low	**5,5 m/sec** Ave. strong	**6 m/sec** Strong	**7.5 m/sec** Very strong	**9 m/sec** High
Average wind at 20 m.		**60 m2 wind turbines**	**60 et 40 m2 WT mix**	**60,40&20 m2 WT mix**	**60,40&20 m2 WT mix**	**60,40&20 m2 WT mix**	**60,40&15 m2 WT mix**
High efficiency	**45%**	25 300	28 800	29 500	33 500	42 500	46 200
Average high efficiency	**40%**	22 489	25 600	26 222	29 778	37 778	41 067
Average efficiency	**35%**	19 678	22 400	22 944	26 056	33 056	35 933

Wind-Do

The operation cost of a wind turbine depend on many factors:

1- The number of wind turbines in a wind farm. Both installations and operations costs are reduced with number, our projection regards a one-megawatt farm of 100 modular wind turbines.

2- The installations costs of the engines. That must be finance and amortize.

3- The interest on financing. Generally base on mortgage, actual financing should be 3.5 to 5%. Cash payment must be count as a 1.5% opportunity cost, some commercial loans may reach 6-9%

4- The dampening period. Our wind turbines have an expected live of 50 years or more, with the maintenances expenses increasing with time, while the interests decreasing.

5- Maintenance. Most of the parts will stand for 50 years without maintenance (column, foundation, steel structure, wiring…). Preventive maintenance may count bearing change every 5-7 years, motors / generators refurbishing every 10-15 years, control system every 15-25 years…

6- General expenses. We must calculate inspection, taxes and permit, accounting…

Here are two examples :

Scenario 1, Cash installation by a farmer that handle all maintenance.
Owner manage a part of the installation, overall cost $11,000 per wind turbine

Maintenance cost	Period	Year 1 to 5	Year 6 to 10	Year 11 to 20	Year 21 to 25	Year 26 to 50
General expenses	By the farmer	30 $	30 $	35 $	35 $	40 $
Parts only	By the farmer	0 $	100 $	150 $	200 $	300 $
Total maintenance		30 $	130 $	185 $	235 $	340 $
Amortising and interest (1,5% opportunity cost) Installation 11,000$		528 $	528 $	528 $	528 $	0 $
Total cost		**558 $**	**658 $**	**713 $**	**763 $**	**340 $**

Average annual cost of operation

50 years 511 $

Scenario 2, **Energy production corp. that rent land to farmer. Financing at 5%, have a team for maintenance. Purchase turn key installation at $15,000 per wind turbine**

Maintenance cost	Period	Year 1 to 5	Year 6 to 10	Year 11 to 20	Year 21 to 25	Year 26 to 50
General expenses	By the corp.	50 $	50 $	55 $	55 $	60 $
Parts and manpower	By the corp.	0 $	150 $	200 $	250 $	350 $
Total maintenance		50 $	200 $	255 $	305 $	410 $
Rent of field		*50 $*	*50 $*	*50 $*	*50 $*	*50 $*
Amortising and interest 5% , Installation 15,000$		1 047 $	1 047 $	1 047 $	1 047 $	0 $
Total cost		**1 147 $**	**1 297 $**	**1 352 $**	**1 402 $**	**460 $**

Average annual cost of operation

50 years 885 $

Note that where apply, a carbon credit may reach $150 to $500 and be deduce from the total operation cost.

From above number, we may conclude that in most case, the electricity production cost of our customers will be inside the yellow box of those tables:

With an automated factory producing low cost wind turbines (expected in 3 years):

Average production cost of electricity for a 10 KW wind turbine

Annual operation cost	KWh produce per annum	20 000	25 000	30 000	35 000	45 000	55 000
350		0,018	0,014	0,012	0,010	0,008	0,006
500		0,025	0,020	0,017	0,014	0,011	0,009
750		0,038	0,030	0,025	0,021	0,017	0,014
1 000		0,050	0,040	0,033	0,029	0,022	0,018
1 250		0,063	0,050	0,042	0,036	0,028	0,023

At the beginning with a small factory that can produce 10/20 wind turbines per month:

Average production cost of electricity for a 10 KW wind turbine

Annual operation cost	KWh produce per annum 20 000	25 000	30 000	35 000	45 000	55 000
350	0,018	0,014	0,012	0,010	0,008	0,006
500	0,025	0,020	0,017	0,014	0,011	0,009
750	0,038	0,030	0,025	0,021	0,017	0,014
1 000	0,050	0,040	0,033	0,029	0,022	0,018
1 250	0,063	0,050	0,042	0,036	0,028	0,023

The power curve of our wind turbines

As our wind turbines work in a different mode than giant one, this power curves comparison should complete our cost presentation.

Figure 1 shows the power curve of a standard giant wind turbine. This engine supply 100% of its nominal power for wind between 12.5 and 25 m/s. The yellow rectangle shows the wind zone where the largest quantity of energy is produce in a year. The pink rectangle shows the zone of most common wind. The orange mix part is the better wind zone for wind turbines optimization.

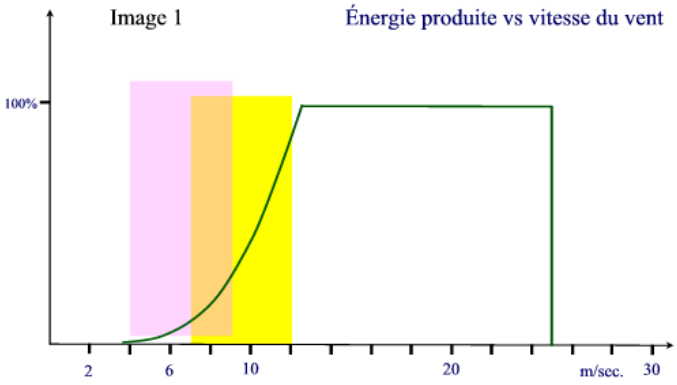
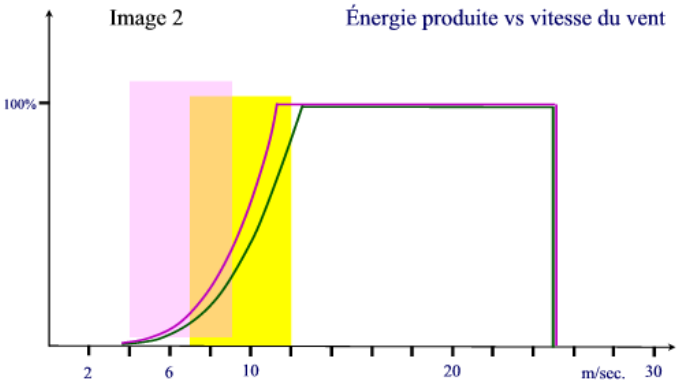
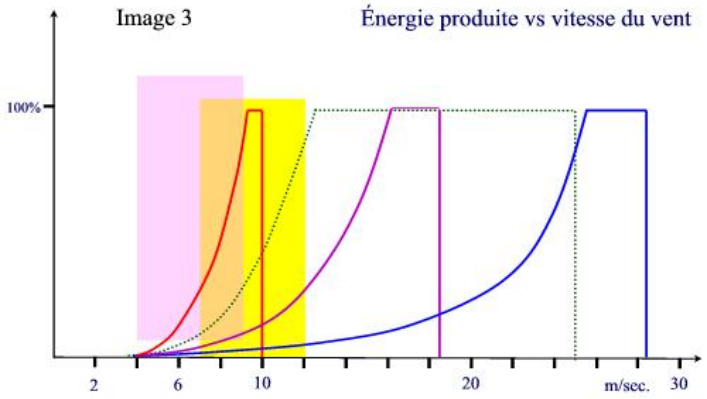


Figure 2 compare and oversize giant wind turbine beside a standard one. We note first that there is no increase of power delivery for wind above 12.5 m/s, which reduce the average efficiency par Sq.m. of the wind harnessed. The maximum output is now reach with a wind of 11 or 11.5 m/s, and in the most effective wind zones, the power delivery is significatively increase. Even if



those wind turbines are more expensive, we can see in the above table (page 3) that it is an excellent strategy.

Figure 3 present the power curves of three different modular wind turbines of Wind-Do.

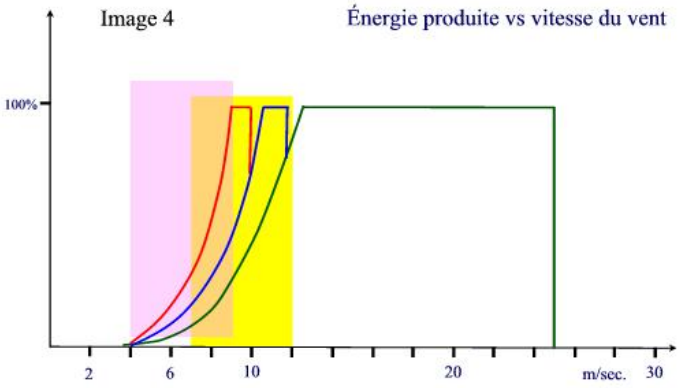


We note first that the peak zone for each engine is small beside the one of the giant engines. This is necessary to keep at minimum the structure cost of our modular wind turbines.

The purple power curve is related to the basic engine with a turbine that harnesses 20 Sq.m. of wind. Because of the scale, this wind turbine may seem inefficient, but up to its wind speed limit, it is comparable to the standard giant engine. The blue power curve is related to a modular wind turbine that harnesses a very small surface of 5 Sq.m. of wind. This engine could be very useful for very high wind site like North of Quebec or Patagonia. As the engine is relatively useless with low wind, it may split the same power electronic and connections used by the red curve wind turbine, with according cost reduction.

The red power curve is related to an engine with an oversize turbine or 120 Sq.m. This apparatus will deliver its maximum power within the most productive wind zone. Base on same nominal power, this wind turbine will harness three times more wind surface than the oversize giant engine.

Figure 4 shows the power curves associated with and existing wind farm that have been boosted with a modular wind farm of Wind-Do.



We note first that the maximum delivery power is not change, which means no modification on grid connection, and often no change on electricity purchase contract.

Both 100 and 120 Sq.m. wind turbines of Wind-Do have to be stopped before the existing wind farm produce its power peak. The energy produce by Wind-Do apparatus is added to the existing system in a way that the nominal power of the wind farm is now available with wind of 8 m/s and above.

In most case, the annual power delivery of a wind farm can be double, which means an availability of more than 50% of the nominal power of the wind farm.