ROBIMOV'IT

SCIENTIFIC NOTICE
24 november 2008

SYCOMOREEN
SYstems for COnversion of MOtions and REnewable ENergies
systèmes pour la conversion de mouvements et d'énergies renouvelables

http://sycomoreen.free.fr

The Rotary Bi-Plan Wind Turbine (ROBIPLAN), original invention coming from Pascal HA PHAM, can be eventually mounted on mobile engines, that they are terrestrial (wind trike, specific car...) or marine (boat) to get a mechanical power. The marine exploitation is a quite considerable stake :

- to power boats while decreasing their consumption of fuel (Diesel),
- to get energizingly autonomous marine mobiles to be used in several domains (beacons, meteo stations, mobile power plants, emergency and rescue stations …).

<u>The inventor has already built and tested a very simple prototype, called **Robikart ,** which will be soon improved **:**</u>

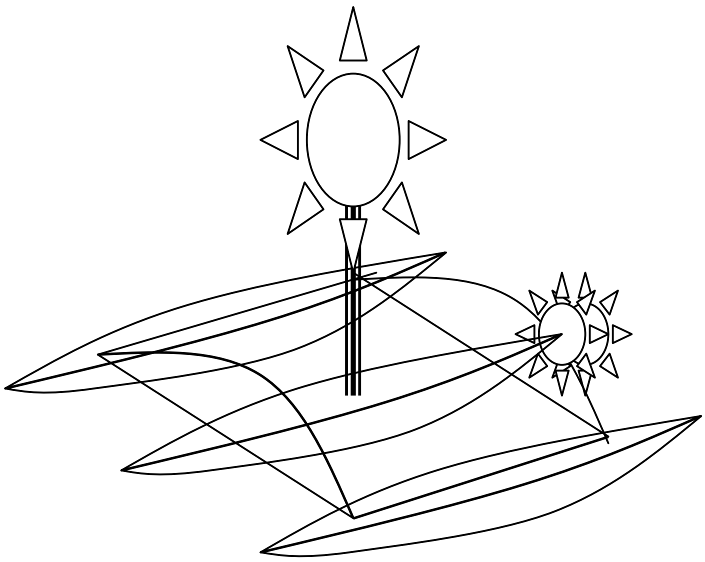
and he shot its ability **to advance against the wind, propelled <u>by the only power it extracts from the facing wind.</u>**

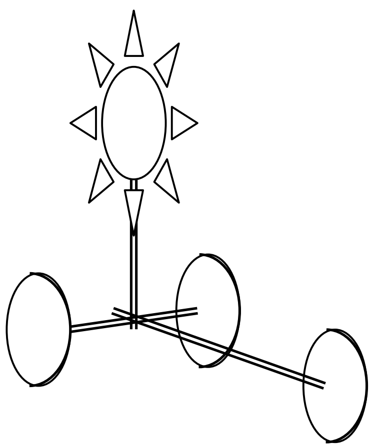
Regarding this type of turbine, both embarked on the mobile and powering it, the Inventor and *SYCOMOREEN* have proposed to call the generic propelling versions of ROBIPLAN :

ROBIMOV'IT

With a lot of information and links about Pascal HA PHAM's inventions available on :
http://sycomoreen.free.fr/syco_annonces.html
http://www.econologie.com/forums/turbine-eolienne-rotative-bi-plan-robiplan-vt4872.html

OVERVIEW





I. Problematics of this scientific notice

I.1. Legal issues

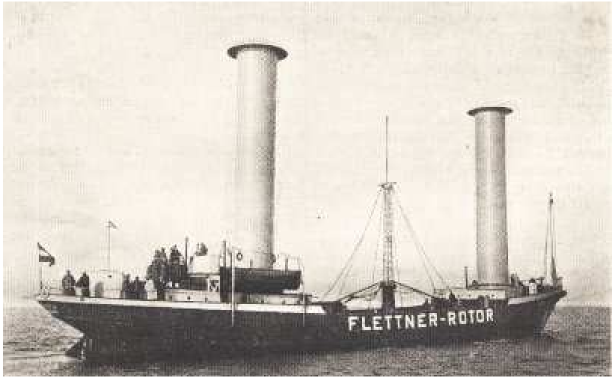
The present notice is written by *SYCOMOREEN* SARL on Pascal HA PHAM's query as a friendly collaboration and without reciprocal engagement.

I.2. Scientific issues

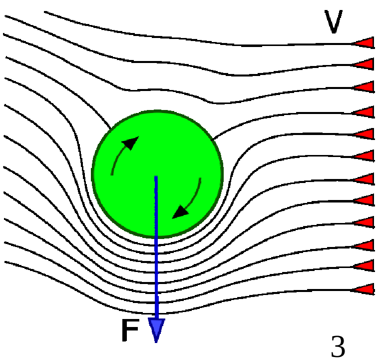
I.2.a) Brief state of the art about eolien propulsion

When the wind is used to move an engine, the sail is generally chosen to deviate the flux of wind. It results in a force able to move the wind trike or the boat (windsurf, or boat with sails (opposite picture)).

In France, The Cousteau's Team launched in 1985 the ***Alcyone Project*** (above) which was a boat propelled by a « Turbovoile [turbosail] », which can be seen as an hybridization between the sail and the turbine regarding its effects of aerodynamic overpressure / vacuum known on the blades of conventional turbines.
http://fr.wikipedia.org/wiki/Turbovoile



However, the Cousteau's Turbovoile (which is fixed as its name doesn't say it…) is not giving an energetical autonomy because fluid has to be sucked in order to reinforce the aerodynamic force applying on the mast. The Turbovoile was itself inspired by the rotary masts based on Magnus' effect and tested by the German Flettner in 1924 (the 'Buckau' opposite). Here again, the energetical autonomy is not reached because a machinery is necessary to make the masts to turn.



This Magnus effect (opposite) is well known by the footballers to curve the trajectory of a ball both in rotation and in translation. It works also on a rotary mast which transmits the strength to the cockle of the boat. Lately, some initiatives and quite confidential thoughts, about to **propel a mobile purely with the wind** took place.

I.2.b) A new paradigm in wind propulsion

- in the terrestrial domain

« August 22, 2008, in Den Helder in Holland, took place a quite not plain competition. 6 universities and European establishments of research faced themselves through a race of ***vehicles propelled solely by the wind propulsion, the "Aeolus Race."*** *It is the "Ventomobil" of the university of Stuttgart that won the first price to the race while arriving first after* ***having browsed a distance of 3 km facing wind.*** *The German vehicle, has been developed and constructs by about twenty students regrouped within the Inventus-Team »*

translated by *SYCOMOREEN* from the original source : http://www.jepasseauvert.net/spip.php?article71

« *DREAM* [ROBIPLAN]

Let's imagine for a moment that a variant of the concept manages ***to help the propulsion of a boat and at the same time to produce the electric energy....***

and/or that from the rotating motion of the setting / pitchfork / gallows, ***one can recover the energy via a chain kinematics to turn a helix.***

one would have ***two propelling vectors*** *then : the one direct of the "robisail" and the one indirect of the traditional propulsion by helix....* »

translated by *SYCOMOREEN* from the original claim of Pascal HA PHAM on:
http://www.econologie.com/forums/post75931.html#75931

- in the marine domain :

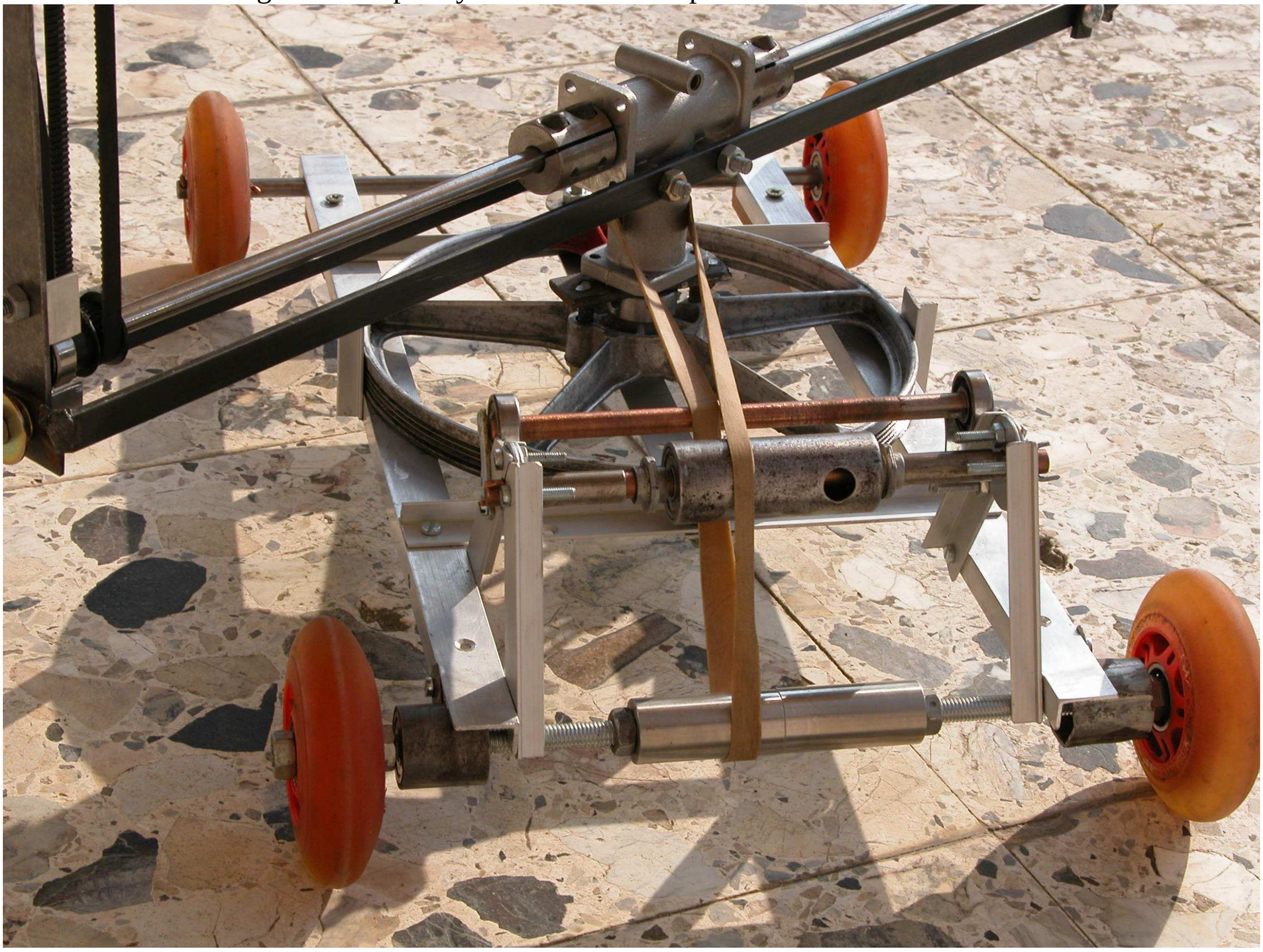
« One considers here ***a ship that carries a wind turbine****. The* ***recovered power*** *by this device will be used to actuate a helix (under water)* ***able to propel the ship... against the wind !*** *To first view, this is a completely crazy idea: that looks like a perpetual motion... But truly, it isn't, because* ***the boat is located to the interface between two fluids, air and the water, that are animated of a relative displacement (wind)****. And one can really exploit this relative motion to make advance the ship on the water. Yes, it works! »*

translated by *SYCOMOREEN* from the original claim of Mr BOISSE on :
http://sboisse.free.fr/technique/voilier_eolienne.php

I.2.c) The purely wind propulsion of mobile engines : some skeptics ?

The ability of the ROBIPLAN to propel a vehicle on which it is adapted and driven with the vehicle generally raises a big skepticism, or even the laughters : the detractors of this principle enjoy to disregard the power extracted from the wind and to overestimate the braking strength that the turbine generates on the engine by facing wind. They generally argue on a balance of static strengths whereas *it is necessary to use a dynamic balance of strengths and the powers of the mobile engine*.

Whatever it is, proof has already been given by Pascal HA PHAM, in very unfavorable conditions (facing wind, gravels on the road, small wheels and direct transmission with skating rubber band!!) that to advance facing the wind purely with this wind is possible with its ROBIPLAN.



VIDEO AVAILABLE ON THE FOLLOWING URL :

http://video.google.fr/videosearch?q=ROBIKART&hl=fr&emb=0&aq=f#q=pascal%20ha%20pham&hl=fr&emb=0&start=0

I.3. Objectives and acquired knowledge for this scientific notice

I.3.a) Uncertainties about the wind output of the ROBIPLAN

Currently, the wind output of the ROBIPLAN is not known. *SYCOMOREEN* estimates that the output of a ROBIPLAN is likely located between 30 and 60% for a large range of wind speeds under the condition to control its speed of rotation.

To throw away any sterile debate and to use some known and currently recognized models, **this scientific survey will therefore make the hypothesis that a triblade wind turbine went up on the mobile with an output of 40%** between the extracted mechanical power and the kinetic power of the incidental wind.

I.3.b) Ambitions of this survey

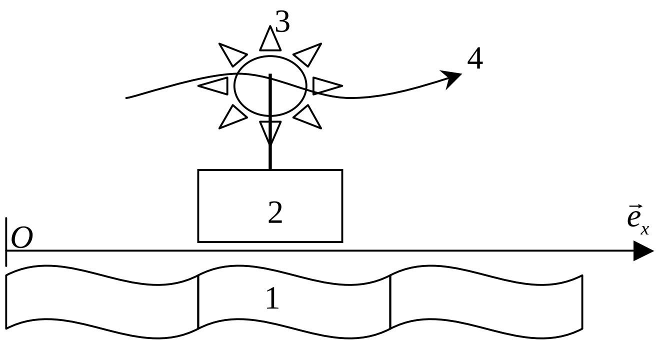
To answer to the following questions and requirements :

<u>1. Qualitative aspect</u>
1.a) Is a wind turbine with 40% of output able to make a mobile to advance with a relative back wind ?
1.b) The same with a relative or absolute facing wind ?

<u>2. Quantitative aspect</u>
2.a) To develop a public mathematical model to simulate the advancement of the mobile propelled by wind along a straight axis: *this model will be able to be taken and enriched exclusively to non commercial ends* by other specialists who will have the courtesy to signal it to *SYCOMOREEN*.
2.b) To get from it some precise values with reasonable hypotheses on the parameters piloting the model.

<u>II. Behaviour of a mobile engine in the wind</u>

II.1. Typical situations



There are mainly 4 *entities in relation* :
1. The support of the displacment (water or soil)
2. The mobile which is moving
3. The wind turbine mounted on the mobile
4. The wind which is crossing the turbine

All these elements are animated of relative speeds in relation to a stationary referential *Rg* (supposed Galilean), materialized merely here by the referential $(O,\vec{e}_x)$ which constitutes in this unidirectional survey the unique axis of displacement of the 4 previous entities.

One will note the following speeds <u>*positive by convention*</u> in relation to *Rg* :
- ***u*** absolute speed of the support (1), ***v*** absolute speed of the mobile (2)
- ***w*** absolute speed of the wind (4)

The typical situations are :
- ***u=0*** : immobile support (soil or water without marine current)
- $\vec{v} = v\,\vec{e}_x$: the mobile is going to the positive *x* ; $\vec{v} = -v\,\vec{e}_x$: the mobile is going to the negative *x*
- $\vec{w} = w\,\vec{e}_x$: the wind is going to the positive *x* ; $\vec{w} = -w\,\vec{e}_x$: wind is going to the negative *x*

In the whole continuation, we will suppose that the support (1) is stationary and that *the mobile advances toward the positive x, direction systematically wished by convention for the mobile :*

u=0 et $\vec{v} = v\,\vec{e}_x$ où ***v***>0

II.1.a) Situations and relative wind discerned by the wind turbine

The wind turbine(3) is in the referential of the mobile(2) and discerns ***the relative wind*** : $\vec{w}_{eol}$

<u>**Case n°1 : When wind goes toward the x>0**</u> **(** $\vec{w} = w\,\vec{e}_x$ **),** thera are 3 sub-cases :

a) $w > v$: relative back wind (**pushing**) : the speed of the wind is greater than the one of the mobile : $\vec{w}_{eol} = (w-v)\vec{e}_x$

b) $w < v$: relative facing wind (**braking**) : the speed of the wind is smaller than the one of the mobile $\vec{w}_{eol} = -(v-w)\vec{e}_x$

c) ***w=v*** : static situation seen on the mobile which is homocinetic with the wind: $\vec{w}_{eol} = 0\ \vec{e}_x$

Cas n°2 : when the wind goes towards the x<0 ($\vec{w} = -w\,\vec{e}_x$ **), it is always facing wind :**

$$\vec{w}_{eol} = -(v+w)\vec{e}_x .$$

II.1.b) Powers and forces applying on the wind turbine

The wind turbine is in the referential of the boat and discerns the relative wind $\vec{w}_{eol}$: one will note to simplify the notations : $w_{eol} = \|\vec{w}_{eol}\|$

The usual results coming from mechanics of the fluids in permanent out-flow with a perfect fluid of volumic mass ρ on a wind turbine sweeping a section S give :

- The **massic debit of crossing fluid :** $D_m = \rho S w_{eol}$:
- The **incidental kinetic power** on the turbine : $\boxed{P_{cin} = \frac{1}{2}\rho S w_{eol}^3}$ where:
  - o ρ is the volumic mass of the air (1,3 kg/m^3 in usual pressure and temperature)
  - o S is the surface swept by the turbine
- The **wind trail** applied on the mast of the turbine $\boxed{F_{aero} = D_m(1-k)w_{eol}}$ where :
  - o D_m is the massic debit of crossing fluid
  - o k is the reduction factor for the relative speed of the fluide before and after its course through the turbine : to extract power from the wind, it has to be slow down : one demonstrates in mechanics of fluids that k = *1/3* is the best factor, which, when the fluid is perfect, allow to attempt the Betz' limit (wind output of 16/27=59%). We will keep for this survey k= *1/3* and a wind output $\boxed{\eta_{eol} = 40\%}$
- The **extracted wind power** : $\boxed{P_{eol} = \eta_{eol} P_{cin}}$

II.1.c) Propelling power available for the mobile

The mobile has a transmission towards the support(1) : gearings, straps, wheels or streamlined helixes. One will note η_{prop} the global output of theses transmissions so as the propelling power is :

$$\boxed{P_{prop}^{eol} = \eta_{prop} P_{eol}}$$

In complement, the mobile is possibly displaced by a thermal motor also having its own transmission: therefore, the mobile could use the additional power of the motor : $\boxed{P_{prop}^{mot} = \eta_{mot} P_{mot}}$

II.1.d) Braking aerodynamic power created by the turbine

The aerodynamic strength is invariant by change of referential and provokes a power having the tendency to slow down the mobile in the referential *Rg* :

$$\boxed{P_{aero} = F_{aero} v}$$

II.1.e) Other braking trailing powers

The mobile is braked by trails in the referential *Rg* in addition to the trail coming from the turbine:

- in *terrestrial case* : ripage and resistance to the rolling of the tires, aerodynamic trail,
- in *marine case* : hydrodynamic and aerodynamic trails of the cockle and the ship.

Theses trails have the global force F_{tr} always opposed to the motion and resulting in a trailing power :

$$\boxed{P_{tr} = F_{tr} v}$$

When the frictions are fluid, F_{tr} is itself proportional to ***v*** or to ***v²*** **:**

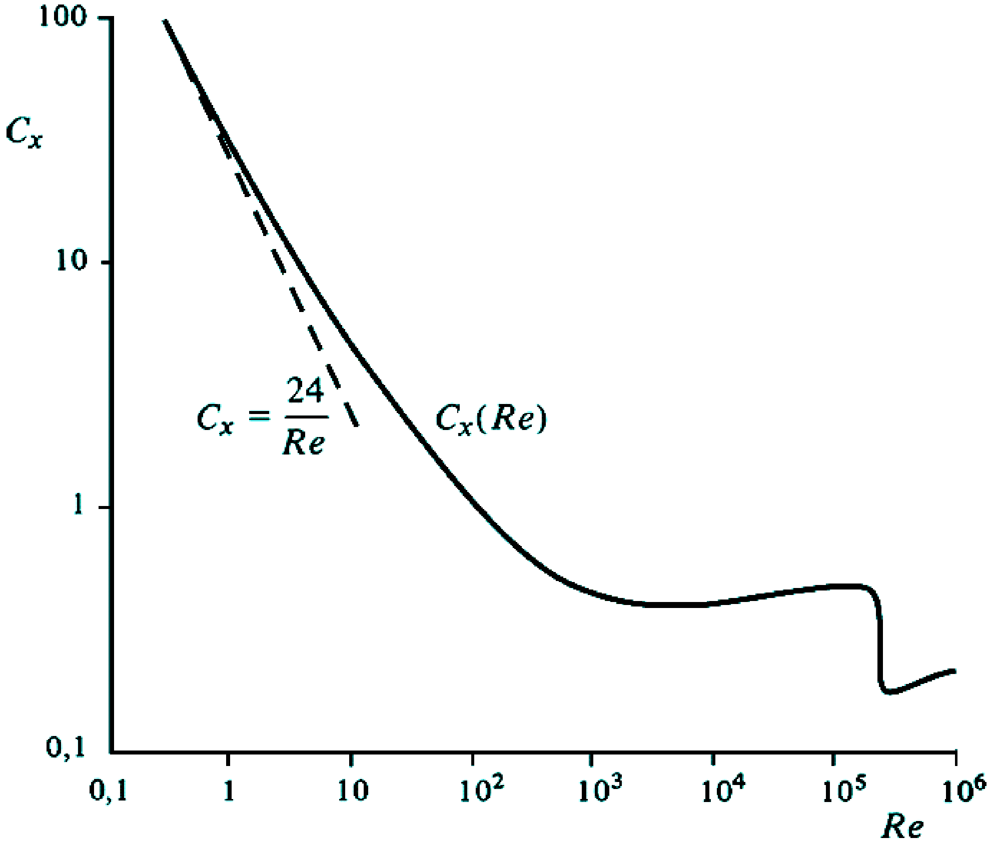
At low speed : $F_{tr} \simeq 6\pi\eta_{fluid}\sqrt{\frac{S_{mobile}}{\pi}}v_{mobile/fluid}$, and at high speed : $F_{tr} \simeq C_X S_{mobile}\frac{\rho_{fluid}v^2_{mobile/fluid}}{2}$

Regarding the Reynolds' number **Re** of the out-flow. In the marine case, one has even to consider 2 trails : the aerodynamic trail (emerged part of the boat in the air) and the hydrodynamic trail (immersed part in the water). To be more accurate, the general formula giving the trail in an unique fluid is :

$$\boxed{F_{tr} = C_{X(\mathrm{Re})}S_{mobile}\frac{\rho_{fluid}v^2_{mobile/fluid}}{2}}$$

where Cx is the trail coefficient : it depends on the Reynolds' number : $\mathrm{Re} = \frac{\rho_{fluide}d_{mobile}v_{mobile/fluide}}{\eta_{fluide}}$

according to the following curve in logarithmic scales



Typically for a mobile having a facing section of 5 m² and running at 50 km/h :

$$* \ \mathrm{Re}_{water} = 1000\sqrt{5}\frac{50/3,6}{10^{-3}} \simeq 3,1\ 10^7 \Rightarrow C_{X_{water}} \simeq 0,3$$

$$* \ \mathrm{Re}_{air} = 1,3\sqrt{5}\frac{50/3,6}{18.10^{-6}} \simeq 2,24\ 10^6 \Rightarrow C_{X_{air}} \simeq 0,2$$

<u>We will keep raised values</u> (unfavorable hypotheses):

- for a terrestrial mobile *Cx*=0,5 (N.B. : 0.25 à 0.4 for usual current cars)
- for a marine mobile *Cx*= 1 (very unfavorable hydraulic Cx*)*

II.2. Theorem of the kinetic power

II.2.a) Balance of power

By putting that the mobile has a mass ***m*** :

$$\boxed{\frac{dE_c}{dt} = mv\frac{dv}{dt} = P_{received} - P_{released}}$$

Received powers

$$\frac{dE_c}{dt} = P_{received} - P_{released}$$

The mobile stores and unstores kinetic energy according to the received and released powers

Released powers

II.2.b) Different cases

<u>Case n°1 :</u> **wind is blowing towards the x>0**

Sub-case 1a **: relative back wind (pushing : w>v)**

$$mv\frac{dv}{dt} = P_{prop}^{eol} + P_{prop}^{mot} \oplus P_{aéro} - P_{tr}$$

either $$\boxed{mv\frac{dv}{dt} = \frac{\eta_{eol}\eta_{prop}}{2}\rho_{air}S\left(w-v\right)^3 + \eta_{mot}P_{mot} \oplus v\rho_{air}S\left(1-k\right)\left(w-v\right)^2 - vF_{tr}} \quad (1a)$$

Sub-case 1b **: relative facing wind (braking : w<v)**

$$mv\frac{dv}{dt} = P_{prop}^{eol} + P_{prop}^{mot} - P_{aéro} - P_{tr}$$

either $$\boxed{mv\frac{dv}{dt} = \frac{\eta_{eol}\eta_{prop}}{2}\rho_{air}S\left(v-w\right)^3 + \eta_{mot}P_{mot} - v\rho_{air}S\left(1-k\right)\left(v-w\right)^2 - vF_{tr}} \quad (1b)$$

Sub-case 1c **: zero relative wind (w=v)**

$$mv\frac{dv}{dt} = 0 + P_{prop}^{mot} - 0 - P_{tr}$$

either $$\boxed{mv\frac{dv}{dt} = +\eta_{mot}P_{mot} - vF_{tr}} \quad (1c)$$

<u>Case n°2 :</u> **wind is blowing towards the x<0 (always braking)**

$$mv\frac{dv}{dt} = P_{prop}^{eol} + P_{prop}^{mot} - P_{aéro} - P_{tr}$$

either $$\boxed{mv\frac{dv}{dt} = \frac{\eta_{eol}\eta_{prop}}{2}\rho_{air}S\left(v+w\right)^3 + \eta_{mot}P_{mot} - v\rho_{air}S\left(1-k\right)\left(v+w\right)^2 - vF_{tr}}$$

where F_{tr} is computed with the formulas shown at II.1.e) :

$$F_{tr} = C_{Xair}S_{mobile}^{air}\rho_{air}\frac{v_{air/mobile}^2}{2} + C_{Xwater}S_{mobile}^{water}\rho_{eau}\frac{v_{water/mobile}^2}{2}$$

<u>III. Numeric simulations in stationary situation</u>

In this paragraph, **one supposes that the speed of the mobile is constant** because the applied total strengths are zero (what is like to consider the **balance between the received and released powers by the mobile)**.

III.1. Piloting parameters of the computation

m : mass of the mobile : ***m*** = 1500 kg (without effect in III. because *dv/dt=0*)

η_{eol} : wind output for the turbine : 40% = 0,4

η_{prop} : output in the transmission of the extracted wind power : 60% = 0,6

ρ_{air}, ρ_{water} : volumic mass of air and water, respectively 1,3 et 1000 kg/m^3

S : swept surface by the blade of the turbine : 25 m², either a blade approximately long of 3 m.

w : absolure speed of the wind : 10 m/s (36 km/h)

k : decreasing factor of the wind speed before and after its though the turbine : 1/3

$C_{Xair,} C_{Xwater}$: aerodynamic and hydrodynamic trail coefficients : 0.5 et 1

$S^{air}_{mobile}, S^{eau}_{mobile}$: facing surfaces of the mobile running in the air and in water : 5 m² and 5 m²

P_{mot} : power of the thermal engine : **zero** when the wind is sufficient to make the mobile advance.

η_{mot} : output in the transmission of the mechanical power from the thermal engine : 60% = 0,6

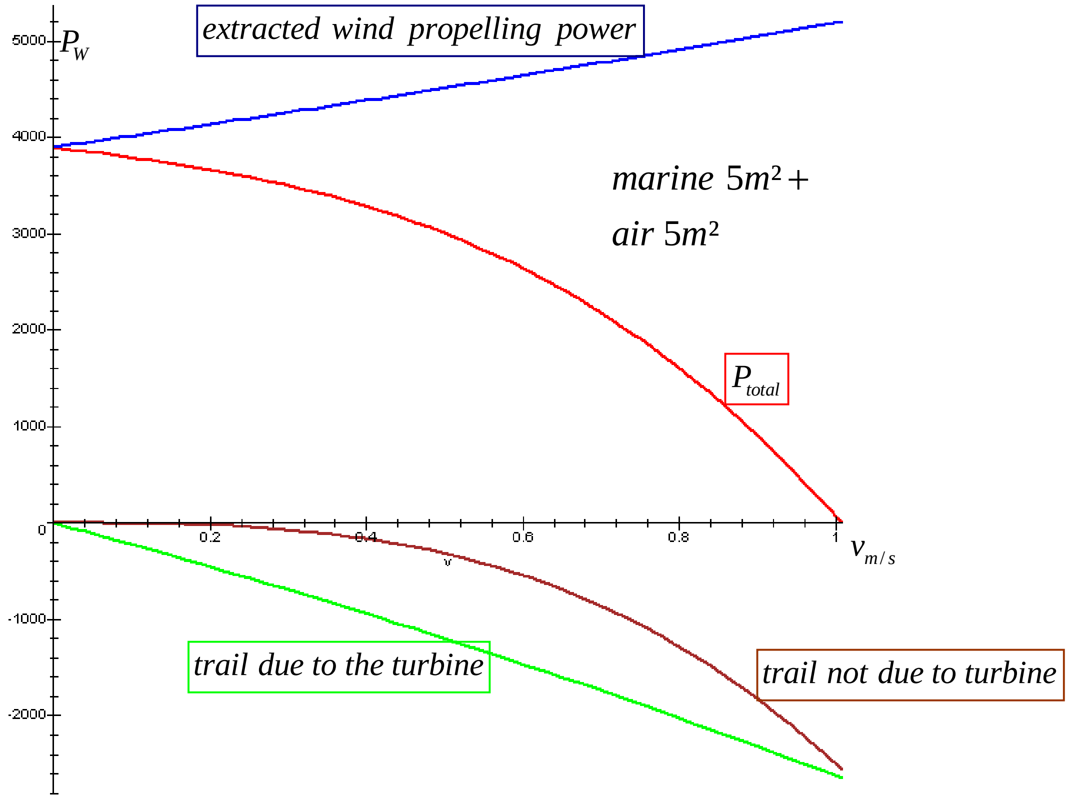
III.2. Curves of power and speed of the mobile

One draws according to the speed ***v*** of the mobile and in Watt :

- in red : the exceeding power for the mobile (which raises its speed)
- in blue : the propelling power coming from the turbine
- in green : the aerodynamic power applying on the mast carrying the turbine
- in brown : the total power of the other trails not due to the turbine

A negative curve corresponds to brake the advancement, a positive curve corresponds to contribute to the advancement. **When the red curve is zero, there is balance and the corresponding top speed is the limit of the advancing speed due to the only wind power.**

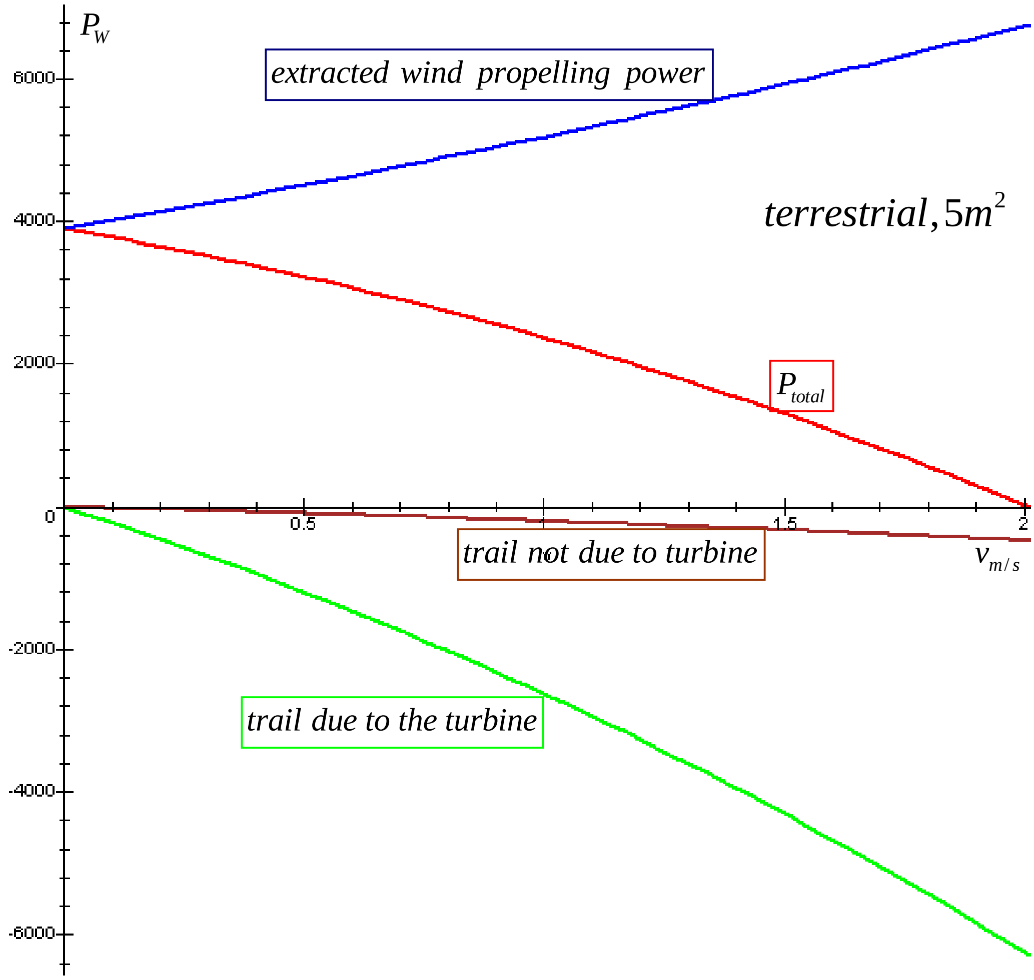
III.2.a) Case n°2 : facing wind always braking



This case is favorable because a lot of wind power is thus available (blue)

The braking power of the mast decreases linearly and remains quite weak at low speed.

The areodynamic trails decrease in $-v^2$ and become strong when v raises.



<u>Marine mobile</u>

The point of balance takes place at v = 1 m/s either 10% of the absolute wind speed.

<u>Terrestrial mobile</u>

The hydrodynamic trail disappears and raises therefore the final speed.

The point of balance takes place at v = 2 m/s either 20% of the absolute wind speed.

III.2.b) Case n°1a : relative back wind pushing

The situation is different here : the extracted wind power decreases with the speed of the mobile (because the relative speed of the wind is decreasing when v raises…). The trailing power of the turbine is positive here : **the turbine is like a sail with back wind, in addition, it extracts wind power**.

<u>Marine mobile</u>

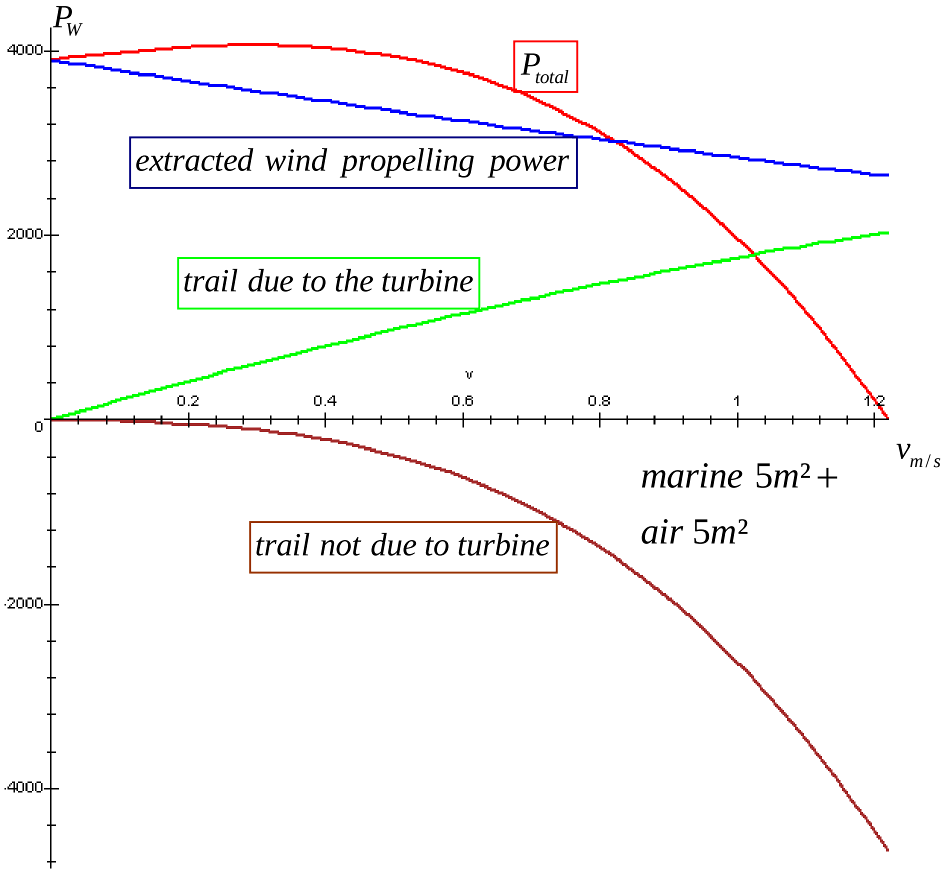
The point of balance takes place at v = 1,24 m/s either 12.4% of the absolute wind speed.

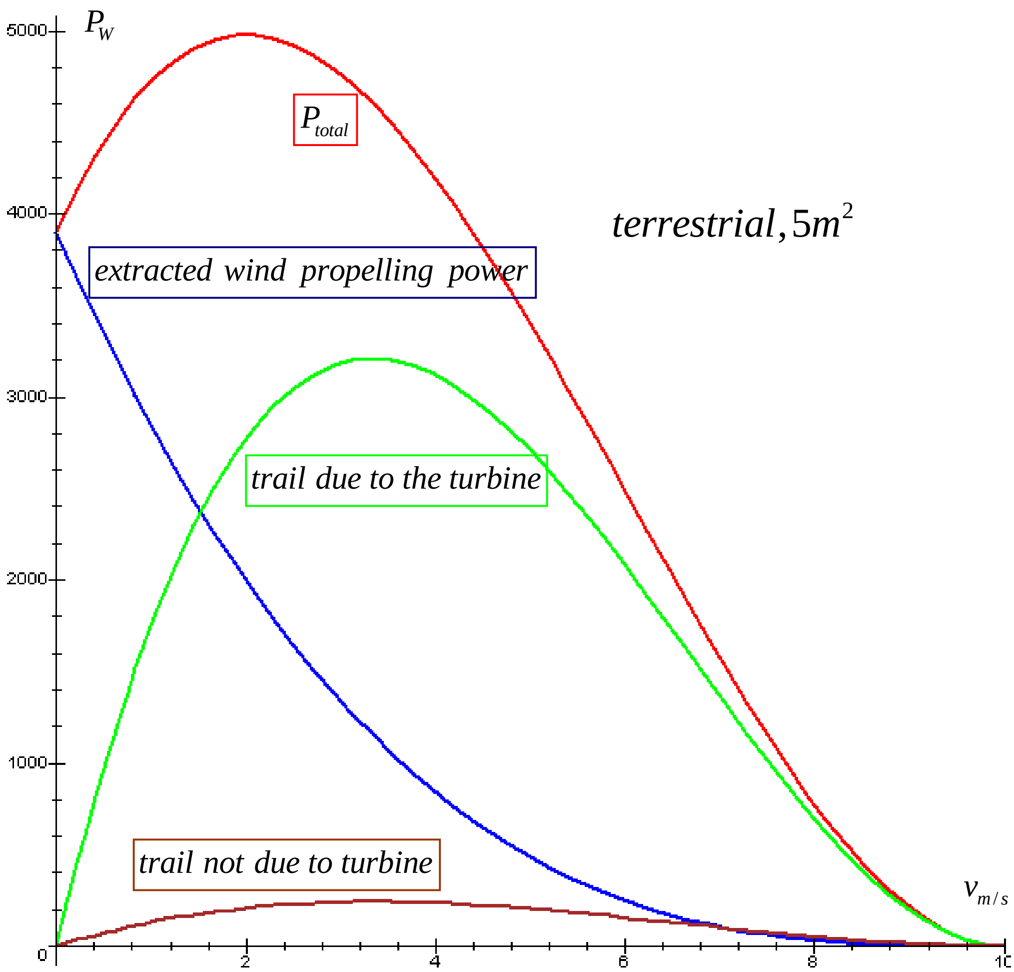
The trail not due to turbine is especially strong when v raises.

<u>Terrestrial mobile</u>

The hydrodynamic trail disappears. Only the aerodynamic trail remains.

The point of balance takes place at v = 10 m/s soit 100% of the absolute wind speed. **The trails, that they are due to turbine or not, are vanishing progressively** because the relative wind is becoming zero while the mobile, pushed by the wind, gets the speed of the wind.

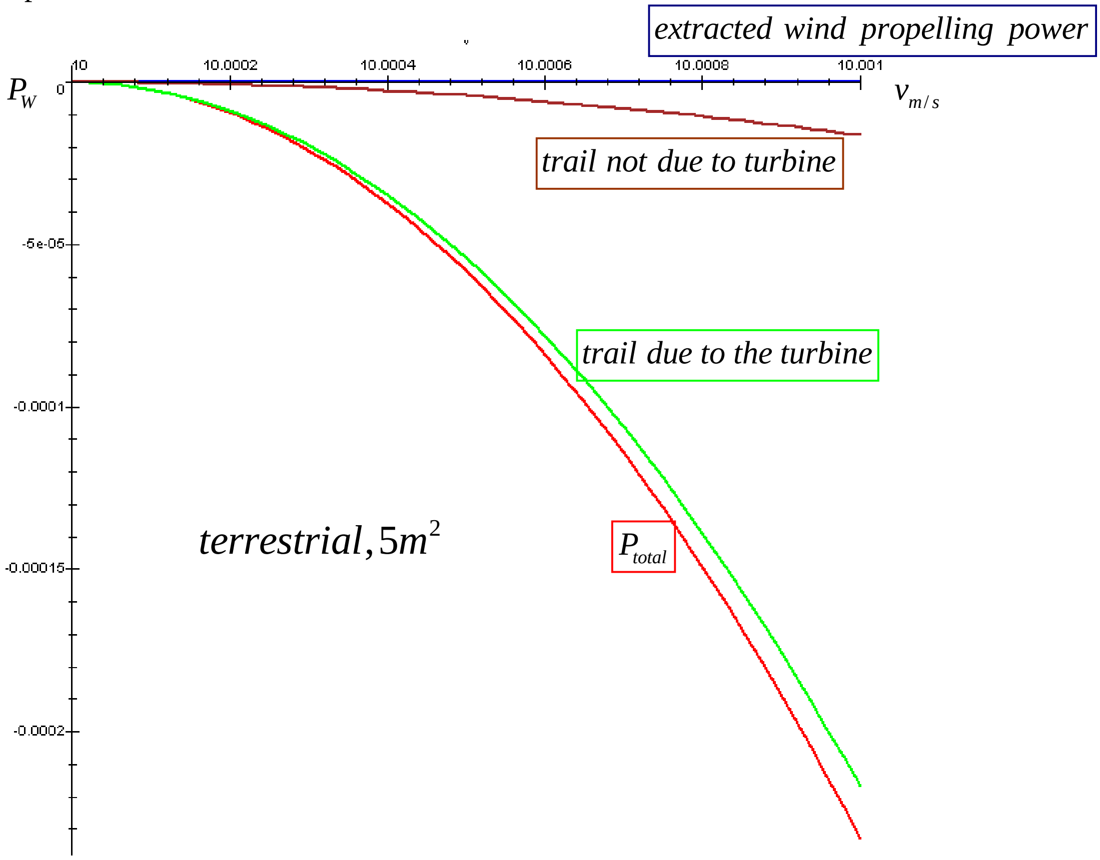


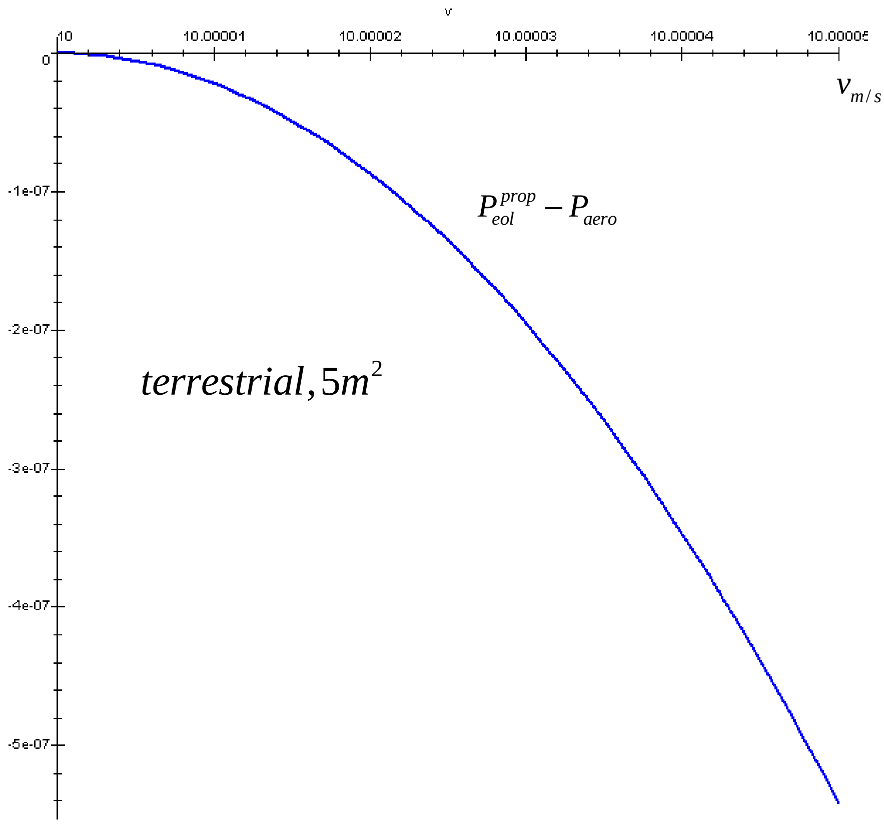


In this last case, the wind is faster than the mobile : all the powers are positive and come to 0 while the mobile gets the limit of the wind speed.

III.2.c) Case n°1b : relative facing wind (braking)

Without the power of the thermal engine, it is impossible to make advance the terrestrial and *a fortiori* marine engine more quickly than wind. Just over of the wind speed, the extracted wind power is very weakly positive whereas the powers of trails are very negative, like the total power. The mobile invariably comes back to the previous case (1a). The extracted wind power is always very insufficient to compensate the power of trail of the turbine.





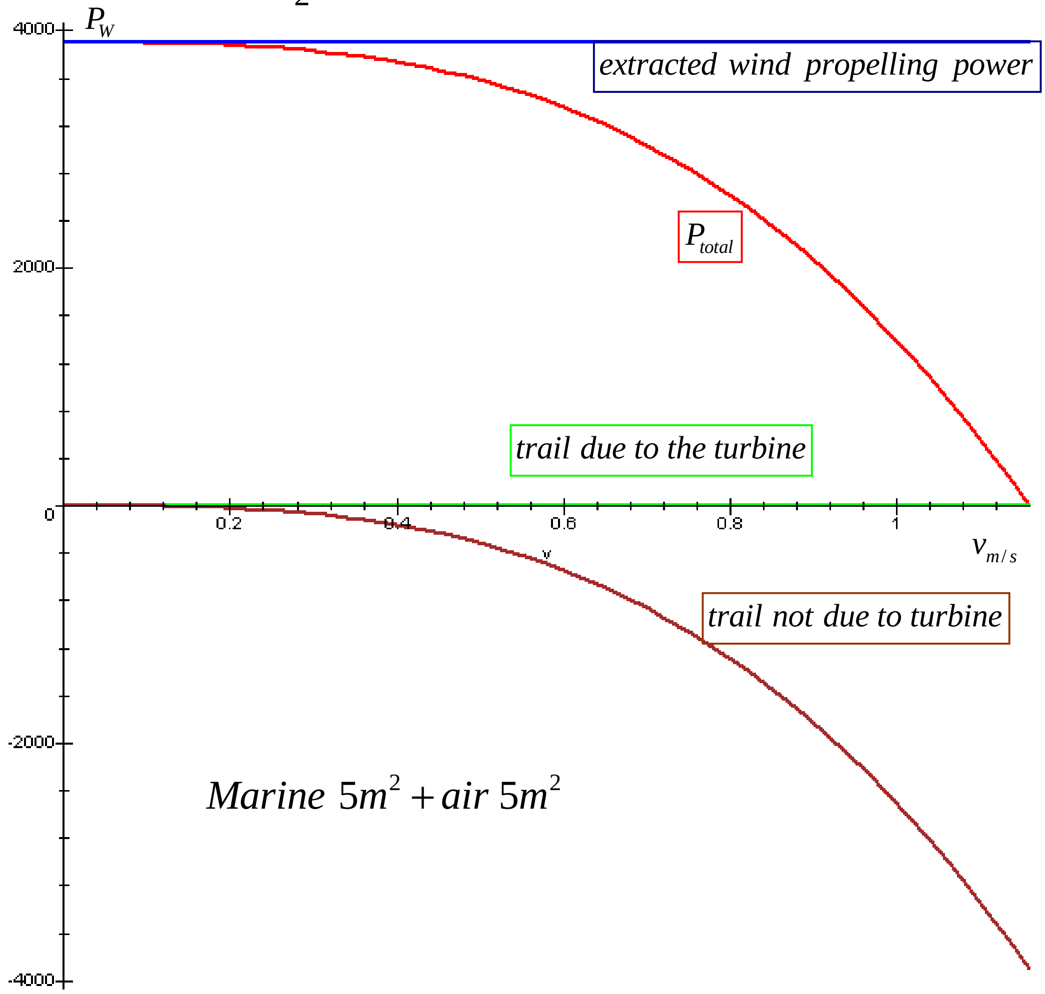
III.2.d) Case of the purely lateral wind

In the case of a purely lateral wind (babord or tribord), the aerodynamic strength of wind on the turbine doesn't work because it is orthogonal to the displacement of the mobile: its power is zero. With a sail, *it is impossible to extract the power of wind in this configuration,* ***but not with a turbine.*** Then the extracted wind power can be sent on propellant mechanisms (wheels, helix.) to make the mobile run in the wished direction. Mathematically, it is sufficient to take the previous seen relations while suppressing *Paero*

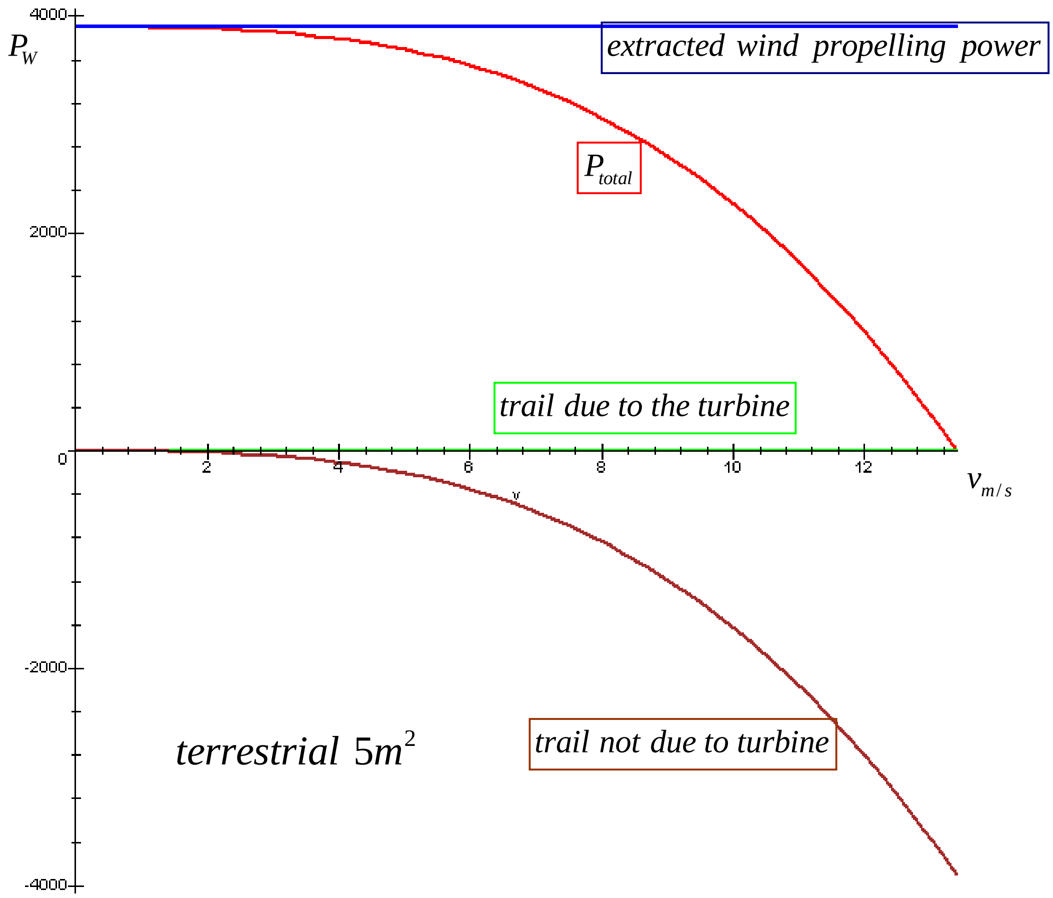
$$mv\frac{dv}{dt} = P_{prop}^{eol} + P_{prop}^{mot} - 0 - P_{tr} \textbf{ soit } \boxed{mv\frac{dv}{dt} = \frac{\eta_{eol}\eta_{prop}}{2}\rho_{air}Sw^3 + \eta_{mot}P_{mot} - vF_{tr}}$$

Of course, it is necessary to make the ship able to support this aerodynamic strength which could reverse it : however, in typical intensity, this strength is the same that the one that a sail (with the same expanded surface that the area swept by the turbine) would make the ship undergo in the same lateral wind conditions. A monoshell ship will be little discriminating, on the other hand, a catamaran or a trimaran will be able not to reverse themselves, and more again for the gigantic cargos balanced by thousands of tons of goods. For the terrestrial mobile, it will be necessary to be careful by endowing them with an enough large way (distance between 2 wheels of a same axle). In any case, once the structure of the mobile proportioned and designed for the implantation of the turbine, **the wind propelling power** :

$$\frac{\eta_{eol}\eta_{prop}}{2}\rho_{air}Sw^3 \textbf{ is available and constant}$$



Here is the situation quite simple : constant wind propelling power and top speed of 1,16 m/s, either 11,6% of ***w***, corresponding to the balance between the power of trails not due to turbine and the extracted wind propelling power.



The situation is here a lot more favorable : because of the absence of the hydraulic trail, the top speed is a lot bigger, and even greater than the speed of wind (13,4 m/s, either 134% of ***w***)

III.3. Some computations with another set of parameters

We take here more favorable piloting parameters, but still realist :

m : mass of the mobile : ***m*** = 1500 kg (without effect in III. because *dv/dt=0*)

η_{eol} : wind output for the turbine : 50% = 0,5

η_{prop} : output in the transmission of the extracted wind power : 80% = 0,8

ρ_{air}, ρ_{eau} : volumic mass of air and water, respectively 1,3 and 1000 kg/m^3

S : swept surface by the blade of the turbine : 50 m², either a blade approximately long of 4 m.

w : absolute speed of the wind : 15 m/s (54 km/h)

k : decreasing factor of the wind speed before and after its crossing of the turbine : 1/3

C_{Xair}, C_{Xwater} : aerodynamic and hydrodynamic trail coefficients : 0.3 et 0.5

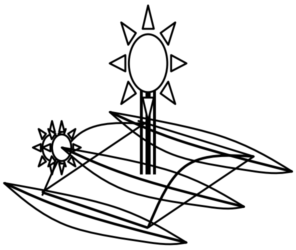
$S^{air}_{mobile}, S^{eau}_{mobile}$: facing surfaces of the mobile running in the air and in water : 5 m² et 1 m²

P_{mot} : power of the thermal engine : **zero** when the wind is sufficient to make the mobile advance.

η_{mot} : output in the transmission of the mechanical power from the thermal engine : 80% = 0,8

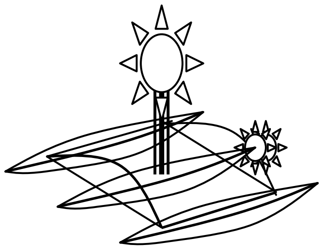
The following arrays regroup the results and permit a double comparison :

- about the parameters : unfavorable/favorable
- about the mobiles : terrestrial/marine

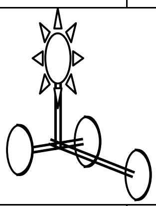


Marine Mobile

(boat)

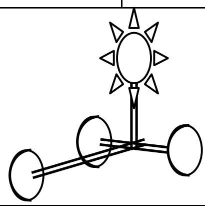


CASE	Parameters of III.1.		Parameters of III.3.	
Absolute facing wind	$v_{\lim} = 1$ m/s	10% of ***w***	$v_{\lim} = 4{,}4$ m/s	29,4% of ***w***
Relative back wind	$v_{\lim} = 1{,}24$ m/s	12,4% of ***w***	$v_{\lim} = 5{,}1$ m/s	34,2 % of ***w***
Relative facing wind	To use thermal engine	To use thermal engine	To use thermal engine	To use thermal engine
Lateral wind	$v_{\lim} = 1{,}6$ m/s	11.6 % of ***w***	$v_{\lim} = 5{,}6$ m/s	37,2 % of ***w***



Terrestrial Mobile

(Wind trike)

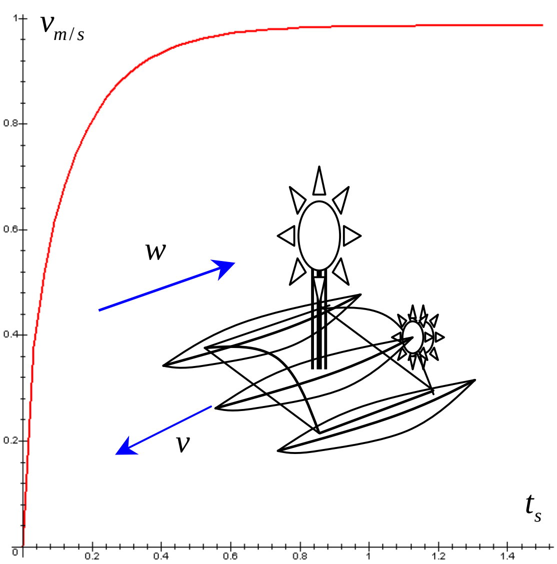


CASE	Parameters of III.1.		Parameters of III.3.	
Absolute facing wind	$v_{\lim} = 2$ m/s	20 % of ***w***	$v_{\lim} = 6{,}2$ m/s	41,5 % of ***w***
Relative back wind	$v_{\lim} = 10$ m/s	100 % of ***w***	$v_{\lim} = 20$ m/s	100 % of ***w***
Relative facing wind	To use thermal engine	To use thermal engine	To use thermal engine	To use thermal engine
Lateral wind	$v_{\lim} = 13{,}4$ m/s	134 % of ***w***	$v_{\lim} = 35{,}6$ m/s	237 % of ***w***

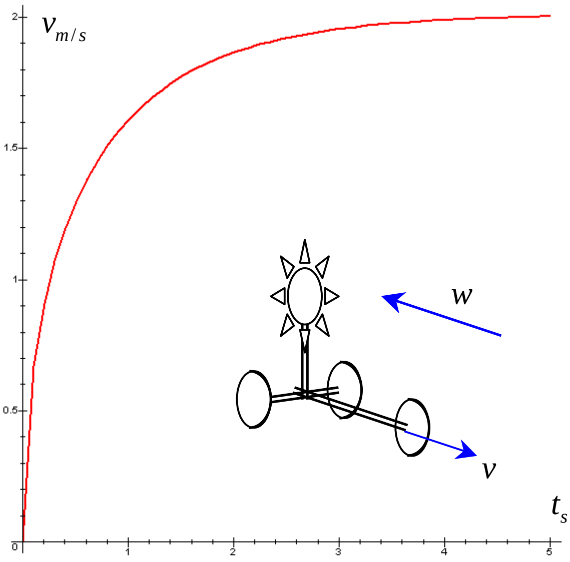
IV. Numeric simulations in dynamic situation

In this paragraph, **one studies the instationary behaviour bringing the mobile from its initial speed supposed zero to its top speed limited as calculated in the III.** The mass ***m*** of the mobile intervenes here because ***dv/dt*** is not zero anymore so much that the total power (drawn in red in the paragraph III.) applied to the mobile remains positive.

Absolute facing wind, set of unfavorable parameters (III.1.)



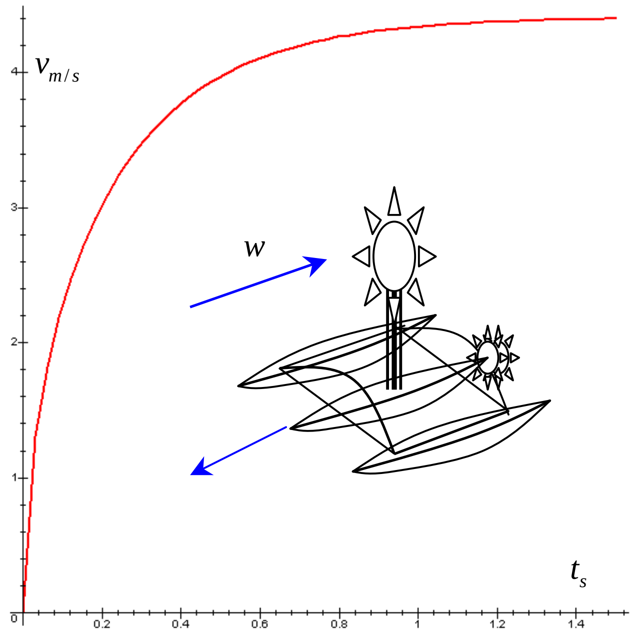
marine



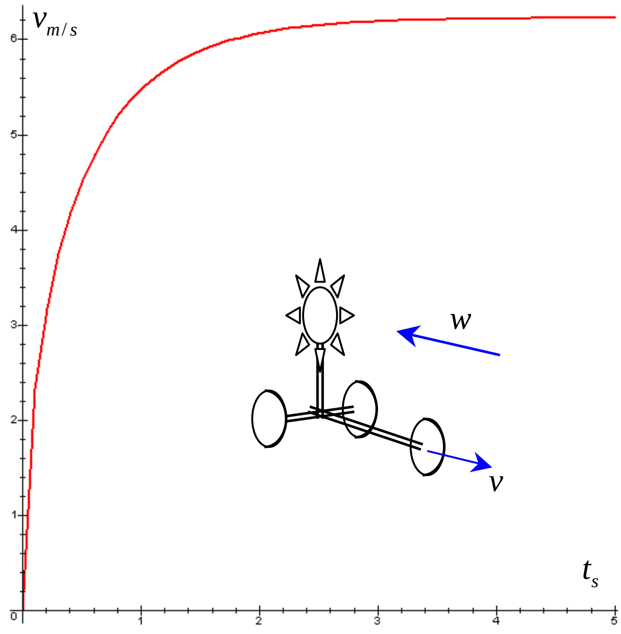
terrestrial

The time of reaction is very short ; the top speeds are around 10 to 20% of the one of wind.

Absolute facing wind, set of favorable parameters (III.3.)



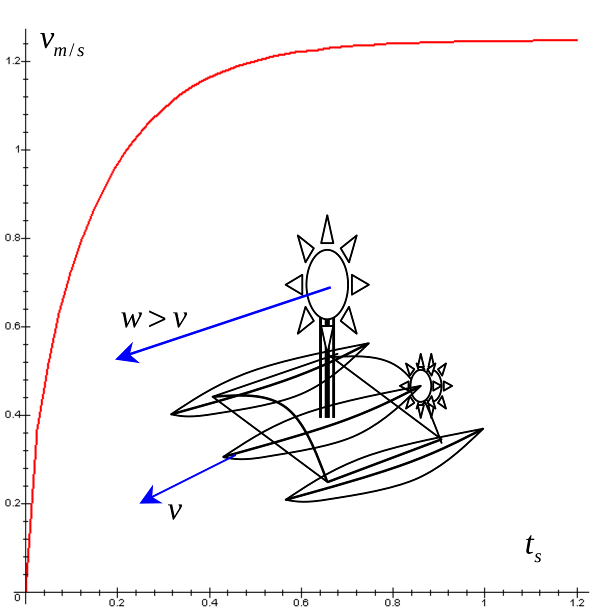
marine



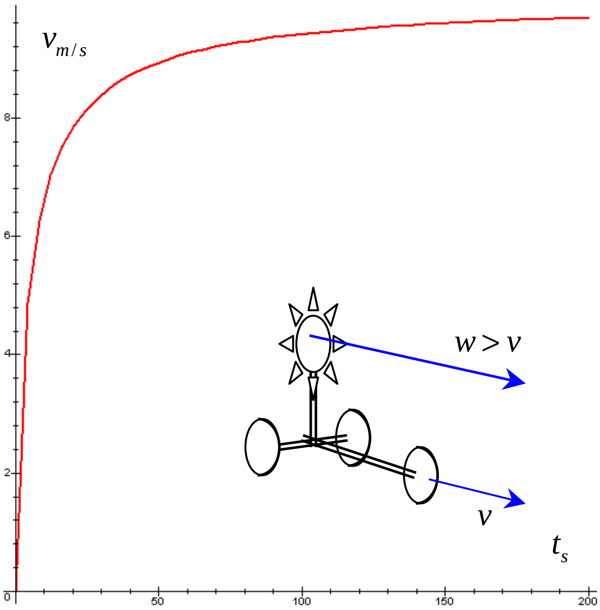
terrestrial

The time of reaction is quite short ; the top speeds are around 30 to 40% of the one of wind.

Relative back wind (pushing), set of unfavorable parameters (III.1.)



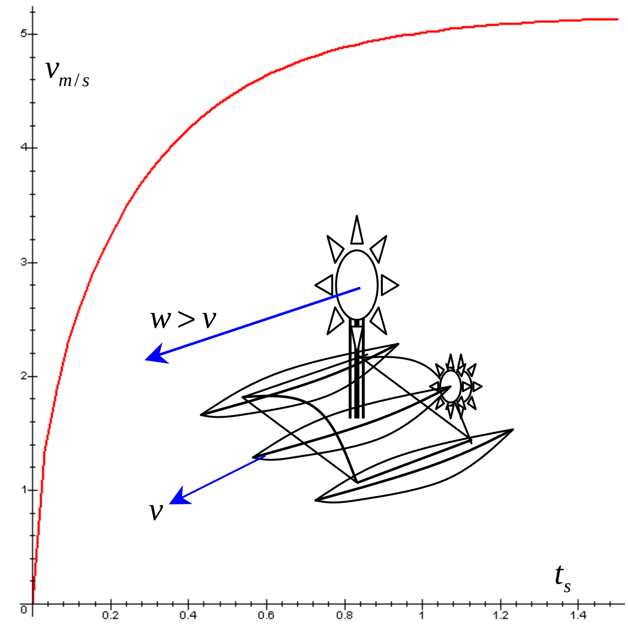
marin



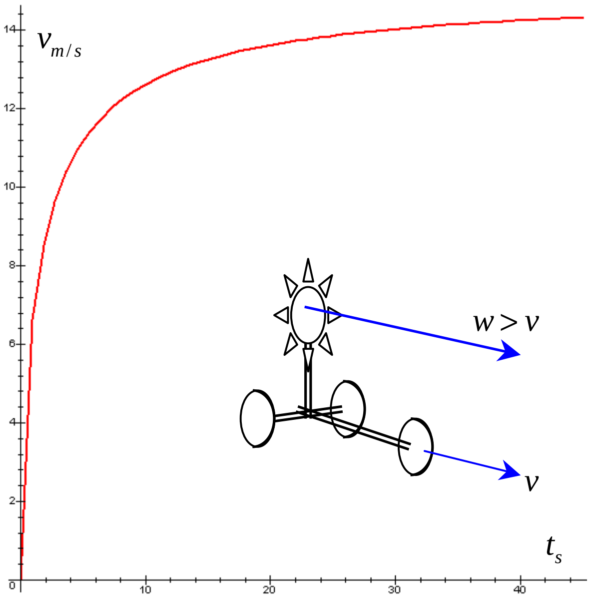
terrestre

The times of reaction remain short for the marine mobile, and greater for the terrestrial mobile. The top speeds are around 12 to 100% of the one of wind.

Relative back wind (pushing), set of favorable parameters (III.3.)



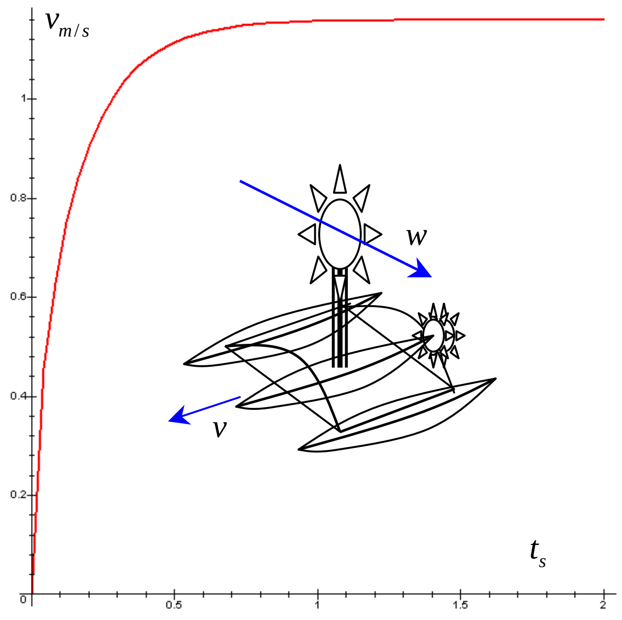
marine



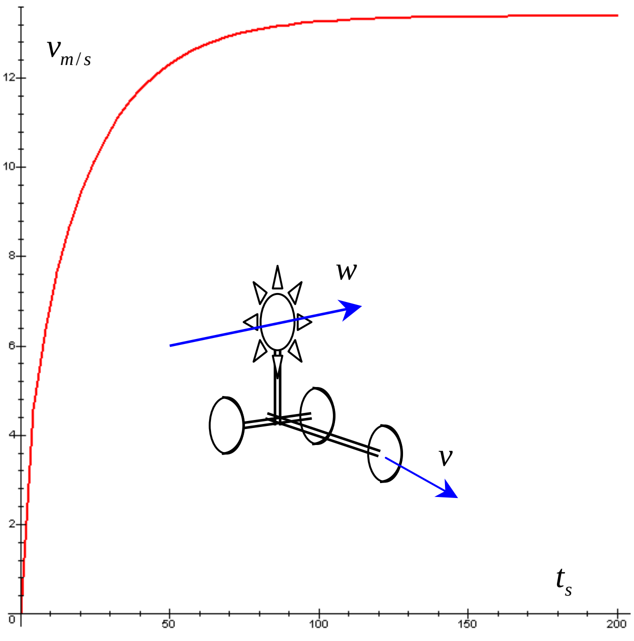
terrestrial

The time of reaction is quite short, although a few longer for the terrestrial mobile ; the top speeds are around 50 to 100% of the one of wind.

Purely lateral wind, set of unfavorable parameters (III.1.)



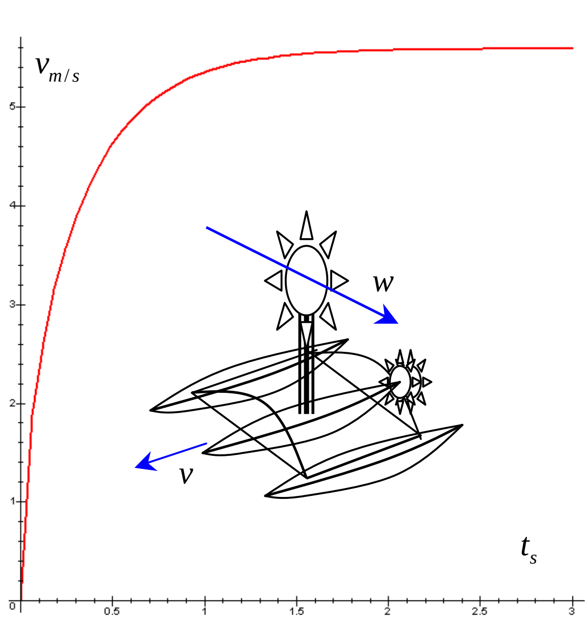
marine



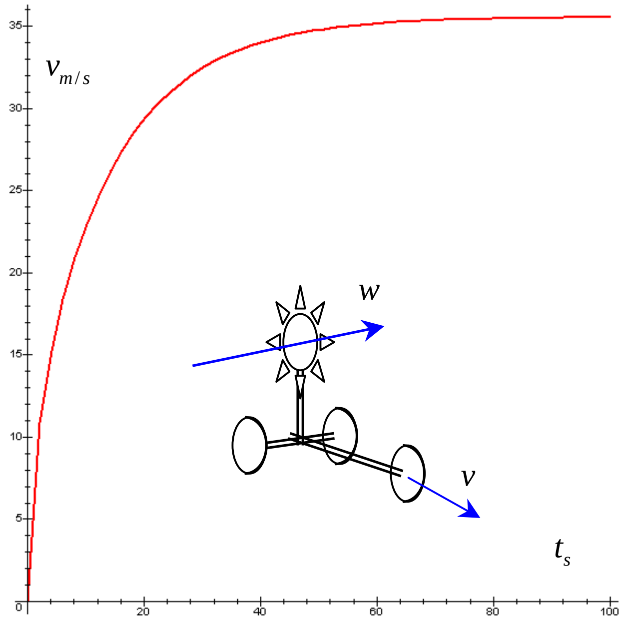
terrestrial

The time of reaction is very short for the marine mobile, a lot longer for the terrestrial mobile. The top speeds are the around 10 to 40% of the one of wind.

Purely lateral wind, set of favorable parameters (III.3.)



marine



terrestrial

The time of reaction is short for the marine mobile, longer for the terrestrial mobile. The top speeds are the around 35 to 237% of the one of wind.

V. CONCLUSIONS

The survey answers to the questions :

1.a) Is a wind turbine with 40% of output able to make a mobile to advance with a relative or absolute back wind ? 1.b) The same with a facing relative wind ?

With an absolute facing wind : YES

With a relative back wind : YES

With a relative facing wind : NO

1.c) The same with a purely lateral wind ? YES

This study has designed a mathematical public modelling to simulate the motion of a mobile propelled by the wind along a linear axis :

This modelling will be improved and enriched exclusively to non commercial ends by other specialists who will have the courtesy to notice it to *SYCOMOREEN*. **In the marine domain, the shipowners, the sailors and naval engineers have a sensitivity and technical data which may be very useful.**

The survey results in precise and realist evaluations with reasonable hypotheses : **the *absolute facing wind, the lateral wind* and in a least way, *the relative back wind*, are the 3 configurations where an embarked turbine can bring a substantial mechanical power to the mobile, moreover not polluting and free, and making the wind not an adversary, but an ally.**

TO FINISH, a small touch of humor giving matter to think.

« Concerning wind,
the essential is to have the breath
and not to lack any air »

SYCOMOREEN

SYstems for COnversion of MOtions and REnewable ENergies
systèmes pour la conversion de mouvements et d'énergies renouvelables

The Naturally Energetic Movement !
Le Mouvement Naturellement Energique !
Die Natürlich Energische Bewegung !
El Movimiento Naturalmente Energico !

To discover other studies, concepts and engines relative to renewable energies :

http://sycomoreen.free.fr

LINKS AND DOCUMENTS RELATIVE TO WIND PROPELLING TURBINE

DISCUSSION in English:
http://www.boatdesign.net/forums/projects-proposals/windmill-wind-turbine-powered-boats-how-many-out-there-they-viable-14182.html

http://www.sunfishforum.com/autogiro-boat-wind-turbinet3853.html?s=0b28f36b3c5ca797dcc22318c437d878&;

A video of boat propelled by a wind turbine :
http://www.youtube.com/watch?v=NNbNNSDljGI

The Ventomobile by the Inventus Team (Stuttgart)
http://www.inventus.uni-stuttgart.de/
http://www.sciencedaily.com/releases/2008/08/080804123039.htm

The ship with triblade wind turbine « Revelation II »
http://www.multihullcentre.co.uk/mhcnews.htm
http://www.treehugger.com/files/2007/02/windmill_sailbo.php
http://www.boatdesign.net/forums/projects-proposals/another-idea-1289.html
http://forum.darwinawards.com/lofiversion/index.php/t7858-50.html