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Reaction Paper to the Recent Ecorys Study KI0118188ENN.en.pdf[1]

Challenges for the commercialization of Airborne Wind Energy Systems

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[1] Ecorys AWE report available at: https://publications.europa.eu/en/publication-detail/-/publication/a874f843-c137-11e8-9893-01aa75ed71a1/language-en/format-PDF/source-76863616 or https://www.researchgate.net/publication/329044800_Study_on_challenges_in_the_commercialisation_of_airborne_wind_energy_systems

TRL State of the Art (ref. Ecorys doc - III Findings of the Study -State of Play of Technology Development)

Key Barriers (ref. Ecorys doc: III Findings of the Study - Barriers to AWES)

Scale (ref. Ecorys doc: IV Conclusion and Recommendations - The AWES Case for EU Energy Security)

Sharing of Knowledge (ref. Ecorys doc: IV, Conclusion and Recommendations - Anchor Learning)

State of the Art (ref. Ecorys doc: 2.2 Overview of Airborne Wind Energy Systems)

Airspace Barriers (ref. Ecorys doc: 2.3 Regulatory State of Affairs)

Safety Buffer (ref. Ecorys doc: 2.4.3 Net Resource Potential)

Markets (ref. Ecorys doc: 2.5 Markets)

LCOE (ref. Ecorys doc: 2.5.1 Cost Performance)

Onshore On-Grid Markets (ref. Ecorys doc: 2.5.2 Onshore On-Grid)

Repowering Offshore Wind Farms (ref. Ecorys doc: 2.5.2 Onshore On-Grid)

Wind Resource and Availability (ref. Ecorys doc: 2.5.2 Offshore On-Grid)

Footprint (ref. Ecorys doc: 3.2 Spatial and Airspace Footprint)

Weather (ref. Ecorys doc: 3.2 Weather Conditions)

Industrial Barriers (ref. Ecorys doc: 3.3)

Public Support and Regulatory Barriers (ref. Ecorys doc: 3.4)

Environmental Impact (ref. Ecorys doc: 3.4 Environmental Impact)

Resource Potential (ref. Ecorys doc: 4.2)

Source of the Specifications: Wind/Wing vs. Alternators/Pulleys

6MW Siemens turbine data

Abstract

Europe desperately needs adequate energy to sustain its economy, since the available energy per capita is currently falling. Europe imports more than half of its primary energy, making energy its largest economic burden. The modern age promise of continuous and progressive growth has been broken.
European people are clearly feeling the loss in their quality of life and security, thus the rise of nationalism. Solidarity is yielding to selfishness while we fail to recognize the real issue, which is ultimately nothing less than energy scarcity[2] and non-affordability.
The purchase of foreign energy, including expensive renewable energy devices like photovoltaic (PV), is the single biggest contributor to Europe's spiraling trade loss and indebtedness, while a proclaimed distress has risen about environmental pollution, resources, climate and the prohibitive costs to address them.
We only have a limited resources to address such hurdles, so it's necessary we make sure we focus on those resources where we can do the most good. KiteGen is certainly offering the most powerful and definitive solution[3].
KiteGen, after having discovered a new and untapped energy reservoir[4] that initially triples the harnessable energy of wind turbines, realized the energy potential is a thousand times the current requirements of Europe, invented also the main and the most recognized[5] technological methods to harness it[6].
Having full awareness of the paramount importance of the development/opportunity with no room left for gambling with the energy sector, KiteGen set forth a medium-term plan of focused activities.
KiteGen was the first in the world to produce energy with this new concept in 2005[7], and the result was so encouraging that it confirmed the validity of the plan to investigate and develop

[2] It is recommended to follow the message spread by this French engineer which offers a clear view on the economic matter very usable by technical entrepreneurs, scientists and mathematicians Jancovici, J.M. « L'économie aurait-elle un vague rapport avec l'énergie? »(2013), LH Forum, 27 septembre 2013. Are also available several english lectures. The most insightful collection of articles to the matter is "Our Finite World" site cured by Gail Tverberg, here a link: https://ourfiniteworld.com/2018/11/07/why-we-get-bad-diagnoses-for-the-worlds-energy-economy-problems/

[3] The risk to consider this merely an hype is known, but, if happen is due to lack of information, knowledge and understanding. The outcome of dozen of technical diligences confirmed us such conviction.

[4] Well before having awareness of high or tropospheric winds stronger and more constant than the biosphere winds; KiteGen addressed undisturbed wind flow exploitation at low Betz efficiency, that has been revealed to be a resource worth at least three times the harnessable power of a wind turbine in the same conditions. This feature is currently not understood or grasped in current literature.

[5] New patent filings worldwide are clearly converging towards the KiteGen concept. This is an indirect indicator of recognition.
https://www.slideshare.net/ScopeKnowledge/airborne-wind-turbines-25409238

[6] See KiteGen Carousel and KiteGen Stem which is the implementation of the pumping kite concept.

[7] 2005 MobilGen Sardinia test campaign first 130 kWp energy production from pumping kite
https://www.youtube.com/watch?v=QISHH_djn94

the required technology with private funds and practices, defying conventional investment logic[8].
During the ten-year technological development of KiteGen, dozens of issues or ancillary problems emerged that threatened to compromise the entire project, but were resolved with commitment and technical knowhow. In the end, with great satisfaction, a solid and exhaustive knowledge base and exceptional Intellectual Property (IP) were created.
Now KiteGen has the greatest number of patents as well as the record for the most in-depth experience in this field. The remaining need is no longer for research but simply for best engineering practices and a strong organization hiring the most qualified people and the commencement of batch production and deployment. An unconstrained plan could offer this technology, at full industrial scale, to our societies in less than two years, because there are no more show-stopper issues.

The sacred grail of energy[9] is definitely the research, and KiteGen has just completed one of the most promising, successfully.
However, KiteGen has met unforeseen non-technical hurdles that threaten the project. Scientific and technological advances have been generally ignored, and as has happened with previous inventions, there have been ignorant unimaginative voices rising against innovation. The telephone and the airplane are the most obvious examples.
KiteGen filed dozen of proposals at European and national levels in order to obtain resources and visibility. Unfortunately, there was some powerful political agendas against the opportunity, aiming paradoxically to kill the initiative in its cradle[10].
This domain has long since passed any possible suspicion of unviability as it is easy to search in *Google Scholar* the thousands of references available for personal learning, KiteGen was the first initiator and its contribution was barely cited or mentioned in the Ecorys study, which only offers inaccurate information and far fetched theories that threaten to cause confusion and misrepresent our research and achievements.

KiteGen considers the document published by Ecorys[4] as repetitious[11] and delays progress by at least 10 years due to not comprehensively understanding all aspects of the technology, which has created misleading information as well as the support of erroneous claims that contradict most already-published results and state of the technology already in place.

Perhaps the logic of this report and its authors is to bring back the knowledge achieved in those years through concept massification in order to justify and legitimize the questionable

[8] The 130 shareholders of KiteGen Venture are self-committed to take effective action against peak-oil effect, economic decline, pollution, nuclear proliferation, energy poverty, and third world exploitation. Democracy decline and the future uncertainty for the next generations.
[9] The Copenhagen Consensus on Climate project gathered 27 of the world's top climate economists and three Nobel Laureates, who found that the smartest, long-term climate policy is to invest in green R&D, to push down the price of green energy.
[10] One example: Eu Officers of DG energy tried to dissuade KiteGen from going ahead with the research project and its dissemination because it was potentially commercially harmful to the embedded European wind turbine industry, with no hope of EU extending funding, and by the way, honoring the pledge [2003-2010].
[11] A.Cherubini et al. PERCRO institute - Scuola Superiore S.Anna Pisa - AWES review https://www.sciencedirect.com/science/article/pii/S1364032115007005

existence of other competing or IP-infringing initiatives, by the way the report's lack of logic, encourage to fund further research focused on a concept just depicted by the Ecorys Report as plenty of definitely inescapable hurdles.

This reaction paper will provide five main technical evidences and additional topics that will equip the reader with sufficient technical understanding to recognize the fallacies of the Ecorys Report, and enable the reader to recognize its triviality/irrelevance as well as the misconceptions of the claims made in the report that treat questionable findings as established truth.

This triviality was raised to an institutional level as an EU publication/commission, and is irresponsible; risking harm not only to KiteGen or the project to harness high winds but, assuming as true the huge impact, also the interests of common good.

Executive Summary

Tether Drag issue, Carousel performance, Technology Readiness level, Tethered airfoils and System Architecture, are the five technical evidences, developed here with enough detail allowing anyone to understand the discrepancies between KiteGen know-how and the common false beliefs about high wind technology which the Ecorys report simply parrots and is guilty of disseminating poor science.

This reaction paper is designed to serve as an introductory, balanced information, fact-based, and analysis-driven guide for stakeholders involved in electrical energy. Policy makers, utilities, energy companies, regulators, investors, and other power-sector stakeholders can use this debate to better understand the unforeseen challenges, and the great opportunities, currently facing troposphere wind energy in Europe and around the world. The Ecorys report and this reaction paper barely cover the available technical know-how in the domain. A comprehensive understanding of results and findings from more than ten years of primary and technological research, a review of the state of the art, and quantitative modeling and analysis, can be easily obtained directly from KiteGen, thus overcoming the current state of confusion.

KiteGen cannot recognize AWES as an umbrella name for technology aimed to exploit high altitude winds. The first reason is the verbiage which recognizes primarily flygen-developed concepts, like drones and blimps, while giving short shrift to flying power wing concepts.
Therefore, KiteGen is not willing to be included among such supposed actors and stakeholders with their basic and simple conceptual problems. As a logical consequence, KiteGen has good reason to distinguish itself.
Globally, people are realizing the enormous potential economic return and positive impact on transport, climate and energy this project represents. This has unleashed a pointless "gold rush", the aim of which is to be a protagonist in this technology without any intellectual effort or historical reflection, thus creating the emergence of a cacophony of fakes.

The great work done at KiteGen is currently reflected in the logic of industrialization and is intended for the primary benefit of the common good[12]. However, this general concept is suffering from confusion arising from greedy behavior, plagiarism, and personal career interests representing both academic and patently invented untitled startups for questionable and/or dispersive fundraising purposes.

But this reaction paper is also intended as a novel attempt to create a merging with existing good culture and develop initiatives toward a serious, respectful and responsible developmental path, and establish a titled reference committee, in order to clearly communicate the domain commitments and status. Some rules must be agreed upon in order to set-up an effective démarche.
This scientific committee may Include:

- all individuals and entities that gave worthwhile contributions to the restricted domain of **groundgen** architecture, excluding all other misleading concepts
- anyone who has valid and meaningful IP in the domain

Excluding and defending ourselves from:

- anyone vocal but not understanding of our achievements in the domain, spreading incorrect ideas, creating confusion among investors and building initiatives
- anyone guilty of plagiarism and/or IP infringement

Following the article published by Ecorys under the authority of AWES, including other hobbyistic approaches, here are the principal criticisms:

1	Technologies which cannot achieve realistic economic performance levels, TPL ie low-CoE, are still considered among the viable architectures[13].

[12] From the entrepreneurial point of view, privately conducting long-term research without institutional support is considered suicidal.
[13] Reckless concepts, such as helium filled blimps, have always been included among the possible architectures. While they have merit to spread the high-altitude wind meme as they are welcomed by the oblivious public, they add confusion and suggest a synthesis inability to forecast and physically understand the expected behaviour. When unfolding the laws of physics and aerodynamics for these technologies, they turn out to be ineffective for high altitude wind technology due to very improbable and non-scalable methods. A similar negative opinion, for similar reasons, is extended to other AWES enumerated concepts and initiatives in terms of both proposing wrong technological paths or riding on the innovation of others but creating confusion and dispersion of resources without added value. Nevertheless, they are attempts to circumvent or infringe existing patents and generally are a disservice to potential investors.

2	Development paths are rigid and retaining initial early, incorrect and alternative conceptual ideas to find a path to eliminate existing patents and knowledge[14].
3	Technology improvements by changing system fundamentals are typically avoided
4	Development is focused on the advancement of technology readiness instead of step-by-step validation of all valid theoretical and technological assumptions[15].
5	Excessive focus on demonstration of underdeveloped technology for public showing and fundraising purposes instead of experience and knowledge collection.
6	Techno-economical system performance is considered too late in the process
7	Reduction of CoE is limited, too expensive and/or risky when pursued at high TRL
8	Lack of conformance and attention to status of the art, lessons learned and intellectual property
9	Hobbyist approach, both sci paper and lab test. Excessive freedom due to lack of guidance and effective peer to peer review
10	Focus on small scale demonstrators[16]
11	Confusion in communication and dissemination
12	Plagiarism, copyright infringement and conflicts of interest

[14] This is the epilogue of Google and Makani. They attempted to obtain a similar patent four years after the KiteGen approach was public, quite unfair approach due an existing negotiation with KiteGen. https://patentimages.storage.googleapis.com/8c/91/e5/275c6bfeb89438/US7656053.pdf After that attempt Makani surprisingly focused the efforts towards a bad idea despite was already discussed and discarded by KiteGen in 2003 because clearly unfeasible and at low TPL.
This is the recent official Google statement, "***Actual results may differ materially from the results predicted. The potential risks and uncertainties that could cause actual results to differ include, among others, risks related to our ability to hire the appropriate people and our ability to identify and pursue the technologies necessary to achieve these goals***"
http://googlepress.blogspot.com/2007/11/googles-goal-renewable-energy-cheaper_27.html They are saying that it will fail if they cannot hire the right people or develop the required technology; a prediction of incompetence.

[15] *KiteGen made a continuous technological survey of the scenario outside of KiteGen in order to discover possible and valuable partners suitable to join us and internationalize the initiative. Unfortunately, we rarely observed or assessed valuable technological or theoretical achievements within AWES and other actors that are worthy of attention.*

[16] Renewable energy is dispersed in time and space, thus implying large-scale systems, the current and numerous successful demonstrators are more than sufficient for their own scope, but they have shown a limit that with the absence of subsidies cannot sustain expanding industrial activity, exactly as happened to the small wind turbines (<500kW) that, despite the rich subsidies available, exposed even poorer limits.

Differences Between AWES and KiteGen

As mentioned before, KiteGen stands unique compared to the players in AWES.
This table highlights the key points comparing two of KiteGen's technologies, the KiteGen Stem and the KiteGen Carousel, with Airborne Wind Energy Systems **(**AWES) .

Comparison	AWES (typical)	KiteGen Stem	KiteGen Carousel
Architecture	**Vary**	**Pumping wing**	**Carousel**
Size	**Small or very small preferred by almost all**	**Comparable to the biggest Wind Turbine**	**Comparable to the biggest power plant burning fossil fuels or Nuclear**
LCOE	**48-150 € / MWh Admitted high uncertainty**	**<25 € / MWh Comprehensive evaluation and high confidence[17]**	**<10 € / MWh Comprehensive evaluation and high confidence[18]**
Capex	**1.5M € / MW**	**<< 0.5M € / MW**	**<0.5M € / MW**
Opex	**20% Capex**	**5%**	**5%**
MWh / MWnominal	**4800**	**6400**	**8300**
Wing - harnessing device -aerodynamic efficiency	**Variable types AE 4-11**	**C-shaped rigid Wing AE> 28**	**C-shaped rigid Wing AE> 28**
Supporting theories strength	**Questionable or often affected by reckless plagiarism**	**Strong and serially validated in field, scaling issues investigated by KiteGen only**	**Inherit theoretical framework from the stem concept, avoiding most of the rope reel out/in drawbacks**
Status Research phase / demonstration / production	**Strong need of further investigation. Uncertainty about the final architecture**	**Research and demonstrations completed. Executing Industrial plan and collaboration with extended supply chain component suppliers**	**No further research needed. For the wide ring track, best engineering practices are more than adequate**
Goal	**Main focus toward Commercialization of minimal systems**	**Propaedeutic to KiteGen Carousels The success of this scaled technology opens seamlessly to the next step, the KiteGen Carousel**	**The term "commercialization" seems inappropriate for a system capable of providing energy to an entire region. It is like talking of commercialization of hydro dams, or nuclear power plants**

[17] The very unlikely case that LCOE goal is missed, the unconstrained linear scalability of the industrial machine as a consequence at least to cubed increase of performance, allowing to align the specifications with little additional effort. This is one of most desirable feature of the KiteGen architecture.
[18] See above

Evidence 1: Tether Drag - a Non-Issue

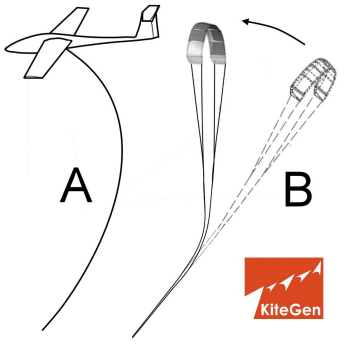
The Ecorys report cites "tether drag", stressing it no less than eight times in the report and falsely depicts it as an unsolvable problem that will prevent the project from succeeding.
The overconfident authors of the report, as well some scientific publications, appear to have fallen into a cognitive trap in this regard: they have adopted as true the simple methodologies to build models, failing to understand or make reference to the much more complex and articulated nature of both the geometrical and physical phenomena. It is quite incredible that 10 years of claimed simulation activity has failed to report the correct analysis.

This issue was the subject of an exchange of ideas between Wubbo Ockels [Laddermill] and KiteGen [Carousel] almost 12 years ago, which was thoroughly supported with documentary evidence[19] showing that, during crosswind flight, the rope section contributing to the dissipation of energy due to drag was only about 300m, while the rest of the rope remained stationary or had very minimal movement. This confirms the deepening level of the already-achieved basic precepts of this emerging technology.

We were confident that these theoretical questions and their ambiguity would be resolved and consolidated without effort, thanks to the copious activity and third party production of scientific publications worldwide and the review processes triggered by the success of the first KiteGen prototype. Unfortunately, however, contradictions and ambiguity do still remain [20].

Tether Drag doesn't affect the wing speed or the system AE.

The reasons are quite easy to figure out:



1. During the tests, we pushed a wing at 2400m and 65m/s observing no tether drag issues. This demonstrates KiteGen's right to reject the overly simplistic analysis based on the "system drag" idea that combines rope and wing, which appeared for the first time in the Loyd patent, the validity of which is limited to tethered aircraft (A) equipped with a tail that drives and forces the pitch.
2. Thanks to in-depth research and simulation, it has been established that the drag of the rope is irrelevant to wing speed and energy production. It is, instead, simply a geometric dynamic, conceptually affecting the path in airspace only (B). Tether drag and resulting sag,

[19] Modeling and Control of a Kite on a Variable Length Flexible Inelastic Tether (Wubbo Ockels et al. 2007)
[20] Drag power kite with very high lift coefficient - Florian Bauer et al. 2017
https://www.researchgate.net/publication/320742362_Drag_power_kite_with_very_high_lift_coefficient

only limits the crosswind motion distance that can be achieved in one stroke, before the wing has to change direction. This is a feature that could be successfully exploited by the control in order to extend the wind power spot.

3. Issues related to transverse wave propagation on the rope. The wing is typically set to fly at 80 m/s. When the wing changes direction, a new displacement transverse wave acts upon the rope, while the axial wave is running at 270 m/s. Such a transverse wave is slow, due the air mass added to the rope's linear density, taking several seconds to affect the entire rope. Thus, the wing has the freedom to fly for a few hundred meters before the rope bending will change its optimal angle toward the wind. The models adopted in literature expose an excessively tight time boundary or even a snapshot to track such behavior.
4. Rope drag is applied axially to the wing, the same effect that gravity has on gliders, that obviously never slows the aircraft. The force vector representing the drag of the ropes binding the wing is only manifested axially, thus thrusting the wing as with gliders. (above picture B case)
5. The Reynold number of the segment of rope near the wing reaches a high value where a new effect called the "drag crisis" takes place, greatly reducing it.
6. The tether drag issue is speculation based on a fixed cylinder in a flow experiment setup, with a measured coefficient ranging between 1.2 and 1.5. The ropes are light in specific weight which means they are locally free to oscillate and rotate on the axis, dynamically losing air pressure accumulation, thus they cannot be compared to a typical fixed cylinder in a flow.
7. Larger scales create a lessening of the significance of the issue; this due to the rope section and Reynolds surface ratio, rope section is squared function of the diametre and the drag surface is linear, an advantage that grows dramatically with increasing scale.

The scientific committee of KiteGen published an article[21] explaining the limits and errors of the proposed models in the literature review.

Furthermore, in order to gain more flight freedom, KiteGen patented ropes that were appropriately tapered in order to reduce the drag coefficient to 0.03, instead of the classic 1.2 of a cylinder immersed in a fluid that the ropes are immersed in as well.
This patent applies to the domain of possible and potential future enhanced optimization of the technology.

To repeat, as this is an extremely important concept, because the production of energy depends on the square of the flight speed, the drag of the ropes is not added to that of the wing, which remains free to fly at the speed of its glide factor or aerodynamic efficiency.

[21] G.Abbate, E.Saraceno - The largest renewable, easily exploitable, and economically sustainable energy resource on Europhysics News 49/1 2018
https://www.europhysicsnews.org/articles/epn/pdf/2018/01/epn2018491p16.pdf

Evidence 2: KiteGen Carousel

KiteGen Carousel was selected, among all possible and imaginable architectures.
The advantage of the Carousel compared to both wind turbine and pumping kites is its full wind exploitation without losing wind speed for aerodynamic activation. The cut-in speed is the wind speed needed for both wind turbines and pumping kites to commence energy conversion. The pumping kite needs to reel out the ropes to convert the kite's energy into electrical power, and the wind turbine does the same drift leeward, screwing into the wind with the blade spinning. It is the same wind interaction concept.

The Carousel instead has a cut-in speed that matches the nominal power, and greatly reduces the operative wind speed requirement, allowing a capacity factor of more than 95%, thus resolving the intermittency issue and providing humankind access to a huge energy accumulator represented by the atmospheric geostrophic pseudo-flywheel[22].

The Ecorys Report asserts:
"Theoretical and numerical studies have already shown that there is no difference between these two approaches[Pumping kite and KG-Carousel] in terms of energy yield."

This farfetched assertion conceals a conflict of interest and is very suspicious and/or shameless because the historical evidence is written into the patents. The cited numerical studies were expressly conceived by Milanese, and Fagiano (Fagiano being one of the authors of the Ecorys publication) to prevent or delay KiteGen Carousel validation. The duo filed a patent for a similar[23] but reckless concept, under the name of a different company; but the Carousel concept patent was validated, theoretically and in simulation, and currently belongs to KiteGen exclusively.

The Ecorys Report asserts:
"...while on the other hand, the cost of the Carousel ground structure might be as high as that of conventional wind turbines, which has reached 740,000 €/MW for the world market leader at the end of 2017. This would partially eliminate one of the main claimed advantages of AWES."

The most important economic parameter in sensitivity analysis is the capacity factor. It is meaningless to guess the order of magnitude of the CAPEX required to perform a comparison. The comparison could be effectively done with a synthesis value like the LCOE, that includes all the evaluations[24]. The KiteGen Carousel has, among renewable sources,

[22] The full atmosphere motion amount equals 500EWh of accumulated and noble kinetic energy. This accumulator receives about 3600TW from the pressure differential driven by the sun and loses the same amount of power against the earth orography.
[23] The elegance of the KG Carousel concept is its continuous and smooth operation. Competing and later patents fail to understand it, proposing a reciprocating machine shaped similar to the Carousel (*Fagiano Milanese Patent EP2689130).*
[24] See the above table of comparison

the ability to operate as baseload, thus allowing systemic savings of expensive grid-balancing needs, the most desirable feature of an energy converter.

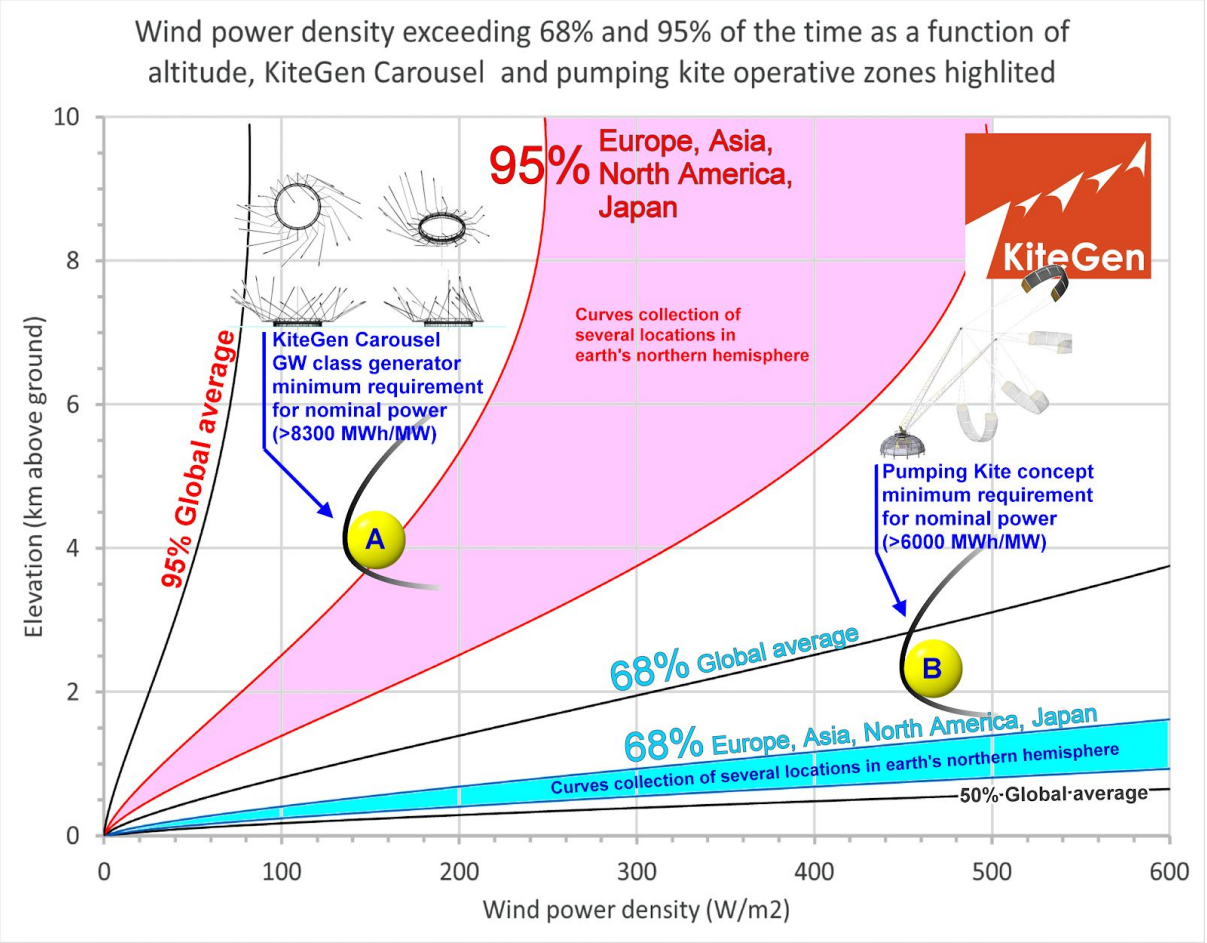


Fig 1 , It is strongly recommended to take sufficient time to understand the intended meaning of this graph. The KiteGen Carousel is superior to the best baseload power plants, including coal, gas and nuclear. The data are coming from several available reanalyses. The pink area depicts wind speeds available in the temperate zones of the planet, actually better with respect to the global average. This means that the KiteGen Carousel needs a very low wind speed (about 8 m/s on average) to work at high capacity for more than 8300 hours per year, even at altitudes less than 3000 m, especially in energy intensive areas of the world (yellow balloon “A”). The pumping kites need more power density to work at a capacity factor greater than 6000 hours per year at even lower altitudes (about 10 m/s on average - yellow balloon “B”). Wind turbines work for 2000 equivalent hours per year, requiring a minimum wind speed of 12-14 m/s or 1100 W/m2 to provide nominal power well outside the scale of the graph.

The KiteGen Stem concept (pumping kite) is propaedeutic to the KiteGen Carousel. The single-wing pumping kite developments are fully utilised by the Carousel, for both mechanical and aerodynamic components. The giant C-shaped rigid wing design is mandatory for both developments.

The remaining element is not research but simply best engineering practices and a strong organization for the initiation of deployment.

Carousel Addendum

The Carousel architecture is ideally a collection of KiteGen Stems arranged on a rotating ring.
Energy is produced by the relative movement of the wide ring and the supporting/bearing base.
Considering that the generated power grows linearly with the kite's effective area, with the cube of wind speed and the square of the aerodynamic efficiency CL/CD, the mean power obtained can increase up to 1000 MW, considering a wind speed magnitude of 8m/s, by employing about 100 giant power wings (200m2 area) on a 2550 m radius Carousel. Such a KiteGen plant would have territory occupation 40 times lower, costs about 1/5 that of a wind farm of the same nominal power and costs 1/25 of a wind farm with the same energy production. Further research on optimisation will lead to even better performance.
During power production, the rope tension (axial force) is set and maintained constant by the Stem machinery via reel in/out and maintained below the safety limit of the rope's strength. This implies that the flying speed of the wing is also determined by control of the axial force and maintained constant in terms of relative or apparent speed.
The Wing's relative flying speed is 80-110 m/s, Aerodynamic Efficiency >28.
The axial force of the wing is ½ vrel ^ 2 * air density * CL * projected area.
For a 200 sqm Wing 320kN @ 80m/s 605kN @ 110m/s
The power needed by the steering machineries is exchanged evenly around the ring and is maintained in balance.

Reasonable data derived by simulation are:

- Wide Ring rotation speed 15-25 m/s tangential. Full Diametre, 2550m
- Circumference 8000m, distance between vincula 80m, Number of wings, 100
- Path length of the vinculum, 8000m per turn, circular motion
- Typical time per turn of the wide ring, 400 s
- Typical path length of each wing in airspace, 32,000m per turn, enveloped motion
- Max path length of each wing in airspace, 56,000m per turn @ 140m/s, enveloped motion
- Rope axial tension, 300 kN each, Wing traction, 600 kN each
- Mean tangential force applied by one wing/rope system to the ring, 400 kN
- Typical power harnessed by a wing tangential force*ring rotation speed = 8MW
- Maximum power per wing tangential force * ring high rotation speed=10MW
- Total power of the Carousel 100 wings * 8MW = 800MW
- Maximum power of the Carousel here depicted, 100 * 10 MW = 1 GW

Hypothesis for Explanation:

We start from an initial condition having all the wings well-displaced and distributed in airspace with 4500m of rope, and as hypothesis a sudden stoppage of wind speed.

To maintain the generating ring rotation and its sustained power production, each rope machine has to quickly reel-in the ropes, maintaining the force, the rotation and the wing flying speed.

In this exercise, the wings act merely as sky hooks and the reel-in speed is approximately the ring speed plus the relative axial speed of the wing, about -23m/s average with a force of 300 kN on each wing.
It is easy to compute what is needed to consume about 1 GW to allow the main ring generator to produce 800 MW until the ropes are completely wound.
Take in account that the power, resulting or requested steering the wings, is shared among all ring machineries.
Such exercise imply that wind presence and speed effect requires a different evaluation. It is inappropriate to apply it to machine operativity, as it is solely related to the rope length balance over a full turn of the rotating ring, greatly simplifying the understanding and the performance computation. The mechanical power needed by each machinery, steering each wing, is reduced proportionally up to a certain wind speed where the exchange balance between the machineries on the ring goes to zero.

The minimum wind speed in crosswinds to maintain constant over a turn in the rope length = Path in airspace / glide factor / Time per turn = 2,86 m/s

Effective wind speed for operation at nominal power (the kite is rarely aligned in crosswinds) (Minimum wind crosswind / total efficiency) / (cos mean pitch * cos mean yaw) = 8 m/s.

The cos mean pitch and the cos mean yaw are derived from the wing position in air space in respect to the vinculum chosen in real time by the control.
The efficiency is the sum of the loss in energy exchange between the machinery, loss from rope reeling, and the system's friction.

The wind power density needed for operation = ½ * air density@4000m * W wind ^3 = 128W/m2.

Evidence 3: TPL vs TRL Matrix - KiteGen Stem

A lot of hypothesized technologies in the energy domain can be evaluated in advance before being implemented. The metric would be the technology performance level (TPL[25]). The first assumption is to consider solving by default all technological requirements. This greatly simplifies the analysis because all the hurdles have been virtually/by default addressed successfully. At this point, the focus is on the interaction of such a virtually perfected machine with its theoretical limits and the environment where the energy is harnessed. For example, somebody could decide to investigate the possibility of harnessing lightning's energy with a machine supposedly already having achieved TRL9. It is true that this weather phenomenon can provide millions of volts and hundreds of amperes, thus a remarkable source of power. Unfortunately, the topological frequency of the event and the duration of the spark are greatly unfavourable, leading to a capacity factor of a few hours per century and a stellar LCOE.
At this point, somebody could introduce the idea of an ionizing laser projected toward the sky, suitable to likely drive the lightning to the machine in order to increase the topological frequency; but also, in this case, the zonal available static potential and the economic break-even point with the laser energy consumption is computable, leading to the same unthinkable LCOE; not precise, but certainly beyond the threshold of acceptability.

Several major projects richly funded by the EU research wing, DG energy, and the European Investment Bank, should have had accountability for such a very low computable TPL. An incomplete list includes all Hydrogen economy-inspired projects, sea wave harnessers like Pelamis, and the Ouarzazate solar array.
The same analysis was performed on HAWE at the beginning of the KiteGen project, also for photovoltaic and wind turbines performing a comparison, making known the outstanding role/position of KiteGen.
We are expert in special machines. Usually the problem in this field is to understand in advance, in the design phase, how to build the machines and what and how they must operate without any need of a TRL classification, which is only a cosmetic overstructure invented for communication with executives who are not skilled technologists and/or deeply involved.
In other words, it is necessary to build and validate detailed specifications, but there are none for a non-existent machine. They must be developed through years of tests, creativity, study and research. After that, there remain only good engineering practices.
KiteGen has consistently followed this path to the end. That is why we can demonstrate this clarity of ideas and project our reasoning both on process and performance.

If such classification is absolutely required, it is better to adopt a more meaningful criterion in order to allow better understanding of managerial decisions.

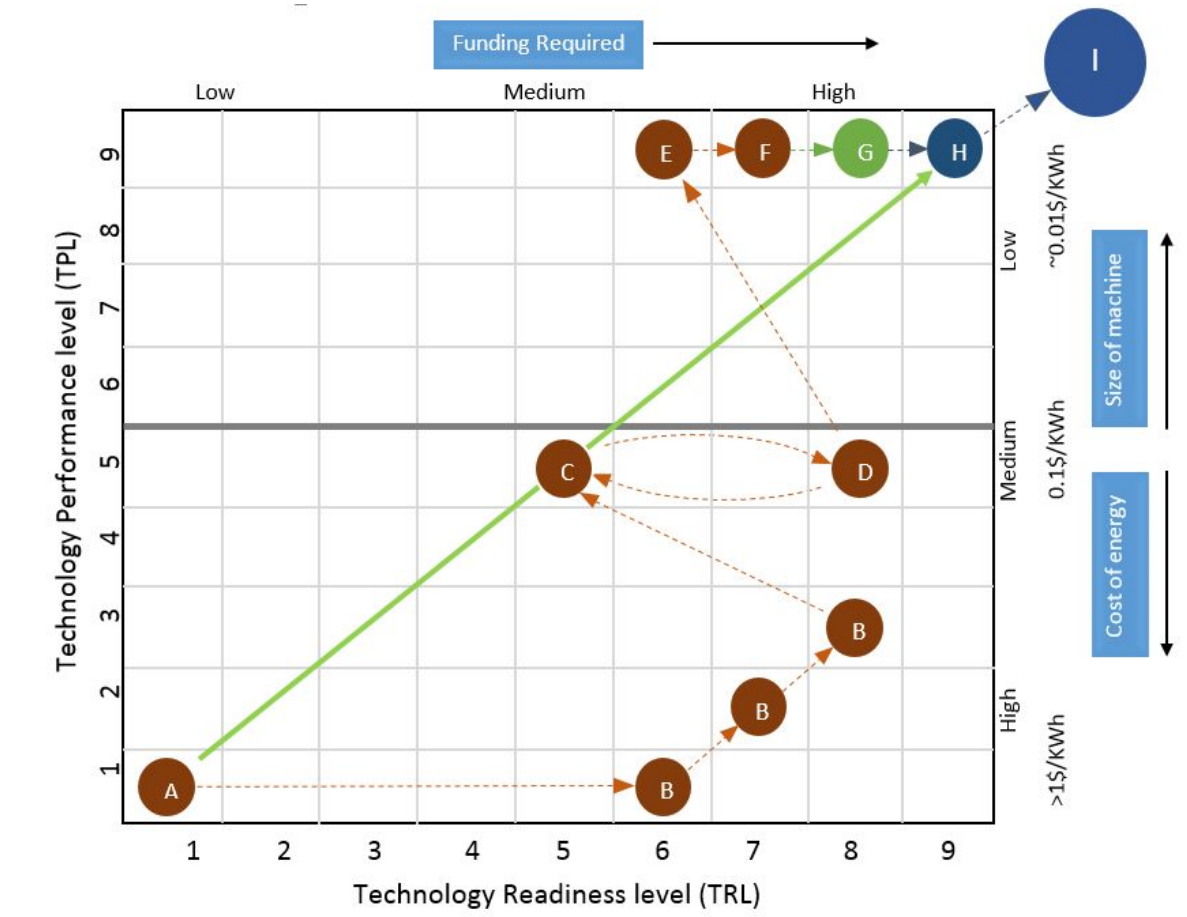
[25] J.Weber https://www.nrel.gov/wind/assets/pdfs/wec-technology-readiness-performance-matrix.pdf

The Ecorys report attempts to introduce a new classification of technology readiness level (TRL), and this new classification is clearly in contradiction with what KiteGen has correctly reported in its own documents, but attention has been lacking to appreciate the disagreement. In fact, the correct method to evaluate this technology must be a performance and technology matrix. The exploitation for the purpose of energy production of tropospheric wind has already reached TRL 8 several times, with numerous prototypes that have succeeded over time.

The concept certainly produces copious amounts of energy but, unfortunately, it is not feasible if the operation cannot be implemented on an appropriate scale.

The authors developed a specific TRL scale for the different AWE concepts. It may be argued that the proposed scale does not fit with an early stage of energy sector technologies, where the scale of TRL is modified. Here, the TRL is inversely related to the CoE (cost of Energy), Capex (capital expenditure), and Opex (operational expenditure). In fact, in the proposed study, the TPL (Technology Performance Level) has not been considered, but the TPL is what establishes the stages of development in AWE, considering the CoE. A two-dimensional matrix can be represented based on TRL and TPL, that narrates a completely different story.

Many of these technologies at high TPL closely reflect similarities to the aerospace industry (aircraft and rockets may not be tested before reaching an industrial quality level because of safety issues), requiring emphasis on industrialization, safety, and quality before going to field testing. In this respect, such industrialization and quality improvement work done by our company is ignored and pushed back by the proposed TRL scale. Upon examination in the proposed scale, the TRL value for KiteGen scores an “8” and is in its transition phase to a TRL value of “9” allowing deployment of the final product. This is depicted in the following matrix:



Icon	TPL,TRL	Description	Timeframe	Cost
A	1,1	Ideation phase and first assessments	<2003	Voluntary based
B	1-3,6-8	First energy-producing prototypes	2003-2007	0.5M€
C	5,5	New design efforts, exploiting the experience of the first functional prototypes	2008-2012	0.5M€
D	5,8	Second, third and fourth working prototypes, developed in a loop with problem-solving and architectural modifications (this level was adequate for deployment under subsidiary policies reserved to PV or WT)	2010-2013	$2M

E	9,6	Final design based on clear and firm specifications (surpassing the TPL 5 threshold)	2013-2014	3M€
F	9,7	Component development and validation, i.e wing, high-efficiency pulley	2014-2018	$18M
G	9,8	System integration i.e. full robot piloting wings (current KiteGen phase)	2018-2021	$6M
H	9,9	Farm deployment with an expected initial LCOE of $30/MWh @ 5000h	Fund dependent	$100M
I	n,n	Continuous optimization up to $5/MWh and 8300h with new wings and Carousel architecture	Fully depend on a friendly policy/gov environment	**auto-breeding** the technology supports itself, both for further research and deployment efforts

TPL Glass-Ceiling/Threshold/Barrier and Scalability Issues

As depicted in the TPL, the TRL matrix technology level presented a barrier at TPL value 5, a sort of “glass ceiling” that, despite all efforts, seemed impossible to overcome.
It is a scalability discontinuity:

- Flexible fabric wings cannot survive the forces and aerodynamic stress required for energy production.
- Rigid flat wings cannot structurally withstand the forces without unacceptable weight (longeron beam).

The solution from KiteGen is a rigid C-shaped wing. The C-shaped wing is a consequence of great ingenuity, set up by the Legaignoux brothers, inventors of the inflatable leading edge, thereby opening a revolutionary new wing concept. Before this invention, the existing C-shaped wing could only be framed, and was unable to fly independently. It was a wing that could sustain the aerodynamic forces maintaining the shape span by exploiting those same forces.
The KiteGen power wing consists of 9 to 11 different segments that are connected with flexible joints. This solution combines all the advantages, allowing MN class traction forces with a few hundred kg of wing weight while maintaining flexibility for sideslip maneuvers.

Evidence 4: Tethered Airfoils and the Power Wing

Tethered Airfoil in General

Occasionally, new technologies are developed that meet global needs but generate disruptive effects on the economy. Widely recognized examples are the steam engine, the dynamo, the telephone, the light bulb, the transistor, the radio, fax machines, television, computers, the automobile, airplanes, etc. The intent here is to highlight another technology, the tethered airfoil, with the potential to generate a paradigm shift exceeding any of these. The development and deployment of this technology could yield the cheapest and cleanest means of electrical power generation ever employed to date. That would especially benefit energy intensive processes, namely: synfuels, water desalination, mining and smelting in general.

Each of these four areas could be revolutionized by the introduction of products that incorporate tethered airfoils, aerodynamically efficient wings that have sufficient lift-to-drag ratios of ten-to-one or greater. Unless stated otherwise, they are extremely light and resistant, providing traction in the range of MN forces. These airfoils have onboard power and autopilot auxiliaries for stable, remotely controllable tethered flight. Most importantly, they provide a means of harnessing wind power to provide the mechanical power required to convert it into electricity.

The amount of power that a tethered airfoil could generate is not merely proportional to the size of the airfoil. It is proportional to the area swept by the airfoil per unit of time, as with wind turbines. Even a small airfoil that quickly traverses a large area would generate great amounts of power. Tethered airfoils could generate far more power than wind turbines simply because they could sweep a greater area for an equivalent expenditure, since they would not have the cost of the tower or be limited to the blade sizes that towers could accommodate.

It is easy to compute such an increase in performance through Betz laws. In particular, the flying wings expose a lower Betz efficiency, compensated for by the larger area swept, which allows it to outperform the energy-harnessing potential of the wind turbine blades by a factor of three, assuming equal conditions of wind speed and aerodynamic surface.

KiteGen's Giant Power Wing

This is the most successful development for KiteGen. The complexity of the design matches the typical design of a new aircraft, the difference being that a company like Boeing or Airbus employs thousands of workforce personnel and billions in investment to do so. KiteGen does not.

KiteGen's solution is a rigid C-shaped wing. The C-shaped wing is a consequential piece of genial ingenuity set up by the Legaignoux brothers who invented the inflatable leading edge,

thereby opening a new wing concept. Before this invention, the C-shaped wing had to be framed, and it was unable to fly independently. It could sustain the aerodynamic forces maintaining the shape span by exploiting those same forces. The KiteGen power wing consists of 9 to 11 separate segments that are connected with flexible joints. This solution combines all the advantages, allowing MN class traction forces with a few hundred kg of wing weight while maintaining the flexibility for sideslip maneuvers.

The wings produced by KiteGen are waiting for the launcher robot that is currently being developed/improved. The wings have already been submitted to extensive testing activity. Unfortunately, there is no existing wind tunnel large enough, but a clever method has been adopted to generally assess and validate the AE(aerodynamic efficiency), the wing balance and behavior.

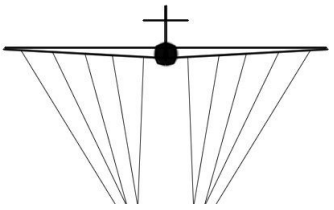
This significant development is not mentioned in the Ecorys study, even as a category of wing concept. To summarize, it is an ultralight wing that weighs 250-400 kg with a total surface of 130-300 sqm.
The wing is comprised of 9-11 rigid segments with an aerodynamic profile of 130 of AE. The preliminary assembly exposes a total AE of 28 with CFD forecasts ranging from 18 to 60.
This wing combines all the desired features of a Power Wing tailored for energy production: high AE, flexibility, ultralight weight, MN class of axial resistance, and inexpensive flight equipment.
It is the long-awaited innovation to break the performance threshold that was limiting the HAWES concept to a maximum of about 100 kW when operated with flat wings or fabric kites.

Inflatable Kites - good for research

Introduced the C-shape concept (Legagnoux draft below)
Allowed basic research in high winds
Unfortunately are very low in AE and durability

Flat Rigid Wing

This type of wing dramatically misses the requirement to provide a favorable traction/weight ratio while exposing a barely acceptable advantage in terms of AE compared to C-shaped wings.
Simple structural analysis shows that the resistance requirements are similar to those of aircraft.A flat wing designed to sustain 1MN of traction on a single rope can sustain an object that weighs up to a hundred tons.
In order to deal with this hurdle, it is possible to divide the load on the beam/longeron with a spread of multiple bridles, but incurring in penalizing issues like the bridle drag exactly applied close to the aircraft or the need to manage the bending moment applied to the flying path.



Drones and Propellers

The most important parameter to consider to harness energy is the aerodynamic efficiency or Glide Factor. Unfortunately, all airfoil wing concepts that carry propellers must find a reasonable compromise between AE and the fraction of power reserved to the propellers.

Evidence 5: Best Concept System Architecture

The report claims that "*there is no agreement yet on the best concept or set of best concepts*".
We strongly disagree. KiteGen, as the first concept developer and inventor of the pumping kite and Carousel concepts, was also first in aligning all the possible architectures in order to make a systematic selection of the best concept.
KiteGen took considerable time to consider opinions, receive contributions and make an early and comprehensive selection of the architectures, having achieved a firm and wide understanding of the multidisciplinary domains involving the technology. Hundreds of hours of brainstorming allowed us to exclude all of these suboptimal, low TPL, concepts such as:

- FlyGen (main reason for exclusion lies in the conductive tether that will make an electrostatic short circuit between the atmosphere layers)
- Underwater Kite (the energy in sea currents is very small, harnessing it in larger scales suppresses oceanic movements, and its natural "breathing", an environmental hazard)
- Flat wings (structurally unfavourable, too heavy when designed to withstand the nominal force)
- Blimps and balloons (not suitable in presence of wind or even a breeze)
- Traction Parachutes (missing the wing lift multiplier)
- Crosswind Drones (the propellers reduce aerodynamic efficiency)
- Static drones (too heavy vs. wind front harnessed)
- Traction Roto-kites (excessive complexity to address the non-issue of tether drag)
- Torque Roto-kites (the mechanical power is transferred with the tether torque)
- Flying Persian Panemones (there is an inflation of those machines, that obviously miss the basic understanding of the effective wind exploitation theory, also loop drive concepts -like laddermill- belongs to this category)

KiteGen Carousel

The first choice is indeed the KiteGen Carousel concept, both onshore and offshore, due to the attainable scale in the GW class in order to provide the only credible and feasible solution to the energy industry, acknowledging the dimensions and enormity of the energy problem we face. The Carousel has been sufficiently developed and designed to be ready

for industrial applications. The baseload behavior of the KiteGen Carousel alone justifies the absolute prominence of this architecture.

The second choice was the KiteGen Stem Single Pumping Kite, but the first to be developed because the Carousel, despite its advantages and obvious feasibility, seems too large to start as a new technology deployment. However, this decision wasn't harmful to the project, as the Carousel Inherits the theoretical framework and most of the developments from the pumping wing concept, eliminating most of the rope reel out/in drawbacks
KiteGen shared this knowledge with patents, conferences, publications, movies and during all the meetings including considerable due diligence in negotiation proceedings in order to disseminate the ultimate solution.
The main problem, perhaps, is the novelty of this domain and the limited resources spent for its dissemination. Typically, it takes months of training to develop a skilled and receptive technician with all the knowledge required to be productive and suitable for the development team or to be able to provide reliable evaluations or contributions.

FlyGen and GroundGen

From the emergence of High Altitude Wind Energy (HAWE), players have been divided between ground-gen and fly-gen. Following the missed opportunity to merge the IP asset of KiteGen and Pete Lynn (acquired by Makani - Google-X), the latter party was obliged to abandon the ground-gen design to avoid infringement of KiteGen's IP and developed a flygen generator derived from Lynn's concept.
Airborne Wind Energy (AWE) describes the concept of a flying wind turbine connected to the grid by a conductive cable.

KiteGen remarks about the AWEC conference

Many other players who have entered the HAWE field have no valid IP assets and, surprisingly, some have been invited to participate in a yearly conference called the Airborne Wind Energy Conference (AWEC).

KiteGen has been criticised for having never officially attended said conference.
Our reasons for doing so are:

- We are not working on an AWE(Airborne Wind Equipments) system; the correct acronym for our concepts should be HAWES (High Altitude Wind Energy Systems)
- To avoid losing credibility by mixing with scam projects (like blimps) that sometimes are actually presented and discussed at the conferences
- 40 worldwide extended valid granted patents give added value to KiteGen, which is open to cooperation with those companies or individuals that are willing to work together under the protection of KiteGen's IP.
- Many companies in AWE circles do not consider KiteGen's IP important. In search of financial resources, they prefer creating new initiatives with no valid patents or

knowledge to replicate small scale generators that were produced by KiteGen *ten years ago*,

- Ideas declared crazy by the same proponents are claimed deserving of membership rights, as particularly funny and confusing in this emerging sector, without measuring the awareness spreading damages.

Illogical Accusation in the Report towards the developers.

The report mentions, falsely, that the actors who lead the development in AWES are optimistically biased due to self-interests; this seemingly a demonstration of bad faith and fear of admitting problems in their go-no-go issues. KiteGen took care of a risky mission outside a logic profit. The devil hides in the details and the project was close to be aborted several times due to apparently insolvable technological and safety hurdles but has always used realistic and conservative figures in regard to the expected system's performance, rather, the problem now is the strong advancement of technology towards the poor generalized capacity to understand science declined in technology.

At KiteGen, we would prefer to be asked timely questions about our statements or doubts about our assertions rather than be surprised after the fact. This is an open invitation to meet the team, In any case, it would be a good opportunity to continue the discussion of this unprecedented opportunity. The main goal of this report seems to be to obfuscate our vision and our work toward social good.

The dilemma: Demonstrate or be Committed to Design and Improve the Specifications

In order to overcome this lack of understanding, new prototypes and demonstrations are certainly required, but this is not a best practice in development, as immature prototypes consume time and resources when operated outside the appropriate logic of validation steps.
This technology deserves a special machine's approach, and is similar to the aerospace approach, which is by far the best and most economical method to reach a successful result. A set of specifications applied to the subcomponents and the relative interfaces must be first experimented with, validated and, finally, fixed.

A good example of this would be a rocket endo-reactor, which is a complex piece of technology that includes turbo-pumps for combustibles, and deals with cryogenic temperatures as well as full combustion temperatures. To test such developments directly aboard the rocket wastes an inordinate amount of time and expense for even minor failures. So, the best approach is to test and finalize the engine in a special ground-level fixture, suitable to reach the maximum thrust without flying, thus gaining operative data, control and experience.

KiteGen aligned a set of brand new components. Each one needed to be tested and optimized before any integration. The wing does not need to be flown in order to check the moto-alternator or its high-efficiency pulley. Testing validation of sensors, the radio link, the actuators, the tenso-structural resistance of the wing or the Cm, does not require flight.

Continuous Operation as a Requirement

KiteGen conducted tests involving dozens of people and we never felt a need for continuous operation before technological completion of the machine, especially in a situation of under-capitalization of the development activity.
Continuous operation of immature systems during technological development is an expensive luxury that can only be afforded if there is a serious commitment and policy of publicly financed research. It costs a hundred thousand euros per day to assure public and workers safety, security of the equipment and correct test procedures. This money only has a formative value for the people involved because the actual device is already designed, realized and installed.
Tests have the paramount goal to collect specifications and drive decision making, after that, months of further design and laboratory activity is required before planning another test. All actors have immature prototypes and a lot of homework left to do. In particular KiteGen assume ended own investigative test activity, the next tests will be only performed on a mature and industrial scale design.

What could go wrong during a week or a year of operation?
It is very easy to list the foreseen problems. Some are:

- Wearing out of ropes
- Wing loss of rigidity, delaminations and fatigue failures
- Electronic equipment maintenance issues

Other Methodological Errors of the Ecorys Report

The report raised doubt about the contribution that the technology can provide to decarbonisation targets, but this could be measured in advance with simple assumptions about the complete solution of technological issues and upper-boundary evaluations.

The authors have also missed making a critical conclusion from the literature review (background study) and have claimed that AWES has to compete with conventional wind for spatial and airspace resources. They have also limited AWES to assume an advantage only in the event of other renewable energy sources not producing electricity economically. It is globally acknowledged that AWES does not strive to compete with conventional wind systems, as it has obvious potential to harness energy at a much cheaper cost of electricity (CoE) than any other currently utilized renewable methods. This is because:

- HAWES can sweep through more area than conventional wind turbines and can reach higher altitudes, harnessing energy from the stronger winds
- There is a considerable reduction in Capex in the absence of need for structural support

HAWES has an immense potential to reach established targets of energy generation, not within reach of conventional renewable energy systems.
As mentioned in the ECORYS report, AWES has to compete with other uses of airspace, like transport or possible emergencies; but, during the establishment of automation and engineering practices, this competition would certainly become a collaborative operation.

Auto-Breeding Concept Missing

This was a method used to evaluate the quality of an energy source as well the EPT (energy payback time), abandoned because it was considered too severe.

Regarding solar photovoltaics and traditional wind energy, the EU decided to launch and impose these concepts' deployment despite the lack of good EPT, TPL values, with the belief that there would be improvements in the future. After 10 years, despite the grandiose announcements and almost €1000 billion of cumulative investment in Europe and fivefold that worldwide, we have yet to see a single example of an entirely renewable-energy powered factory producing silicon and panels or steel/cement and wind turbines. This auto-breeding concept would have been a renowned demonstration of the success of these technologies. KiteGen instead is agreeable to be measured by just such a method.

EroEI Energy Quality Concept Missing

This important parameter is within the sophisticated domain of Emergy, Exergy and LCA analysis, the main property being predicting the quality of energy generated, even in an immature technology; avoiding financial issues, subsidies and other related issues.
The great success of the ERoEI indicator is ultimately demonstrated by PV technology, but after about $5T of worldwide investment and a dramatic cost-per-W reduction, many scientists are still arguing whether it is an energy source, or sink.[26]

It is a meaningful indicator of the performance of each energy technology and the economic effects[27] .
Unfortunately, the original formulation was hindered due to a political agenda introducing the need to boost adoption of renewable sources by a factor of 10.
The main problem is photovoltaic conversion, which has a legacy ERoEI of about 1, and this makes evident the inutility of its adoption in a large-scale connected grid.

The dramatic forcing of this parameter was done by boosting the EROEI formula (ENERGY RETURN / ENERGY INPUT) RETURN of Solar PV by 300% as it replaces coal energy, having 33% thermal efficiency. As well, under the hypothesis that the solar plant is built using only renewable energy instead of coal, the INPUT is reduced by 2/3.

In brief, if the new source of energy allows reduction of coal in thermoelectric plants, the output energy “ER” is no longer the output kWh counter, but the coal energy equivalent saved in the plant, de facto more than tripling the output.

The analogue strategy was adopted for the “EI” term if panel manufacturing was powered with renewables, such as hydroelectric, the energy cost is reduced by more than 2/3.

The reality often shows a different history. The panels and silicon are produced with Chinese coal and the output competes with a mix, including nuclear energy, gas turbines and renewables.

Regardless, for KiteGen, what is important is the relationship with other sources adopting the same methodology for consistency. Several LCA studies, based on a deep mastery of the concept and comprehensive design activity, give the following results:

[26] Luis De Souza
https://cassandralegacy.blogspot.com/2016/06/photovoltaic-is-energy-source-not-sink.html
[27] Jancovici, J.M. « L’économie aurait-elle un vague rapport avec l’énergie? »(2013), LH Forum, 27 septembre 2013

ERoEI	Raugei/Fthenakis/Bardi/ Elliott et al.[28] methodologies	Hall/Ferroni[29]/Prieto et al. /Weissbach Methodology
KiteGen Carousel	1500[Saraceno Bardi[30]] -10000	150
KiteGen Stem	375[Bardi[31]]-3000	35
Hydroelectric	58-250	80-100
Coal	3.5 [Raugei and Leccisi] -17	50
Wind turbines	10-40	4
Nuclear	5-30	5
photovoltaic	10-40	0.8 -2.5
biofuels	0.6-1.2	<1 [Pimentel]

The quality of traditional energy sources is in decline and renewable sources that aim to replace them are of even lower quality. With our high standard of living dependent upon high quality energy sources, the need to accurately measure ERoEI has never been greater. Systems analysis should be focused on the social benefit derived and used to define the boundaries of ERoEI to provide a universal point of reference as a means of comparing various energy sources.

[28] Collection of EROI figures by D.Elliott: http://www.feasta.org/documents/wells/contents.html?two/wellselliott.html

[29] Ferruccio Ferroni and Robert J. Hopkirk 2016: Energy Return on Energy Invested (ERoEI) for photovoltaic solar systems in regions of moderate insolation: Energy Policy 94 (2016) 336–344 **A new study by Ferroni and Hopkirk estimates the ERoEI of temperate latitude solar photovoltaic (PV) systems to be 0.83. That means more energy is used to make the PV panels than will ever be recovered from them during their 25 year lifetime. A PV panel will produce more CO2 than if coal were simply used directly to make electricity. Worse than that, all the CO2 from PV production is in the atmosphere immediately, while burning coal to make electricity spreads the emissions over a 25 year period.** https://www.sciencedirect.com/science/article/pii/S0301421516301379

[30] Le proposte di KiteGen Resarch per un Nuovo Piano Energetico Nazionale basato sugli obiettivi UE 20-20-20 [italian] http://kitegen.com/wp-content/uploads/2010/07/PEN-KGR2010.pdf
This value of 1500 or even 10000 of ERoEI is the direct consequence of what KiteGen considers junk science that has been tolerated too long. KiteGen proposes this value because a provocation like "the emperor is naked" has in fact triggered a controversy, from which has emerged serious contradictions of the indiscriminate manipulation of the ERoEI as an indicator of the quality of energy. It is difficult to understand why this boost methodology of the ERoEI, according to one of the promoters themselves, should be reserved exclusively for solar photovoltaics and wind turbines. Dr. E.Mearns review on HAWE EROEI http://euanmearns.com/the-eroei-of-high-altitude-wind-power/#comment-20704
[italian] https://ugobardi.blogspot.com/2016/01/ugo-bardi-il-kitegen-e-la-culona.html **In this post, Bardi denies ever claiming that the EROEI of KiteGen was 1500. Actually, he calculated 375, as in the oil drum post cited above, and this value refers to the KiteGen Stem. So Bardi has forgotten, or pretends to have forgotten, that KiteGen has two configurations and that if he finds ERoEI=375 for the Stem configuration, then, following the fourfold performance increase of the Carousel configuration with respect to the Stem, it comes to exactly 1500.**

[31] High altitude wind power: an era of abundance? http://europe.theoildrum.com/node/5538

Why KiteGen Claims to be the Last Energy Reservoir Left to Humankind

Of course, there is wide consensus about the finite quantity of fossil and nuclear resources available on Earth and that solar irradiation is a clean source of energy, ten thousand times greater than the world's current energy demands, available as light (solar PV), kinetic energy (wind), biomass or potential (Hydro). But solar irradiation has to be collected over the planet's surface and the different technologies deal with many constraints. Hydropower is limited by the availability of suitable rivers and water reservoirs, biomass is limited by the low efficiency of photosynthesis that requires very large surfaces to exploit the energy content. Wind power is limited by the structural limits of wind turbines, harnessing only the lower and less powerful layer of the atmosphere. Solar PV is limited by the available and accessible surface. So the future energy strategy of the world may be to build as many solar PV as needed to get the needed power or to try to get to the higher altitude winds as KiteGen is proposing.
When it comes to energy strategy, it is necessary to assess the best useable tools like EROI. There is a lot of confusion about EROI; it is never a single value for a given energy source but a variable, as the inputs and the outputs may change because of constraints, policy, technology advances and so on. Moreover, many scientific studies are financed by stakeholders that have biases about a particular technology and try to "cherry pick" positive results or other tricks to raise the subjective reported performance of that technology.

One of the best examples is the Raugei/Ftenakis assessment of solar PV EROI. Once calculated, taking into account the energy inputs and outputs, the two researchers claim that the result has to be multiplied by three because it saved electricity produced using coal (33% thermal efficiency). Moreover it is multiplied by three one more time because they claim that the solar panels are produced using renewable energy, thus avoiding purchasing electricity produced from coal. A first issue using such EROI figures is that the above claims do not really multiply by three and the energy available from solar PV plants does not really divide by three the energy input needed to produce them. So it isn't useful to evaluate this technology. After all, it is a fact that most of the solar PV are produced in China powered 70% by coal and are deployed in developed countries that have an energy mix with a coal share much smaller than China, exactly contrary to Raugei/Ftenakis claims.

So it may be useful to introduce a neutral and parametric methodology to calculate a quality index for any given technology. Its name should be the "Auto Breeding Consistency Index". The index would answer the question, "What it is the best use of a unit of energy?"

In other words, we are asking ourselves how a certain class of energy facility ranks compared to others. To avoid the artificial boost created by Raugei/Ftenakis, it should be assumed that each technology is auto-breeding. In other words, the energy needed to build its facility comes from the same kind of facility or from the same source (a solar plant for solar PV, a coal mine for coal power, a gas field for gas power).

The methodology does not need to know the industrial process technicalities in depth because it uses a strict correlation between energy consumption and GDP which suggests that the costs incurred to maintain a certain amount of energy production reflect the energy input spent to do so. If there is a government subsidy for the technology, it only means that energy has been consumed in the past to produce the funds given to subsidize the technology, so it must be accounted for in the energy Input to produce an accurate result.

Deployment cost represents the amount of energy needed to build the energy facility. In this case, the kWh/$GDP indicator could be misleading, as it describes an average energy consumption per unit of GDP, including both light industry, heavy industry, services and agriculture, while the construction of a power plant is always an endeavor using heavy industry. Therefore, a better indicator is the cost of the electricity for industrial use. As a rule of thumb, useful in the analysis of industrial processes, half of the deployment cost of the power plant is used to buy the energy needed to build and deploy the facility. It is simple to determine which is the share of energy cost in the price of aluminum, steel, refined silicon, concrete, copper and glass, the most relevant components of any energy facility. To solve the unknown about whether the production process used electricity and/or thermal, the cost of electricity is to be adjusted by the thermoelectric efficiency rate, thus taking into account both the direct use of thermal energy and the use of electricity (that is transformed thermal energy).
By the way, deployment costs per kWp do not accurately describe the CAPEX needed to generate a given quantity of energy in a one-year timeframe. It must be adjusted multiplying by the ratio between the desired quantity of energy and the capacity factor.

Need to know:

- Average market deployment cost for one kWp
- Average maintenance cost
- Anticipated lifetime
- The average capacity factor
- The thermoelectric efficiency (if thermal power, 100%, if renewable)
- The amount of any subsidy given
- The industrial cost of energy

Method:

1) Calculate the energy cost of the fuel or consumables: c, capacity factor * thermoelectric efficiency. If the source is renewable, put zero[32].
2) Calculate the cost to deploy a reasonable amount of power in order to produce an amount of energy given as a reference[33]. I suggest using 6000 kWh/kW, as it is the typical capacity factor of 1 kWp of baseload coal fired or CCGT plants.

[32] That's not really correct because the process to produce a renewable energy facility may also require thermal power.
[33] The calculation should be refined taking into account a storage system to manage the intermittency when putting solar and wind into the model.

3) The adjusted deployment cost is used to calculate the energy embedded in the plant assuming that half of its cost is spent directly to buy energy for the construction process.
4) Calculate the energy cost of maintenance using the kWh/$ energy intensity of your country, or better, the world average of 1.45 kWh per $ of GDP
5) Calculate the energy cost of the subsidy (if there is one) using the same ratio
6) The total energy input is the adjusted deployment cost plus the sum of fuel plus subsidy plus maintenance multiplied by the expected lifetime
7) The total energy output is the reference capacity factor multiplied by the lifetime
8) Determine the EO/EI rate
9) To take into account auto-breeding, the EO/EI is to be multiplied by the EROI of the energy source (if fossil) or just squared if it is a renewable as you are assuming to use the same device to get the energy needed to get another device.

The result is an index that shows how many energy units could be produced starting from an energy unit and using a plant of a technology built using the energy obtained from the same source.
Let's follow the calculation for both a fossil and for a renewable source.
A coal-fired plant deployment cost is about $2500/kWp and has a maintenance cost around $50 per year per kWp. 6000 kWh/kWp is a typical capacity factor (CF) for such a plant that is fit for a baseload role. 6000 kWh/kWp is a good reference CF for whatever power production technology. Typically, the lifetime of a coal-powered plant is 20 years before repowering and refurbishment that usually means a total rebuilding. Thermal efficiency is 35%-45%, 40% on average. We want to produce 6000 kWh a year, so 1 kWp will be enough and 15,000 thermal kWh of coal will be consumed to such effort. Assuming 0.04 $/kWh cost of electricity for industrial use, the energy embedded in the 2500 $/kWp is 2500/(2 * 0.04 * 40%). 78 MWh is the energy embedded in the CAPEX per kWp of a coal plant. Assuming $50/kWp, the yearly cost of maintenance energy embedded in the OPEX is 50 * 1,45 *20 = 1.45 MWh in 20 years (1.45 KWh/$ is the world's average energy consumption per $ of GDP). Thus, summing up the three factors, the total energy cost of 1 kWp of a coal power plant that produces 120 MWh in 20 years is about 380 MWh. That means a ratio of 0.32 for Energy Output / Energy Input. In the coal auto-breeding scenario, a kWh to mine coal will yield about 30 kWh of thermal coal to burn in the power plant, thus producing 9.48 kWh of electricity.
The wind turbine deployment cost reference is about 1500 $/kWp while the average capacity factor is 20% (Northern Europe). So the CAPEX needed to produce the reference 6000 kWh per year is $5,000. Since we are auto-breeding the wind turbine, there will be no thermal efficiency rate to consider; thus, the embedded energy is 5000/(2 * 0.04 * 100%) = 62.5 MWh.
Assuming a green certificate (or other subsidy) of 0.16 $/kWh, the energy embedded in the subsidy is about 1.4 MWh per year while there will be no cost for fuel nor for maintenance, as it is yet to be accounted for in the subsidy. EO/EI for wind turbines is 1.33; to auto-breed it, the energy for building and deploying comes from a wind turbine as well, so investing an energy unit to auto-breed a wind turbine will yield 1.33*1.33 = 1.76 units.

Inserting the performances expected for KiteGen in the auto-breeding model (CAPEX as low as $333/kW, OPEX 2% and 80% capacity factor) yields an astounding rate of 1000 kWh for each kWh invested in auto-breeding while solar PV is penalized by the low capacity factor and subsidies are still needed, getting a ranking of 0.23 kWh for each kWh invested in auto-breeding. The table below is a summary that shows the results from the methodology.

	deploy cost $/kW	capacity factor kWh/kW	Fuel or consumables kWh th/y	FIT $/kWh	grid burden $/kWh	energy embedded in FIT kWh/y	deploy cost $ per coal fired equivalent kW	energy embedded in capital kWh/kWp	O&M 20y (kWh)	Total energy cost 20 y (kWh)	thermoelectric efficiency	Energy Input / Energy Output (conversion)	EROI energy supply	Autobreed EROI energy unit lifecycle
coal	2500	6000	15000				2500	78125	1450	379575.0	40.00%	0.32	30.00	9.48
gas	1000	6000	12000				1000	25000	1450	266450.0	50.00%	0.45	10.00	4.50
wind	1500	1800		0.1	0.06	1392	5000	62500		90340.0	100.00%	1.33	1.33	1.76
solar PV	3000	1200		0.3	0.06	3132	15000	187500		250140.0	100.00%	0.48	0.48	0.23
KiteGen	333	7000	0.02				285	3568	203	3771.3	100.00%	31.82	31.82	1012.49

Where: Cost of electricity=0.04 $/kWh (industrial use), energy intensity=1.45 kWh per $ GDP, total energy production target 120 MWh/kWp in 20 years

Recalling the “last energy reservoir for humankind” claim after such analysis helps to better understand its meaning. Without a subsidy from fossil energy (i.e. in an auto-breeding mode) the current candidates for the role of new energy sources for humankind, namely solar PV and wind turbines are not efficient. The low values are also conservative because thermal inputs and storage systems are not counted in the calculation (see the notes). In other words, we can claim that current solar and wind technologies depend on a fossil subsidy. KiteGen High Wind technology could be the quantum leap needed to overthrow fossil fuel dominance and finally bring us to the clean and renewable energy era.

Techno Fixes classification score for KiteGen[34]	
Effectiveness at reducing greenhouse gas emissions:	**10/10** - embodied energy of KiteGen is 1/100 of wind turbines. Baseload feature no need of backup power. This means a strong carbon negative.
Living up to the hype (science-to-spin ratio):	**10:1**- up until now, there has been no broad advertising or dissemination of the achievements of the successful research. Only a few scientists and respected professionals around the world are aware and fully understand the technology.
Democratic ownership and control:	**10/10** – very decentralised and distributed at community levels, local employment potential, not selfish individual and expensive implementation as with solar PV
Social justice:	**10/10** – no negative side-effects and allows wide deployment of electricity availability into off-grid areas. It reduces or eliminates energy poverty. Electrical energy access while easy the life, enhance education, birth control and reproduction responsibility.
Sustainability:	**10/10** auto-breeding technology, inexhaustible natural source of power. No land consumption
Scalability:	**10/10** – could provide for virtually total global consumption including primary energy, storage is completely solved, no relevant negative side effects to the atmosphere.

[34] The word “Tecnofixes” itself has assumed a negative connotation in discussions about the future, and KiteGen as geoengineering has often been blamed for this as hype, but metrics are still important. https://corporatewatch.org/wp-content/uploads/2017/09/Technofixes.pdf

The Real Barriers to Technology Deployment

Exceptional Unfair Negotiation

The lack of institutional support or recognition, depresses the value and the strength of the project even during private negotiations due the unmitigated aggressivity of counterparts, resulting in damage to the common good in favor of maintaining the status quo.
At KiteGen, we consider the project, as already explained, has been concluded as of 2016, and ready to be mass or batch produced with the help of a major partner. We do not need to expend any effort to find contacts because all the major companies are well informed about the KiteGen opportunity and anonymously ask to open contacts and negotiate with us with a suggested rate well over our capability to follow those partnership projects.
Since this date we were involved in almost six negotiating desks, strictly following the liturgy of important agreements between companies:

- Preliminary technical diligence
- Preliminary discussion and MoU
- Full technical diligence
- Full legal diligence and patents verification
- JDA and foreground IP agreement
- Framework agreement
- Deployment agreement, including patent and licensing agreements

KiteGen itself spent almost 500MM for internal human resources involved in the due diligence and 100,000 euros for legal consultants in order to follow and set-up those agreements with those biggest players in the industrial and energy sectors.
With hindsight these resources would have been better used to form a young technologist
An incomplete list of the big actors met for negotiations includes: AEM-Iren ACEA(utilities of Turin and Rome); Edison-A2A-EDF; Makani Power (Google); Enel-GRTN; Enel Research; Toyota Research Europe; Carnival; Enel Green Power; Dongfeng Turbines; Huayi Electric; ExxonMobil; Toyota Japan-USA.

The companies that helped the project with minor or without counterbalance were:

- Shell (some early Phds master work supports)
- Naish Sails (don Montague giftes us of a series of inflatable power kites to test)
- Siemens Automation give us support at the very beginning of the research project
- Finally, Sabic Venture, that gave us the positive and substantial final push up to the end of the research and the beginning of industrialisation.

A special mention must be reserved for the worst actors we encountered, which are EGP, Huayi and ExxonMobil, that, after successful and optimistic technical diligences, they subjected KiteGen to a years lasting nightmarish gauntlet of bureaucratic requirements along with unfair and incompetent M&A officers that pointlessly cost us most of our effort while

wasting our money without any regard for the opinion of their own technicians and the relative size of our companies. KiteGen is a small engineering studio that has completed and applied the basic as well as technological research on the concept, and is owner of a comprehensive knowledge base and all the relevant patents.

During those tiresome negotiations, we discovered a common political/strategic agenda revealing the intention to purchase and freeze the KiteGen project or at least delay it. This feeling isn't cospirationism. Analyzing the financials of one of them, EGP, reveals an important part of the activity is energy subsidy dependent, and KiteGen certainly will intrinsically breaks such immorality. Exxon is even worse because their involvement in alternative energy is mainly dealing with algae processes, as seen before unanimously the lowest TPL available, raising the suspicion of "greenwashing" to give a sop to some rioting shareholders and "green" antagonists.
The current shareholders of KiteGen are even prepared to lose control of the company and patent ownership in exchange for a formal guarantee of full and serious industrial development and support of a reasonable and robust industrial plan. This point is not negotiable due to our ideals and vision. Unfortunately, our rigid position on this issue punctually killed any engagement, despite the early communication of our position.

Unfair Competitors

Wind Turbine Industry

The European wind industry refuses to tolerate the likely possibility of a more efficient alternative. They have deployed effective barriers to the support of our research, originating also by the various too specialistic HAWT referee called to evaluate wind power projects in general.

The Kyoto Protocol

Who remembers the Montreal Protocol regarding the ozone hole? The international organisation was dismantled after the industry easily found the right solution; swapping chlorofluorocarbons with hydrofluorocarbons.
The same is feared by the gang regularly attending COP conferences without any chance of success and effectiveness.
There is practically no evangelist of anthropogenic climate change who is not also an active supporter of photovoltaics. What a curious thing, because these specific climatologists claim the right to have the last word on the climate as they are the "real" specialists and with the same vehemence prescribe the photovoltaic solution, but it is clear that they haven't mastered the basics of the energy matter.
The strenuous defense to justify their existence manifests in their opposition to effective solutions. The catastrophic climate change "bandwagon" poses systematically a significant threat to promising initiatives like some geoengineering projects and KiteGen.
All this opposition is short-sighted because it will eventually be overwhelmed by relatively microscopic investments that will make it feasible to initiate the industrial plan that KiteGen has laid down, even if KiteGen isn't the one to carry it forward.

AWES Itself

The AWES concept has plenty of players claiming to add value in high altitude wind research and claims to be “inventor” of the pumping kite concept[35]. Makani has even decided to patent the concept of "pumping kite" after seeing it made in KiteGen[36].

KiteGen naively opened an early communication channel with Mac Brown, COO of Magenn, trying to explain the game-stopper flaws of the Magenn concept. Surprisingly, instead of drastically changing the focus at system’s architecture, Magenn adopted a new narrative based on the Magnus Effect. The Magnus Effect is a “homeopathic” force acting on a rotating body immersed in a flow. This was supposed to counteract the hundreds of kN force the wind could exert on the helium-filled blimp. However, this was very successful from the point of view of the oblivious investors and VCs, who finally preferred to invest in Magenn instead of KiteGen, so we had direct experience with that.

There is a lack of literature from Altaeros about their technology and assumptions, missing crucial details about the the power rating of their turbine in order to figure out their goals, and it gives the same impression as Magenn; not being an honest development, as Magenn, if addressed to the energy sector. Somewhat confusingly, they call their balloon “BAT”, which allegedly stands for “Balloon Airborne Turbine”.

This concept does not really capture the power of the wind the way a kite does. One can envisage it in a productive wind, but the device would get blown toward the ground, losing any advantage that altitude might offer. This lack of effective harnessing of energy makes it a nonviable technology, and it is also the reason that KiteGen does not participate in AWES, as unlikely concepts are still embraced and are primarily designed to collect money from unwary investors and VCs.

The Ecorys report still enumerates such concepts among others in a maniac style of the numismatic syndrome, where all the post stamps are collected independently of their value. Such an exercise became even more irrelevant and misfit when the report was assigned the role of a lesson to be learned; frustrating because of the engineering capabilities required to compute in advance the performance (TPL) and behaviour of such a concepts.

The Big Impact of a Few Minor Publications and False Studies Critical of the Technology

Over the course of technological evolution, we have seen thousands very positive scientific publications toward the concept. Unfortunately, a short series of publications trying to

[35] This paper is particularly painful for us because the signature of Wubbo Ockels among authors and no reference to KiteGen but the attempt to assign the Laddermill name to our IP.
http://www.kitepower.eu/images/stories/publications/lansdorp08.pdf

[36] Makani Power attempt to patent the pumping kite concept
https://worldwide.espacenet.com/publicationDetails/biblio?CC=WO&NR=2009020516A1&KC=A1&FT=D&ND=3&date=20090212&DB=&locale=en_EP#

undermine or contradict the concept have had a disproportionate impact and have spread widely.

Inexplicable Fury Against a Concept Defined as Promising by Many

Occasionally, powerful concepts like KiteGen successfully proceed privately because they are theoretically sound and well-demonstrated, and a decent number of private investors believe in them.
In this case, the EU seems to aim to disturb the initiative and tries to kill it in the cradle before it achieves any equilibrium. EU publications and research not only don't help the initiatives that are possibly harmful to the established renewables industry but also dare to damage the related intellectual property without any regard to the very essence of EU's own policies and values about protecting and promoting the creation of IP.

A Max Planck group claimed that the maximum possible extraction of energy from the atmosphere is only about 7.5 TW[37], while in reality, the established value is 1800 TW (100 times the human need) without affecting atmospheric circulation. In this deeply exploitive case, more energy is extracted from high altitude winds, and more is made available by the physics of the atmosphere where the pressure differentials are smoothed more slowly, creating a regenerating resource[38]. This allows a reasonable classification of it as an inexhaustible resource and, at this time, practically unlimited.

Other publications have made, perhaps, a concerted effort to establish technical limits to the extraction of energy by the wings and the machine, attempting to reformulate the famous Lloyd equation *i.e. adding the cosines elevated to the cube. This "achieves", as a result, the sole and incorrect recalculation of the cut-in speed of the tropospheric wind, the consequence of which, in the case of KiteGen, is that the wind speed at the beginning of energy production* changes only a few decimals.

Today, there is a potential technology that aims to extract energy from an immense reservoir, able also to respond effectively to energy storage issues. With this technology, the great concern of conscientious designers is to develop the equipment to withstand the high stresses applied by the wind at tens of meters per second. At the same time, it is hurtful to see a university committed to redefining minor details of this system such this cut-in speed.

Not surprisingly, followed by a lot of sequels, currently there is plenty of irrelevant, me-too, repetitious papers; papers that focus on optimisation of energy yield, looking for the max resource/max extraction, when in reality, papers focusing on the survival of the equipment through de-optimisation and escape strategy ahead of such a huge resource are more useful.

Drawing a parallel to the report by Ecorys that has been ordered by the European Commission is no exception and probably the cost of this report is compatible with the cost

[37] Miller, L. M., Gans, F., and Kleidon, A.: Jet stream wind power as a renewable energy resource: little power, big impacts, Earth Syst. Dynam., 2, 201-212, https://doi.org/10.5194/esd-2-201-2011, 2011. https://core.ac.uk/download/pdf/25951764.pdf
[38] J. C. Bergmann https://www.earth-syst-dynam-discuss.net/2/C244/2011/esdd-2-C244-2011.pdf

of test flight experiments of AWES as well as the energy production at an educational and research level. In fact, what the tropospheric wind needs is an increase of awareness and competence, not misleading and immature publications. In the report, there are some claims that are particularly offensive to those who are working with a serious dedication on this opportunity. By protesting against the approach of EU research, the energy, which is considered a strategic level emergency, still has not found a credible path. However, at the same time, the EU community is already spending more than 100 billion a year purely for subsidies to renewables when the energy turnover of a region like Saudi Arabia to the world is 200 billion annually.

The Viral Effect of Bad Literature

After the papers arguing to limit the altitude due to the tether drag issue, Cristina Archer accepted without criticism the finding and prepared a new paper[39] about wind maxima at lower altitudes, risking endorsement of such inaccurate papers.

Conclusion

There is no reasonable doubt that tropospheric wind will be the main energy source of the future for the simple reason that this global reservoir exists and is vastly superior to any other form of energy[40], including physically still-extractable coal. The research conducted in KiteGen has fulfilled all the theoretical and technological issues necessary for conceptual validation and drafting of design specifications of the potential extraction machines.
The best architecture for the extraction of energy from tropospheric wind is the KiteGen Carousel which, beyond easy feasibility, approximates maximum theoretical efficiency and offers superior economic and energy performance when compared to conventional power plants.
However, the KG-Carousel faces, like the general concept, objective difficulties in being correctly communicated, measured and accepted. The development of industrial scale plants must find at all levels of the chain an aware, informed and professional environment that will be definitely favorable and proactive. Publications such as the Ecoris report, which inexplicably add uncertainty, confusion and do not give added value, are a demonstration of the improper and unfortunately ineluctable burden which we are forced to dispatch to pave the way for innovation and a positive operational environment.
We believe, no matter what anyone else may say, KiteGen, or an entity like KiteGen, will develop the technology that will be the ultimate solution to the energy crisis.

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[39] *The ideal candidates for AWE farms, however, are where temporally consistent and high wind speeds are found at the lowest possible altitudes, to minimize the drag induced by tethers.*
Cristina L.Archer et.al - Airborne wind energy: Optimal locations and variability
https://www.sciencedirect.com/science/article/pii/S0960148113005752

[40] Other sources, such as nuclear fusion cannot be considered competitors because the base operation depends on finite resources which are already under stress such as lithium (isotope 6) and beryllium (as secondary sources of neutrons).
Current renewables, when compared mainly to hydro and KiteGen, can no longer sustain the narrative of the artificially high ERoEI, revealing their greenwashing political nature.

The accusation of being affected by an optimistic bias about the technology is rejected by common sense. By consolidated experience, the scientifically and technologically ill-equipped skeptical sentiments of personalities dissolve with the acquisition and direct application of remarkable scientific investigation conducted by KiteGen, which for obvious reasons cannot be summarized in simple publications.

What we must avoid is the Ecorys report becoming a justification of DG's (Directorate General for Energy of Europe) research that has systematically received and rejected dozens of project proposals submitted by different actors who are all focused on the exploitation of high-altitude winds. This reveals a serious malfunction of the institution, which means the EU is unable to properly spend European taxpayers' money.
Who has had the patience to follow the arguments presented here, can only agree that:

- It is shocking to see how the nonsensical and arrogant authors of the Ecorys report are trying to damage the ultimate solution that addresses the two most alarming issues that threaten human communities.
- It is equally unacceptable that the six authors of the report, without any skills in the technological sciences, are allowed to deliver a study on a multidisciplinary subject that they have not mastered, and demonstrably barely understand.
- It is absurd to oblige KiteGen, currently engaged in the development of industrial tooling for the project, to return to argue the ABC's of the project and defend its activities, let alone the concept itself, from the slander so prevalently insinuated in the report.
- It is outrageous, from part of the authors, to give rise to suspicion of optimistic bias driven by the interests of the people involved in such development. Today, the matter is quite simple and straightforward for insiders, and has been repeatedly validated and is mature for the industrial phase.
- Logic dictates that the authors are lazy investigators, or are indeed acting in bad faith, because it means they are committed to persisting in intimidation against energy innovation and and this is one of the most striking cases were censorship of knowledge violates human rights.

Recommendation

Promote and Enforce Respect of Intellectual Property

Europe has expressed, on several occasions, the importance of intellectual property practices. But, in this case, DG research encourages patent infringements and delays in legitimate exploitation of wind energy.

In particular, the report shows evidence of plagiaristic[41] practices:

[41]From Wikipedia:
Plagiarism is the "wrongful appropriation" and "stealing and publication" of another author's "language, thoughts, ideas, or expressions" and the representation of them as one's own original work. Plagiarism is considered academic dishonesty and a breach of journalistic

The author Lorenzo Fagiano cited a paper contradicting previous works and introduced a new private enterprise among the supposed stakeholders: Kitenergy
September 2011[42]

Adopt a Top-Down Approach More Suitable for Policy Makers

Europe desperately seeks new and affordable alternative sources of energy in order to sustain regional growth. Energy is a strategic issue, as 55 % of EU's primary energy is imported.
Europe has spent at least €100 billion per year for the last 10 years to subsidize sub-optimal options like photovoltaic and wind turbines, which then subordinates other options.
Tropospheric wind presents the opportunity to extract almost 1000 times the region's needs, for which a clear and solid concept has been proposed for its exploitation.
With very little funding, private investors supported the project, which provided the concept with a very positive result. To complete the industrialization phase of tropospheric wind exploitation and start its deployment would cost 0.01% of the total amount Europe spends for highly risky and suspect policies like subsidies for renewable energy and tax exemptions.
The great advantage of tropospheric wind technology is that it will not rely on subsidies to scale up its deployment.

Decarbonisation Target

Tropospheric wind exploitation will offer the most important contribution toward decarbonisation and conformance to the COP Paris commitments, which is a priority for the EU. When it comes to decarbonisation, tropospheric wind has the potential to be a hundred times more effective than wind turbines and a thousand times more effective than photovoltaics, CCS (Carbon Capture and Storage), fusion, algae, bioenergy or thalasso-energy.

Pay Attention to Conflicts of Interest Assigning Evaluation Work on this Opportunity

The DG research involved in wind energy is strongly prejudiced in favour of the wind turbine industry and prefers to create obstacles to new concepts. A new independent sub-organisation is needed to gather legitimate data and investigate this opportunity.
It is very easy to kill a technology in its cradle, the result of established prejudices.

ethics. It is subject to sanctions such as penalties, suspension, and even expulsion from school or work.

[42] Fagiano, Milanese and Piga, "Optimization of airborne wind energy generators" http://www.dariopiga.com/Papers/Journal/IJRNLKite2012.pdf

We do not know who commissioned this report, but it is in delay of almost ten years, both in content quality and publication. More or less the same time Lorenzo Fagiano left KiteGen.

Leave Site Planning and Experimentation Methodology to the Engineers

At KiteGen, we have spent most of our time writing proposals with detailed plans for national and European inquiries. Including site planning.
We also spent a remarkable amount of time publishing papers and strategizing in order to ease the friction this new concept is facing.
There is no need for the redundant tests recommended in the Ecorys report.

Embarrassing questions KiteGen Posed to the Stakeholder Community the Policymakers

European Research Funds

As the Pitágoras theorem could be easily demonstrated, it is easy in the energy domain as well, to assess and demonstrate performances of the different approaches in advance.
It seems that the research work-programmes that have been supported and approved during the past years are brainless and forgettable copies of ideas and concepts that have already been debunked due low TPL.
Some energy concepts and possible innovations that have gotten great support and have exposed their foreseeable limits and worthlessness are: CSP; CCS; OTEC; THALASSO ENERGY; Hydrogen economy; Fusion; PV; offshore wind turbines…
Furthermore, those numerous concepts have already received considerable research support since the 70's, confirming on field the theoretical barriers.

Despite this, they were seamlessly supported during this period, and genuine brand new concepts like KiteGen were routinely blocked and denied an opportunity to spread their proposals to solve the epochal problem we are facing.

Exclusive Subsidies for Low TPL Initiatives

At KiteGen, we have been following EU policies since the project's beginning, and our impression is that EU research follows a political agenda, or strongly established interests. The ideas already supported in energy research are already doomed to failure, enhancing the belief that only the status quo will be subsidized.

How KiteGen Could Itself Fill the Info/Dissemination Gap

It is very expensive for us to disseminate information in a domain as historically difficult to grasp as energy. Furthermore, the noise in the media is so prevalent and pointless exactly in this domain because it is perceived as the main issue.
The KiteGen domain is a multidisciplinary field that must involve different professionals to be assessed correctly. By experience it cannot be directly received by the public.
This could be the most valuable incentive alongside a specific formation program that the EU could set up. We still hope that Europe Publications and Ecorys intends to start a serious debate with us to fix the error.

Climate Change

The anthropogenic cause of climate change would be for KiteGen a marvelous opportunity to be exploited thoughtfully to further argue the inevitability of the exploitation of tropospheric winds.

KiteGen is the fastest, most powerful and definitive solution, able to quickly cancel atmospheric emissions that mankind is forced to generate in order to keep our complex industrial economy and services running. Furthermore, KiteGen could also easily implement CO2 re-absorption from the atmosphere with an expense a tiny fraction of what IPCC has suggested to meet the challenge.

For questions of ethics and respect for the scientific method we do not find it appropriate to arrogate to us a hypothesis, however pregnant and potentially catastrophic for mere promotional purposes, as the photovoltaic industry intensely did.
Especially now that IPCC has greatly reduced the likelihood that CO2 is responsible.

By far the best investment to tackle global warming is to invest in radical energy innovation by adopting the professional and rigorous tools already depicted in this document. Making better energy for the future so cheap to compete with fossil fuels seems an obvious path, but there is a political agenda which aggressively tries to silence anyone calling for tech innovation as a climate policy[43].
This is the most evident smoking gun. Every day, we endeavor do work toward a solution to the Anthropogenic Global Warming threat (KiteGen has often been recognized among the possible and definitive solutions to the problem), while noted “AGW evangelists” actively avoid having contact or learning about the state of the art. We expect that people sincerely interested in the topic will do everything needed to have a clear view of the issue, especially the current active debate.

Recently Michael Mann, the hockey stick evangelist, came to Torino, Italy, the city of KiteGen, and missed meeting us, despite meeting with KiteGen friends and shareholders.

[43] Pacala and Socolow Stabilization Wedges: Solving the Climate Problem for the Next 50 Years with Current Technologies
https://pdfs.semanticscholar.org/c9e5/2d7a9feadd1ad3b85ea2f39a58f0ab0bafc1.pdf

The Italian “Kyoto Club” has a technical director, Gianni Silvestrini, that regularly critically writes about KiteGen on his web-magazine, but refuses to visit us to understand the state of the art.
We met the author of *Cradle to Cradle,* William McDonough, who seems mostly interested in advocating his recycle/sharing strategy. KiteGen perhaps is disturbing his wider design/strategy.
David MacKay, who wrote *Energy Without Hot Air*, prepared a chapter about the technology, but failed to include it in his book about KiteGen, either against or pro, the reason was the overwhelming effort to understand and give an opinion.
Italian Government primary environmental proponent Realacci who was president of an environmentalist movement, spent his energy blocking the innovation funds reserved to KiteGen.
The “Club” of Rome knows perfectly the KiteGen opportunity, but is too occupied celebrating the Forrester approach depicted in the book *Limit to Growth*, further developed by the Meadows, losing sight of the solutions to the challenges we face.

Annexes

KiteGen’s Disclosure of Plagiarism by L. Fagiano, One of the Authors of the Ecorys Report

Fagiano’s story is exemplary, describing one of the countless attempts to damage KiteGen by attempting to deny the ownership of KiteGen’s concepts, to the advantage of new start-up initiatives without new and valid ideas, but willing to be recognized among the “AWE Competitors”.
KiteGen was founded in 2007, obtaining the experience and IP assets matured since 2003, when Massimo Ippolito, the founder, was collaborating[44] with the Dutch astronaut Wubbo Ockels, creator of the Laddermill concept, to extend the investigation into HAWE concepts. From the selection and refining of all sound concepts emerged the idea of the KiteGen Carousel, whose former name was Kite Wind Generator or KiWiGen, for short.
Lorenzo Fagiano was an intern at KiteGen aiming to work on a dissertation for a Phd at the Politecnico di Torino Doctorate School. The work “*Control of Tethered Airfoils for High–Altitude Wind Energy Generation”*, submitted in 2009, makes explicit reference to the KiteGen high-altitude wind generator featuring the tethered airfoils under study and was advised and tutored by Prof.Mario Milanese from Politecnico di Torino, one of the shareholders of KiteGen, and head of a research group on “Complex System Modeling and Control”. The dissertation[45] won the ENI Award in 2010 as the prize for innovative research. Then he won the IEEE Transactions on Control Systems Technology outstanding paper

[44] “Kite Wind Generator, smart control of power kites for renewable energy production” submitted in PRIORITY 6.1 “Sustainable Energy Systems” Call FP6-2003 -TREN-2
http://energykitesystems.net/KiteGen/2003meeting56pages.pdf
[45] L.Fagiano “Control of Tethered Airfoils for High–Altitude Wind Energy Generation”
http://lorenzofagiano.altervista.org/docs/PhD_thesis_Fagiano_Final.pdf

award for the work[46] *High Altitude Wind Energy Generation Using Controlled Power Kites* in 2011, also explicitly citing in the abstract, "This paper presents simulation and experimental results regarding a new class of wind energy generators, denoted as KiteGen".

After those early collaborations, following the discrepancies between Prof. Milanese and the other KiteGen shareholders on the company strategy, Mario Milanese was forced to leave the company, founded a new company, named Kitenergy,[47] and convinced Lorenzo Fagiano to follow him. The duo patented a suboptimal Carousel concept whose unique granted claim was the ability of the tethered airfoil to proceed back and forth instead of making a circular path. Clearly, for energetic reasons, the repetitive inversion of the kite motion is a big drawback to the efficiency of the process and the intermittent quality of the power output that makes it totally useless.

The bad faith of Fagiano was also evident when he needed to make an addendum to his award-winning Phd dissertation, trying to claim that his work had nothing to do with KiteGen and that, in his words, was just a name for the research project at the Politecnico di Torino[48]. The claim is false, because the "Respira Labs" founded at the Politecnico di Torino to investigate the KiteGen concept, had Massimo Ippolito of KiteGen as a co-founder and head researcher. His early European patent 02840646 "Smart control system exploiting the characteristics of generic kites or airfoils to convert energy" of December 2004 was made available to the laboratory as a background IP, as explained in the introduction of the 2007 publication[49] that acknowledges both Massimo Ippolito and Lorenzo Fagiano as co-authors. Therefore, at the same time Fagiano wrote his Phd dissertation, the company KiteGen Research S.r.L. was already established, the KiteGen trademark was already registered, and the concepts contained in the patents investigated by the Politecnico research project belonged to the founder of KiteGen. Fagiano cannot state he was not aware of working with someone else's intellectual property and using someone else's trademark.

Fagiano wrote with Milanese some more useless papers on HAWE matters, available on the Kitenergy site and participated in a research project, carrying originally planned activities of KiteGen aiming to validate and document the claims[50] of another KiteGen owned patent[51]. This was done as visiting researcher at the Dept. of Mechanical Engineering, University of California, Santa Barbara, CA.

His curriculum vitae and publications list, thanks to the expertise gained when he was collaborating with KiteGen, allowed him to be the "expert" involved as an editor in the Ecorys study.

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[46] Massimo Canale ; Lorenzo Fagiano ; Mario Milanese https://ieeexplore.ieee.org/document/5152910/citations?tabFilter=patents#anchor-patent-citations

[47] Kitenrg company site http://www.kitenergy.net/

[48] Diligence released in April 2007 http://kitegen.com/pdf/Diligence_PoliTo.pdf

[49] Massimo Canale ; Lorenzo Fagiano ; Massimo Ippolito; Mario Milanese "Control of tethered airfoils for a new class of wind energy generator" https://www.researchgate.net/publication/224700260_Control_of_tethered_airfoils_for_a_new_class_of_wind_energy_generator

[50] L.Fagiano et al. "On Sensor Fusion for Airborne Wind Energy Systems" https://www.researchgate.net/publication/233730643_On_Sensor_Fusion_for_Airborne_Wind_Energy_Systems

[51] KiteGen introduced in the patents the notion of ground sensors to follow the wing flight WO2007129341

Before the publication of such Report, KiteGen considered Fagiano's recidivous plagiarism as a minor issue, because notorious and it didn't damage the project and its opportunities and somehow contributed to the dissemination. After the Ecorys Report KiteGen, being damaged by its contents, cannot anymore tolerate and has the full right to disclose Fagiano's poor understanding of the matter and its conflicts of interest proven by the facts cited above and to suspect that he intentionally acted to hide and damage the mission of KiteGen and the effort to spread the awareness. It is not a concern of being contradicted about those grievances because the history of patents unambiguously clarifies and certify the timeline and all attempt of plagiarism and infingenìments against KiteGen. Massimo Ippolito, the founder of KiteGen, is the innovator that first sintetis the HAWE concept from scratch, thanks a great experience and knowledge in applied hard science, it is unlikely that such innovation strength could be found in greedy and opportunistic characters.

Detailed Remarks on the Report

In the next few paragraphs, we list our comments and criticisms of specific Ecorys report contents. From the point of view of the technology developer, the topics found in the report may be perceived as positive or negative (pro or con) for the development of the high wind industry and its players. As a confirmation of our aforementioned claims about the incredibly hostile attitude toward high wind found in the Ecorys report, the "con" topics greatly outnumber the "pros".

Remarks About the Authors of the Report:

This publication may be biased by the geographical concentration of the authors between Netherlands and Germany, with the exception of L. Fagiano. Ecorys should also pay attention to conflicts of interest in assigning work. Lorenzo Fagiano, a former intern at KiteGen, has patented a sub-species of Carousel as well as founded a company that is competing with KiteGen. However, the great energy that Lorenzo commits to establish himself fails due to his inability to be creative with evolutionary thoughts. What Lorenzo does today is what he learned at KiteGen and it was with great difficulty on the part of those who led him because of his haughty attitude, which is evident throughout the report.

Remarks About the Abstract

It is correctly recognized that the concept may be a game-changer because of the reduced production material requirements and the high capacity factor due to the stronger and more persistent wind presence at higher altitudes.

Tautologies

Up until now, the technology still does not exist on an industrial scale, but as a lot of successful small-scale research prototypes. It's a low-risk statement to affirm that the technology is immature as well as a clear redundancy.

Also redundant is the recommendation:
Prove continuous operations: define, achieve and prove reliability targets.
What we could expect from such a report is perhaps an investigation into barriers to scalability of the concept

Decarbonisation or Strategic Issue for EU Economy

KiteGen addresses wind as a resource obviously addressing decarbonisation.
Let talk Larry Page, the following was a press release of Larry Page, a founder of Google when he was informed, in 2007, about KiteGen and HAWE, announced a strategic initiative called RE<C ("Renewable Energy Cheaper Than Coal") :
"If we meet this goal," said Page, "and large-scale renewable deployments are cheaper than coal, the world will have the option to meet a substantial portion of electricity needs from renewable sources and significantly reduce carbon emissions. We expect this would be a good business for us as well."
After that they funded Macani Power revealing a poor technological understanding about the outstanding KiteGen concepts without any credible alternative, but showing a good vision about the impact. The same vision is expected inside a report like ECORYS, especially ten years later and thousand of publications advocating the same outcome.
The error made by Makani damaged Google intention to tackle with the emergency[52] and the possible impulse coming from a private investor.

The following is a recent Google corporate comment to the Page press release:

This press release contains forward-looking statements that involve risks and uncertainties, including statements relating to our ability to develop cheaper electricity from renewable energy sources, our expected investments and capital expenditures, and our ability to accelerate the development of clean energy technologies. Actual results may differ materially from the results predicted. The potential risks and uncertainties that could cause actual results to differ include, among others, risks related to our ability to hire the appropriate people and our ability to identify and pursue the technologies necessary to achieve these goals.

This an emblematic demonstration of the risks to relay on beginners no matter how enthusiastic, instead to address the original innovator or worse trying to circumvent the patents.

[52] Ross Koningstein and David Fork two google engineer that declare non feasible the re<c https://spectrum.ieee.org/energy/renewables/what-it-would-really-take-to-reverse-climate-change

Remarks About Exec Summary

The methodology of semi structured interviews with stakeholders might be good enough for tabloids and TV magazines, but not for an EU position paper or a scientific or technical work. There is a double bias:

- Stakeholders are biased
- Authors may decide not to interview some stakeholders or not even include some of the statements of the stakeholders.

One would expect an equal weight of treating the expected benefits and expected problems. The former are only mentioned, the latter are the essence of this work. This work seems to have the purpose of discouraging investors, prolonging indefinitely the research phase so that the players would ultimately depend on public funding and the edicts of EU policy that may be shaped after pressure applied by the established and commercial renewable industry entities (based on public subsidies) to suppress or delay competitive technology.

TRL State of the Art (ref. Ecorys doc - III Findings of the Study -State of Play of Technology Development)

The authors have developed a specific TRL scale for the sector. It may be argued that the proposed scale does not fit with an industry that is so close to aerospace. Aerospace has its own TRL scale.
The nature of the aerospace industry (aircraft and rockets may not be tested before reaching an established level of industrial quality because of safety issues) requires great effort on production, safety and quality before going to field testing. In this perspective, such manufacturing & quality enhancing work accomplished by our company has been buried and/or pushed back by the proposed TRL scale. Measured against the aerospace TRL scale, KiteGen would score 7-8.

Key Barriers (ref. Ecorys doc: III Findings of the Study - Barriers to AWES)

Autonomous continuous flight issues and resource requirements are mentioned as key obstacles, although it is widely evident from relevant scientific and technical literature that such issues have been completely solved.
Fear, uncertainty and doubt (FUD) about technological complexities and the inability to reach competitiveness are largely stated throughout the document. Great emphasis has been placed on social acceptability, environmental concerns and potential conflicts involving use of airspace. Such concerns are nonsensical. If one really thinks that a technical solution is not feasible, there should be no related social or environmental issues.

Considering the predominant energy sources used today to power the world, coal for instance, they are utilised despite health, environmental and land use concerns because energy production has a much greater priority. It is not understood why High Altitude Wind Energy, a game changer in the energy sector in the words of the authors, should be treated

differently. It is clear to us that if the engineering issues of the HAWES were correctly addressed and solved, it would be so disruptive to the energy sector that all other issues would lose importance, for instance, deaths and environmental issues caused by the use of coal or oil, currently tolerated for the sake of an adequate energy supply.

Scale (ref. Ecorys doc: IV Conclusion and Recommendations - The AWES Case for EU Energy Security)

It is correctly recognized that the scale of the systems *does* matter and that small scale and niche systems would have a negligible contribution to the EU energy supply.

Sharing of Knowledge (ref. Ecorys doc: IV, Conclusion and Recommendations - Anchor Learning)

There is a strong recommendation to share the knowledge amongst the players. Although it is not clear how creating a framework promoting sharing would be accomplished, it seems to stem from the EON's recent interest in HAWES and its policy for gathering different technologies under a single program in order to solve unknowns and help deal with legal issues. An EON test site in Mayo County, Ireland, will host different players.

State of the Art (ref. Ecorys doc: 2.2 Overview of Airborne Wind Energy Systems)

The position paper shows the author's attitude behind most of the works regarding HAWES. All the concepts are enumerated without citing any lessons learned that would lead to abandonment of some of the ideas of the past (for instance, blimps). Despite the author's attitude, most of the technical information is outdated, incomplete, or, simply, *wrong*. Some examples include:

1) It states that all HAWES are in the R&D phase (KiteGen certainly completed R&D, perhaps also Makani but with the achievement that KiteGen patents cannot circumvented).

2) It reports that rigid wings have an AE of 10-11 (gliders have up to 70, KiteGen claims 28 for its semi-rigid, C-shaped wing).

3) It reports that having a single tether that divides into multiple tethers near the airborne device reduces the drag, which is not true because the endpoints of the tether run faster.

4) It states there are no advantages in the Carousel operation vs the pumping kite, also not true. The pumping cycle expends the wind speed needed to reach nominal force; the Carousel does not.

5) It is stated that KiteGen only has a soft kite even though the company announced a semi-rigid C-shaped wing program in 2012 and has demonstrated prototypes since 2014.

6) The reported timeline is incomplete, missing some crucial events of KiteGen, like the 2003 submission of the first European Project on High Altitude Wind Energy, jointly with Wubbo Ockels/TU Delft and the first energy production (order of the tenth of kWh) from a High Altitude Wind Energy System during the KiteGen Mobilgen test campaign of 2005

Airspace Barriers (ref. Ecorys doc: 2.3 Regulatory State of Affairs)

Airspace operations seem to worry the authors' panel considerably, Perhaps there is a bias on the part of the authors that have personal origins in densely-populated northern Europe, where more than a few major airports would compete with the new energy source for airspace.
As already recalled, energy is one of the most important priorities if not the *first* priority of a developed or developing country. From the point of view of an energy expert, it is clear that if HAWES was the only, or at least the best, source of energy in the world, currently fueled by shrinking and expansive fossil reserves, many airports would be closed, or their corridors rearranged by governmental decree to allow energy harvesting from the sky. Countries would engage in wars for energy and the conflicting uses for airspace would appear childish in such scenarios.
Mobility is a priority that depends on energy, of course; so please let us say that this is a lower priority. Well, if one thinks about motorways that are forbidden to cycles and pedestrians because it is a priority to have a fast and safe mobility corridor, it should be understood what we mean when suggesting modifying airspace regulations to share it with a strategic priority like energy supply. Housing is important and so is farming, but you cannot build a house or a farm on a motorway. By the way, you can build them along its sides.

For this reason, we judge the inconsistencies of the paper's findings about probable limits of the HAWES harvesting below 750 m agl. The HAWES concept either will not be suitable as an energy supply (in this case, the technical infeasibility barrier or high LCOE will be the main barrier, not airspace) or HAWES will be one of the most important global energy suppliers; thus, all the needed airspace would be assigned by legislative edict.
On this point, we detect a willingness to suppress or delay the new technology and spread FUD among the stakeholders.

Safety Buffer (ref. Ecorys doc: 2.4.3 Net Resource Potential)

The position paper, without any justification, hypothesizes that HAWES land use restrictions will be similar to that of wind turbines, so the space will be limited and difficult to acquire. It is not clear why, in the view of the authors, a lighter class of generators shouldn't have reduced restrictions.

Markets (ref. Ecorys doc: 2.5 Markets)

Regulatory conformance is one of the most important economic drivers of the HAWES success. In a few words, the authors are saying that a new technology needs to have favorable regulatory policy to be successful. Countless examples say the contrary. New disruptive technology comes first, and then shapes the regulatory matter after: Biotechnologies, ICT, crypto finance, weaponry and countless others. It is a matter of strategic priorities. One cannot change history by decree. Either HAWES does not work, so there is no need for regulatory restriction to limit it, or it works as promised; so a country that wants to place major regulatory restrictions will suddenly find itself having to avoid being left behind by other countries that choose to exploit the new energy source, increasing their competitive advantage.

The story of ideological Japan's ban on firearms in the 17th century, withdrawn when its rulers realized danger of invasion by foreign powers having firearms, should offer a lesson about which come first: technology, strategy, prioritisation, ideology and, lastly, regulation.

LCOE (ref. Ecorys doc: 2.5.1 Cost Performance)

Some of the interviewed players gave LCOE estimations for their systems. The authors compare these early estimations of immature systems to the cost of some recent auctions of solar and wind. We want to stress that such a practice, although very common among the solar and wind fundamentalists (the authors are involved in?), when they try to demonstrate that there is nothing better, is is found to be incorrect. LCOE has to be compared with LCOE only. Bids in auctions have nothing to do with LCOE. It is policy, finance and, sometimes, a misinformed bet. Often the company that will operate the plant is not the same that won the auction and the ownership passes to institutional investors through complex financial transactions, or there is a bet on the reduction of solar device prices within the time frame of the plant construction.

By the way, the authors do not explain why they forecast an LCOE higher than the other renewables and at the same time agree with the following positive market drivers:

- HAWES require about 10% of the materials of a similarly rated wind turbine
- The capacity factor is higher
- Kite wind farms will have benefits from higher production
- Offshore kite farms need lighter or even floating platforms or can reuse abandoned wind turbine platforms at a fraction of the cost
- Less site constraints for onshore kite farms vs. wind turbines.

Onshore On-Grid Markets (ref. Ecorys doc: 2.5.2 Onshore On-Grid)

Despite previously expressed concerns about land and airspace use or needed safety buffers, the authors expect that the most convenient on-shore on-grid applications will be for small and medium sized islands where there is less available land and, typically, the unrestricted operation of the local airport is much more strategic than on the inland (A sound example in the EU is Malta). Apparently, such a contradiction is due to the notion that LCOE will be expensive and comparable with the energy price on the island's market (usually higher than inland).
Again, there is a need to find a niche to which the new technologies could be limited.

Repowering Offshore Wind Farms (ref. Ecorys doc: 2.5.2 Onshore On-Grid)

On this issue, the authors are very positive, maybe because EON is calling for such a repowering program and asking for support from the EU.

Wind Resource and Availability (ref. Ecorys doc: 2.5.2 Offshore On-Grid)

The position paper is positive in this respect.

Footprint (ref. Ecorys doc: 3.2 Spatial and Airspace Footprint)

It is recognized that HAWES will occupy relatively little "footprint".

Weather (ref. Ecorys doc: 3.2 Weather Conditions)

It is stated that there is no evidence of capability to withstand unfavorable weather. Such concern reveal inability of the authors to think out of the box even for trivial issues, and in particular they miss to read the comprehensive FAQ yet available.

Litening - in ground-gen architectures the rope is an insulator, no preferential path offered
Rain - same issue of aircraft, no reason to limit the operations
Icing - same issue of aircraft, hydrophobic wing coating solve the issue
Fog - instrumental wing navigation by design
Storms - Cut-out issue, it barely affect availability
Sandstorms - it is an issue for the ground machinery not for the wing
Hailstorm - radar visible, could be avoided
Tornadoes - Cut-out issue or KiteGen could be adopted as mitigation praesidium
Hurrycane - Cut-out issue or KiteGen could be adopted as mitigation praesidium

Industrial Barriers (ref. Ecorys doc: 3.3)

Some of the listed barriers in the industrial domain are outdated or incorrect, and include:

- Difficulties of the control system are also attributed to the limited life of the battery onboard the flying device. That's incorrect as the FP7 KitVes project had a delivery of a 0.2 kg 7W onboard micro turbine to recharge the battery.
- The high cost of a crash is cited without stressing that it is more important for the flygen concepts than for the groundgen ones
- A supply chain for rigid wings is not as well established. That's not correct as KiteGen announced in 2017 that a composite company realized all the tooling and molds for autoclave curing of specifically designed HAWES power wings.

Public Support and Regulatory Barriers (ref. Ecorys doc: 3.4)

Device noise and the NIMBY effect are envisaged by the authors. Such an idea is due to the conviction that the HAWES will have to operate at low altitudes due to the airspace problems. This is a a beautiful example of a regulatory problem created by another regulatory problem. The continued tenacious position of the authors to say that High Altitude Energy Systems would work only at low altitudes is so contradictory that it seems suspicious to us, and perhaps to any other reasonable observer.

Environmental Impact (ref. Ecorys doc: 3.4 Environmental Impact)

According to the authors, the biggest concern regards the impact on bird populations. They want to work at low altitude just to avoid encroaching on high-altitude airspace interests but create a new issue that needs more regulatory effort, which would be to save birds.
High Altitude operations only have a potential concern for seasonal bird migrations that occur at high altitudes (i.e. geese). Such events are predictable, and issues may be avoided using a radar-based facility to detect bird flocks.
Moreover, the alleged necessity to operate at low altitude is due to the misleading concept of system drag found in the work of Argatov et al. that has been proven to be inconsistent in a work in 2016, by F. Roselli[53].

Resource Potential (ref. Ecorys doc: 4.2)

The authors state that there is no clear way to measure the wind at high altitude. Perhaps they are unaware of advances in LIDAR technology. Moreover, KiteGen patented drone technology for the express measurement of wind shear.

[53] F.Roselli "Study on the dynamics of the flexible cables of a KITE-GEN type of energy generator" http://kitegen.com/pdf/TESI_Roselli.pdf

Source of the Specifications: Wind/Wing vs. Alternators/Pulleys

Severe weather conditions, with very strong winds, may happen once in decades. For this reason, good practice in wind farm deployment requires collection of wind data records for the past 60 years. Wind turbine structures and foundations have to fully withstand the said bad conditions without any opportunity to take shelter.

Recently, in Northern Italy, millions of trees were felled by an extremely severe storm with up to 200 km/h wind speeds. For a typical wind turbine subjected to such conditions, one may do the math and find that it is like an equivalent force of 1500 kN applied at a 60 m height of the 100m tower, resulting in an overturning event of 90MN/m. If the tower grows twofold in height to better exploit the wind, it requires an *eightfold* growth in weight and materials to sustain the *fourfold* growth in average power and avoid buckling due to the 720MN/m overturning event from a 200 km/h wind speed. It is clear that the cost of wind turbines diverges because the power grows with the square of the height, but the size of the tower grows with the cube. For these reasons the vast majority of the deployed wind turbines do not exceed 100m and their output ranges from 1.5-2.5 MW.

The KiteGen design concept is totally different because it does not have fixed structures that have to withstand the worst weather conditions that occur once in decades but starts from an arbitrary design choice of the nameplate power of the generator, without taking into account the wind data. Thus the cost of the generator is a linear function of the design power specification.

Using a 16 mm diameter 3GPa ultimate tensile strength rope, the force may reach up to 600kN before breaking. When the wind is strong enough, the wing may exert forces greater than the rope's ultimate tensile strength. The order of magnitude of such exceptional forces may raise the power of a high altitude wind generator to 25 MW. So it is not useful to apply the features of the wing/wind system to impose the specifications of the generator. Better to find a compromise with weaker power that is easily manageable and can be produced with a high capacity factor because it requires lower wind speed.

Following such design guidelines, it is the generator that shapes the dynamics of the operation, controlling the ropes through its pulleys. It is not necessary nor useful to have a full wing speed and force profile depending on the available natural resource. The chosen 3 MW nameplate generator will manage up to 300 kN of force (50% of the maximum load of the rope) when the wind speed does not exceed 15 m/s. Stronger winds will not be exploited by regulating the operative altitude and the wing direction compared to the wind direction (exiting the power spot by not flying crosswind). That being said, there are a lot of automatic controls and engineering solutions to ensure safety and to manage transient conditions and all the possible issues that may arise when dealing with this natural resource.

6MW Siemens turbine data

Rotor

Type	3-bladed, horizontal axis
Position	Upwind
Diameter	154 m
Swept area	18600 m²
Speed range	5-11 rpm
Power regulation	Pitch regulation with variable speed
Rotor tilt	6 degrees

Blade

Type	Self-supporting
Blade Length	75 m (B75)
Aerodynamic profile	Siemens proprietary airfoils, FFA-W3-XXX
Material	GRE
Surface gloss	Semi-gloss, <30 / ISO2813
Surface colour	Light grey, RAL 7035

Aerodynamic brake

Type	Full-span pitching
Activation	Active, hydraulic

Load-Supporting Parts

Hub	Nodular cast iron
Main shaft	Nodular cast iron
Nacelle bed plate	Nodular cast iron

Mechanical brake

Type	Hydraulic disc brake

Canopy

Type	Totally enclosed
Surface gloss	Semi-gloss, 25-45 / ISO2813
Colour	Light grey, RAL 7035
Material	Fire retardant GFRP with integrated EMC shielding

Generator

Type	Synchronous, PMG, Direct Drive

Grid Terminals (LV)

Nominal power	6000 kW
Voltage	690 V
Frequency	50 Hz

Yaw system

Type	Active
Yaw bearing	Externally geared
Yaw drive	Electric gear motors
Yaw brake	Passive friction brake

Controller

Type	Microprocessor
SCADA system	WPS
Controller designation	WTC 3.0

Tower

Type	Cylindrical and/or tapered tubular
Hub height	Site-specific
Corrosion protection	Painted
Surface gloss	Semi-gloss, 25-45 / ISO2813
Colour	Light grey, RAL 7035

Operational data

Cut-in wind speed	3-5 m/s
Nominal power at	12-14 m/s
Cut-out wind speed	25 m/s
Maximum 3 s gust	70 m/s (IEC version)

Weights (approximately)

Towerhead mass	360,000 kg

The nominal power reported is reachable at 12-14 m/s this imply a wind power density of 864-1372 W/m2 to compare with the wind power densities required by the KiteGen concepts.
The related chart is shown in the above KiteGen Carousel Chapter.