

# Executive Summary



*energy from the high flyer*

Marco Ghivarello

Marco Ghivarello, glider and paraglider pilot, after a significant work experience in the Airborne Wind Energy field, developed some innovative ideas, which could contribute to solve the issues currently holding back the development of this sector. He has decided then, with the support of some colleagues and friends, to start its own project, the KGM1, giving it an entrepreneurial dimension through the “GHIVA progettazione CAD”, who has coordinated the Step1 of the project.

# CONTENT:



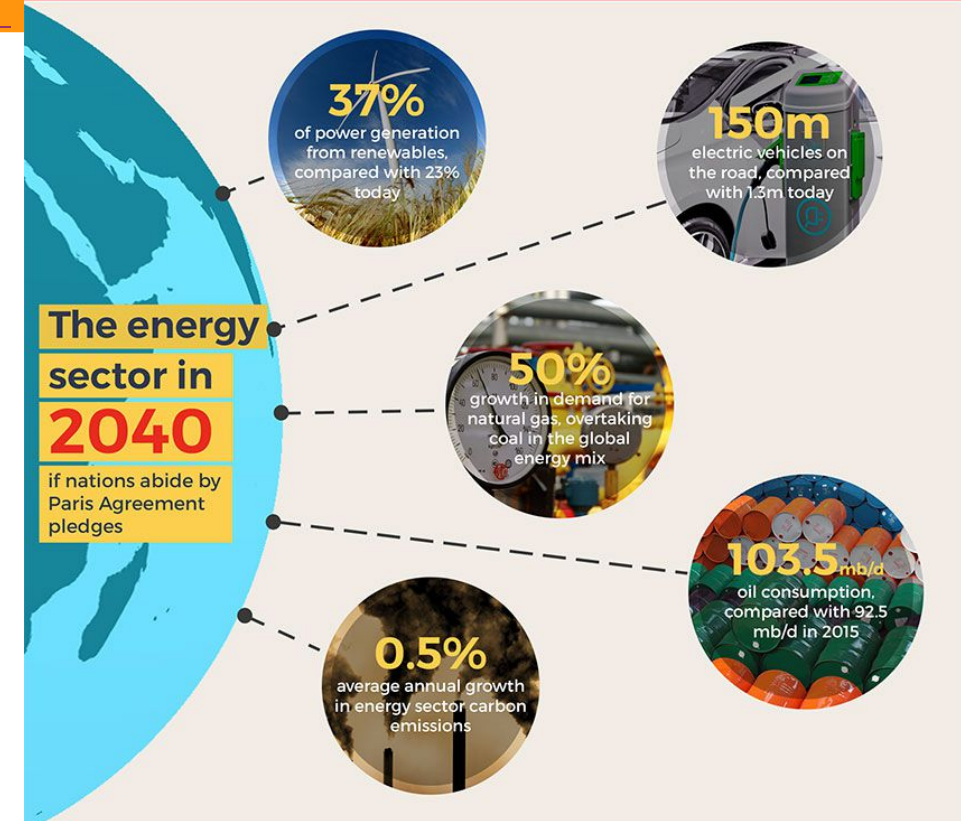
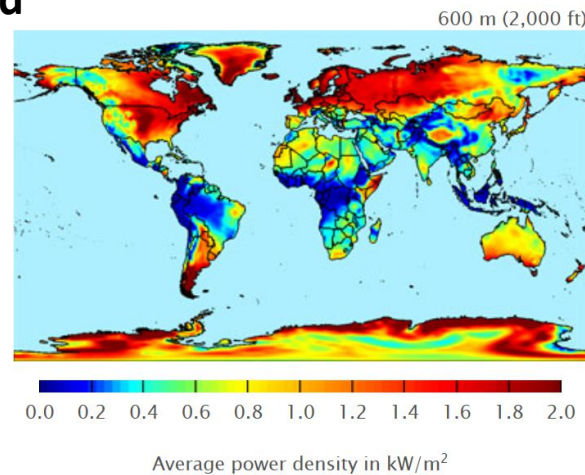
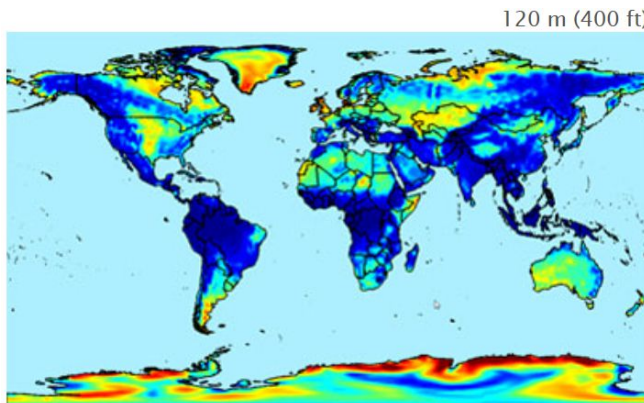
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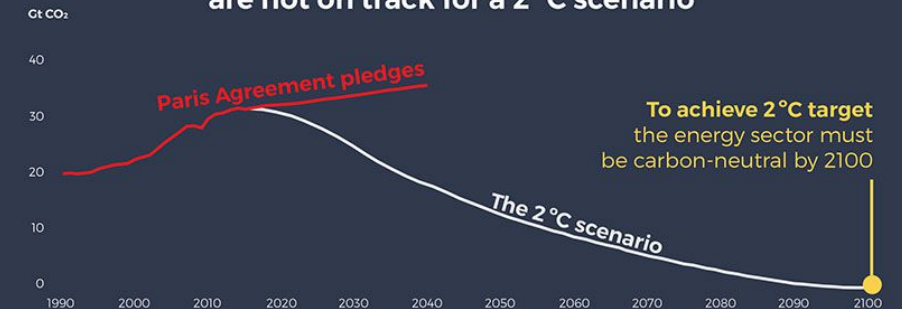
# ENERGY FOR LIFE ON EARTH

- The availability of energy is the first and foremost element for survival of humanity on Earth
- However its generation and distribution, even if insufficient, is already taking a toll on the carbon balance of our planet
- Pledges to control the carbon emissions, like COP21, albeit demanding, will not stop the trend of increasing atmospheric CO<sub>2</sub>
- The above is true even if the current renewable sources of energy are exploited at optimal capacity
- There is an obvious need for a breakthrough in achieving the exploitation of a permanent renewable source available world wide:

## High Altitude Wind



But even then, energy sector CO<sub>2</sub> emissions are not on track for a 2 °C scenario



# HIGH ALTITUDE WIND: A RENEWABLE ENERGY SOURCE

- The high altitude (or tropospheric) winds are the largest available reservoir of energy in our planet
- Due to intrinsic physical limitations, they cannot be exploited with "wind towers"
- Research is on-going world-wide to develop technologies aimed at achieving the so-called "Airborne Wind Energy" (AWE) generation
- Two families of technologies are mainly pursued: the flying generator and the ground generator

- ▶ The expectation is that costs for AWE MWh production will be lower than those obtained with any other source, including coal

Average LCOE plants entering service in 2022, EIA data		
	\$ / MWh	\$ / bbl Jet A1
High altitude wind power**	30	98
Onshore wind	65	213
Hydroelectric	68	223
Solar PV	85	279
Advanced nuclear	103	338
Offshore wind	158	518
Solar thermal	236	774

[https://www.eia.gov/forecasts/aeo/pdf/electricity\\_generation.pdf](https://www.eia.gov/forecasts/aeo/pdf/electricity_generation.pdf)

\*\* Unaudited Google Makani

LCOE = Levelised Cost of Electricity

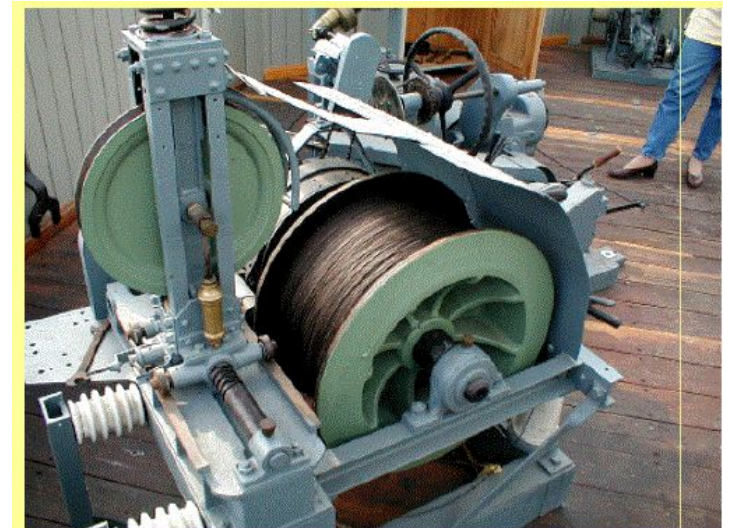
# THE KGM1 PROJECT: TAPPING THE STREAM

- The outcome of the project will be essentially an industrial robot, which will be working in full automation to convert into electricity the highest percentage possible of the kinetic energy of the high-altitude winds
- The energy will be captured by a specifically designed wing
- The "active phase" of an alternating cycle, called "YO-YO", will generate electricity from the wing traction, putting in rotation a device present on the ground generator and unwinding the cable from a coaxial drum.
- It will then back down the wing only with a fraction of the energy accumulated therein, rewinding the cable into the "passive phase".

**The wing will perform a YO-YO cycle**



**During the active phase the ground generator will deliver electricity**



# THE KGM1 PROJECT TEAM

- Marco Ghivarello – Founder and project leader



- Leonardo Libero – Contacts, research and writing



- Massimo Speranza – Work organisation and communication



- Marco Marzot – Electronic design



- Andrea Cento – Flight consultant



- Luca Ghivarello – Flight operations

The current team has performed Step 1 of the project.

For the following steps appropriate skills and resources will be brought on board according to the plan.



# ENGINEERING: SEVEN STEPS TO INNOVATION (I)

The engineering analysis of current endeavors in AWE projects has highlighted shortcomings and pitfalls which the KGM1 project intends to avoid and bypass with a specific innovation approach across critical engineering domains. That, in turn, will significantly enhance and protect the value of the project:

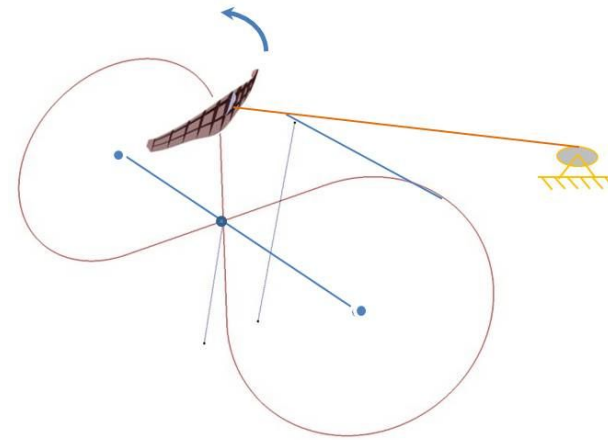
- 1) Development of a tracker device for preset paths: *a simple device, obtained by modifying existing Hw / Sw platform on the market, which will be able to “draw” in the sky the path that will be predefined by a computer*

*In fact, “a connecting bridge” between the human brain and a sophisticated automatic control, to be made already available in the early stages of study, as that is necessary to the development of the test program.*



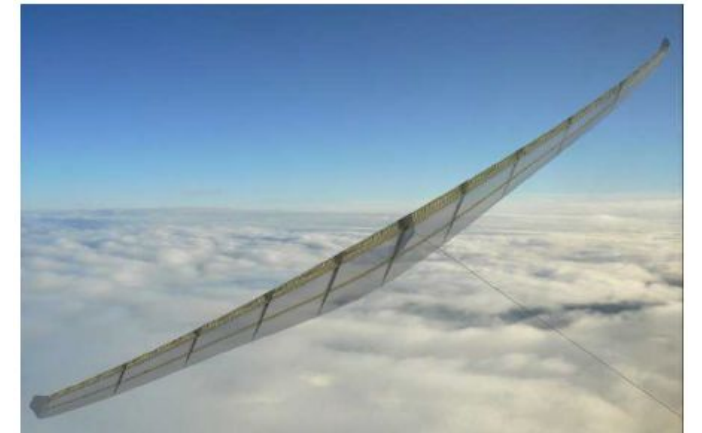
# ENGINEERING: SEVEN STEPS TO INNOVATION (II)

- 2) Improved YO-YO cycle: *a Yo-Yo cycle already partially simulated by calculation and different from competitor ones, should be tested during the early stages. It will offer, when validated experimentally, crucial advantages whose implications could play a key role in the development of future wings.*



- 3) Customised wing: *two studies related to each other, who have gone after a benchmarking analysis, and will try to chart a new way for the development of future AWE wings.*

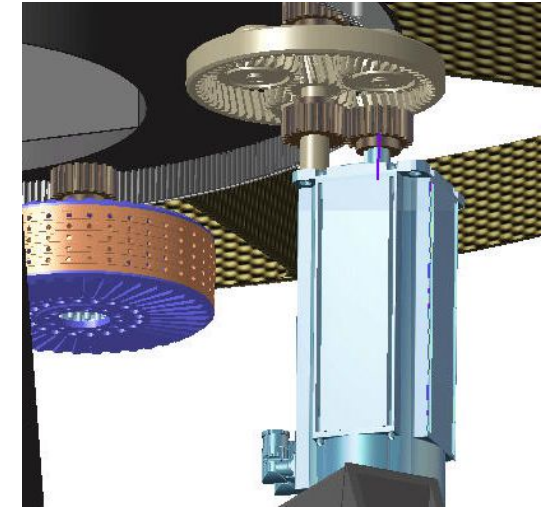
*This is the main goal of Step 2: chase the maximum aerodynamic efficiency allowed by the system (wing + rope), in order to maximize the energy production, but with simple technical solutions.*



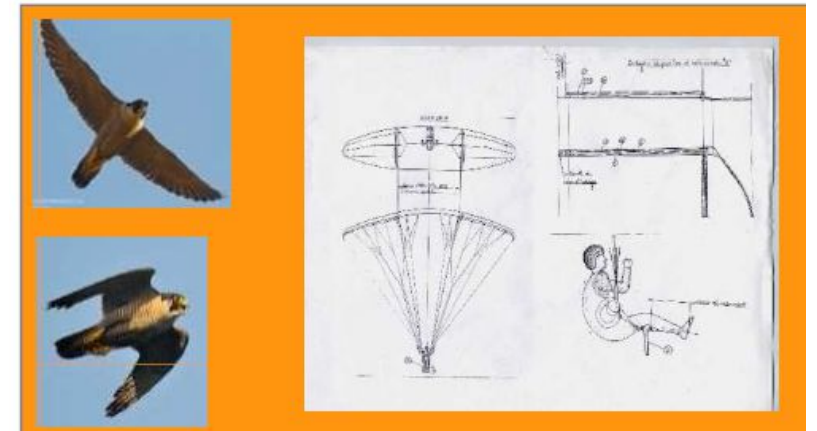


# ENGINEERING: SEVEN STEPS TO INNOVATION (III)

- 4) Generator, with equipment specifically designed: *a scaled generator, to contain the costs of Step 2 (maximum peak 25 kW, modular growing size), with a different concept from any competitor. It will be equipped with a device that will be customized in collaboration with external suppliers of the studied components, to increase the efficiency and stabilize the end-to-end power generation.*

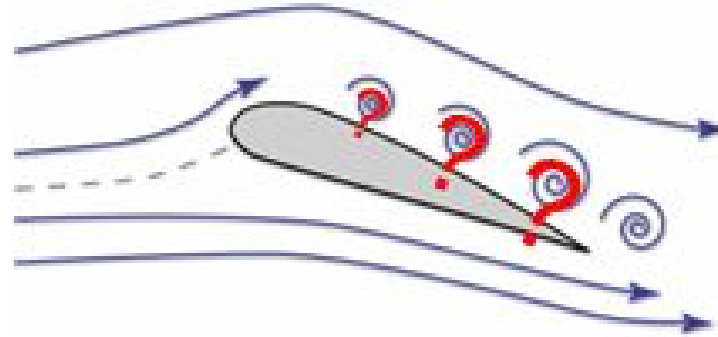


- 5) Semi-rigid kite with variable profile: *complementary research study, already partially tested on a paragliding canopy, which will help to understand the key opportunities offered by the possibility of reducing “dynamically” the wing area and the elongation of a flexible or semi-rigid wing.*

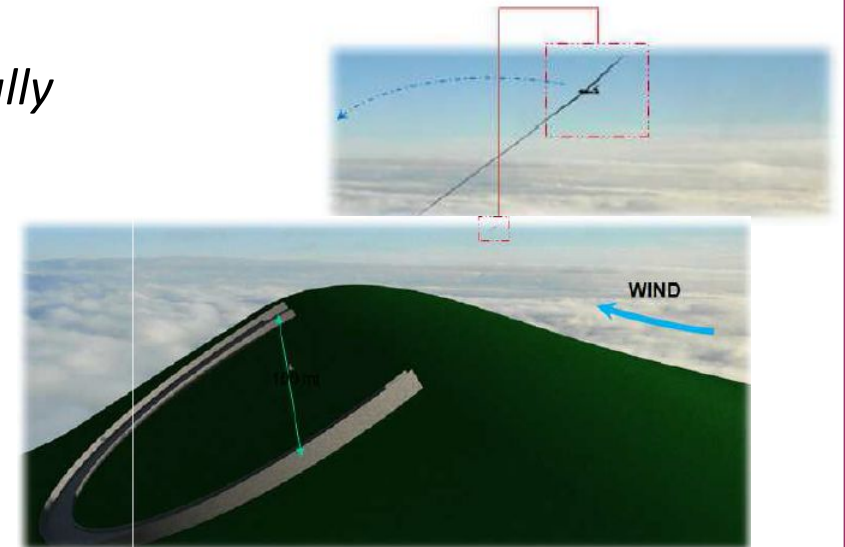


# ENGINEERING: SEVEN STEPS TO INNOVATION (IV)

- 6) Virtual profile's semi-rigid kite: *complementary research study on a new wing profile, whose results could have a significant impact on the entire aviation industry.*



- 7) Extreme generator, based on the “Dynamic soaring”: *complementary and parallel investigation on the extreme limits of AWE technology, subject to the available budget.*  
*A generator different from any other with stunning performance, fully customized for the exploitation of this phenomenon.*



# THE PLAN: A PRAGMATIC INCREMENTAL APPROACH (I)

Completed

**STEP 1:** CREATION TEAM - MACRO FEASIBILITY  
'PROJECT - PRELIMINARY TESTS ON PROJECT OF A  
TECHNOLOGICAL DEMONSTRATOR

In progress

**STEP 2:** PATENTS - WINGS COSTRUCTION -upgrade  
ELECTRONIC - FLIGHT TEST - PROTO DEMONSTRATOR  
TECHNOLOGY SLIDING, AND THE NEXT DONE IN SMALL SCALE  
(25-50 Kw)

TOWARD: "TRL 6-7"

Planned

**STEP 3:** LOOP OF AGING - UPGRADE SIZES / POWER - ENERGY PRODUCTION ON  
BOARD - GROWTH "CRITICAL MASS" OF THE TEAM - PRESENTATION OF WORK -  
ACTIVITY 'OF MARKETING

TOWARD: "TRL 7-8"

Planned

**STEP 4:** DESIGN & DEVELOPMENT PROTOTYPE SCALE 1: 1 (MEDIUM SIZE> 100-500 kw ??) - PROJECT / TEST /  
STUDY & UPGRADE OF AN AUTOMATIC CONTROL - PROJECT LAUNCHER AND INQUIRIES ON RECOVERY  
AUTOMATIC / ENAC PERMITS PROCEDURES FLIGHT - REFINEMENTS / TECHNICAL SPECIFICATIONS

TOWARD: "TRL 8-9"

timeline

2014

2015

2016

2017

2018

2019

2020

2021

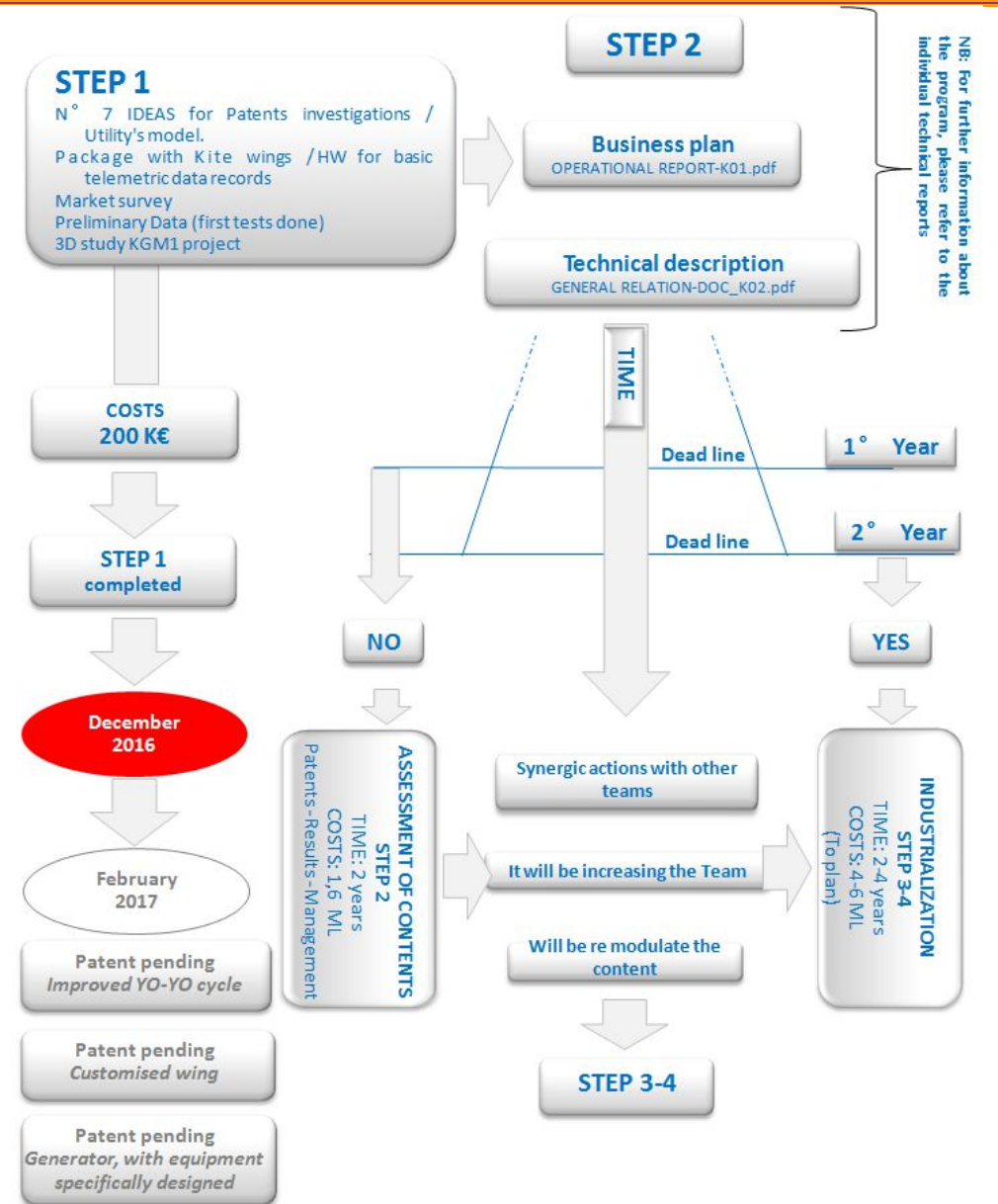
2022

2024-5

The plan is based on an incremental approach, thereby progressively identifying solutions and reducing the project development risk.

# THE PLAN: A PRAGMATIC INCREMENTAL APPROACH (II)

- Step 1 is successfully completed, with KGM1 having reached a Technology Readiness Level to prove feasibility (TRL 2-3)
- The project is now moving from an early feasibility stage to a concrete engineering phase, further enhancing content value by producing design solutions and unique IPRs
- This phase, accordingly, requires the organizational shift from a minimal start-up to a small engineering, business driven company
- Partnering with providers of competence and capital will be a key to foster the development plan and optimise the time-to-market



# MANUFACTURING AND OPERATIONS: FROM SUPPLY CHAIN TO GRID

- KGM1 project will leverage on existing manufacturing and operational experience to deliver end-to-end optimal generation/transmission of power
- Agreements will need to be arranged, for instance in these domains:

Involved companies /  
Research centers

## Targets:

- Subcontracting the construction of the WING
- Create connection with the lab:  
<http://www.tensairitysolutions.com/research/>
- Select young graduates to be included in the research Team
- Transversally finalize the wing study on one or more of degree thesis

Involvement of the  
paraglider / kites  
manufacturers

## Targets:

- Exploit the know-how about flexible wings to develop the prototype of a VARIABLE GEOMETRY WING
- Make a MULTIDISCIPLINARY STUDY of a wing by exploiting the related technologies.

Involvement of the  
Generator component supplier

## Target:

- Interface on KGM1
- Create eventual CUSTOMIZED solutions (patents)
- To increase the project dimensions

# THE BUSINESS: OPPORTUNITY AND RISK

The KGM1 project is a unique opportunity to bring to fruition, in a reasonable time, the exploitation of High Altitude Winds

That is because the KGM1 project:

- has thoroughly analysed current AWE endeavours world-wide identifying pitfalls and shortcomings
- has devised innovative ideas which constitute solutions to the current technical issues affecting AWE projects
- has already studied solutions in 3d models and, concerning the electronic package, has already tested it with a preliminary telemetry on board and ground,
- has already identified technical partners to support development, avoid duplications and reduce risk
- has a plan to incrementally build unique knowledge, protect it and grow the value of the project

Obviously, the current level of maturity of the project contains also risks in critical areas:

- Technical: the overall maturity of the project, whose solutions need to pass critical engineering steps to achieve the Technology Readiness Level of an overall demonstrable prototype
- Organisational: the team competence which need to be consolidated in the technical areas and expanded to cover more business skills
- Financial: the level of financial resources which need to match the growth of the project and its value

# THE VENTURE: PARTNERING FOR SUCCESS

At this stage of the project, the team is looking for a partner which:

- Believes in the unique proposition offered by the KGM1 project,
- Shares the view of creating a world class provider of an untapped source of energy
- Understands that the incremental, stepped approach defined, while requiring patience, reduces risk at the earliest possible project milestones
- Is willing to partner by contributing financially into the success of the venture
- May also want to provide support in the business development area of the company to be created on purpose

## References:

- Slide 3: IEA World Outlook 2016, JOBY Energy wind maps
- Slide 4: US Energy Information Administration