
Renewables of the Future

Onshore Energy Conference,
London, 9 Nov 2016

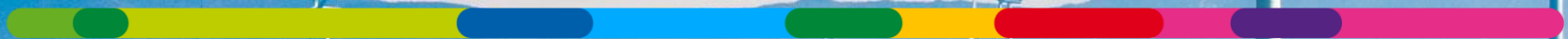
ENGIE - Métier Centralized Generation of Electricity

Stefaan VERSTRAETEN

Xi YAO

The ENGIE logo features a white, semi-transparent dome shape above the word "ENGIE" in a white, lowercase, sans-serif font.

ENGIE



AGENDA

1

ENGIE in Renewable Energy

2

Renewable Energy Overview

3

Wind Energy

4

Solar Energy

5

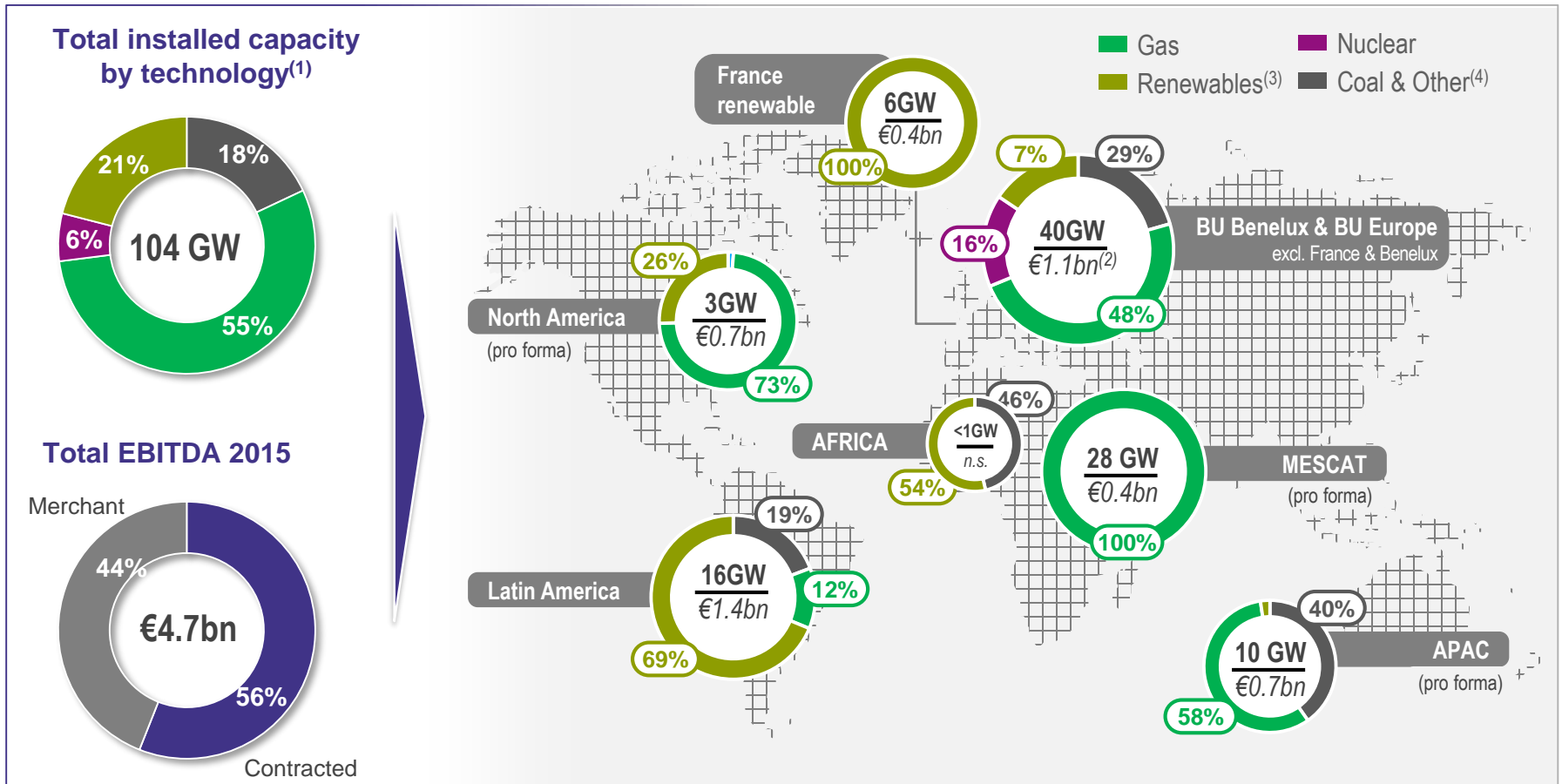
Marine Energy

6

Conclusion

ENGIE TODAY: 21 GW RENEWABLE ENERGY

INSTALLED CAPACITY (1) & EBITDA 2015



(1) 31/12/2015 figures at 100% – pro forma announced disposals (US & Coal Indonesia / India)

(2) Including EBITDA for Global Energy Management

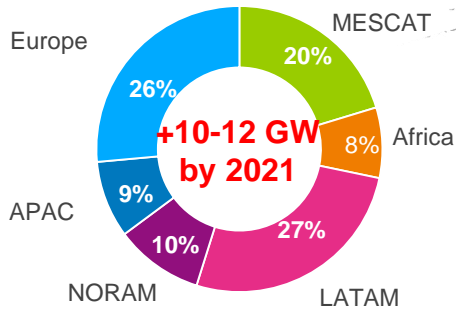
(3) Excluding pumped storage for hydro capacity

(4) Including pumped storage for hydro capacity

ENGIE: RENEWABLE CAPACITY TO GROW SIGNIFICANTLY

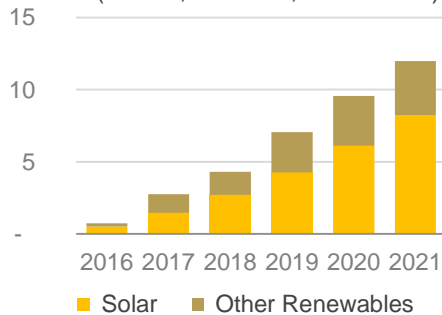
ADDITIONAL RENEWABLE CAPACITY, BY REGION

(in GW, at 100%)

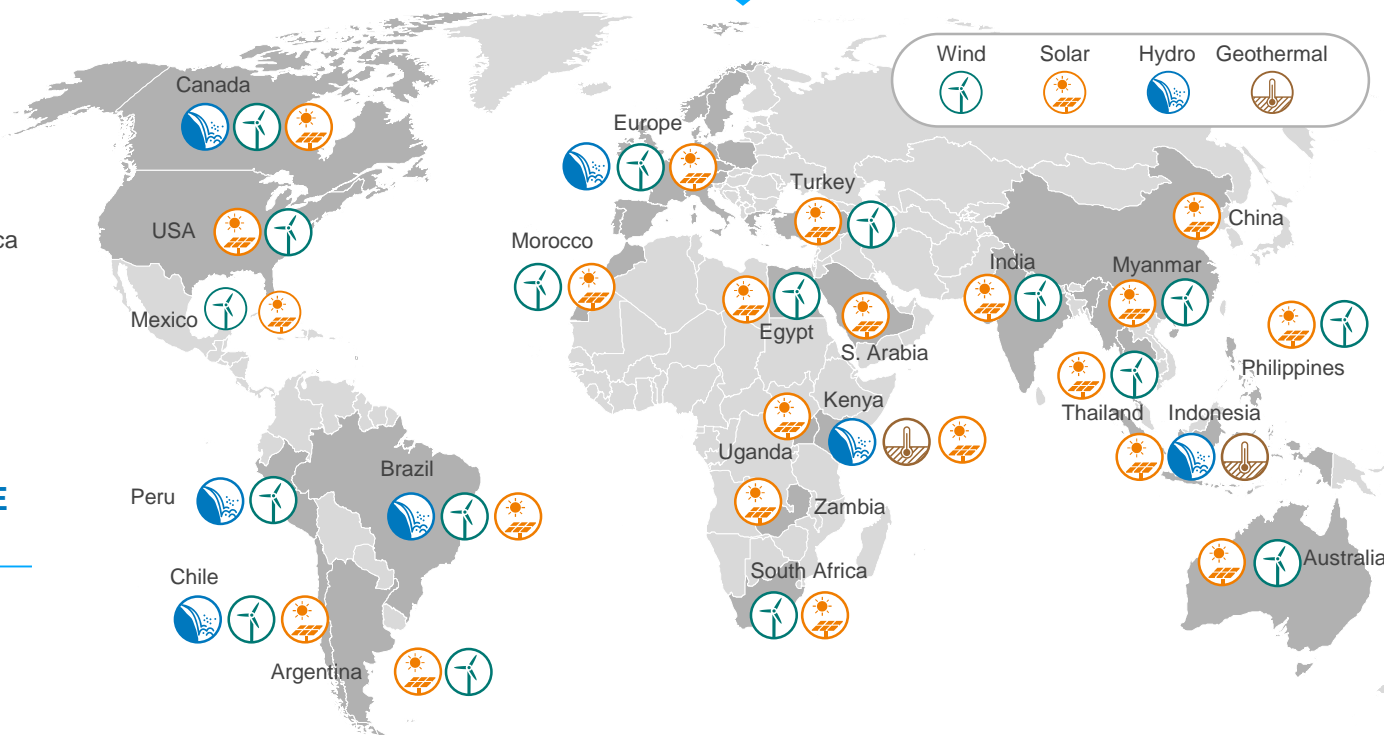


ADDITIONAL RENEWABLE CAPACITY

(in GW, at 100%, cumulative)



RENEWABLES PIPELINE⁽¹⁾

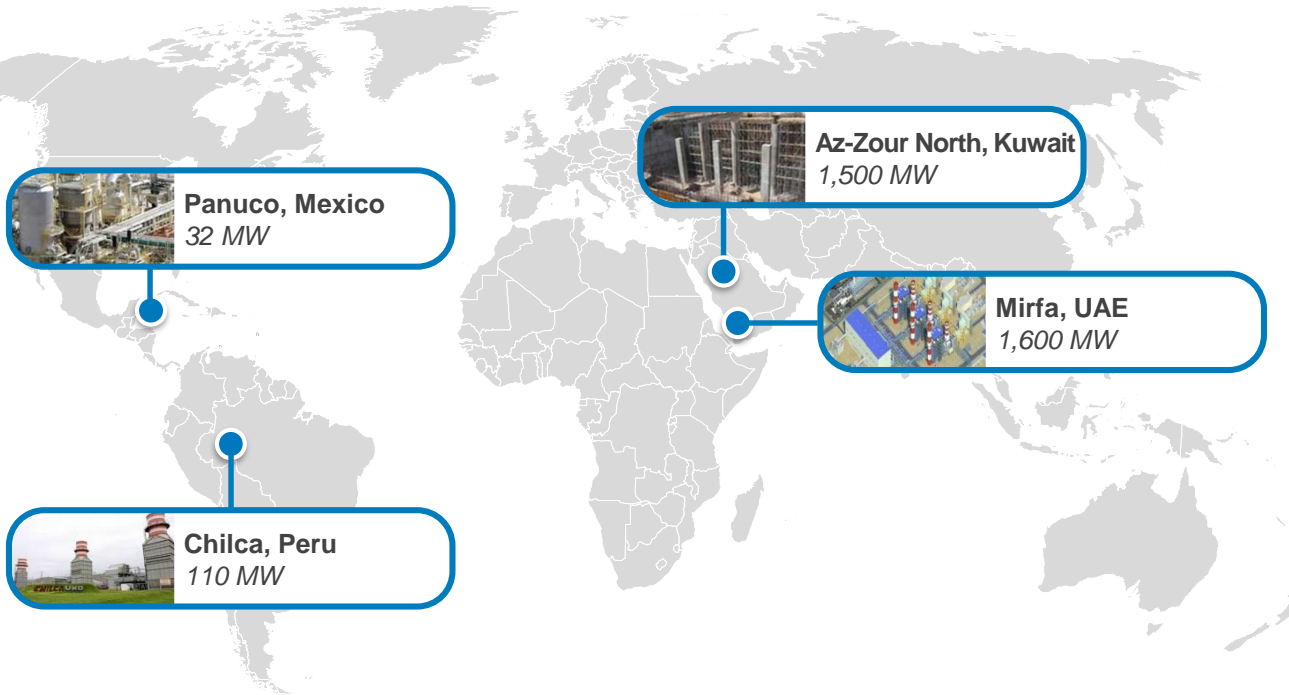


Accelerate solar and onshore wind in fast growing markets

Pursue selected opportunities in offshore wind, hydro and geothermal, building on current key positions in fast growing markets

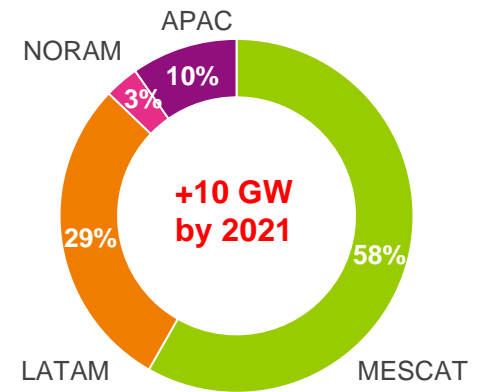
GAS CAPACITIES WILL CONTINUE TO BE A CORNERSTONE OF LOW CO₂ POWER GENERATION PORTFOLIO

PROJECTS UNDER CONSTRUCTION (1)



ADDITIONAL GAS-FIRED GENERATION CAPACITIES

(in GW, at 100%)



MAINTAIN LEADING POSITIONS IN GAS-FIRED GENERATION

OPPORTUNISTIC ACQUISITIONS

FOCUS ON GREENFIELD DEVELOPMENT

DEVELOP GLOBAL O&M SERVICES BUSINESS

(1) Projects total capacities (at 100%)

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1

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3

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4

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5

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6

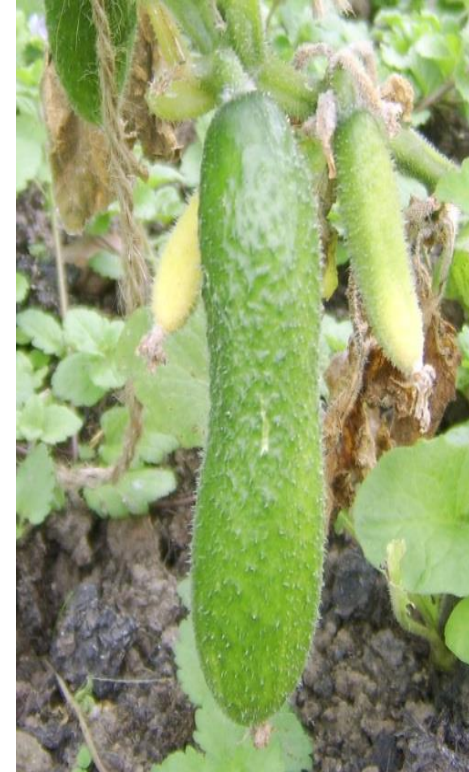
Conclusion

WHAT DO YOU THINK OF THEIR SIMILARITY ...



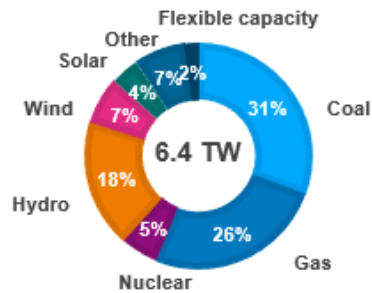
Energy Self- Sufficient

- Building integrated PV
- Underground source energy
- Energy storage
- Smart grid
- Energy efficiency solutions



RENEWABLE ENERGY DEVELOPMENT

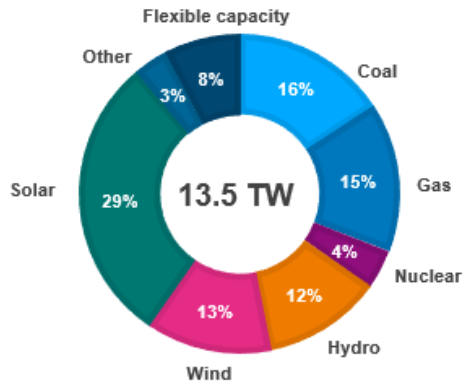
POWER MIX, 2015 (GW)



Renewable Energy

29%

POWER MIX, 2040 (GW)



Renewable Energy

54%

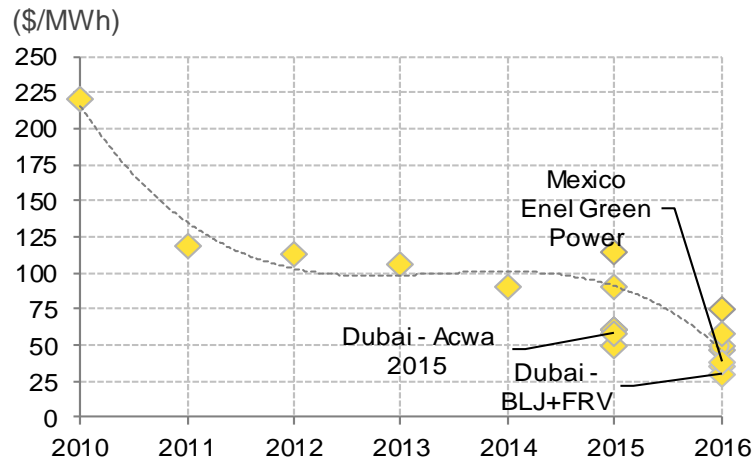
RENEWABLES AMBITIONS

Country	Technology	Ambition
China	Solar	100 GW by 2020
	Non-fossil fuels	15% by 2020 (share of primary energy consumption)
India	Solar	100 GW by 2022
	Wind	60 GW by 2022
USA	Coal retirement	20 GW by 2022
Morocco	Renewable	32% by 2020, 52% by 2030
KSA	Solar	9.5 GW by 2023
	Gas	70% of energy mix (from 50%)

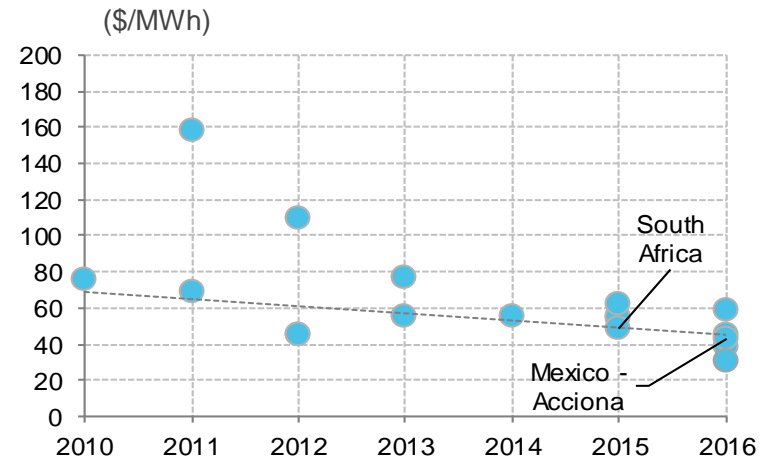
Sources: Bloomberg New Energy Finance, IEA, ENGIE

WIND AND SOLAR AUCTION PRICES SHARP DECREASE

UTILITY-SCALE PV AUCTION PRICES

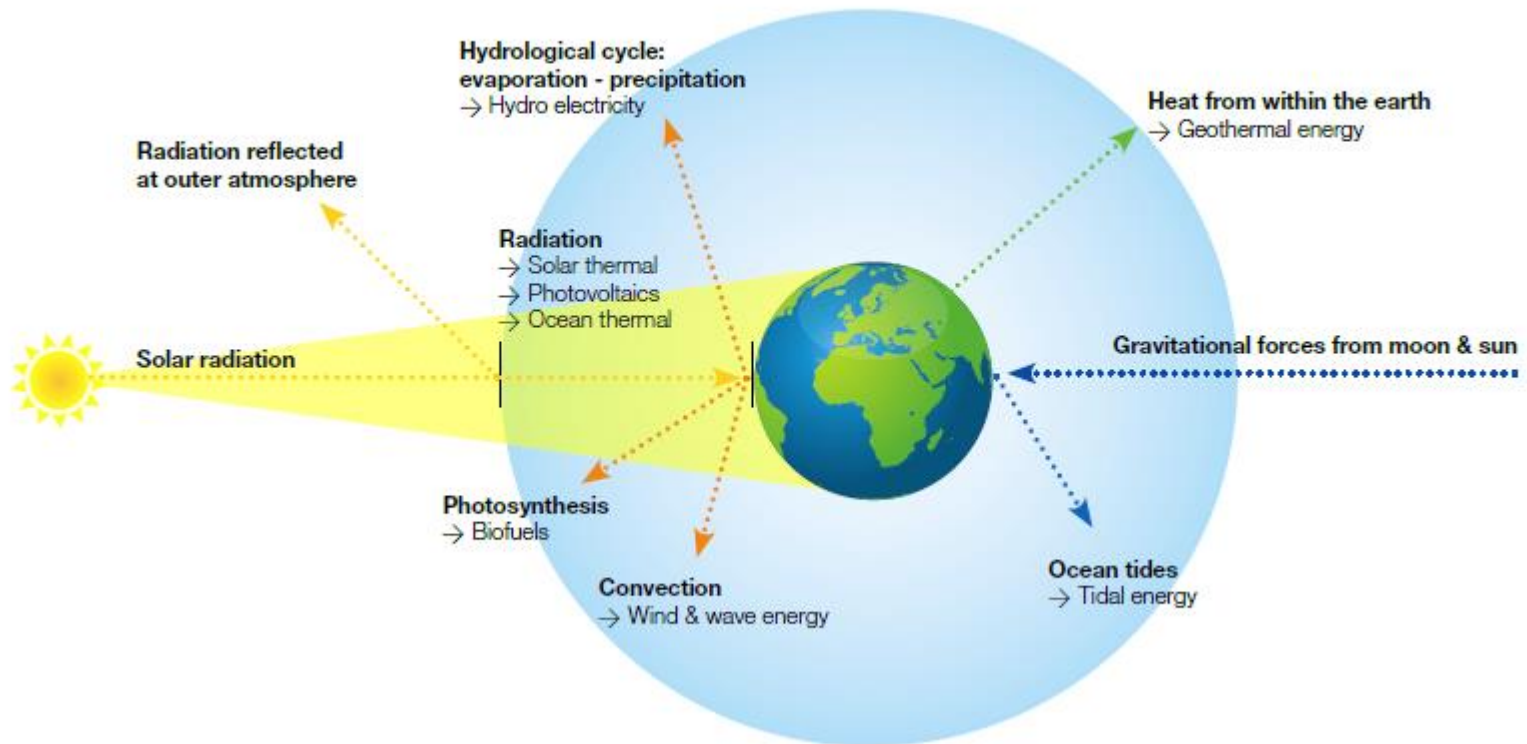


ONSHORE WIND AUCTION PRICES



- Technology progress
- Sustained policy
- Improved financing conditions driven by long term PPA
- Expansion into newer markets with better renewable resources

RENEWABLE ENERGY RESOURCES FOR POWER GENERATION



AGENDA

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5

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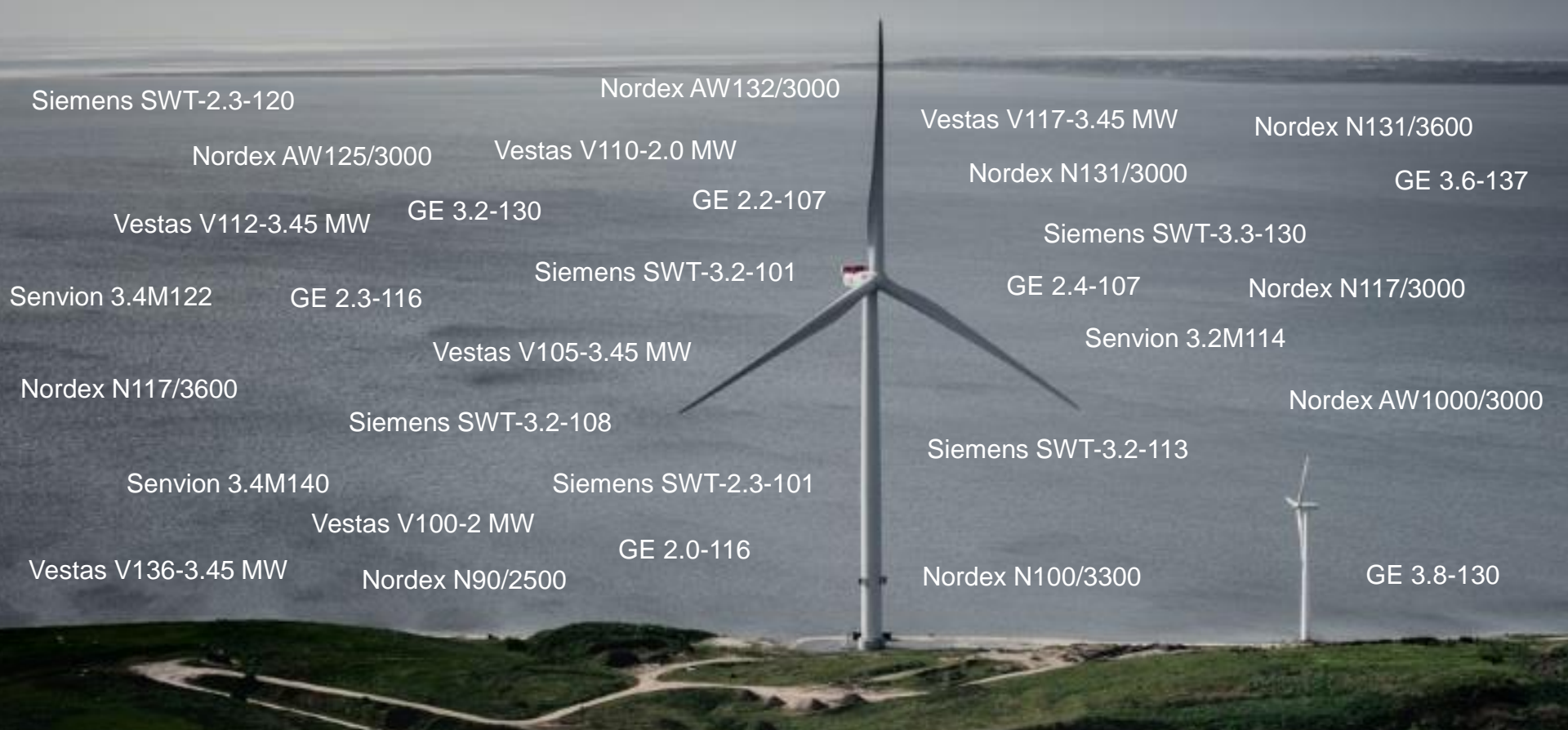
6

Conclusion



Craigengelt WF - Nordex N90's located in Stirling, Scotland

Blade length increase
Hub height increase
Site optimized turbine designs
IEC class III designs: enabling development of low wind speed sites



Siemens SWT-2.3-120
Nordex AW125/3000
Vestas V112-3.45 MW
GE 3.2-130
Senvion 3.4M122
GE 2.3-116
Nordex N117/3600
Senvion 3.4M140
Vestas V136-3.45 MW
Nordex N90/2500
Nordex AW132/3000
Vestas V110-2.0 MW
GE 2.2-107
Siemens SWT-3.2-101
Vestas V105-3.45 MW
Siemens SWT-3.2-108
Siemens SWT-2.3-101
Vestas V100-2 MW
GE 2.0-116
Nordex AW1000/3000
Vestas V117-3.45 MW
Nordex N131/3600
Nordex N131/3000
GE 3.6-137
Siemens SWT-3.3-130
GE 2.4-107
Senvion 3.2M114
Siemens SWT-3.2-113
Nordex N100/3300
GE 3.8-130



LM WIND POWER
Pilot Plant

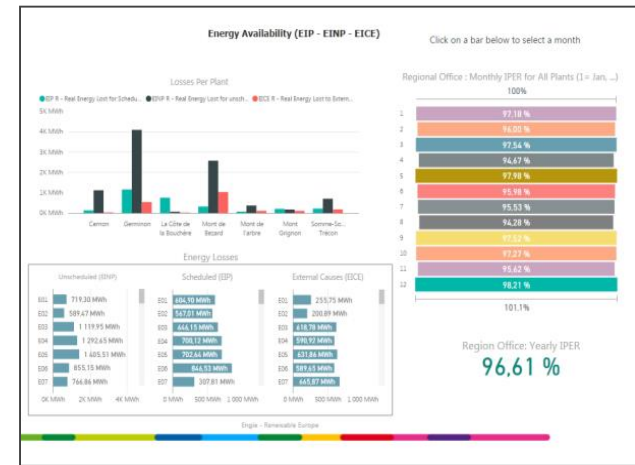
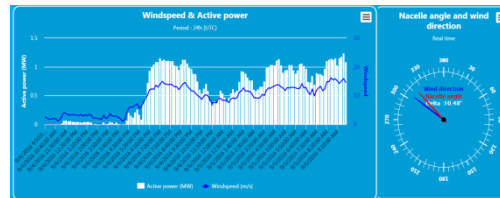
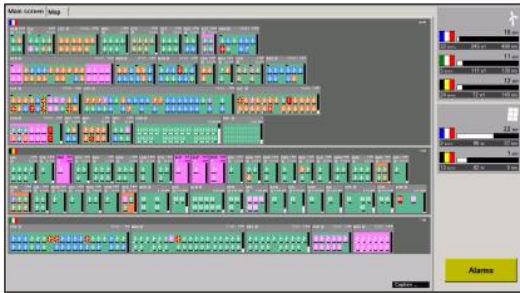
World's longest blade: 88m



Nacelle mounted LIDAR

WIND - FOCUS ON OPERATIONAL EXCELLENCE

DIGITAL - DARWIN



WIND - FOCUS ON OPERATIONAL EXCELLENCE

NEW TECHNOLOGIES



WIND - FOCUS ON OPERATIONAL EXCELLENCE

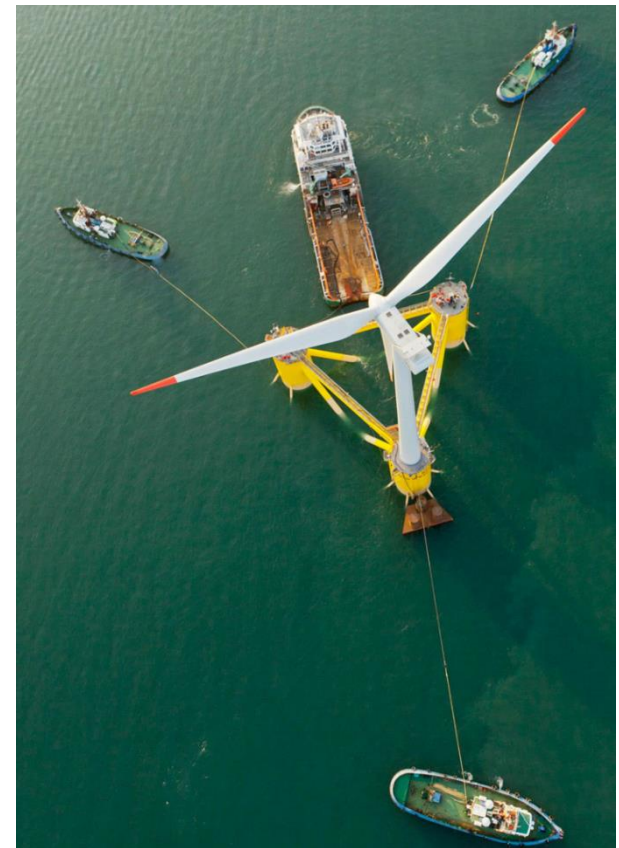
ROOT CAUSE ANALYSIS



INNOVATION – FLOATING WIND



WINDFLOAT ATLANTIC

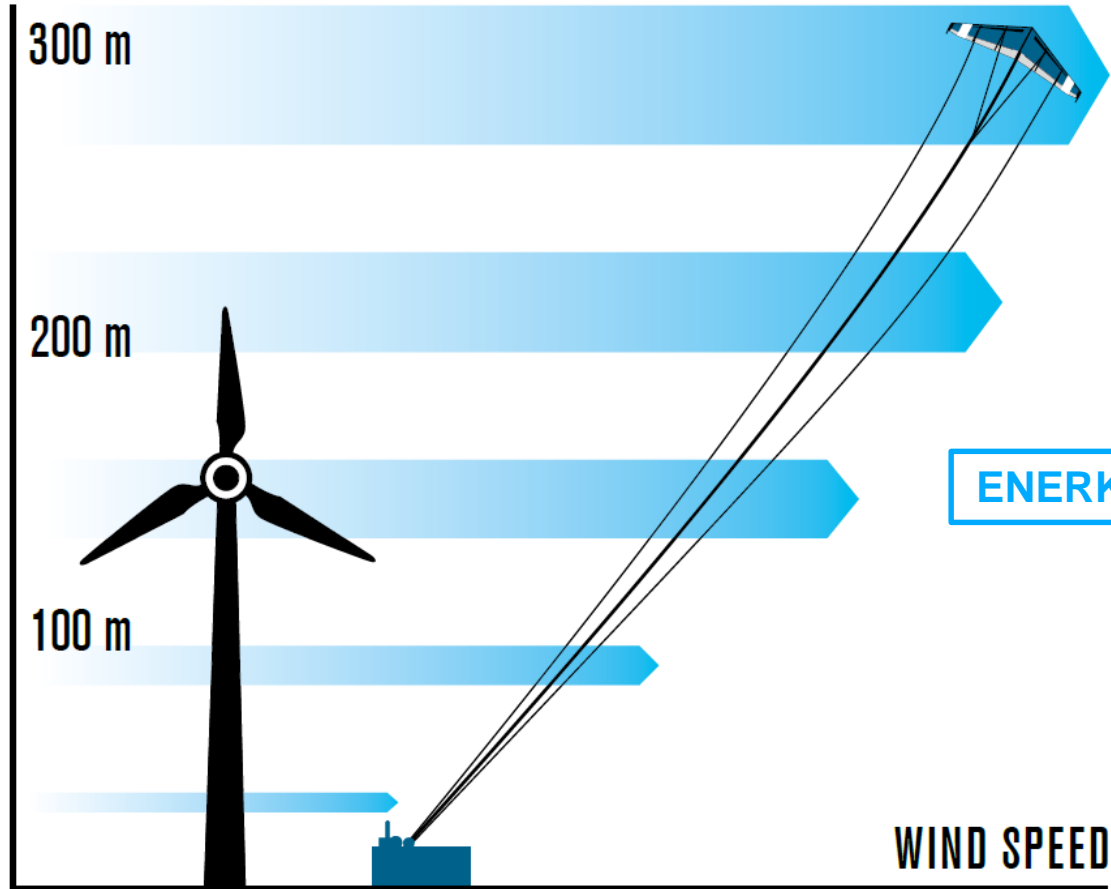


INNOVATION - FLOATING WIND

RISKS



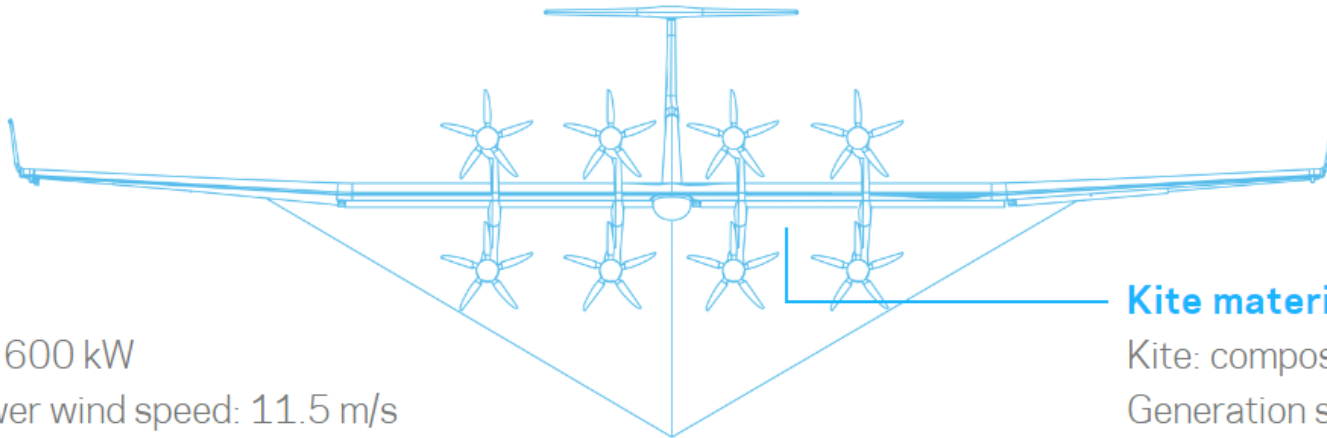
WIND ENERGY – AIRBORNE KITES



WIND ENERGY – AIRBORNE KITES

MAKANI

600 KW ENERGY KITE



Operations

Rated power: 600 kW

Full rated power wind speed: 11.5 m/s

Operational altitude range: 140 m - 310 m

Circling radius: 145 m

First Power Point: 4 m/s

Kite materials

Kite: composite

Generation system: 8
brushless DC motors

Tether

Structure: carbon fiber

Conductor: aluminum

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4

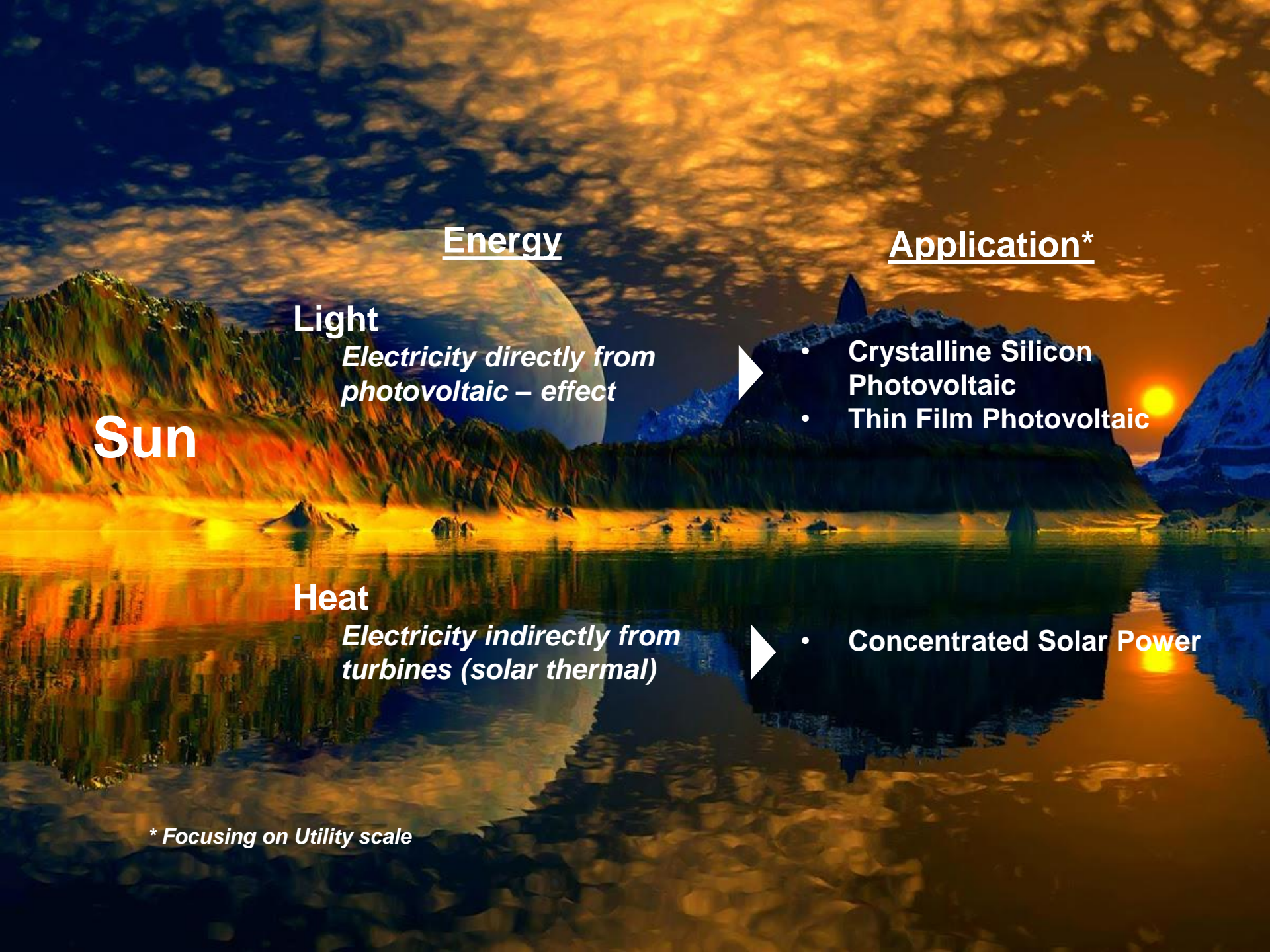
Solar Energy

5

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6

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Sun

Energy

Application*

Light

*Electricity directly from
photovoltaic – effect*



- **Crystalline Silicon Photovoltaic**
- **Thin Film Photovoltaic**

Heat

*Electricity indirectly from
turbines (solar thermal)*



- **Concentrated Solar Power**

** Focusing on Utility scale*

SOLAR PHOTOVOLTAIC APPLICATIONS

Ground Mounted Solar PV

GW Scale



Solar PV Carports / Shade Structure

ENGIE Rivesaltes Solar Park (Parking) in France



Floating Solar PV



Distributed Energy

Engie Solar PV for Telecom Towers in Guinea



THIN FILM PV - ORGANIC SOLAR PHOTOVOLTAIC (OPV)

In 2016, ENGIE invested in Heliatek, the German industrial, specialized in the manufacture of organic photovoltaic film, holding a world record efficiency of 13.2%. Application to building and automobile



Flexible

Exhibiting minimum radius of 10 cm



Ultra-light

With an extremely low weight of 500g/m²



Ultra-thin

Less than 1 mm thin solar film

Numerous colors

Possible in shades of blue, green and grey



Transparent

Achieving up to 50% light transmission with 6 % efficiency



Custom-designed

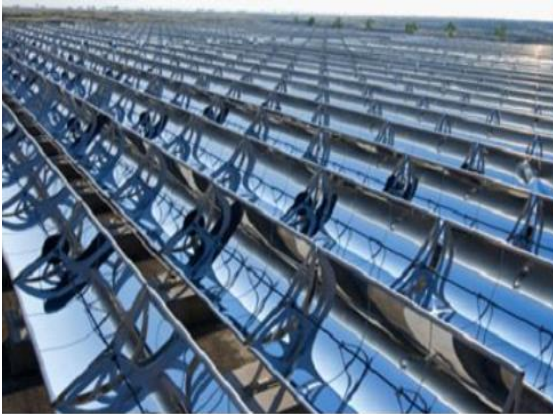
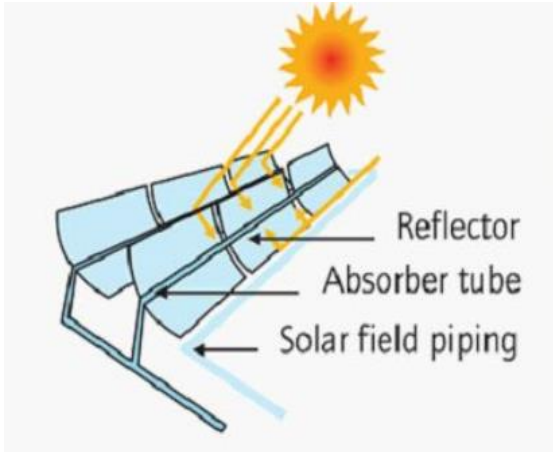
Flexible dimensions in lengths



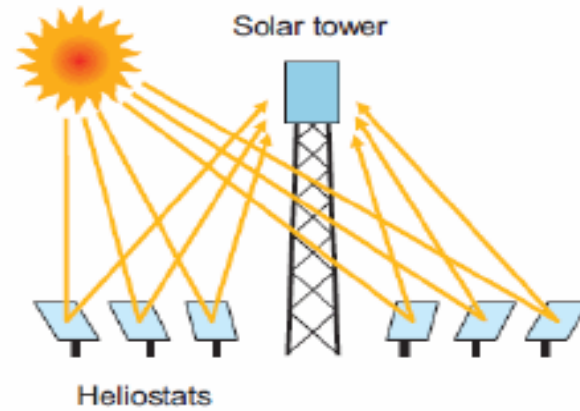
Singapore Cleantech Building Façade with HeliFilm installation

CONCENTRATED SOLAR POWER

Parabolic Trough



Central Receiver Tower



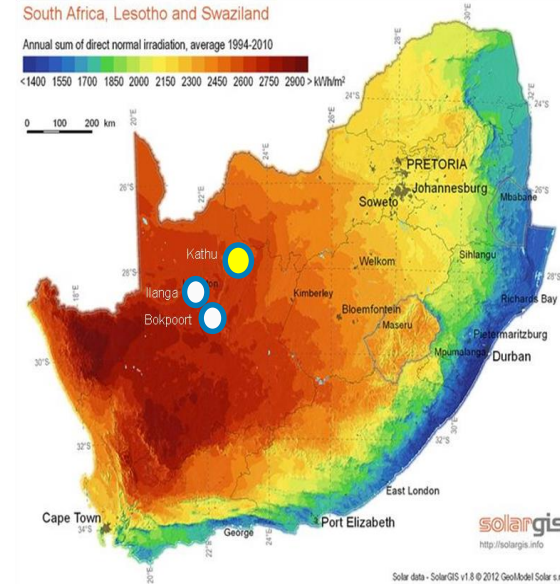
CONCENTRATED SOLAR POWER AND THERMAL STORAGE

CSP Kathu

Parabolic Through + Storage

- South Africa - Kathu
- Operation date: 2018
- **CSP: 100 MW Parabolic Trough**
- **4.5 H of Molten Salt Thermal Energy Storage**
- 20 Year PPA With State – Owned ESKOM

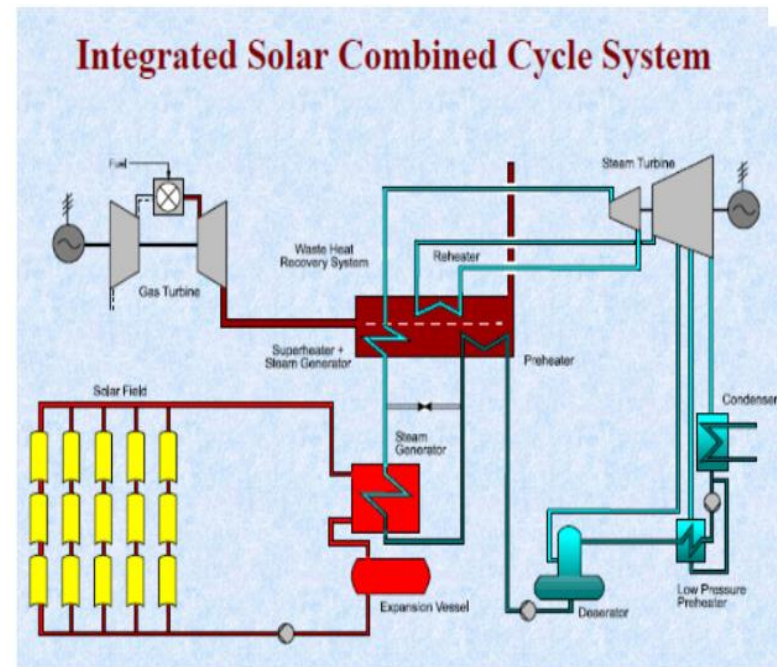
(Video)



HYBRID SOLAR ENERGY SOLUTIONS

Solar Thermal + Combined Cycle

- Kuwait - Abdaliya
- Integrated Solar Combined Cycle
- Total capacity 280 MW
- Solar contribution 60 MW - The plant's utilization of solar energy will contribute to fuel saving



SOLAR ENERGY – TERRAWATT INITIATIVE (“TWI”)

In 2015, UN Climate Change Conference COP 21, the **Terrawatt Initiative** (TWI) was launched by ENGIE, as a global non – profit solar organization

- Promoting globally, the acceleration of and increased **production of (affordable) solar energy** in the member states of the *International Solar Alliance* which gathers today 121 states and IRENA (which represents today, 170 country states)

AND

- Promoting actual deployment of affordable capital in **solar power generation assets at the trillion USD scale, to finance the deployment of 1TW solar power production capacity by 2030**



Isabelle Kocher, Chairperson of Terrawatt Initiative.



TERRAWATT INITIATIVE
GROWING SOLAR POWER TOGETHER

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4

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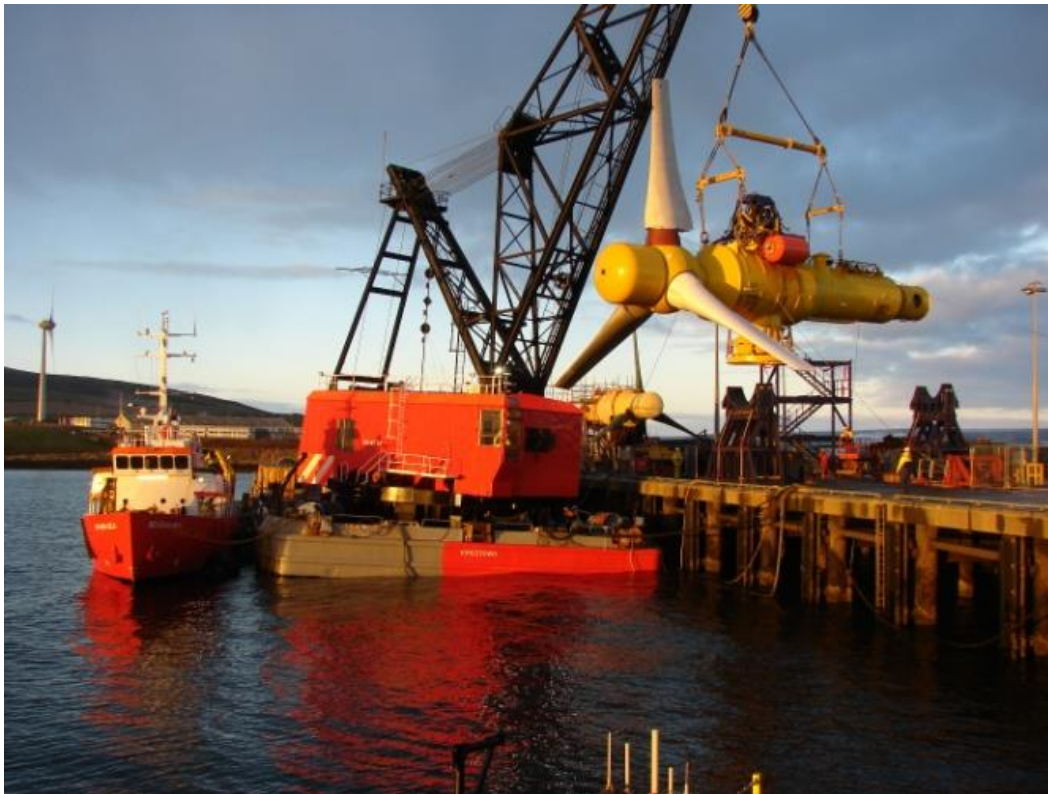
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Marine Energy

6

Conclusion

MARINE ENERGY – TIDAL & WAVE ENERGY



GE DeepGen IV Tidal turbine prototype at EMEC 2014 - © Cyril Abad - GE

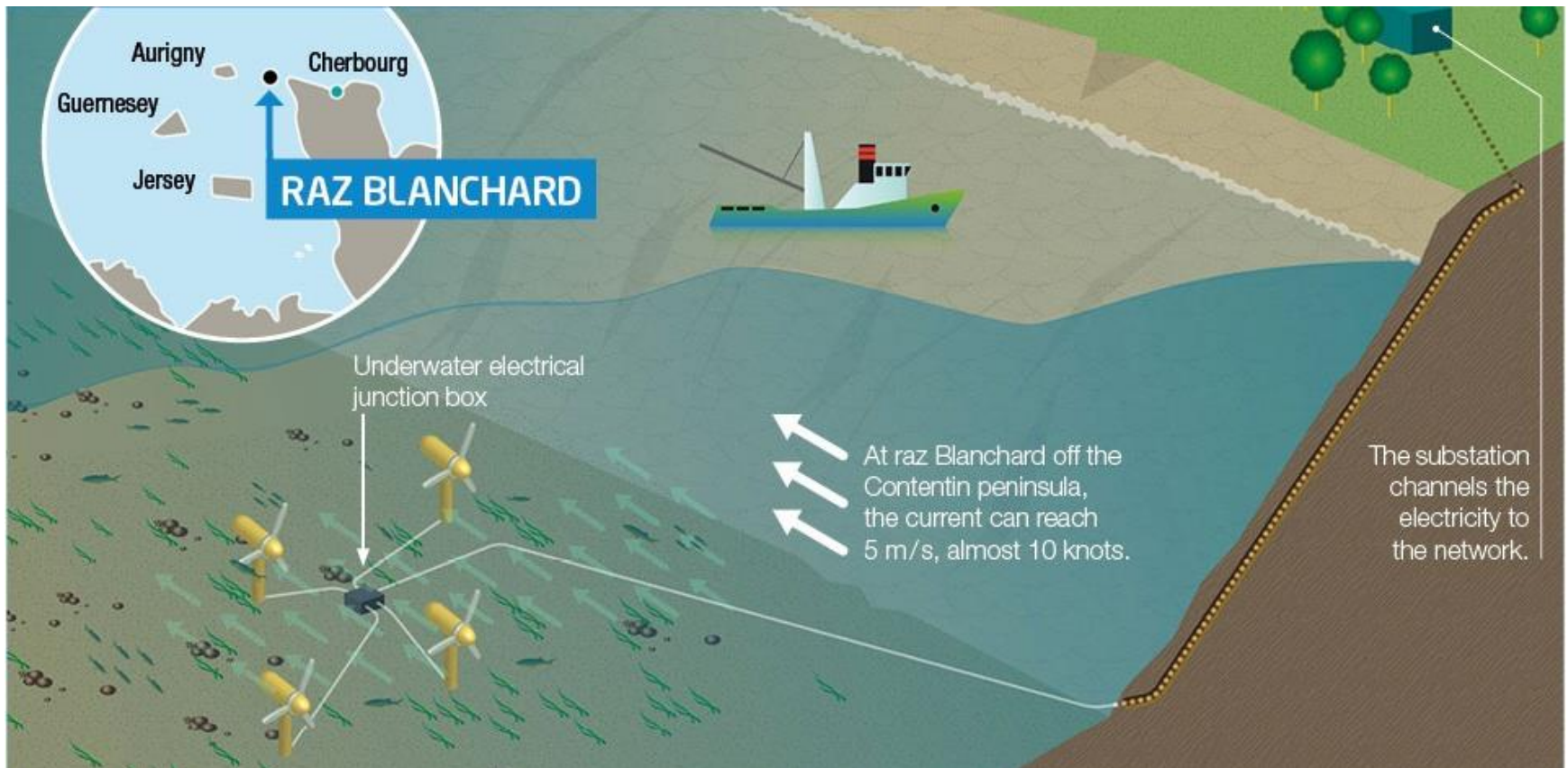


Bleubird marine systems



MARINE ENERGY – TIDAL ENERGY

RAZ BLANCHARD PILOT PROJECT



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1

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2

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4

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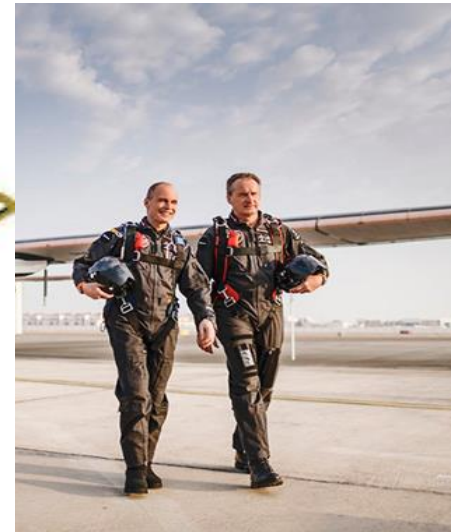
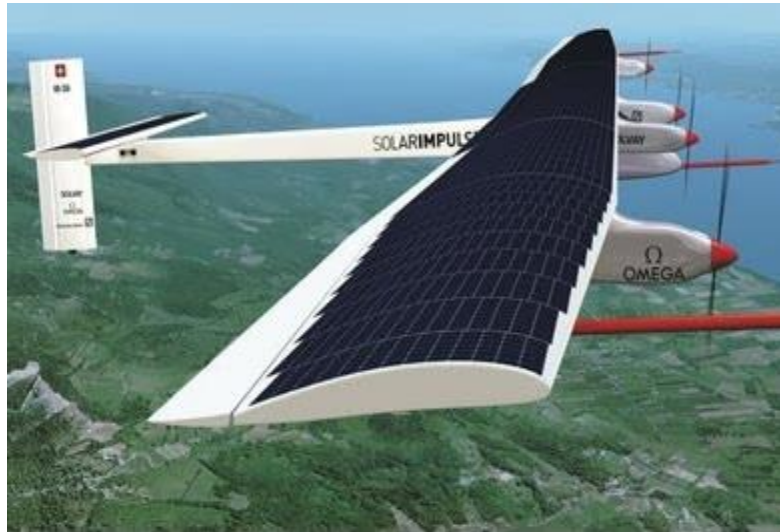
5

Marine Energy

6

Conclusion

DREAM BIG AND ACHIEVE BIG



TECHNOLOGY INNOVATION AND PIONEER ACHIEVE THE IMPOSSIBLE

... FUTURE OF RENEWABLE ...

... BEYOND OUR IMAGINATION...



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