ETIP Wind

EUROPEAN TECHNOLOGY & INNOVATION PLATFORM ON WIND ENERGY

D.4.1 and D.4.2 Report with conclusions from the workshop on wind research and innovation policy

WindEurope

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Introduction

Following the publication of the Strategic Research and Innovation Agenda (SRIA), two workshops were organised by the ETIPWind secretariat, corresponding to the deliverable 4.1:

- Workshop 1: "Wind energy in a digitised world", Hamburg, 14:30-16:00, 27 September 2016: addressing a major topic for wind energy R&I, included in the second pillar (operation and maintenance) of R&I mentioned in the SRIA; and
- Workshop 2: "Making the most of R&I", Hamburg, 17:00-18:30, 27 September 2016: discussing the conditions of success of EU R&I funded projects throughout the whole process from application to delivery.

These two workshops took place as sessions in the main conference programme of the first day of WindEurope Summit 2016, Hamburg Messe & Congress, Germany, 27-29 September 2016. The Summit, organised by WindEurope, gathered 1,750 wind energy stakeholders from over 60 countries from industry, research and academia, as well as policy makers from international, national, regional and local authorities. For full details see windeurope.org/summit2016

The Summit was held alongside WindEnergy Hamburg Global On- and Offshore Expo, that took place in the adjacent Hamburg Messe from 27-30 September 2016. Over 35,000 people and 1,400 exhibitors attended WindEnergy Hamburg.

Maroš Šefčovič giving opening speech

The joint opening ceremony for the Summit and Expo featured keynote speeches from Olaf Scholz (First Mayor, Hamburg), Maroš Šefčovič (Vice-President in charge of the Energy Union, European Commission) and Sigmar Gabriel (Vice-Chancellor and Federal Minister of Economics and Energy, Germany) plus a panel debate with C-level representatives of Enel Green Power, Nordex, ENERCON and DONG Energy.


ETIPWind Advisory Group handing over the Strategic Research and Innovation Agenda 2016 to European Commission Vice President Maroš Šefčovič, Hamburg, 27 September 2016

1 Workshop 1: "Wind energy in a digitised world", Hamburg, 14:30-16:00, 27 September 2016

1.1 Workshop scope and format

1.1.1 Description

The world economy is going digital, and the wind power sector is no exception. Major manufacturers and operators are all rolling out industrial internet solutions to improve the performance and reliability of their turbines while bringing assembly and maintenance costs down. Digitisation is key to integrate even larger amounts of wind energy into the grid. The combination of unprecedented data collection and computing power opens a wide range of new possibilities to make wind power ever more competitive. However, when it comes to digitisation, the wind energy sector is still in its infancy compared to other industrial sectors.

This session looked at the digitisation of the wind energy sector and asked the following questions:

- What are the challenges and bottlenecks for digitisation in the wind energy sector?
- Which success stories look promising?
- What can be learned from other, more advanced, industries?
- Where should R&I efforts focus and in which area should the collaboration be encouraged?

1.1.2 Format and speakers:

The format of the workshop was 10-15 minute presentations from each of the four speakers with specific questions after each, followed by a general Q&A session at the end.

The workshop was chaired by Aidan Cronin, Chairman of the Steering Committee, ETIP Wind / Advisory Specialist to the CTO, Siemens Wind Power A/S, Denmark.

Speaker name	Job title	Company/University
Thomas Pump	Head of Asset Information Systems	E.ON Climate and Renewables, Germany
Peter Thorsted	Head of Centre of Excellence	Envision Energy, Denmark
Thomas Ward	CEO	Sentient Science, United States
Tom Richardson	Senior Lecturer in Flight Mechanics	University of Bristol, United Kingdom

1.1.3 Attendance:

65 attendees from industry, research and academia.

1.2 Content of the workshop

1.2.1 Presentation 1: Digitisation @ wind energy: how to harvest the full potential?

Thomas Pump, Head of Asset Information Systems, E.ON Climate and Renewables, Germany

Thomas Pump,
E.ON Climate and Renewables

Mr. Pump introduced the topic of digitisation breaking it down into the areas where it offers significant potential for wind energy:

- Project development;
- Wind farm planning;
- Construction;
- Operation; and
- Manufacturing.

The "operation" area was described as the one where digitisation has greatest potential with developments expected in multiple topics including smart repairs, O&M optimisation, augmented reality, machine learning analytics, blade inspection and predictive analytics.

Question from Lyn Harrison, Insight Wind, Denmark, to Thomas Pump after his presentation

Mr. Pump also highlighted the issue of the ownership and access if data as a major challenge to address if digitisation in the wind energy sector is to be successful.

See his full presentation slides on page 26.

1.2.2 Presentation 2: Toward an energy internet. What will digitisation mean for the industry in a few years

Peter Thorsted, Head of Centre of Excellence, Envision Energy, Denmark.

Mr. Thorsted introduced his speech saying that the wind energy industry is at a turning point, where digitisation will introduce significant changes in the way we build and operate wind farms. Digitisation had so far only played a subordinated role, as it was often used as a support tool.

He then defined the smart wind farm, enabled by digitisation. The main areas that would benefit from digitisation according to him were:

- Design and planning: using global weather data for wind farm layouts, turbine choice and optimisation;
- Supply & installation: optimise logistic cost with integrated balance of plant;
- Grid integration: adjusting smart turbines to specific grid requirements; and
- Operation and maintenance: using smart turbines and weather forecast data to optimise yield and reduce downtime.

The lifetime data of wind turbines was then highlighted as a data that will play a vital role, opening up new opportunities for optimisation of yields and maintenance. Envision already has developed strong tools named Greenwich, Wind OS & Apollo OS that enable optimised design, operation and maintenance of turbines, using the data through the value chain.

Mr. Thorsted concluded by widening his speech to the whole energy sector, describing the Energy Internet as a flexible system with a nerve system optimising production, distribution, storage and demand.

See his full presentation slides on page 16.

1.2.3 Presentation 3: Using computational prognostics to extend machine lifetime

Thomas Ward, CEO, Sentient Science, United States.

Mr. Ward offered a different perspective of digitisation, describing the trends and economics behind it. He first noted that Europe is lagging behind in terms of number of digitisation companies with less than a quarter of the value of such businesses in North America. China is also ahead of Europe in terms of number of digitisation companies.

Thomas Ward, Sentient Science

When talking about digitisation in the wind energy sector, Mr. Ward mentioned operation and maintenance as the main topic, enabling significant cost reduction of 13%, i.e. ~10 €/MWh on LCOE of onshore wind turbines. He additionally provided detailed figures about the net return on investment triggered by a life extension investment: a US$750,000 investment per year in digitisation services could trigger US$4,500,000 savings per year thanks to cost reduction mainly due to smart derating enabled life extension.

See his full presentation slides on page 36.

1.2.4 Presentation 4: Autonomous drones and perspectives from the aerospace industry

Tom Richardson, Senior Lecturer in Flight Mechanics, University of Bristol, United Kingdom.

Mr. Richardson addressed a different aspects of digitisation with explaining the added value of autonomous drones for turbine monitoring, including defect identification.

He presented the technical challenges linked to the use of autonomous drones. The path planning of drones was highlighted as the main challenge for their use for wind turbine inspection. The other challenges mentioned were:

- The development of smart algorithms;
- Batteries with alternative power sources;
- Flight envelope; and
- Long term maintenance of the drones.

Mr. Richardson insisted that the technology is already available now, and only needs to be industrialised and deployed commercially.

See his full presentation slides on page 52.

1.2.5 Concluding remarks:

The presentations were followed by a question and answer session with delegates.

Mr Cronin asked Mr Richardson why military drones are not being used, as these can stay up in the air for hours at the time. Mr. Richardson replied that he would be surprised if there is an electricity driven rotor drone that can stay airborne for three hours. However, the key point is that there is no need for such long-lasting batteries because inspections are surprisingly quick. Two or three turbines can be inspected on one set of batteries.

Niya Chen, ABB, asked if there are other sensors besides the camera on UAVs that can detect the condition of a wind turbine. Mr. Richardson replied that currently it is only a camera. The University of Bristol is looking into embedding sensors within the blade that its structural condition can be examined from the inside.

Dorte Juul Jensen, DTU Wind Energy, asked Mr. Thomas that if there is less data from materials compared to what is available from sensors as he explained, how can this small data-set from materials characterisation be brought into the maintenance or extended lifetime of the bearings? Mr. Thomas replied in the same way that you do not save a Google search, if simulators are used to search datasets to find the required answers then there is less need for massive databases. However if simulators are not available the cost becomes prohibitive.

Mr Cronin, Siemens Wind Power, asked Mr. Thorsted how important the software interfaces and visuals that Envision is well known for are compared to hardware and sensors in order to drive the digitisation of the energy system. Mr. Thorsted explained that Envision sees itself as a product company based on advanced technology, not a turbine manufacture. It bases all its technology and development on digitisation and has many different digital solutions not only for wind turbines but also for solar PV, other OEMs and asset owners.

Andrew Garrad, Garrad Balfour, asked to what extent those working on digitisation are working with counterparts specialising in modelling and failure prediction. Mr. Thomas said that Sentient Science has been working on predictions for 10 years and after nine years of incorrect predictions it has managed to develop a reliable simulator for the reliability of moving parts such as gears, bearings, oil etc. The company conduced further testing with industry (GE, Siemens and bearing and oil companies) for 3-4 years before commercialisation.

A representative of DONG Energy and Mr. Richardson what kind of problems occurred in the operation of drone beacons when making inspections on wind turbine components. Mr. Richardson explained that the biggest challenge when operating these kind of vehicles is the hardware that is at the level of a 'hobby' compared to the sophisticated software on them. The software operation has been relatively easy compared to the physical operation of the vehicles themselves.

Mr Cronin concluded by summarising the questions raised and the answers that the discussions in this workshop provided:

- What are the challenges and bottlenecks for digitisation in the wind energy sector?
    - Massive data storage analysis and computation;
    - Interaction with other technologies in the energy system, including solar PV, conventional sources, electric vehicles, demand-side management; and
    - Data extraction with better and optimised sensors, including drones.
- Which success stories look promising?
    - Computational prognostics; and
    - Drones.
- What can be learned from other, more advanced, industries?
    - Aerospace industry: manufacturing, lean management, quality control and preventive and predictive maintenance; and
    - Telecommunications; digitisation of the energy sector and the wind turbines, communication interfaces and smart processes.
- Where should R&I efforts focus and in which area should the collaboration be encouraged?
    - Design and planning: using global weather data for wind farm layouts, turbine choice and optimisation;
    - Supply & installation: optimise logistics cost with integrated balance of plant;

- Manufacturing and industrialisation: enhance factories throughout the value chain to improve the quality and reliability of turbines, thereby decreasing costs;
- Grid integration: adjust smart turbines to specific grid requirements, and adjust to demand; and
- Operation and maintenance: use smart turbines and weather forecast data to optimise yield and reduce downtime.

2 Workshop 2: "Making the most of R&I", Hamburg, 17:00-18:30, 27 September 2016

2.1 Workshop scope and format

2.1.1 Description

Public funding for R&I can be instrumental in enabling major technology breakthrough as shown in various industry sectors such as telecoms and aerospace. All major economies, including the United States and China, use it. The European Union, which has a tradition of investing in research, has pledged to remain the global leader on renewable energy technologies, including wind energy. It is ready to invest significant amounts of public money to reach that objective.

This workshop provided participants with an overview of the challenges ahead for the wind industry in Europe, and presented R&I EU funding opportunities, with concrete examples of successful initiatives.

2.1.2 Format and speakers:

The format of the workshop was 10-15 minute presentations from each of the four speakers with specific questions after each, followed by a general Q&A session at the end.

This second workshop was also chaired by Aidan Cronin, Chairman of the Steering Committee, ETIP Wind / Advisory Specialist to the CTO, Siemens Wind Power A/S, Denmark.

Speaker name	Job title	Company/University
Charles Dugué	CEO	8.2 Consulting, Germany
Matthijs Soede	Research Programme Officer, DG RTD — Directorate-General for Research and Innovation	European Commission
Stephan Wachtel	Senior Power System Engineer - Renewable Energy	GE Power & Water, Germany
Gustavo Quiñonez Varela	Grid Integration Manager	ACCIONA S.A., Spain

2.1.3 Attendance:

35 attendees from industry, research and academia.

2.2 Content of the workshop

2.2.1 Presentation 1: Wind technology - an R&I perspective

Charles Dugué, Chief Executive Officer, 8.2 Consulting, Germany

Mr. Dugué provided a general presentation placing wind energy R&I in the overall energy R&I, and describing the R&I trends of today.

Mr. Dugué first highlighted the importance of China in newly installed capacity as it represented almost the half of global installations of 2015. European leadership is now clearly questioned by China. The United States, as the second country in terms of installed capacity in 2015, stands as another challenger of European leadership in wind energy.

Mr. Dugué then put renewables R&I in a wider context comparing it with other sectors. Renewable energy was highlighted as the fourth most important topic by researchers after IT, nanotechnologies and software.

Among other renewables, wind ranks second in terms of investment from private and corporate bodies after solar photovoltaic (PV) technology. Europe's investment is decreasing and meanwhile the Chinese government provided more investment to renewables R&D than Europe: €1.8bn for China versus €1.2bn for Europe (source Bloomberg New Energy finance, IEA, IMF and various government agencies).

Even though wind energy has become a mature technology, Mr. Dugué stressed the importance of research for wind energy in order to:

- Continue to drive the LCOE down;
- Face the challenges of mature technologies, including blades, grid integration; and
- Explore new territories including floating and radical design change.

See his full presentation slides on page 66.

2.2.2 Presentation 2: Overview of existing funding in Europe

Matthijs Soede, Research Programme Officer, DG RTD — Directorate-General for Research and Innovation, European Commission.

Being the fifth pillar of the Energy Union, research, innovation and competitiveness represents a major challenge for the European Commission. With the core priority of remaining 'number one' in renewables, the European Commission has defined a Strategic Energy Technology Plan (SET-plan) that includes key actions such as sustaining technological leadership by developing highly performance renewable technologies and their integration in the energy system and reducing the cost of key technologies. For the offshore wind energy sector this translates into concrete objectives of reducing costs to less than 10 ct€/kWh by 2020 and less than 7 ct€/kWh by 2030 for waters depth below 50 metres and less than 12 ct€/kWh by 2020 and less than 9 ct€/kWh by 2030 for water depths greater than 50 metres.

EU funds have a major role to address these challenges. Currently four different EU funds can help the development of wind energy sector through R&I:

- Horizon 2020: focuses on cost reduction and improving the performance of wind energy, particularly offshore;

- NER 300/400: financed from the ETS allowances and serves as a catalyst for the demonstration of environmentally safe carbon capture and storage (CCS) and innovative renewable energy technologies;
- EFSI – European Fund for Strategic Investment: aims to overcome current market failures by addressing market gaps and mobilising private investment. Research and innovation is one of the key areas addressed, among infrastructure, education and risk finance for small businesses. EFSI has a total budget €315 billion; and
- ESIF – European Structural and Investment Fund: with €46 billion to be spent on R&I and €45 billion in low carbon economy, it will deliver a critical mass of investment to respond the needs of the real economy by supporting job creation and getting the European Union growing in a sustainable way.

Mr. Soede then described into more detail the energy calls from Horizon 2020 for the period 2016-2017. Giving example of projects in all technology readiness levels (TRL), from basic to advanced research, demonstration and market uptake. More specifically on wind energy, Horizon 2020 funded projects on a broad range of topics including wind turbine, substructures, cost reduction in offshore wind, small wind, airborne wind, education and training and synergies between wind and ocean energy. Mr. Soede presented examples of Horizon 2020 funded projects for each of these topics.

See his full presentation slides on page 98.

2.2.3 Presentation 3: REserviceS – A pan European research project success story

Stephan Wachtel, Senior Power System Engineer - Renewable Energy, GE Power & Water, Germany.

REserviceS was an EU funded project that took place between 2012 and 2014 that provided technical and economic guidelines and recommendations for the design of a European market for ancillary services, as well as for future network codes within the Third Liberalisation Package. It was funded under the FP7 programme (2007-2013).

Stephan Wachtel, GE Power & Water

Mr. Wachtel emphasised several criteria that enabled REserviceS to be a success:

- Relevance of the topic for industries;
- Realistic objectives;
- Intellectual property must be preserved;
- Available skills within the participating companies;
- Sufficient amount of funding must be available and sufficient added value for the businesses; and
- Project coordinator must be experienced.

The lessons learned from REserviceS were divided into two categories:

- EU funded projects rules are complex:
  - The application process is complex;
  - Understanding the rules fully is necessary to identify all potential bottlenecks, and the flexibility that the rules allow for;
  - External support experienced in EU funded projects is very useful; and
  - Internal processes need to be aligned with funding rules.
- Project coordination is paramount:
  - 14 partners project needed very good coordination and alignment on target and objectives;
  - Reporting and putting clear deadlines is important to keep the project going;
  - Dissemination of the results is important in order to share outputs; and
  - Preparation should be made for a possible audit.

See his full presentation slides on page 126.

2.2.4 Presentation 4: Towards grid support services: the contribution of REserviceS

Gustavo Quiñonez-Varela, Grid Integration Manager, ACCIONA S.A., Spain.

Mr Quiñonez-Varela complemented the previous presentation by discussing the contribution of REserviceS towards grid support services in the context of a high penetration of renewables, new electricity markets design with ancillary services, and new European grid codes implementation.

After having acknowledged the added value of EU funded projects in enhancing R&I efforts in the wind energy sector and facilitating the link between research and industry peers, he described the technical outcomes of the REserviceS project:

- Assessment of present status of wind and PV ancillary services, regarding capabilities and costs;
- Advice to EU for the implementation of EU network codes;
- Assessment of additional costs regarding different policy framework if an ancillary service is provided, including for instance voltage control at zero power; and
- Recommendations for future EU market for ancillary services to policymakers.

Mr Quiñonez-Varela concluded on recommendations for policy makers in order to improve the efficiency of EU funded projects:

- Maintain high levels of funding;
- Enhance the European Technology and Innovation Platforms (ETIPs) that align industries;
- Minimise administration to shorten the time laps between proposal and start of project; and
- Keep in mind external competition and intellectual property issues.

See his full presentation slides on page 85.

2.2.5 Concluding remarks:

The presentations were followed by a question and answer session with delegates.

Wei He, Principal Engineer, Statoil, asked Mr Soede how best to make an attractive proposal in order to be selected, but resist the temptation to over-promise what can be achieved. Mr Soede replied that this does indeed happen and external experts assessing the proposals are asked to evaluating whether the work proposed is realistic and credible. That being said, the European Commission allows scope for ambitious proposals and accepts that there is an inherent element of risk that not all awarded projects will be successful.

Responding to remarks that the EC should be quicker negotiating funding, Mr Soede remarked that processes are already faster than under FP7 for example. Under Horizon 2020 99% of grant agreements are concluded within eight months of the application deadline.

Stephan Barth, Managing Director, ForWind, asked what the optimum size of a consortium is, considering that the EC would also like projects to have a connection to networks such as the IEA. Mr Wachtel replied that while GE can consider taking part in large projects, the hurdle to it deciding to join smaller and shorter projects with fewer partners is lower and therefore these are seen as more attractive. Mr Quiñonez Varela concurred saying that while it depends on the specific project, in general involvement in smaller consortia is easier for ACCIONA to agree on. Mr Soede stated that there is no ideal size, and the number of participants depends on the specifics of each project and the expertise each partner can add. He also commented that it would also be valuable to include partners from outside Europe in order to promote international cooperation.

Mr Cronin asked how EU-funded projects are viewed in France and how these can be leveraged. Mr Dugué replied that France lags behind in participating in EU-funded projects and the French wind industry association (FEE) is working on how to improve this situation.

Wei He, Principal Engineer, Statoil, asked how much importance evaluators attach to the advisory board of a project. Mr Soede said that in his view the partners at the core of a project should contribute the main expertise needed, rather than leaving this to less-involved advisors. All partners, including non-European ones, are evaluated on the excellence they can contribute to a project. International involvement should be as a win-win, bringing additional expertise, but not so much involvement that it is to the detriment of the EU.

Mr Soede asked ETIPWind members how they view collaboration with markets outside Europe. Are there countries that companies benefit from dealing with and are there some 'no-go' areas? Mr Wachtel replied that GE has operations on all continents. When it decided whether to join REserviceS the rules did not allow them to involve colleagues with relevant expertise from outside Europe and they had to find alternative European-based staff. They would appreciate more flexibility to be able to optimise the expertise they can bring to a project in Europe. Mr Cronin agreed from the point of view Siemens, and commented that flexibility on the part of third countries would also be beneficial when collaborating on projects outside the EU.

Mr. Cronin concluded that the workshop had provided participants with an overview of the challenges that lie ahead for the wind industry in Europe, and presented R&I EU funding opportunities, with concrete examples of successful initiatives. The discussions provided answers to the following questions:

- What are the goals of R&I for wind energy?
    - Reduce LCOE, to make sure wind energy is competitive with other sources of power generation is affordable for citizens;
    - Enhance grid integration, to ensure that the amount of power generated by wind energy can be optimally absorbed by the grid, at the lowest cost and with the lowest risk for the system; and
    - Explore new areas such as floating to create new opportunities of growth.
- What are the EU funds and how can they help the wind sector achieve these goals?
    - There are multiple EU funds that either citizens; (Horizon 2020, Innovation Fund) or leverage private investment (EFSI, ESIF).
- What is needed to achieve successful EU funded projects?
    - Fast application process;
    - Simple rules, that do not put burden on private companies/research institutes;
    - Good coordination within project with many different stakeholders;
    - Alignment and coordination of R&I through ETIPs;
    - Protection of intellectual property;
    - Sufficient level of funding to realise decent projects; and
    - Set achievable and realistic objectives.

Annex: presentations from the workshops

ETIP Wind

EUROPEAN TECHNOLOGY & INNOVATION PLATFORM ON **WIND ENERGY**

What digitization will mean for the industry in a few years time

Peter Thorsted
Head of Global Windfarm COE

Agenda

- Where we come from
- Smart Wind Farm
  - Design and planning
  - Supply & Installation
  - Grid integration
  - Operation & maintenance
  - Lifetime data
- Beyond turbines
  - Toward an energy internet and smart energy

Where we come from

- Up to today

  Construction and operation has mainly been about different business strategy and thereby fully depending on various of different processes, standards and norms.

  Optimization in design, construction, operation and maintenance was primarily achieved through Engineering studies, lessons learned and best practices.

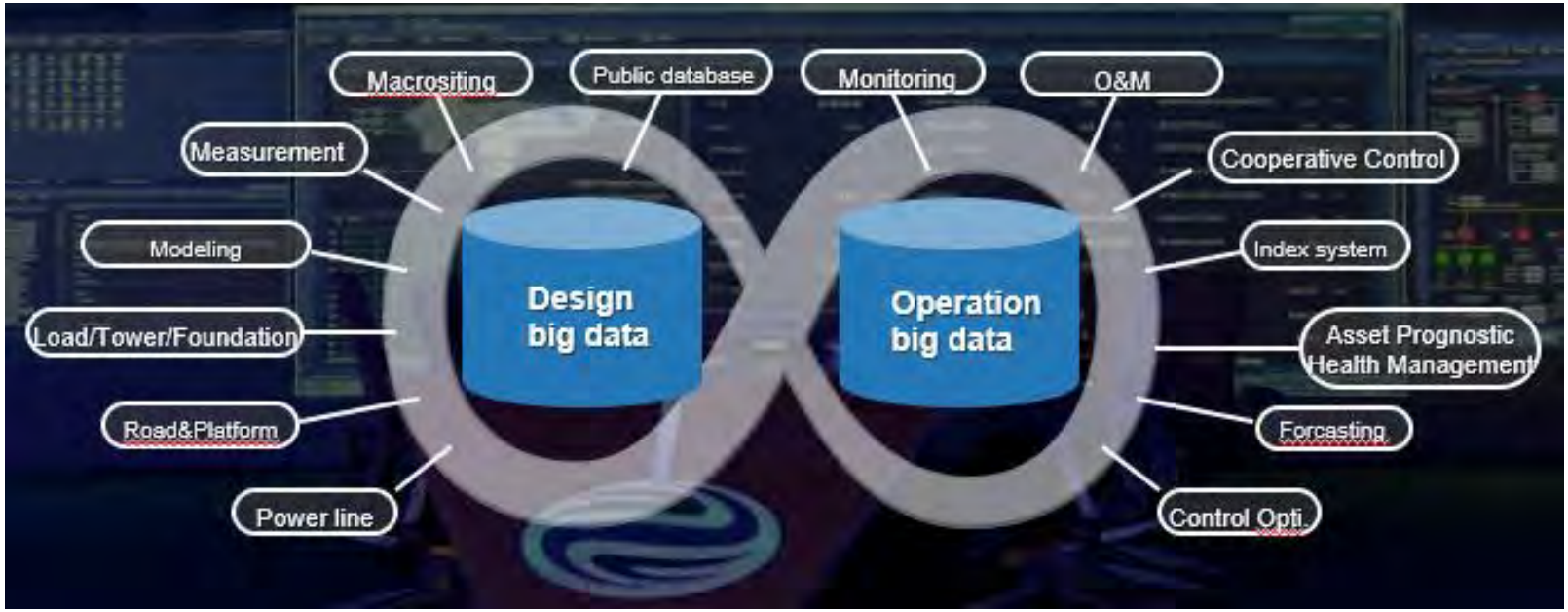
  Digitization has only played a subordinate role.

Smart Wind Farm

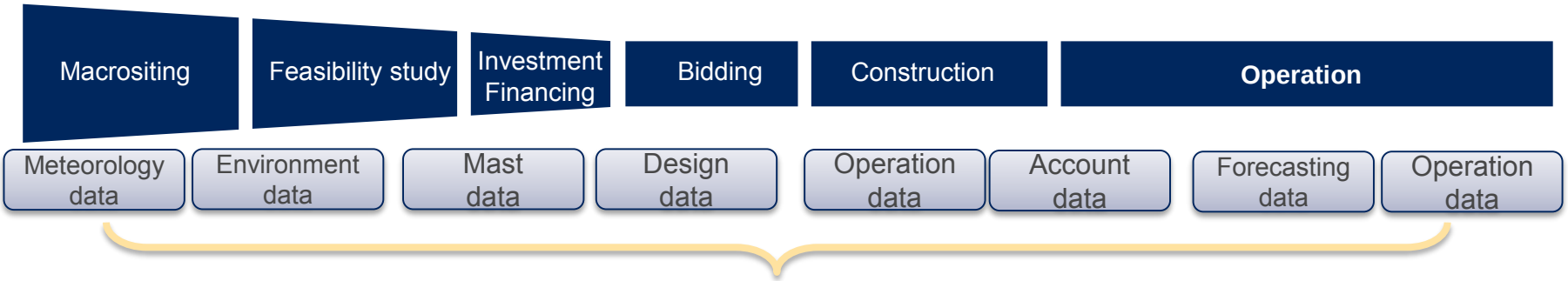
- Design and planning
  - Using global weather data for windfarm layouts, turbine choice and optimization
- Supply & Installation
  - Modualised BOM to optimise logistic cost with integrated BOP
- Grid integration
  - Adjusting smart turbines to specific grid requirements
- Operation & maintenance
  - Using smart turbines and weather forecast data to optimize yield

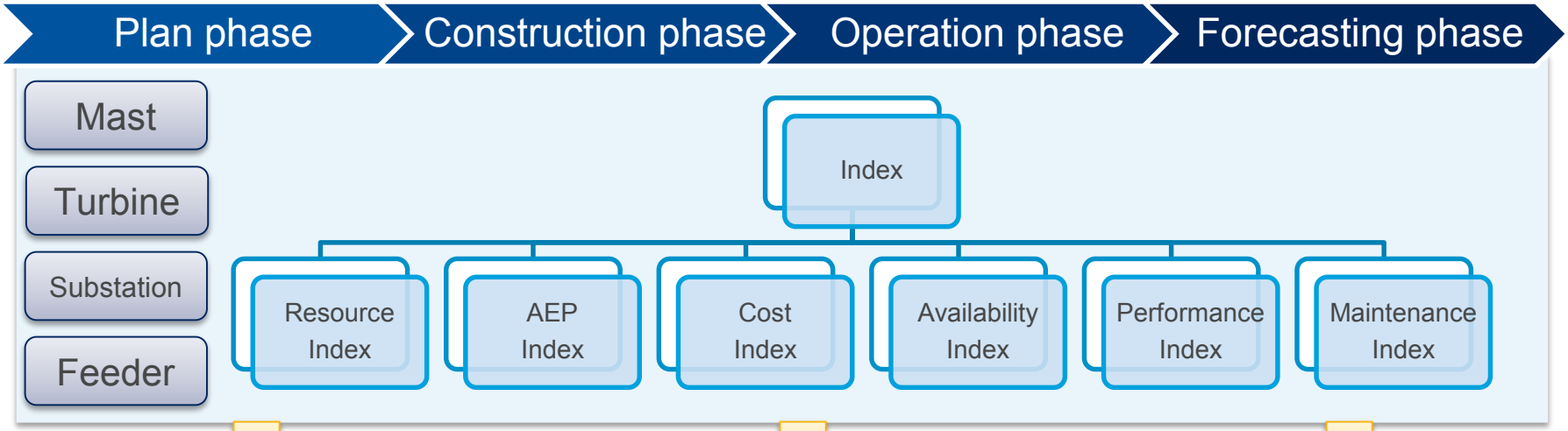
Smart Wind Farm

- The Industry is at a turning point with lifetime data playing the most vital role



Validation system based on assets index big data





Engineering capability

- Develop capability
- Design capability

Risk recognition and quantization

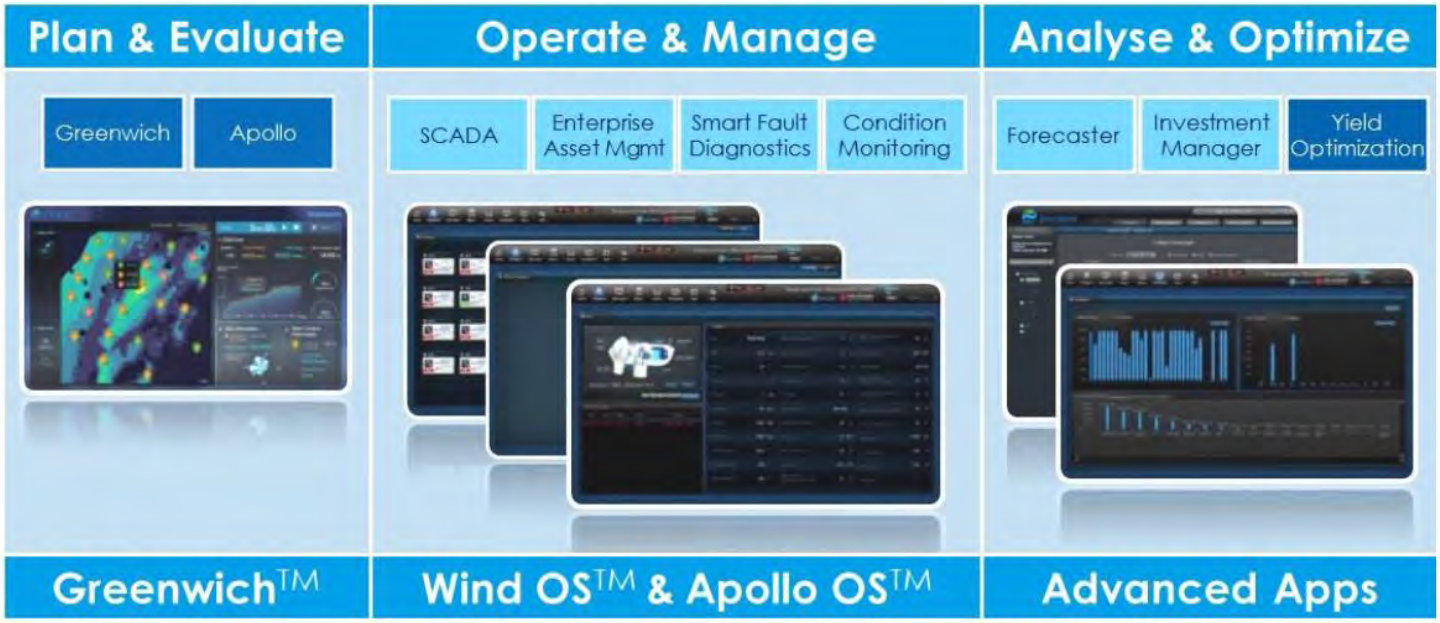
- Investment business
- Purchase business

Assets optimization

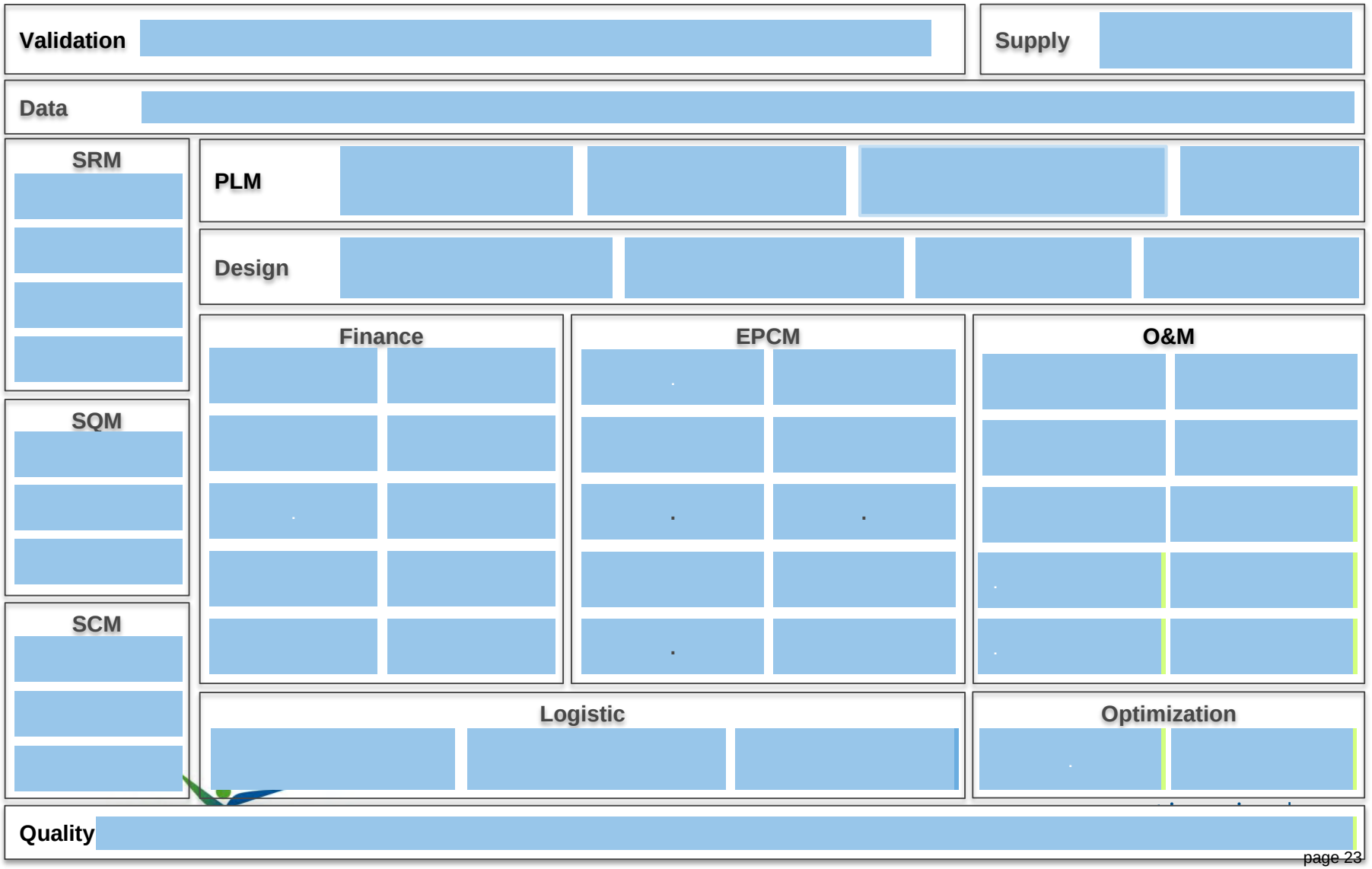
- Macrositing optimization
- Turbine purchase optimization
- Design optimization
- O&M service

Smart Wind Farm

- Lifetime data
  - Optimising wind farm and turbine design, operations and maintenance for the purpose of optimised AEP

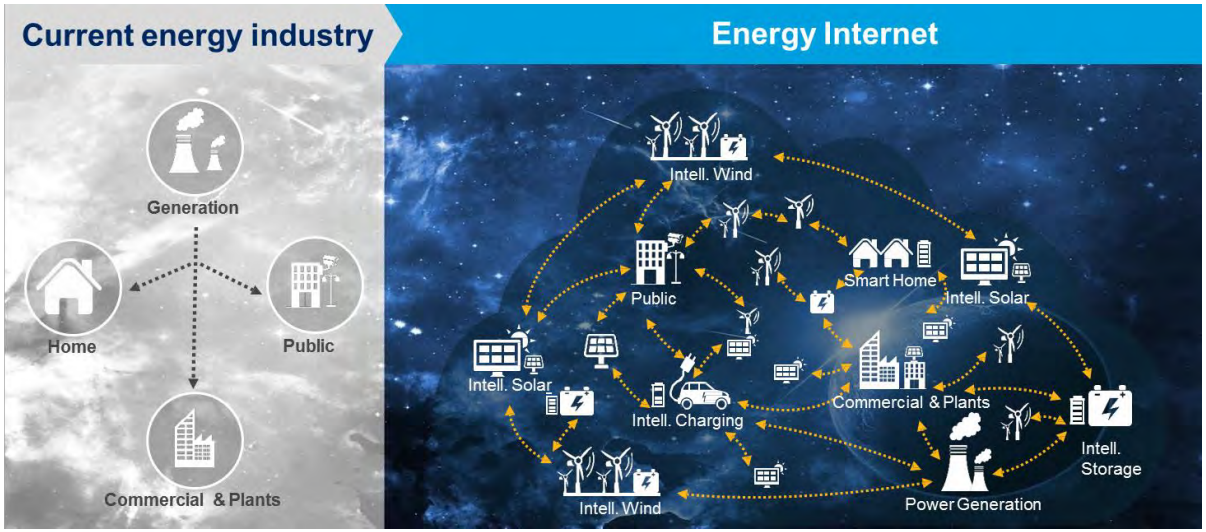


Overview of Digital Architecture



Energy Internet

- What is it?
  - Energy internet is the operating mechanism of renewable energy centric energy system
  - It is a flexible energy system
  - We need a software nerve system which can optimize the production, distribution, storage and demand



So how far can we go by the use of digitialisation?

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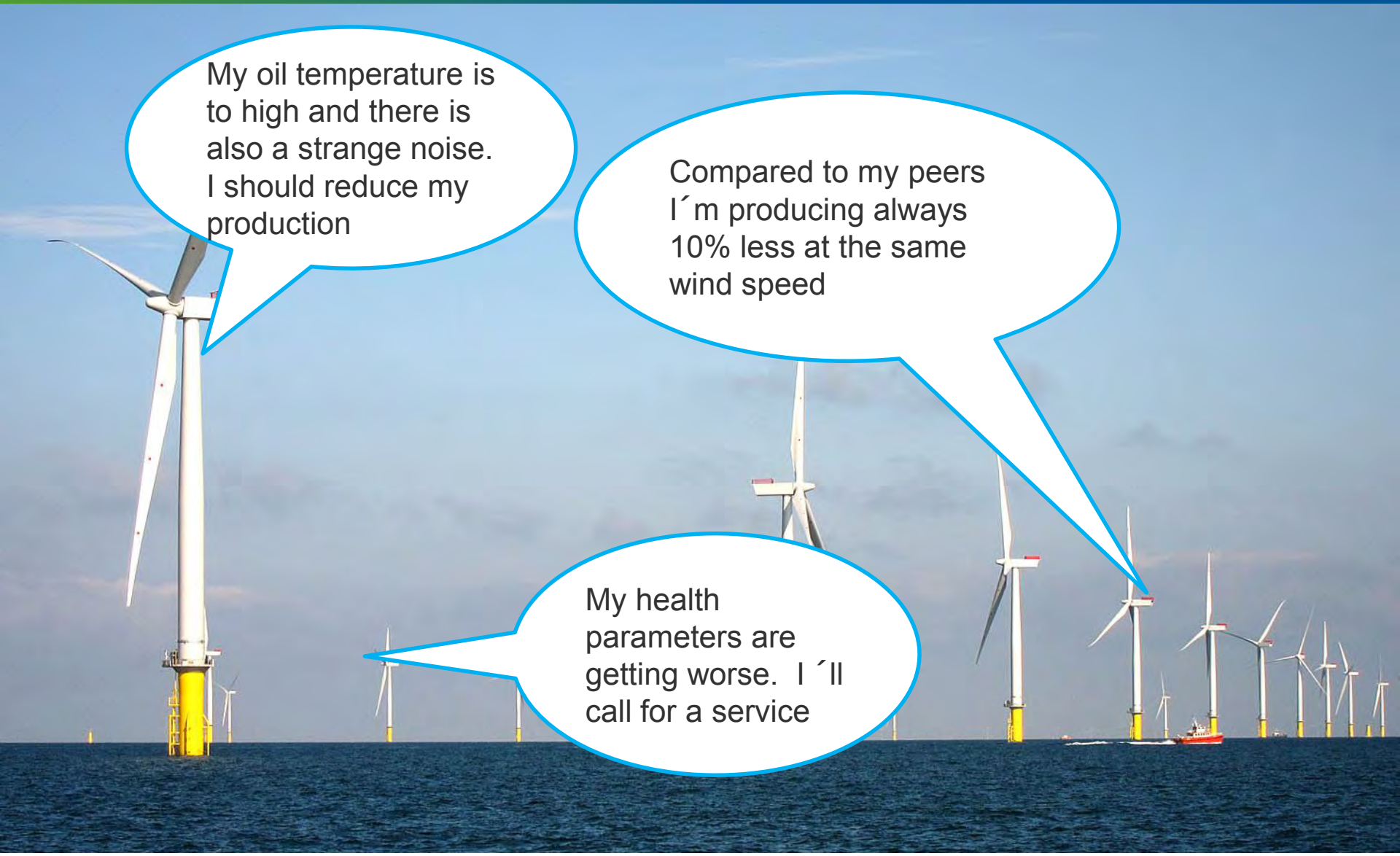
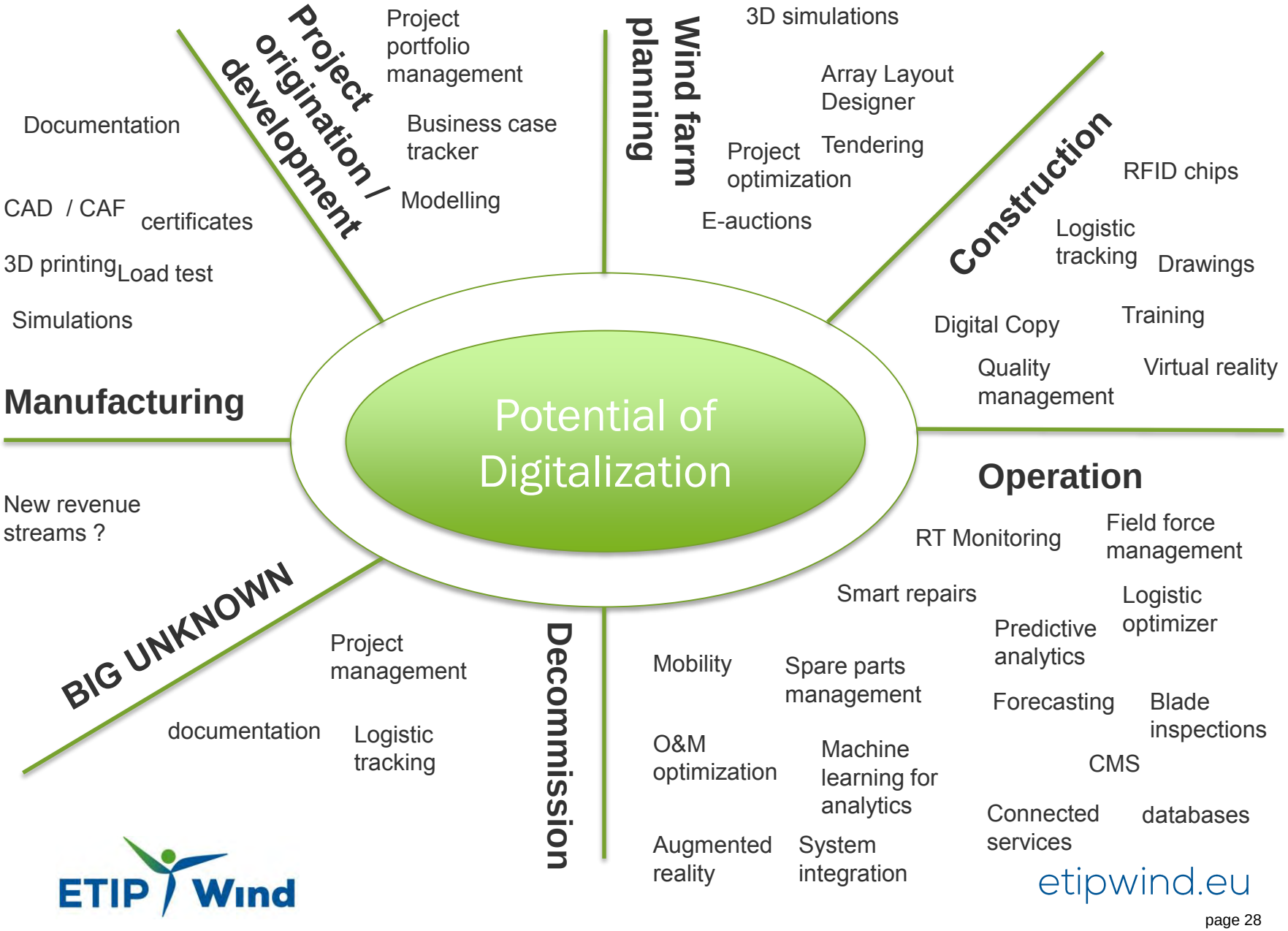
EUROPEAN TECHNOLOGY & INNOVATION PLATFORM ON **WIND ENERGY**

digitalization@windenergy How to harvest the full potential?

Thomas Pump
Head of Asset Information Systems ,
E.ON Climate & Renewables GmbH


My oil temperature is to high and there is also a strange noise. I should reduce my production
Compared to my peers I´m producing always 10% less at the same wind speed
My health parameters are getting worse. I ´ll call for a service



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We are operating in a box - and how to integrate the box?

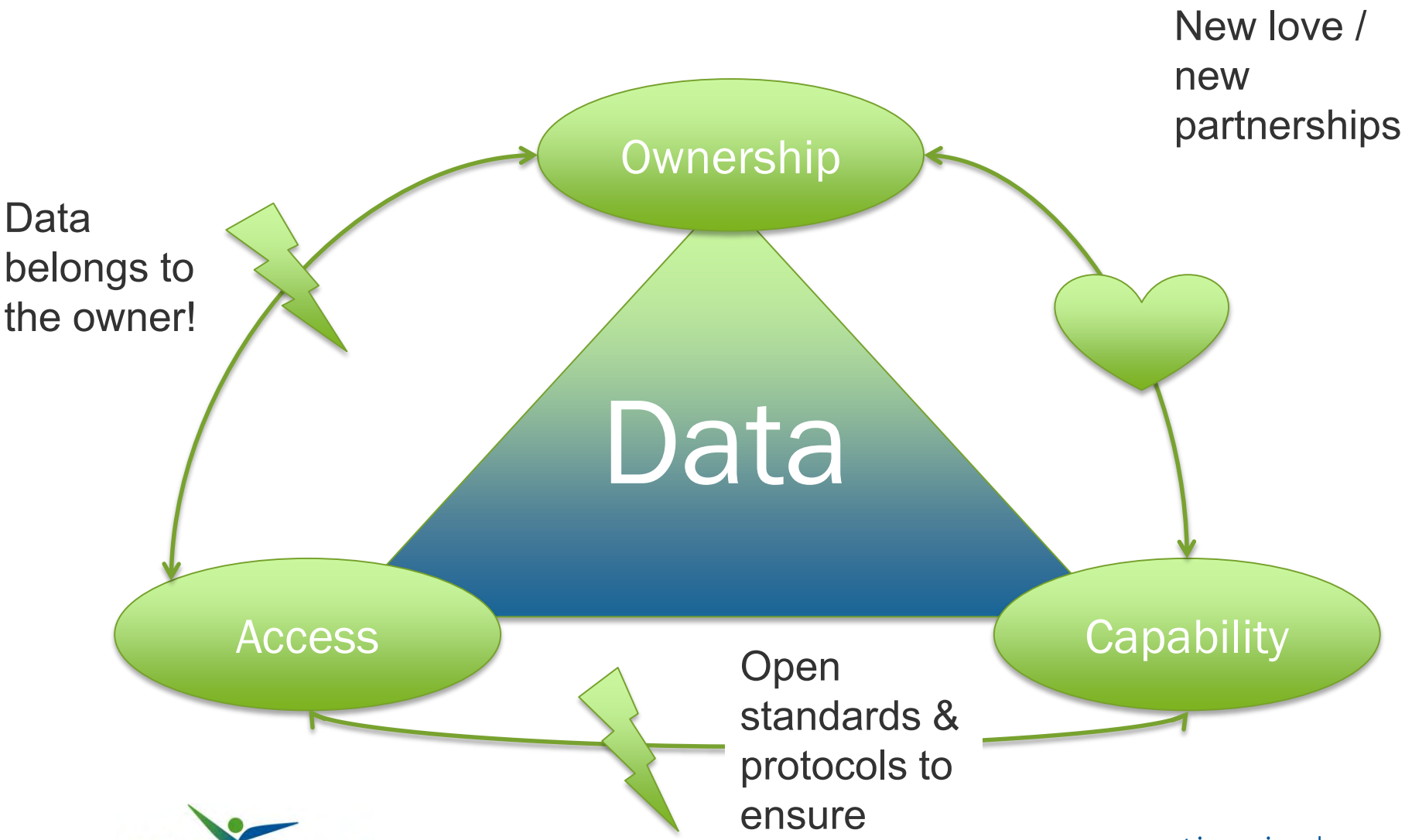
"Expand the box"

- Increase energetic availability/ reduce down times
- Increase efficiency
- Reduce O&M costs
- Extend lifetime

"Integration into the new energy system"

- How to integrate wind farms / Solar PV into a future energy system?
- Number of "Prosumer" is increasing
- Quo Vadis Grid quality?
- Role and potential of block chain technology not clear yet

It is all about data! - a new currency?



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Only if those questions are answered we can create a world of connected services

4 When the data indicates an issue that can cause a problem, a case is created and assigned to the proper skill.

5 Interventions are performed to resolve the issue:

1. **Fleet analysis** provides the operators tips and instructions.
2. **Dispatch** proactively sends updated schedules
3. **Technical Service** is dispatched to perform maintenance or repair.

3 Data is analyzed in real-time to identify issues.

2 Data from many connected devices is aggregated and stored.

Resolutions are triggered before the operators knows there is a problem.

6 The resolution is recorded. Longer Outages are prevented, costs minimised

Higher availability
Lower O&M costs
Longer lifetime
Higher Income

1 Performance and usage data is acquired and transmitted every 10 seconds.

greenbox

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Technology development will not stop - Let's use it – for a cleaner energy world

Imagine ! What if ……..

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EUROPEAN TECHNOLOGY & INNOVATION PLATFORM ON **WIND ENERGY**

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Digitalization Enables the Network Effect

Ward Thomas
CEO, Sentient Science

What is Digitalization?

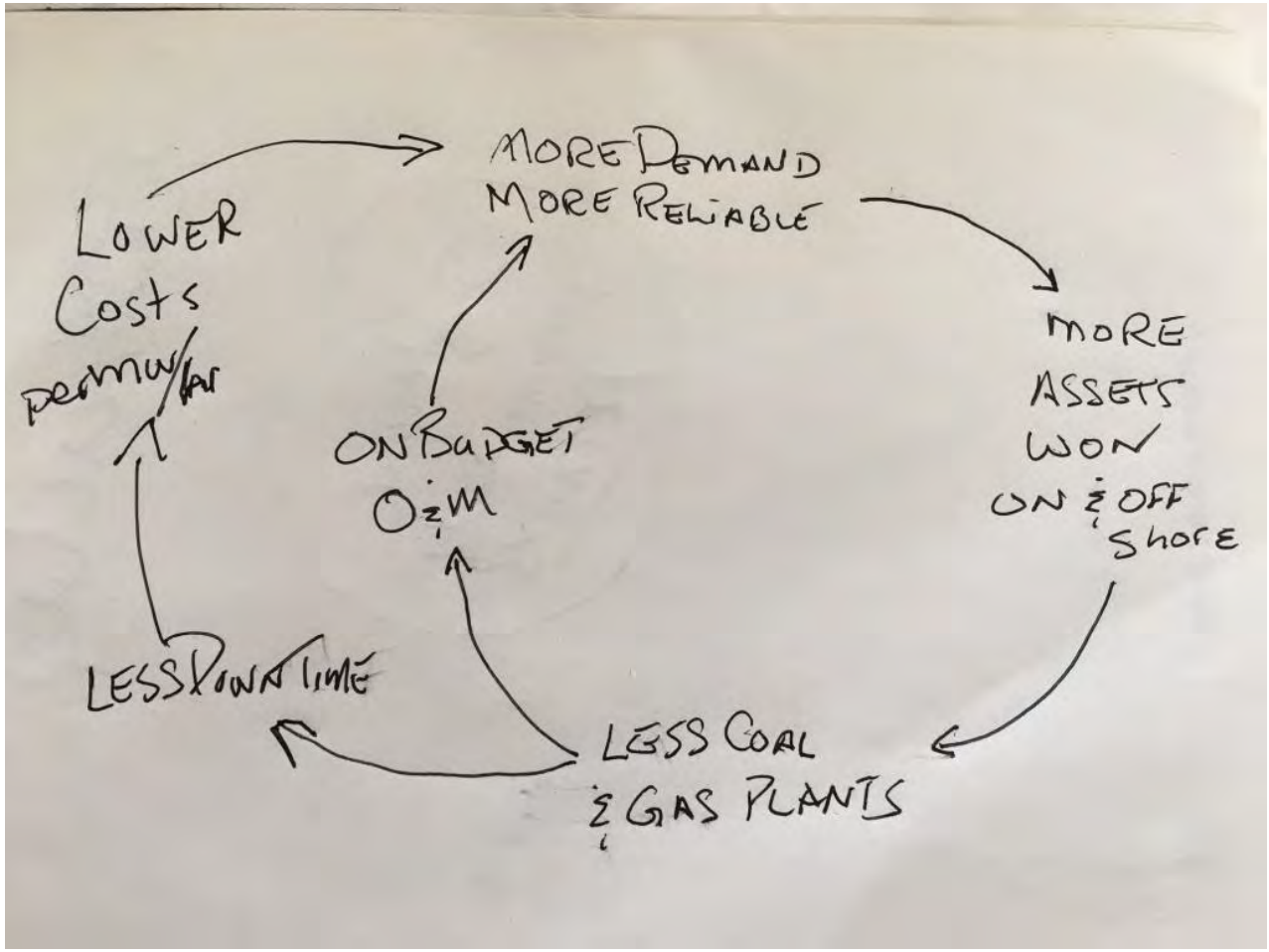
Gartner Definition:

The use of digital technologies **to change a business model** and provide **new revenue and value-producing opportunities**;

Harvard Business Review Definition:

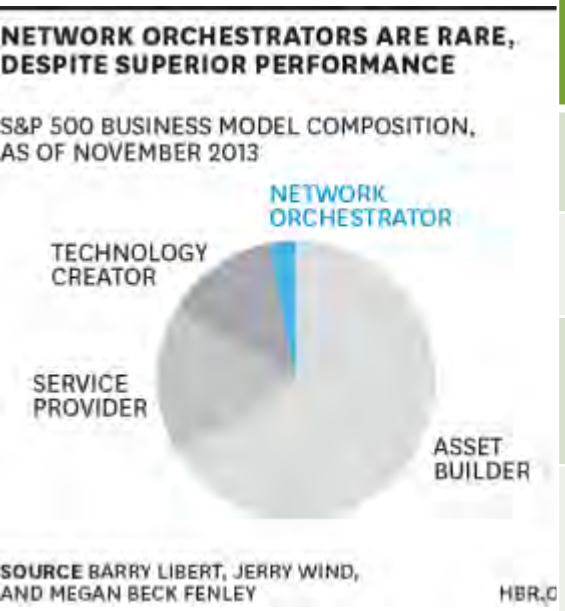
- **Demand-side** economies of scale, also known as **network effects.**
- It occcurs when a **product or service becomes more valuable to its users as more people use it**

Single Customer Value becomes Eco-System Value



Operations & Business Value

Value & Valuations in Digitalization



TYPE	Return to End Customer w/o PTC	Business Valuation Muliiple Revenue	Example in Energy	Examples Outside in outer market	Actual Valuations in USD Market Cap
Asset Builders	< 1 X	2 X	Vestas	GE, Siemens	GE $266 B Siemens $90B
Service Providers	1 X	2.6 X	Vestas	AT&T	$265B
Software Technology Creators	1 X	4.8 X	Big Data	Dassault Systems	$19B
Network Orchestrator (Network Effects)	5X or 10 MW/Hr	8-20 X	Sentient Science	UBER, AirBnB, Facebook, Whats App	UBER - $67B, AirbBnB = $30B Face Book - $300B on its way to 1T? WhastApp - $19B

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of Digitalization Companies – Network Effect Business

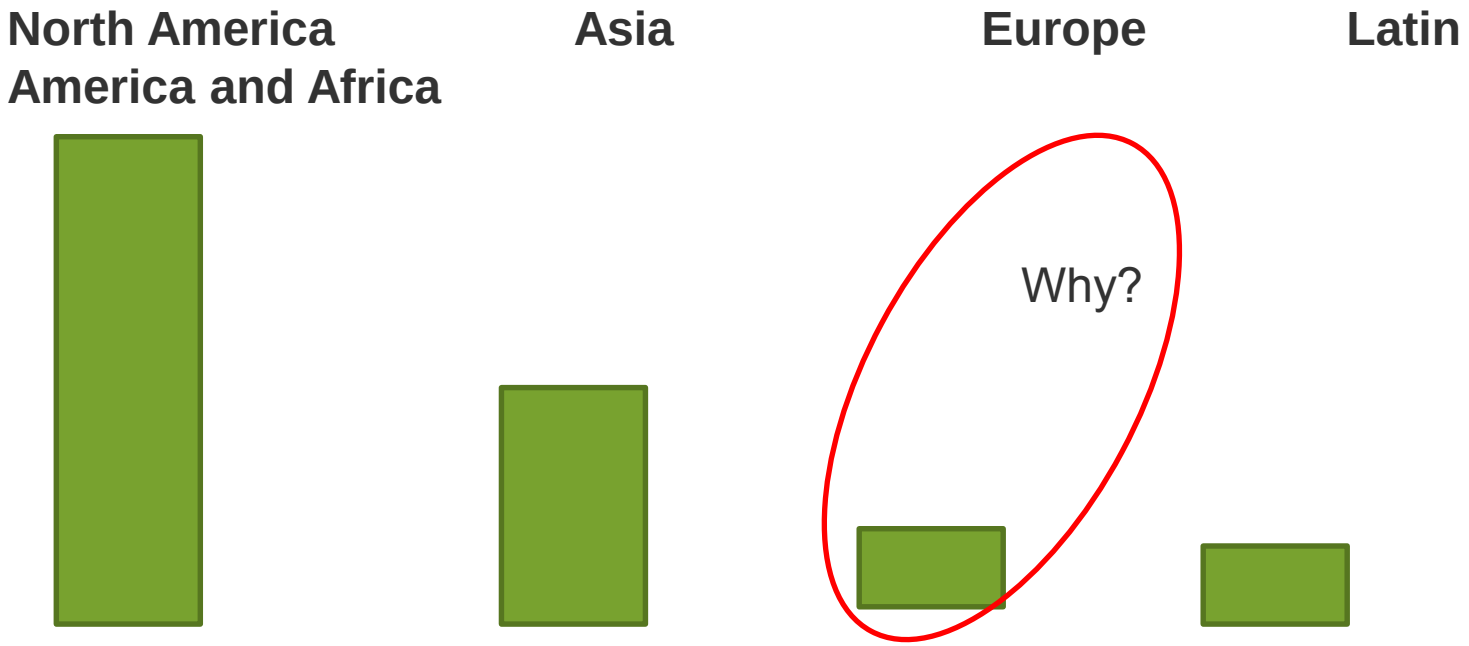
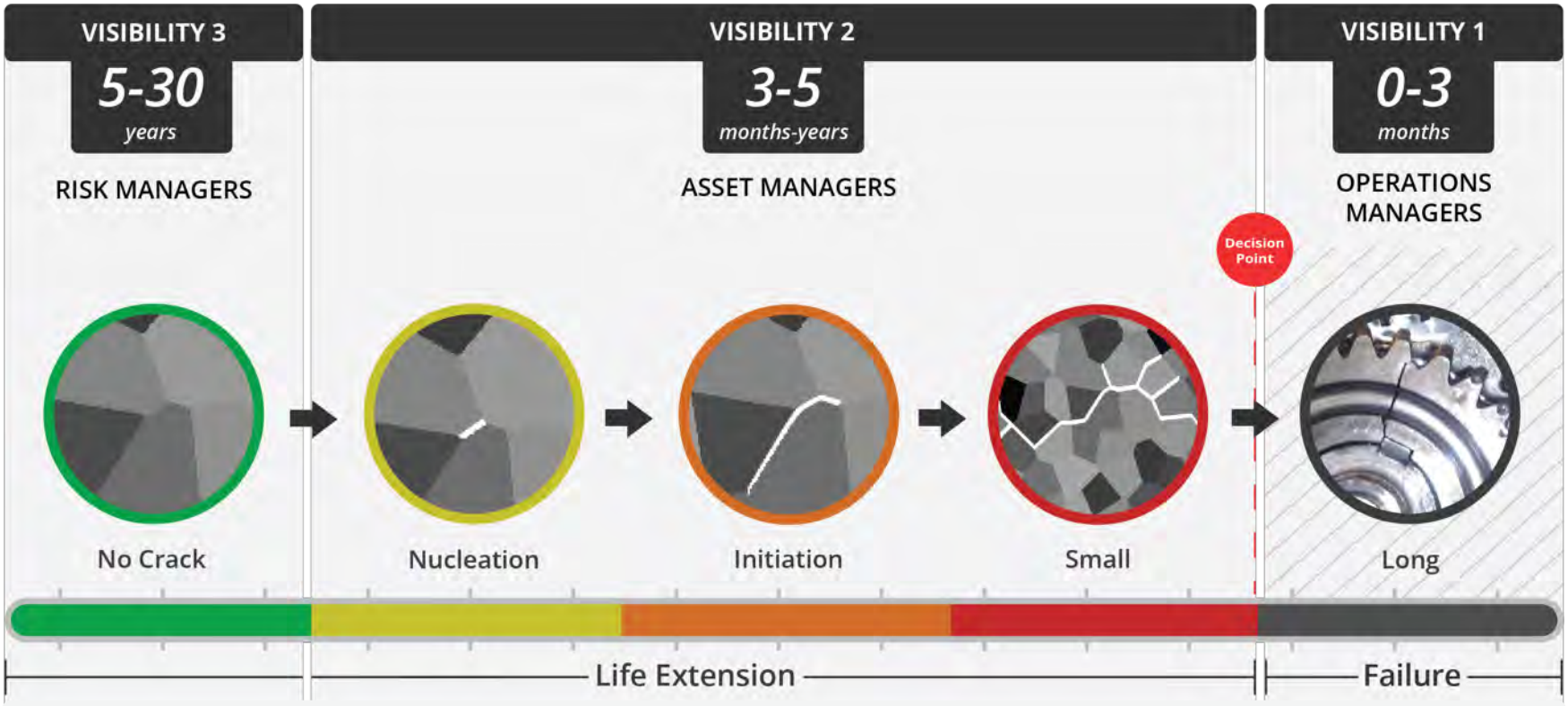


Figure 1.1. North America has more platform businesses creating value, as measured by market capitalization, than any other region in the world. Platform businesses in China, with its large, homogeneous market, are growing fast. Platform businesses in Europe, with its more fragmented market, have less than a quarter the value of such businesses in North America. Source: Peter Evans, Center for Global Enterprise.

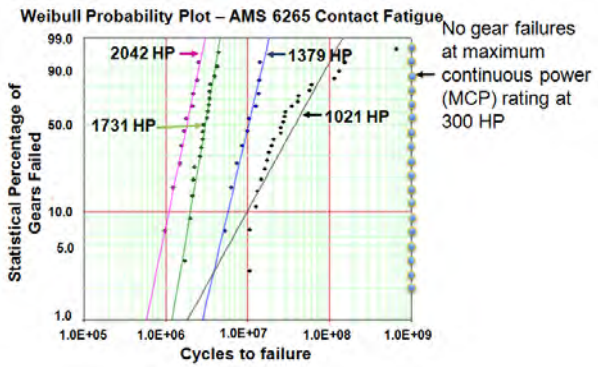
Example: NextEra 5400 Wind Turbines – Digitalized Fleet Small Data from Material Science vs Big Data from Sensors

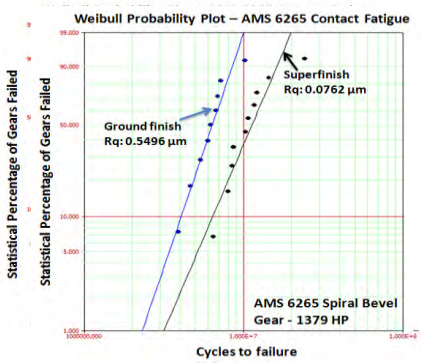


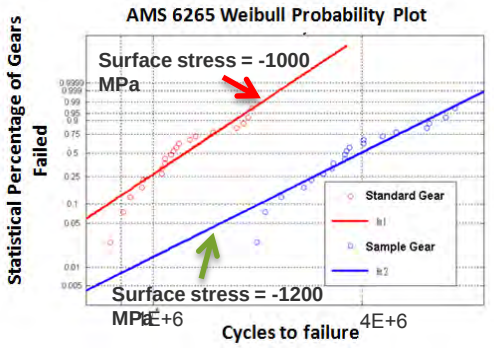
Example Aerospace: Boeing Apache:

BOEING

pache Spiral Bevel Gear Digitalization Model Validation against Physical Test - DigitalClone©







Load Case	Weibull, Life/Eta	Weibull, Slope
300 HP	Run-out	Run-out
1021 HP	5.14E+07	1.72
1379 HP	1.26E+07	3.32
2042 HP	7.49E+06	3.84
1731 HP	2.97E+06	4.28

Surface Finish	Weibull, Life/Eta	Weibull, Slope
Superfinish	1.26E+07	3.32
Ground finish	6.96E+06	4.17
Life ratio	1.81	

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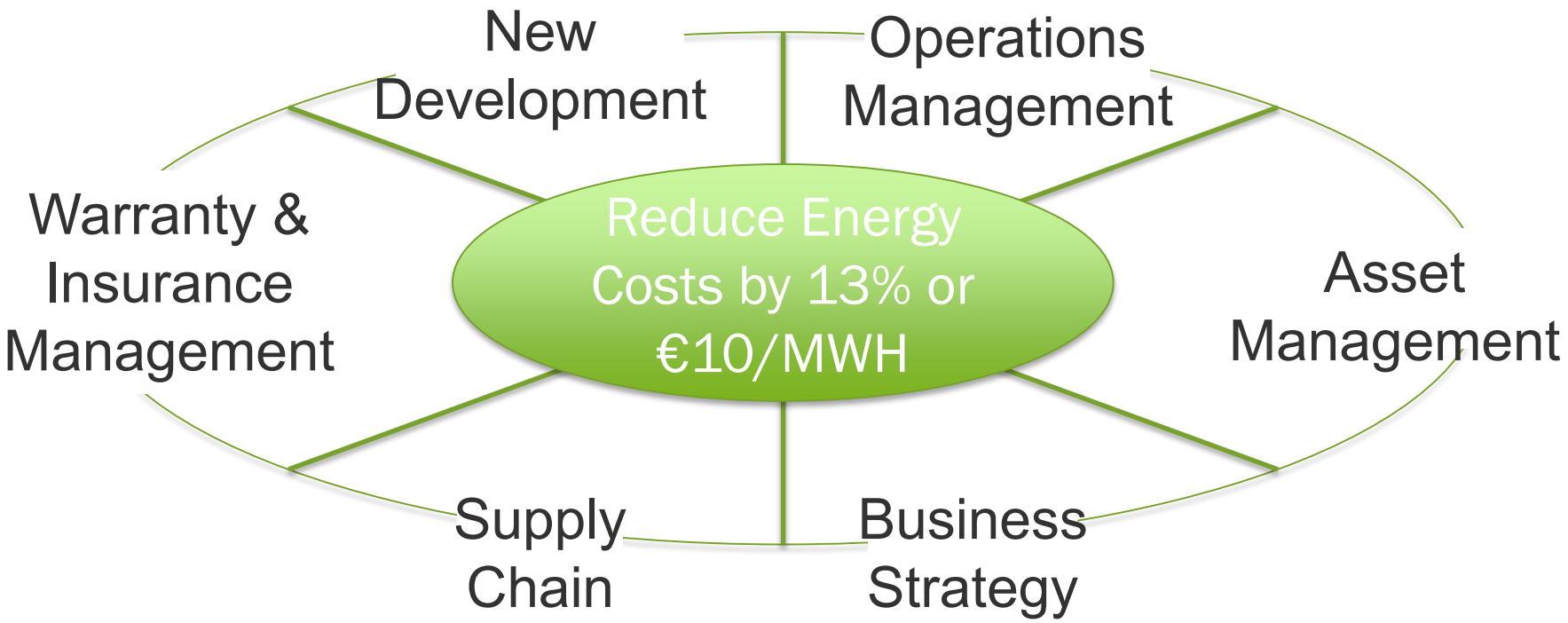
What Business Functions Are Effected by Digitalization



6 Areas of Business Impact, Value and Focus

Net Return on Life Extension Investment – O&M

			2015	2016	2017	2018	2019
5 year Investment	$3,750,000	@500/MW/year	$750,000	$750,000	$750,000	$750,000	$750,000
Cost Avoidance and/or Savings:		WTGs/Year					
1. Smart Derating GBX Life Extension		17.00	$2,693,911	$3,420,839	$4,276,049	$4,276,049	$4,276,049
2. Long term Watchlist Planning		35.00	$1,017,968	$1,292,658	$1,615,822	$1,615,822	$1,615,822
3. Supply Chain Improvements		9.00	$400,746	$508,884	$636,105	$636,105	$636,105
4. Main Bearing Coupling		13.00	$197,883	$251,280	$314,100	$314,100	$314,100
5. Main Bearing Life Extension		7.00	$239,749	$304,443	$380,554	$380,554	$380,554
		Savings/Year:	$4,550,257	$5,778,104	$7,222,630	$7,222,630	$7,222,630
Net Return	$28,246,250	Net Return/Year	$3,800,257	$5,028,104	$6,472,630	$6,472,630	$6,472,630
5 Year NPV	$23,900,904						
5 Year IRR	160%						
5 Year ROI	873%						

DigitalClone® Live for Life Extension of Wind Turbines

www.sentientscience.com

Who are we?

Sentient Science Life Extension Renewable Family – Over 20,000 Wind Turbines on Contract

Agregating Operator Demand
World's Lowest Operational Cost Products

Bring Supply to Operator Demand
World's Most Tested Products

acciona

NEXTera ENERGY

GE Energy

SIEMENS
Siemens Wind Power

enel
Green Power

DUKE ENERGY

MOOG

Gamesa

DONG energy

OGE
OGE Energy Corp.

SENVION
wind energy solutions

Adwen
AN AREVA GAMESA COMPANY

龙源电力
LONGYUAN POWER

Pattern

Sentient Science Pedigree

$21B of EU money coming – Experience - We helped our Operator and OEM partners raise $70B in USA Digitialization Funds

2001-2016

$25M in R&D Funding

From the world's largest operator of heavy equipment

2010

NASA Validation

Of game changing technology, DigitalClone®

2014

Tibbett's Award

White House honors DigitalClone® technology- "decoding the Material Genome"

April 2016

New Energy Pioneer Award

Michael Bloomberg honors commercial impact of DigitalClone® technology in Sentient's 1st Clean Energy market

"Small Data from material sciences versus big data from sensors"

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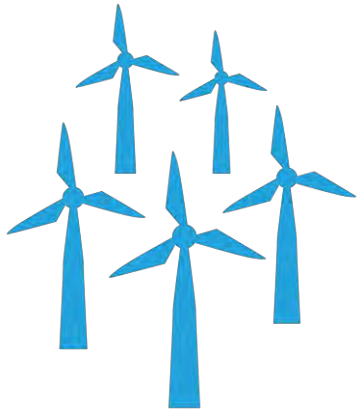
Sentient Live Testing & Database

Digitalizing the Fleet – For Life Extension

- Replace Coal 100%
- Helps to replace the PTC (USA)

- 62,000 Live Life Models by Turbine by 2016
- 205,000 Live Life Models by Turbine by 2020
- 100,000 Live Assets under mgmt. by 2018

- Save $10 MW/hr
  5:1 Ratio



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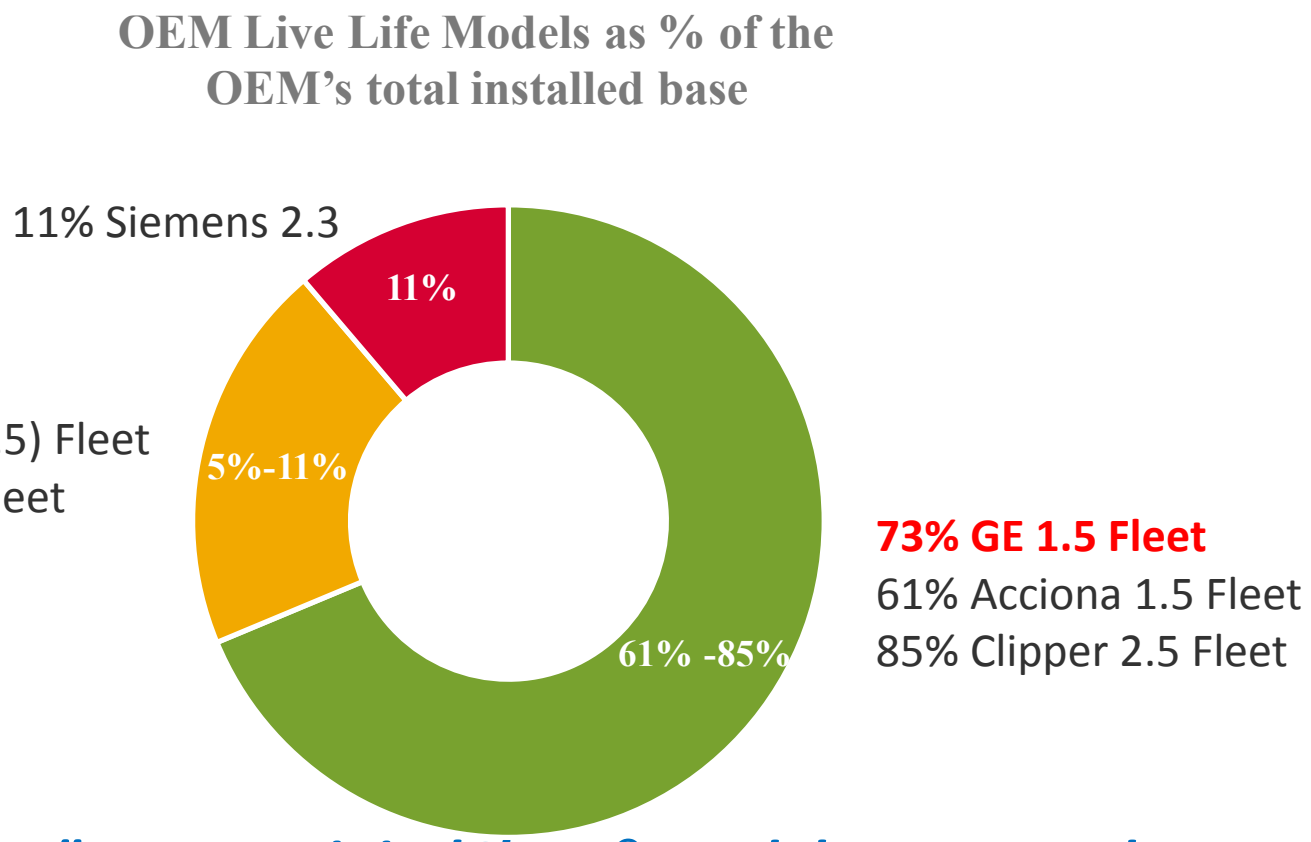
Sentient Live Testing & Database 2016

- **Example: # Turbines as % OEM Fleet - Live Life Models**



"Live" means DigitalClone® Models connected to live SCADA feed from each asset

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Autonomous drones & perspectives from the aerospace industry

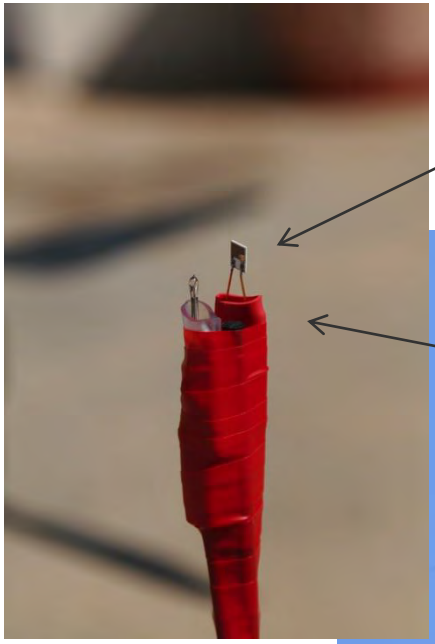
University of BRISTOL

Perceptual Robotics

Dr Tom Richardson
Senior Lecturer, Bristol University

Ascension Island Campaigns 2014-2015

Ascension Island Drone



Humidity and Temperature Sensors

Communications

Sample Collection Box

Digitizing and Tracking Turbine Defects Using Drones

- How?
  1. Requirement driven image capture through optimized flight
  2. Real-time and Post-processing to find and classify faults
  3. Track location and growth for effective maintenance

‘NDT & Interaction with the Environment’

‘Up close and personal!’

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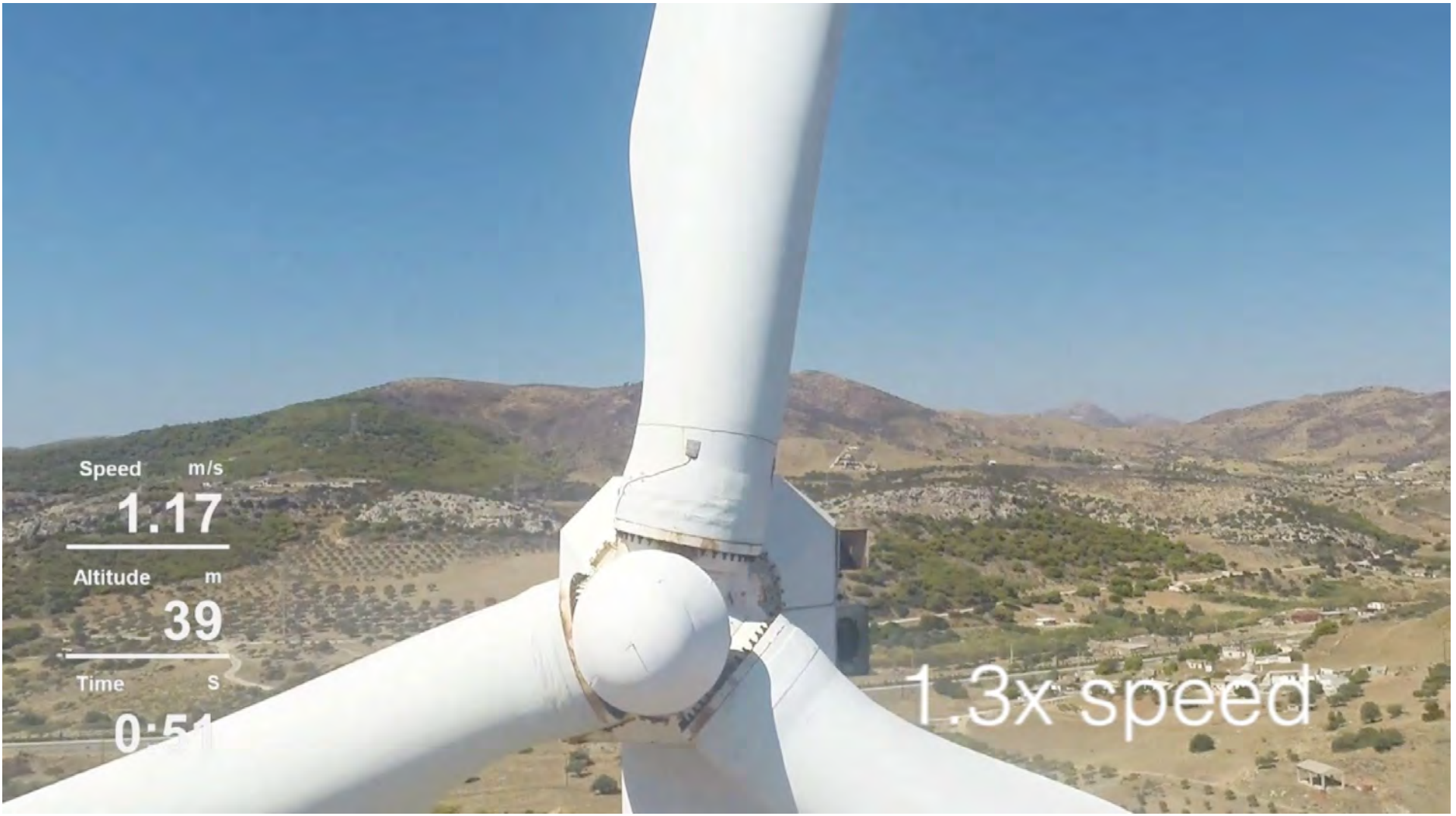
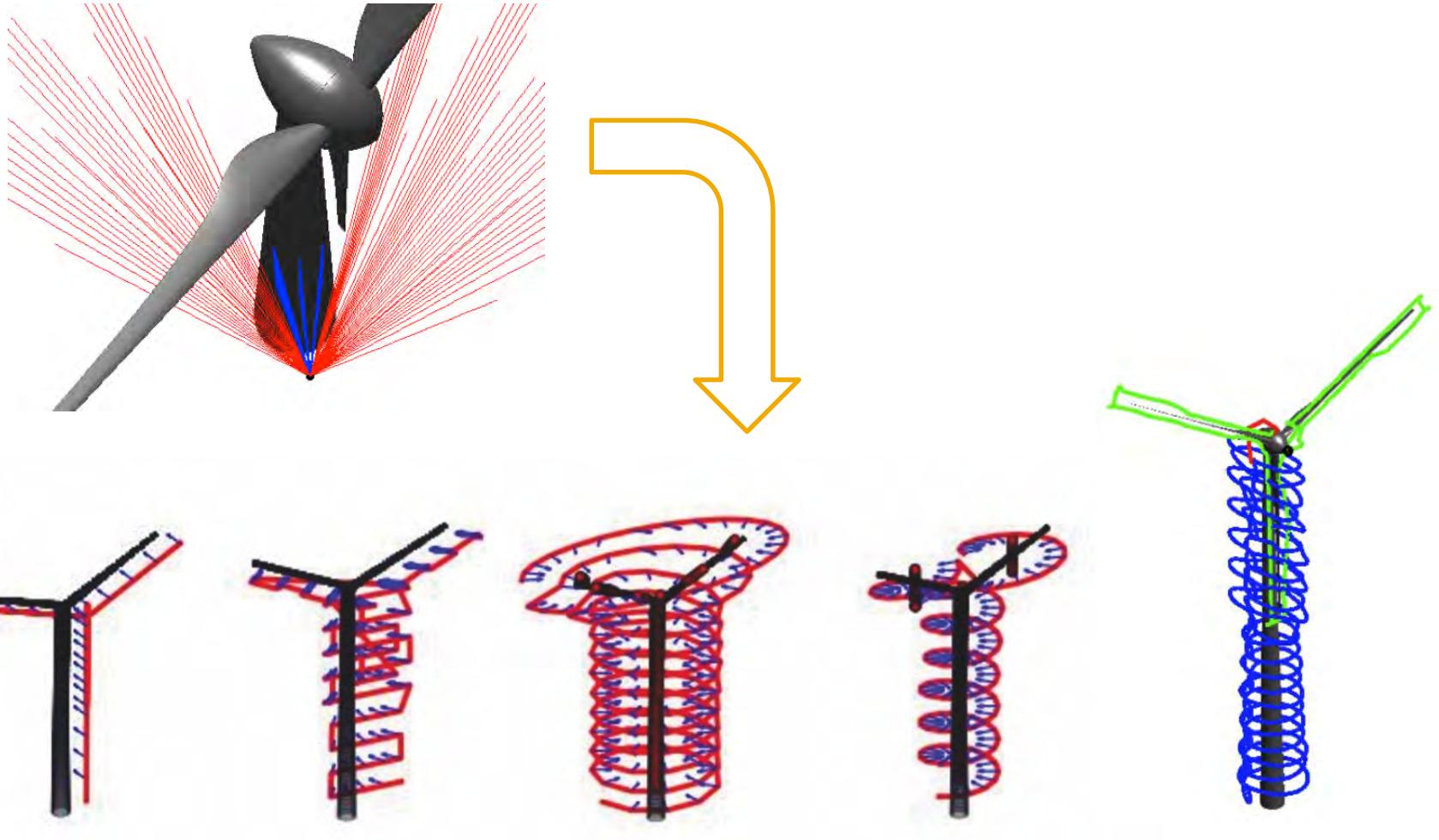
Wind Turbines – Smart automation for Drones

- The goal
  - Automated inspection and and repair of exterior faults
- Why wind turbines?
  - Restricted airspace – reduced uncertainty
  - Large, known geometries
  - Expanding market
  - Piloted drones- uninteresting!
  - This is just the first step…
- Why automation?
  - Can be used as tool by existing inspection teams
  - Consistent data acquisition - create a uniform database
- Faster, optimized & safer than remotely piloted.
  - How can we be smart about this?

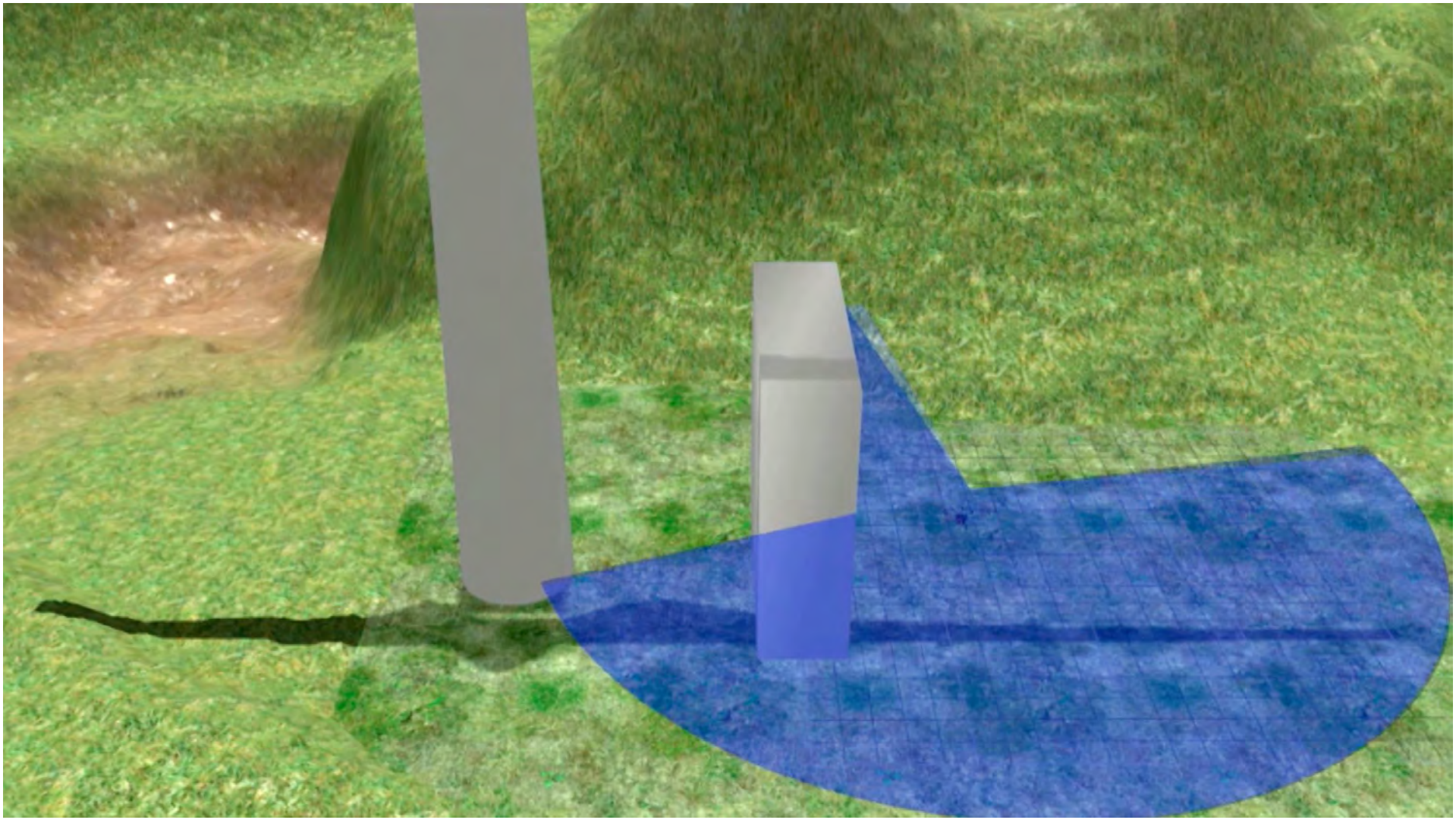
State-of-the-art Automated Inspection



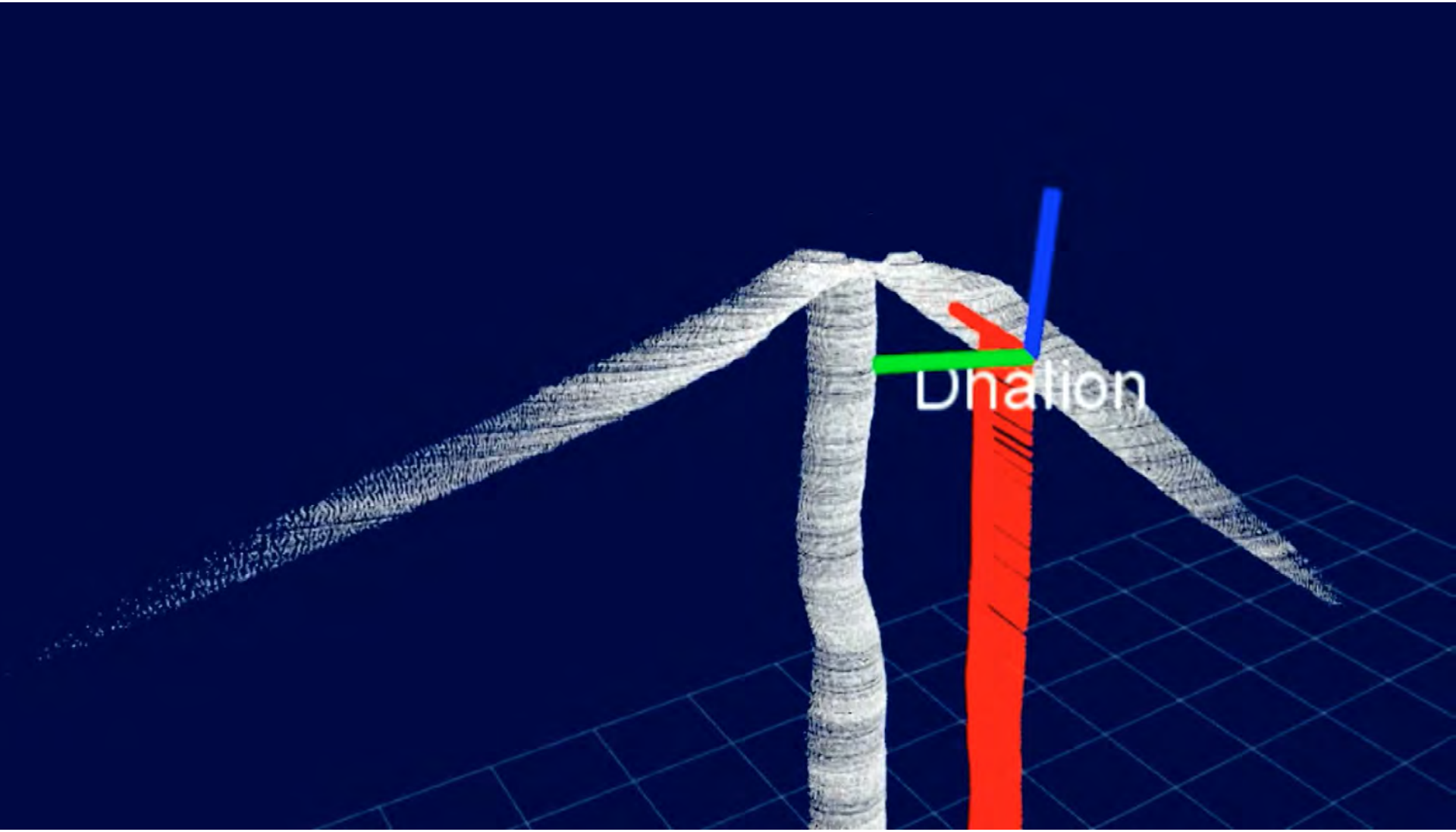
Path-planning options - Ray-tracing



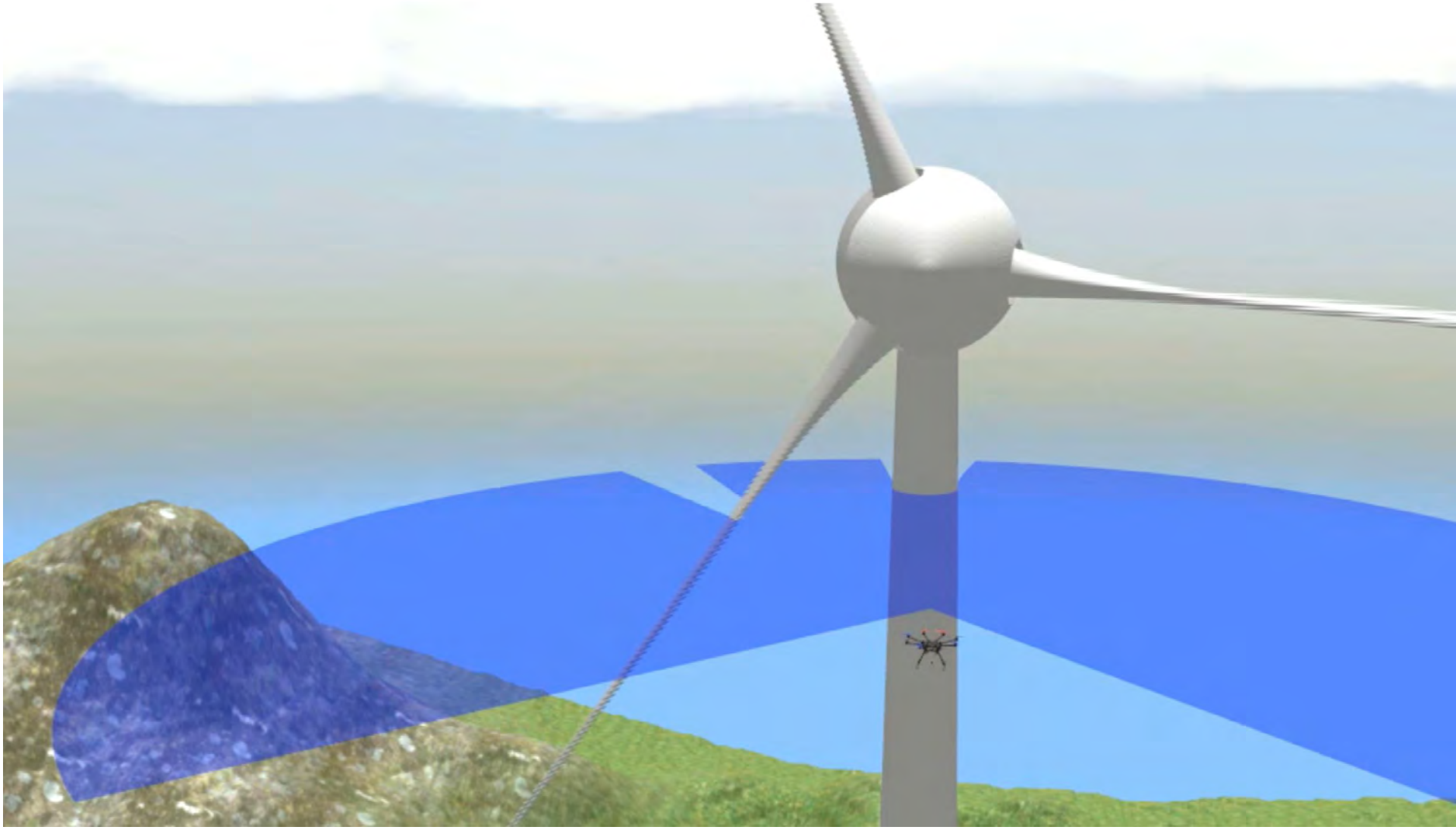
Safe Operation



Safe Operation



Estimators



Real-time & Post Processing

Wind Turbines – Smart Inspection Using Drones

- Primarily a systems development problem.
- Multifaceted challenges – e.g. power, route optimization, sensors, control, estimators, classification, safety, interaction with the environment.
- Can it be done & will it be done?
  - Yes & today!
- Key areas to be addressed?
  - Smart algorithms
  - Batteries (alternative power sources)
  - Flight envelope
  - Processing power
  - Long term maintenance & physical interaction

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Thanks for your attention

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Perceptual Robotics

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Wind technology: R&I perspective

Charles Dugué
CEO, 8.2 Consulting AG

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September 2016

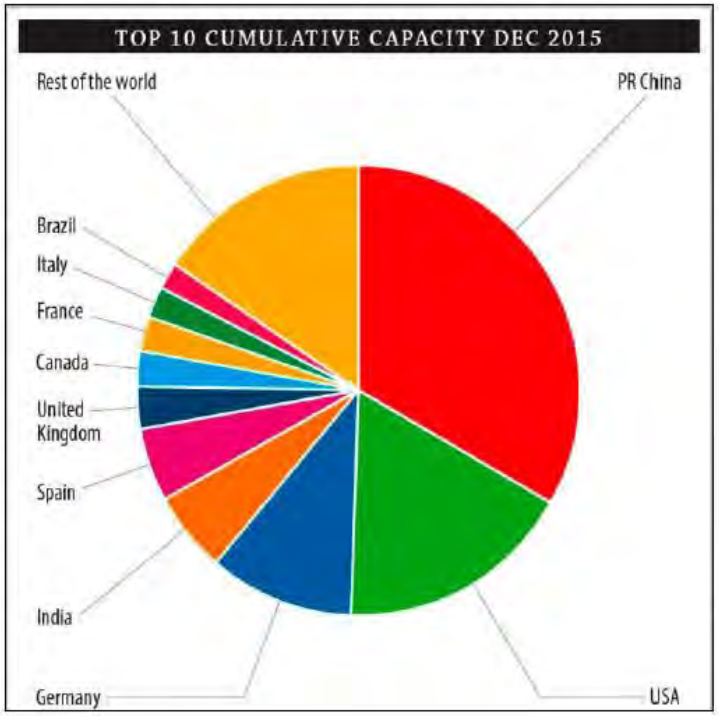
Agenda

- Wind power today in US, Asia and Europe
- R&I in the Renewables
- Examples of technical challenges

Agenda

- **Wind power today in US, Asia and Europe**
- R&I in the Renewables
- Examples of technical challenges

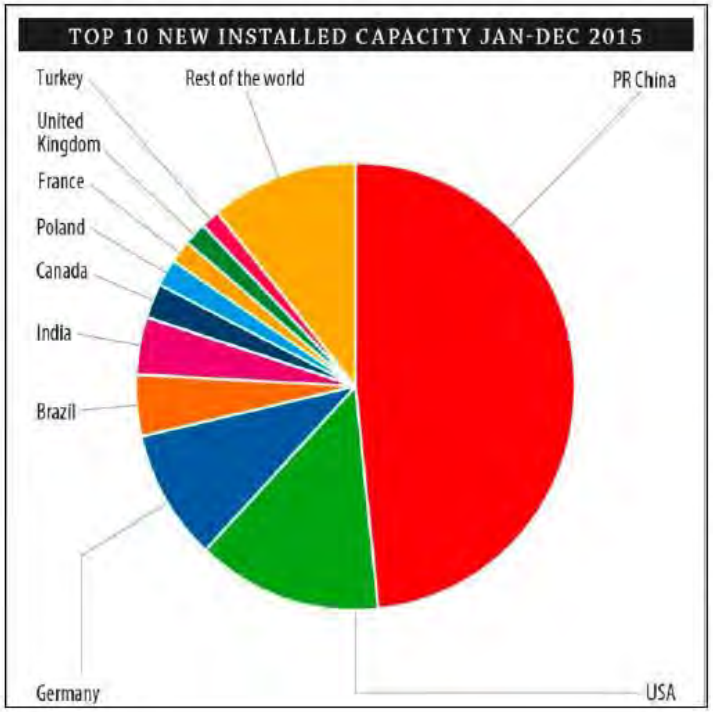
GWEC cumlative capacity



Country	MW	% Share
PR China	145,362	33.6
USA	74,471	17.2
Germany	44,947	10.4
India	25,088	5.8
Spain	23,025	5.3
United Kingdom	13,603	3.1
Canada	11,205	2.6
France	10,358	2.4
Italy	8,958	2.1
Brazil	8,715	2.0
Rest of the world	67,151	15.5
Total TOP 10	**365,731**	**84.5**
World Total	**432,883**	**100**

Source: GWEC

GWEC Newly installed capacity 2015

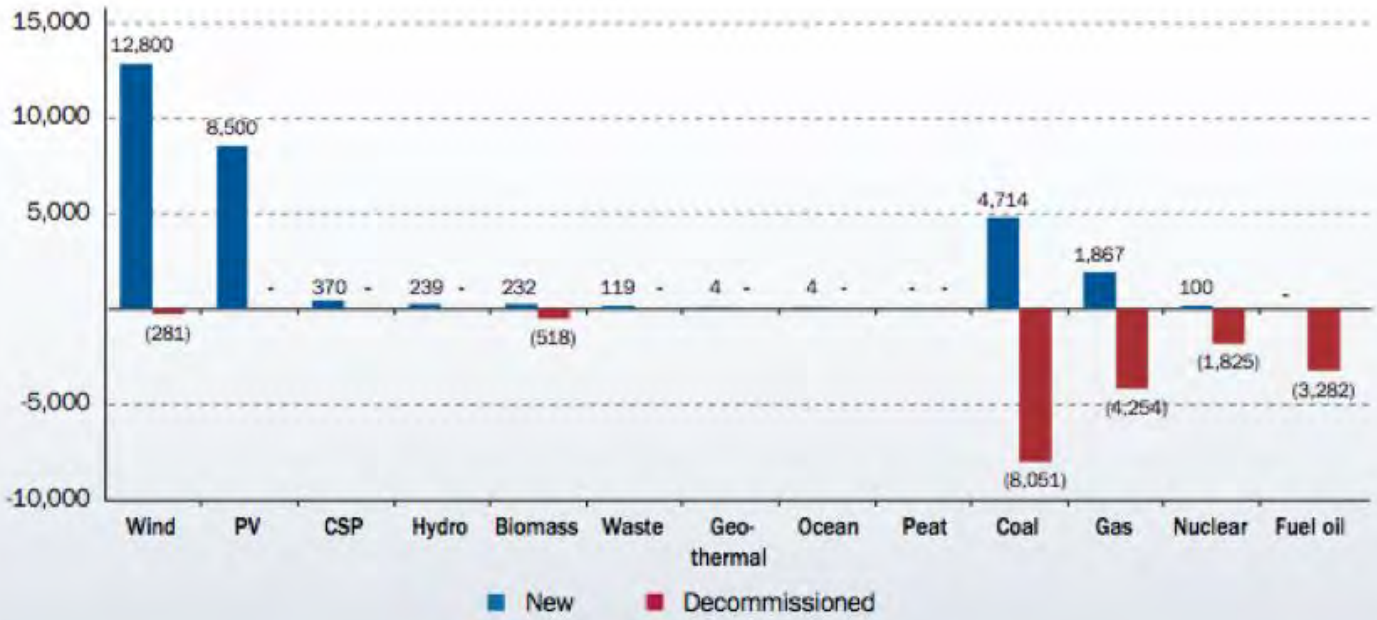


Country	MW	% Share
PR China	30,753	48.5
USA	8,598	13.5
Germany	6,013	9.5
Brazil	2,754	4.3
India	2,623	4.1
Canada	1,506	2.4
Poland	1,266	2.0
France	1,073	1.7
United Kingdom	975	1.5
Turkey	956	1.5
Rest of the world	6,950	11.0
Total TOP 10	**56,517**	**89**
World Total	**63,467**	**100**

Source: GWEC

Wind: today's way to produce electricity

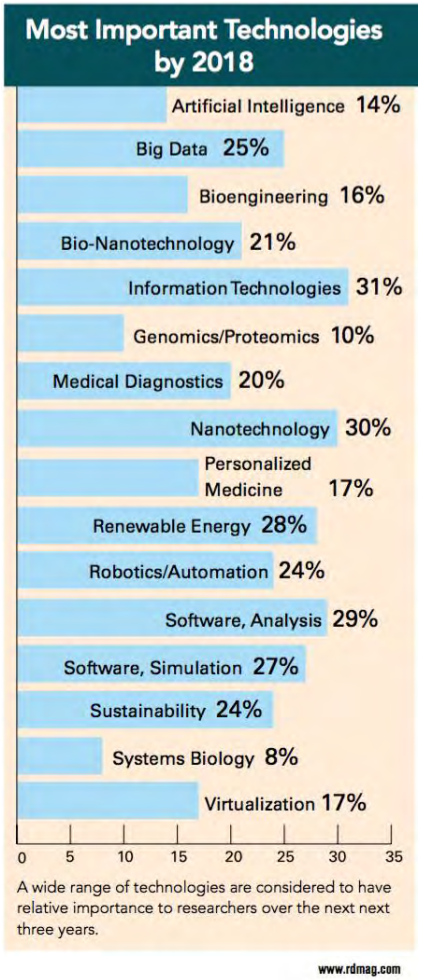
FIGURE 3: NEW INSTALLED AND DECOMMISSIONED POWER CAPACITY IN EU (MW)



Agenda

- Wind power today in US, Asia and Europe
- **R&I in the Renewables**
- Examples of technical challenges

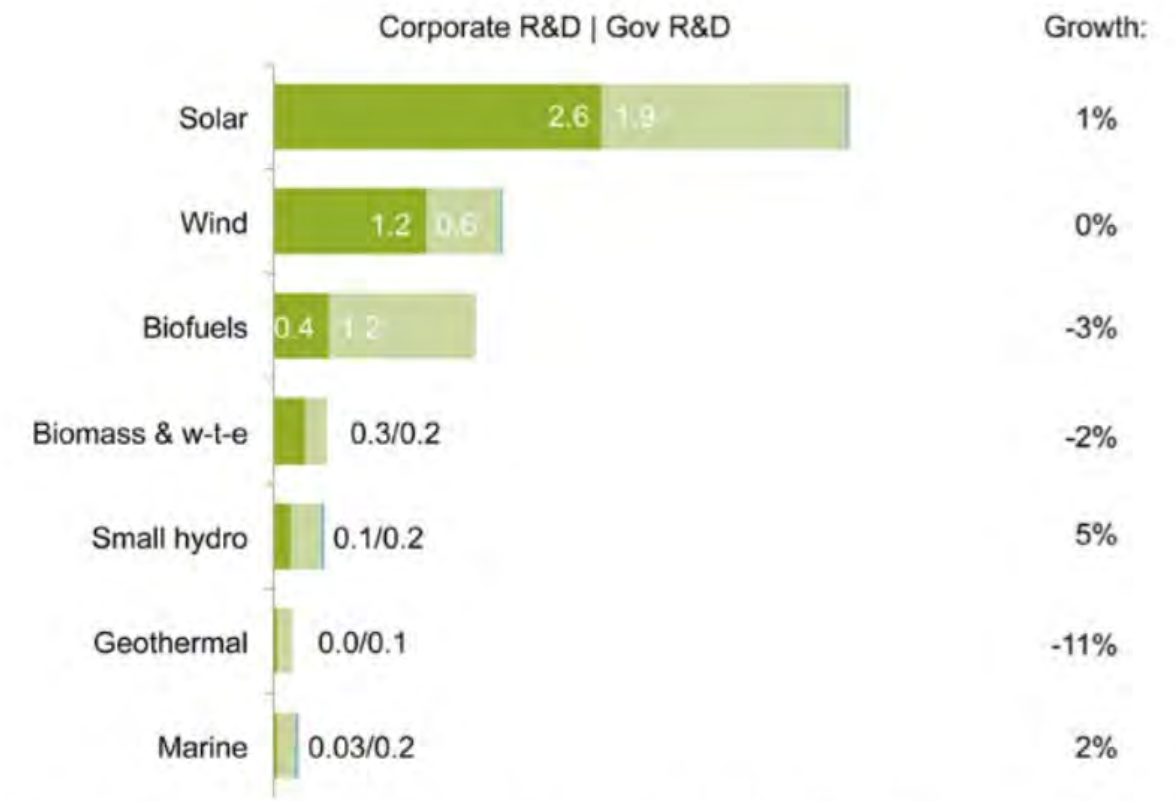
Most important technologies



What technologies are expected to change the most over the next three years by 2018?

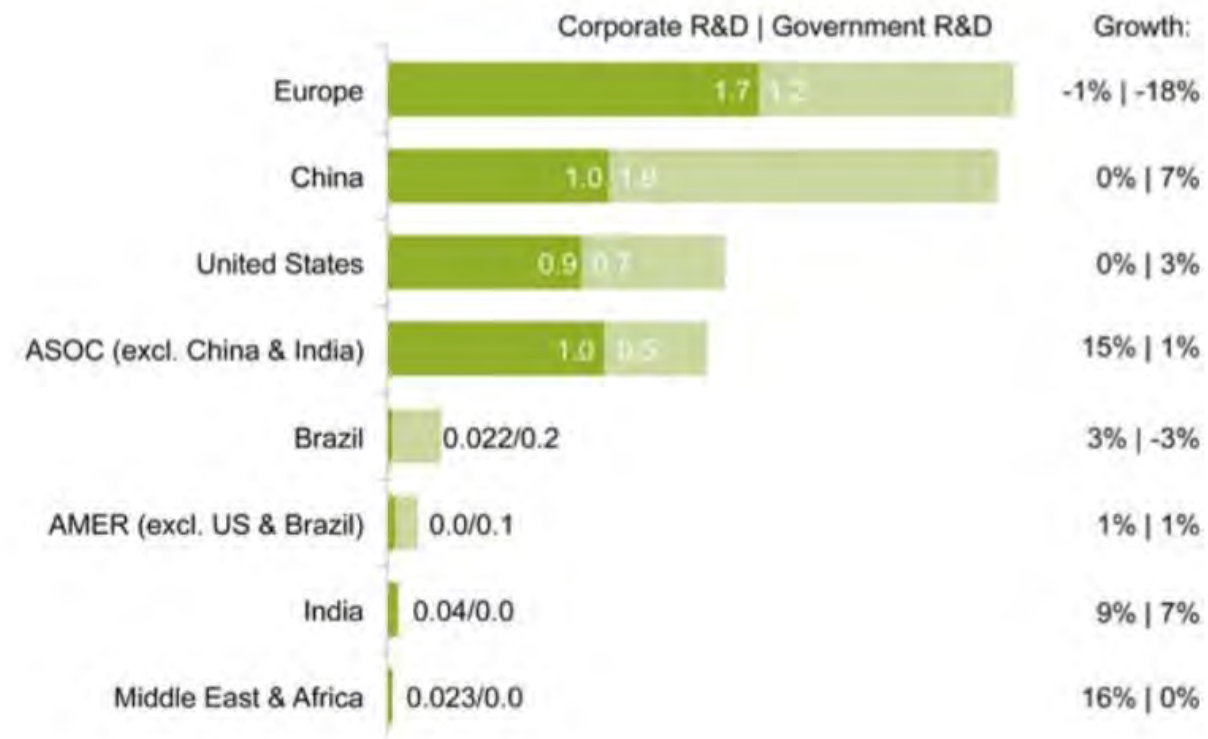
- Renewable energy comes close 4th after IT, nanotechnologies and Softwares

R&D investments in renewables 2015



Source: Bloomberg, Bloomberg New Energy Finance, IEA, IMF, various government agencies

R&D investments in renewables 2015



Source: Bloomberg, Bloomberg New Energy Finance, IEA, IMF, various government agencies

„Why is research needed? Wind energy is a mature technology now!“

- Drive Levelised Cost of Energy (LCoE) down
- Still many technical challenges in the „mature“ technologies
- Explore new territories (floating, radical design change,…)

Agenda

- Wind power today in US, Asia and Europe
- R&I in the Renewables
- **Examples of technical challenges**

Technical challenges

- Blades
  - Size is increasing: Wind turbines are the largest rotating machines on earth
  - Working in uncontrolled environment
  - Subject to variable loads, turbulence
  - Serrations
  - How do components age? Interactions: bondings, blade roots…
  - Specific offshore challenges: erosion, remote
  - Mass production
  - Reduced maintenance objectives
  - Morphing blades?

Technical challenges

- Floating turbines
  - Floaters are only prototypes so far
  - Interface with wind turbine: specific turbine?
  - Anchoring
  - Maintenance strategies
  - Cable interface
  - HSE

Technical challenges

- Improved operation
  - LIDAR controlled wind turbines
  - Load driven actions
  - More sensors and dynamic integration
  - Wind farms instead of wind turbines
  - Big data to improve predictive maintenance
  - Redundancy of key components

Technical challenges

- Grid integration
  - Better integration of more renewables in a grid which was originally designed for centralized power productions
  - Connection of offshore wind parks: AC?
  - Prediction of production

8.2 Consulting – Member of 8.2 Group

- **130 experts worldwide** | active in more than 50 countries
- More than 20 years of experience in renewable energies
- **Technical Consulting**: (e.g. Due Diligence, O&M Optimization, Lenders / Owners Advisor)
- **Technical Inspections**: (e.g. Condition based assessments, Technical surveillance)
- **Grid Connection Expertise**

Due Diligence of more than **2 500 MW offshore** and **3 500 MW onshore**	**Design review** performed for most **on- and offshore turbines**	**> 20 000 turbines** inspected

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Towards Grid Support Services: The contributions of REserviceS

Dr Gustavo Quiñonez-Varela
Grid Integration Manager (Acciona)

etipwind.eu

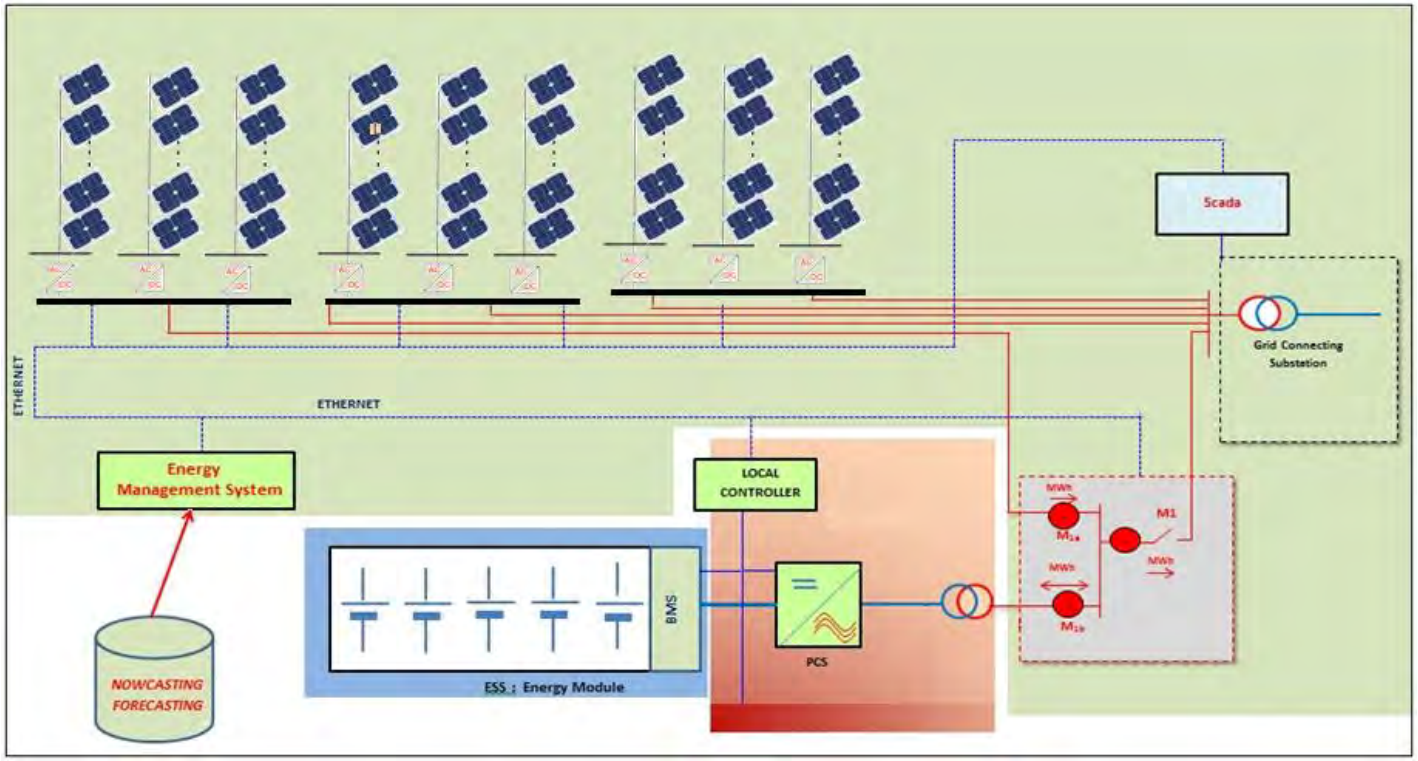
27th September 2016

Publicly funded R&I in wind industry

- Publicly funded projects enhance R&I efforts and investments from the wind industry
  - Help bringing novel technologies faster into the market
  - Also, help setting required adaptation of markets (key to Grid Support Services, GSS)
- Facilitate liaison between research and industry peers
  - Multidisciplinary teams, specific expertise
- Traditionally, had played an important role particularly in:
  - Basic research and knowledge creation
  - Development of technology and tools
  - Demonstration of concepts
  - Setting key references and recommendations

Publicly funded R&I in industry

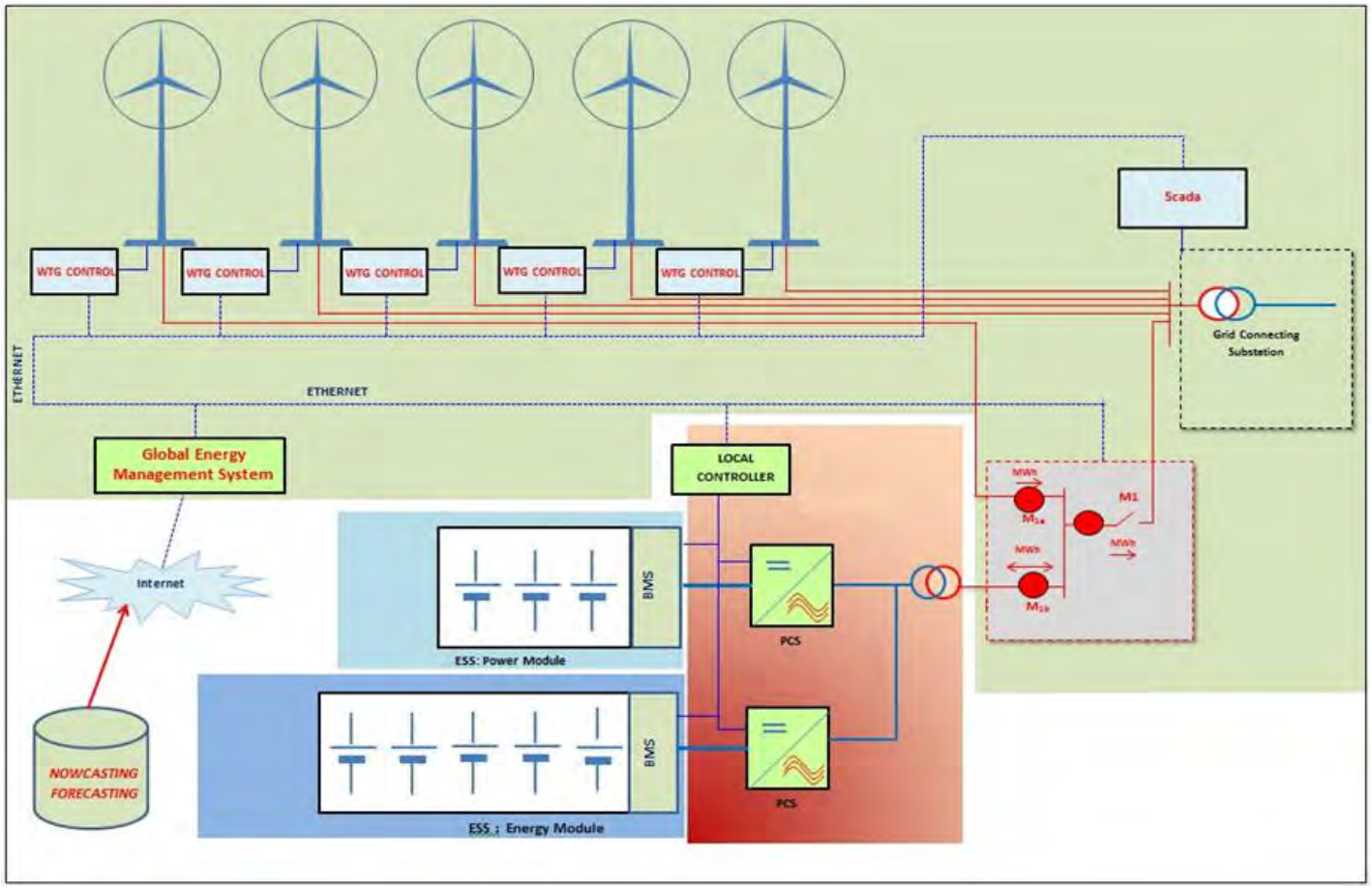
- Example: completed R&I (inputs to REserviceS)



Acciona Energia

Publicly funded R&I in industry

- Example: ongoing R&I



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R&I in the wind industry

- Quoting a dossier from the Spanish government (21/07/16):

> Spain is a world leader in all fields, boasting an industrial fabric that includes companies of high international standing. Their operations all over the world and enormous R&D+i efforts have given them a competitive edge over the global competition.

- National and EU publicly funded projects (FP7, IEE,…) had traditionally play an important role in the development of next generation technologies

Why industry partners joined REserviceS?

- Dealt with R&I issues within the strategic research agenda of the wind/renewable industry
  - High penetration of renewables
  - Electricity markets design (Grid Support Services)
- Timely topic:
  - New European Network Codes under implementation
  - From requirements to system services
    - Technology readiness, additional costs (CAPEX/OPEX), cost allocations,…..
- Well balanced Consortium
  - research institutes, consultancy companies, wind OEMs and power plant operators, DSO's and industry associations.

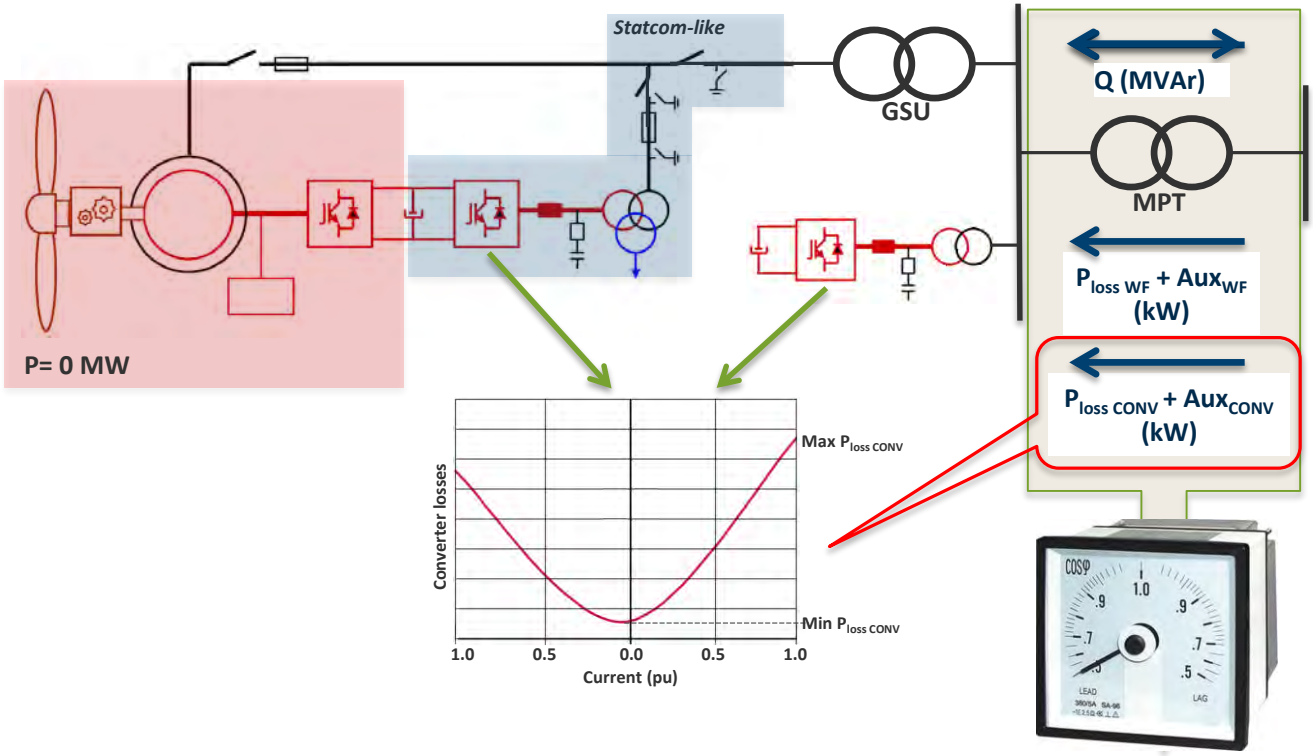
REserviceS project

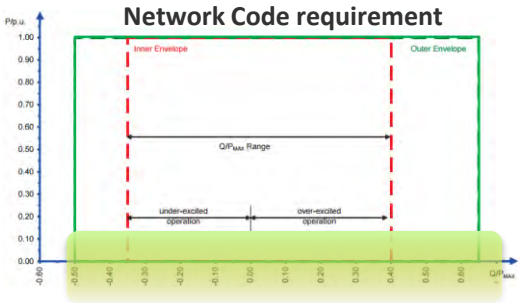
- Established a reference basis and policy recommendations for future grid support services from variable renewables.

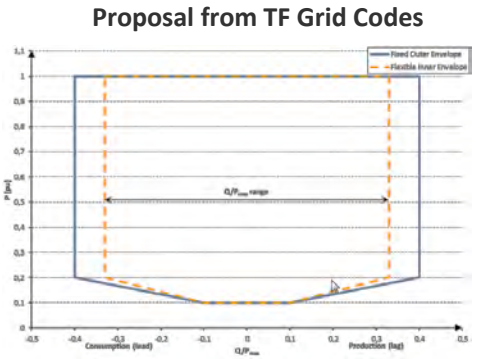
Benifits of REserviceS in the wind industry

- Findings and recommendations helping the ongoing national implementation of EU Network Codes

A practical example: Q at P=0



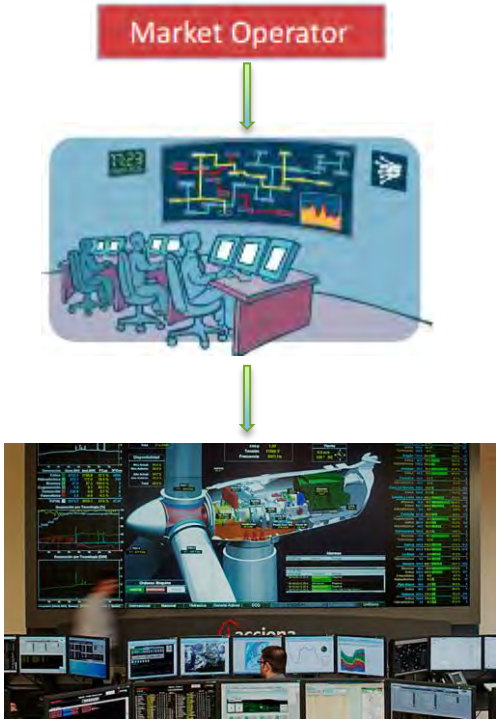


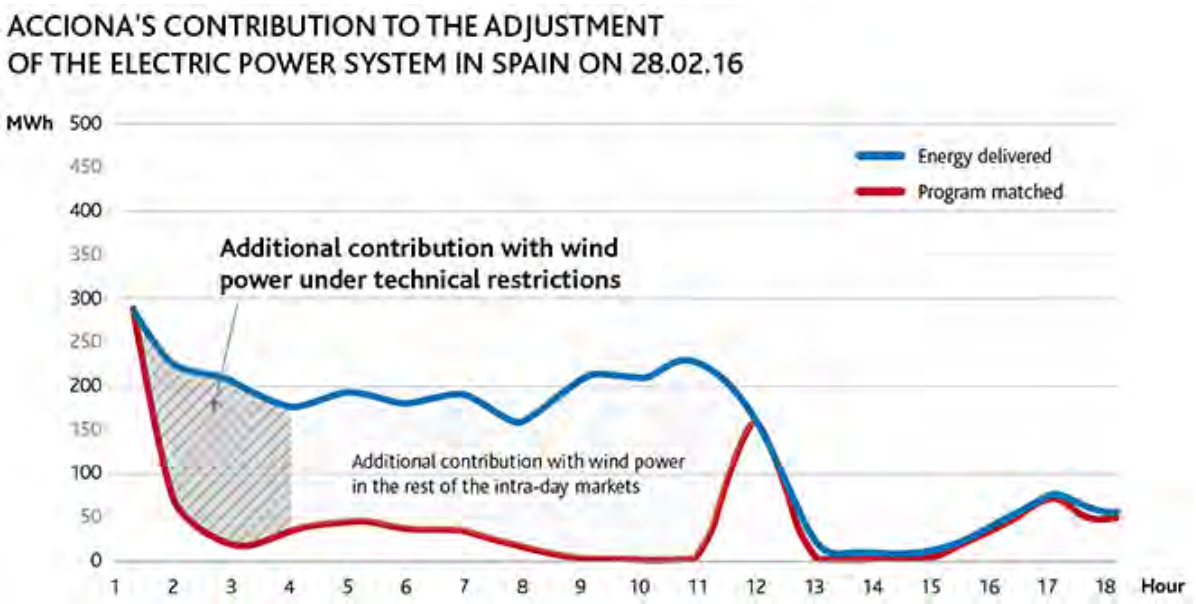


- Voltage control at P=0 a GSS, Why?
- Additional costs?
- Changes in existing regulatory framework?

GSS from wind power are a reality….

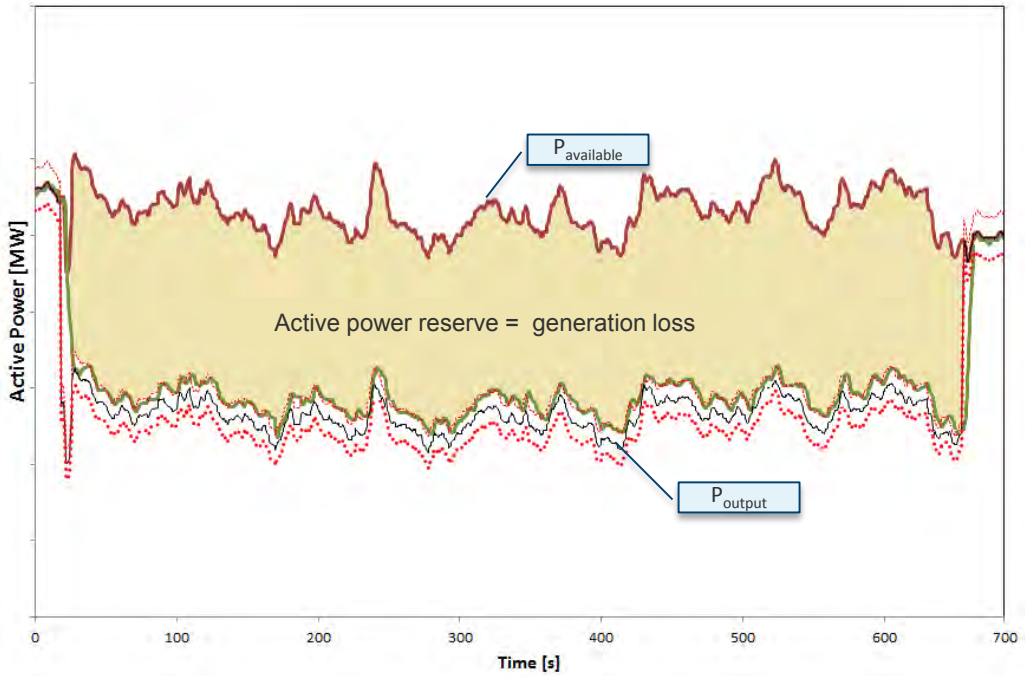
- Spain: new legislation laid down the criteria for participation in GSS and now is legally possible since 10/02/2016





Towards future GSS…..

- Provision of services of frequency containment and restoration reserves



Market design for frequency support services

Fast and reliable Communication

Control strategies

Estimation of available power / forecasting

Recertification for higher loads

Final remarks

- Publicly funded projects significantly contribute to R&I of the wind industry
  - REserviceS is an example of a successful project
- Focus on topics align with industry R&I agendas must be maintained
  - Role of Technology Platforms (ETIPWind)
- Shorter time from proposals to start of funded project
  - Minimise administration, expedite Contract, Consortium Agreement and IPR discussions,….
  - Keep in mind external competition

ETIP Wind

EUROPEAN TECHNOLOGY & INNOVATION PLATFORM ON **WIND ENERGY**

Thanks for your attention

http://www.acciona-energia.com/

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Overview of existing funding opportunities in Europe

Matthijs Soede
Research Policy Officer
European Commission

etipwind.eu

Hamburg
27 September 2016

Feb 2015: **Energy Union**

Energy Union: 5 Pillars

1. Energy security, solidarity and trust

2. A fully integrated European energy market

3. Energy efficiency contributing to moderation of demand

4. Decarbonising the economy

5. **Research, Innovation and Competitiveness**

⇒ **the Strategic Energy Technology Plan (SET Plan) as a key implementing pillar**

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Energy Union Priorities	SET Plan Ten Key Actions

4 Core priorities

No1 in Renewables	1. Performant renewable technologies integrated in the system 2. Reduce costs of technologies
Smart EU energy system, with consumer at the centre	3. New technologies & services for consumers 4. Resilience & security of energy system
Efficient energy systems	5. New materials & technologies for buildings 6. Energy efficiency for industry
Sustainable transport	7. Competitive in global battery sector (e-mobility) 8. Renewable fuels

For each of the 10 Key Actions

1. A few targets proposed by the EC using the Integrated Roadmap
2. Large consultation among the stakeholders and 32 SET-Plan countries
3. **A meeting between all to decide on the final targets**

➔ 'Declaration of Intent'

ETIP Wind

For Global leadership in offshore wind

1. Reduce the levelised cost of energy* (LCoE) at final investment decision for fixed offshore wind by improvement of the performances of the entire value chain to
   - ➔ **Less than 10 ct€/kWh by 2020 and to**
   - ➔ **Less than 7ct€/kWh by 2030**
2. Develop cost competitive integrated wind energy systems including substructures which can be used in deeper waters (›50m) at a maximum distance of 50 km from shore with LCoE* of
   - ➔ **Less than 12 ct€/kWh by 2025 and to**
   - ➔ **Less than 9 ct€/kWh by 2030**

the costs for delivering the electricity to onshore substations are taken into account within the LCoE

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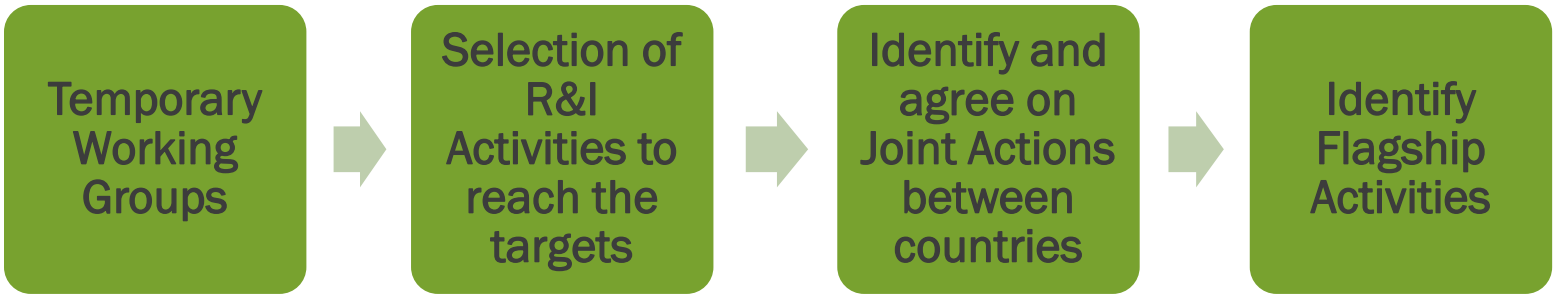
Implementation Plans



- **Mainly at national level**
- **On occasion at EU level**

Off-Shore wind is already an example: MoU signed by European countries around the North Sea

EU funds for wind energy

➔ **Horizon 2020 (focus on ↘ cost, ↗ performance of off-shore wind)**

➔ **NER300/400**

http://ec.europa.eu/clima/policies/lowcarbon/ner300/index_en.htm

➔ EFSI – *European Fund for Strategic Investment* **EUR 315 billion**

http://ec.europa.eu/priorities/jobs-growth-and-investment/investment-plan_en

➔ ESIF – *European Structural and Investment Fund*

- **EUR 46 billion Research & Innovation**
- **EUR 45 billion low cost economy**

http://ec.europa.eu/contracts_grants/funds_en.htm

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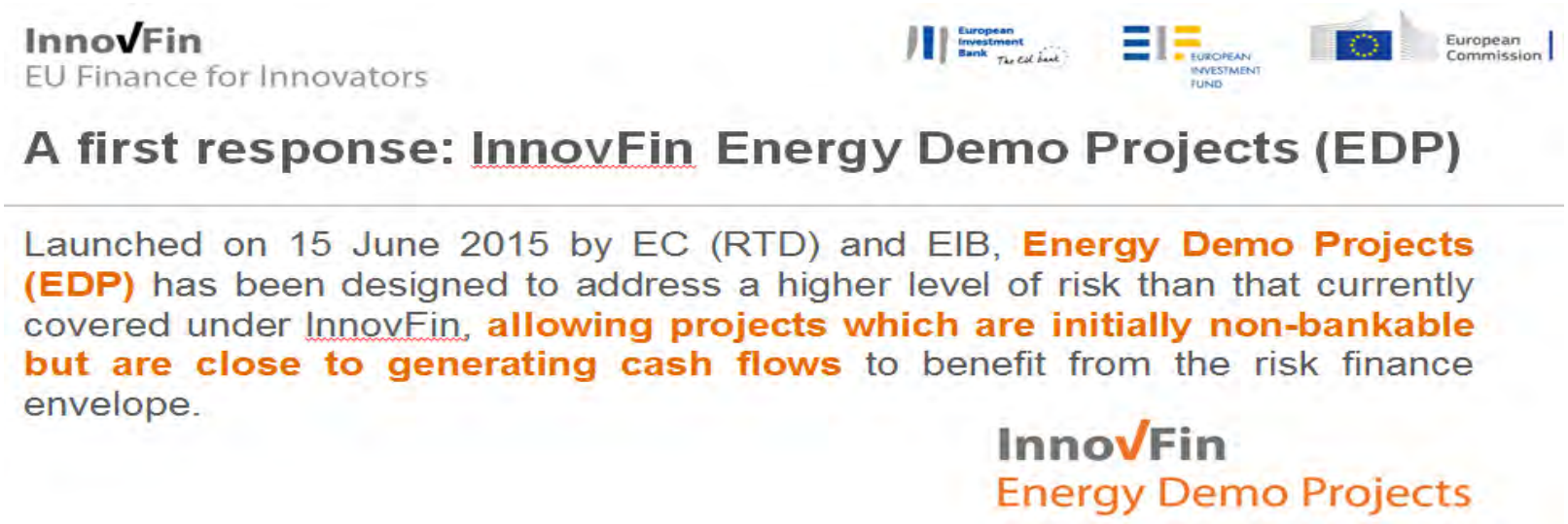
EU funds for wind energy

Innovative Financial Instrument for First-of-A-Kind Energy Project

➔ "Valley of Death" from demonstration to comercialisation



http://www.eib.org/products/blending/innovfin/products/energy-demo-projects.htm?lang=en

Risk finance for demonstration projects

InnovFin Energy Demo Projects Pilot Facility (EDP)

(Other Action#28)

- First-of-a kind commercial-scale industrial demonstration projects (TRL 7-8) for unproven pre-commercial technologies in the field of innovative **renewable energy**, **fuel cells and hydrogen** in support of the SET-Plan
- Loan amount: min EUR 7.5 M€, max EUR 75 M€
- Loan maturity: max 15 years

InnovFin Energy Demo Projects

Application & inquiries: directly with the EIB - New Products & Special Transactions, EIB, Luxembourg
Tel: +352 4379 85002, E-mail: innovfinFDP@eib.org
http://www.eib.org/products/blending/innovfin/products/index.htm

European countries: DE, DK, FR, IT, NO, SE, UK
2 June: European Commission joined

- **Double Governmental Investment in Clean Energy R&D over 5 years ~ $ 30 billion per year by 2021**
- **Link with Breakthrough Energy Coalition, i.e. Private investors**

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THE EU FRAMEWORK PROGRAMME FOR RESEARCH AND INNOVATION

HORIZON 2020

H2020 - Energy Calls 2016-2017

European Commission

H2020 - The 2016-2017 calls of the Energy Challenge Secure, Clean and Efficient Energy

Energy Efficiency (EE)
- Heating and Cooling
- Engaging consumers
- Buildings
- Industry, services and Products
- Innovative financing

Competitive low-carbon energy Technologies (LCE)
- Energy system (grids, storage)
- Renewable energies
- Decarbonising fossil fuels
- Socio-economic research
- European Research Area in energy

Smart Cities and Communities (SCC)
- Light-house demonstration projects

SME instrument (SIE)

Call budgets (in Mio €)

Call	2016	2017
EE	93	101
LCE	352,66	367,62
SCC	60	71,50
SME	46	50

H2020 Wind energy topics

Rationale:

- **European industries are still world leaders but the competition is growing;**
- **Cost reductions for all components essential, in particular for offshore;**
- **Offshore considered as the future market - large turbines to be demonstrated**
- **Issues remain on environmental and social impact, and on public acceptance**

Basic research

- OPEN: Improved understanding of the physics of wind as primary energy source and wind energy technology - *LCE-6-2017 – 2 stage – deadline 29/11/2016*

Advanced research

- CLOSED: Advanced control of large-scale wind turbines and farms – *LCE-7-2016*
- OPEN: Reduction of environmental impact – *LCE-7-2017 – 2 stage – deadline 29/11/2016*

Demonstration

- CLOSED: Solutions for reduced maintenance, increased reliability and extended life-time of off-shore wind turbines/farms – *LCE-13-2016 (EUR 10 million)*
- Large >10 MW wind turbines – *LCE-14-2017 (EUR 25 million) – deadline 7/9/2017*

Market-uptake

- OPEN : Increase market share of wind energy – *LCE-21-2017 – deadline 05/01/2017*

Cross-thematic priorities

LEITs (Leadership in Enabling and Industrial Technologies)

Nanotechnologies, Advanced materials, Advanced manufacturing and processing, Biotechnology

- Energy-efficient Buildings *(EEB-01 - EEB-8)*
- Sustainable Process Industry *(SPIRE-04, SPIRE-05, SPIRE-08)*
- Materials for Energy *(NMBP-2, NMBP-3, NMBP-17 - NMBP-20)*

LEITs (Leadership in Enabling and Industrial Technologies)

Information and communication technologies

- Low energy computing *(ICT-5)*
- Power electronics
- Big Data *(ICT-15)*
- Photonics *(ICT-29)*
- Internet of Things *(EUB-2)*

The SME Instrument

- Seamless business innovation support
- Completely bottom-up – all areas of the Energy Challenge covered
- Only open to SMEs – also single-beneficiaries possible

3 phases of support (no need to start with phase 1)

1. Business innovation grants (feasibility studies, lump sum of EUR 50,000 per project);
2. Business innovation grants for innovation development & demonstration purposes (between EUR 0.5 – 2.5 million / project)
3. Free-of-charge business coaching, access to a wide range of innovation support services and facilitated access to risk finance to facilitate the commercial exploitation of the innovation.

- ✓ 4 submission deadlines per year for phase 1 and 2
- ✓ Budget for the Energy SME topic (SMEInst-09-2016-2017):
  - ✓ 46 M€ in 2016
  - ✓ 50 M€ in 2017

Fast-track to Innovation Pilot

- Innovation from the demonstration stage through to market uptake (starting as of TRL 6)
- Completely bottom-up – covers all areas addressed by H2020
- Small consortia with strong participation from industry
- Business plans mandatory
- 3 submission deadlines in 2016 (15/3, 1/6, 25/10/2016)
- Budget 100 M€ (no earmarking for areas)

H2020 – projects

- Wind turbine
  - Ecoswing – Energy Cost Optimization using Superconducting Wind Generators - World's First Demonstration of a 3.6 MW Low-Cost Lightweight DD Superconducting Generator on a Wind Turbine (<TRL7, IA, 10.591.734 €, 1/3/2015 – 28/2/2019, Envision Energy (DK))
  - Rotary wing CLFC - Closed-Loop Flow Control to Enhance Aerodynamic and Aeroacoustic Performance of Wind-Turbine Blades (MSCA-IF-2014-EF, 171.460 €, 24 months, 1/5/2015 – 30/4/2017, TU Berlin (DE))
  - Riblet4wind – Riblet-surfaces for improvement of Efficiency of Wind Turbines (<TRL7, IA, 3.307.172 €, 42 months, 1/5/2015 – 30/11/2018, Fraunhofer (DE))

H2020 – projects

- Substructures
  - TELWIND – Integrated telescopic tower and evolved spar floating substructure for low-cost deep offshore wind and next generation of 10MW+ turbines (<TRL5, RIA, 3.498.530 €, 30 months, 1/12/2015 – 31/5/2018, ESTEYCO SAP)
  - LIFES50+ - Qualification of innovative floating substructures for 10 MW wind turbines and water depths greater than 50 m (<TRL5, RIA, 7.274.838 €, 40 months, 1/6/2015 – 30/9/2018, Marintek (NO))
  - ELISA/ELICAN – Self-bouyant precast concrete foundation for the craneless installation of complete offshore wind turbines: full scale offshore protype (SME -2, IA , 13.679.850 €, 24 months, 1/6/2015 – 31/5/2017, ESTEYCO SAP)
  - DEMOGRAVI3, innovative gravity based foundation for offshore wind turbines (TRL7, IA, 19.243.042 €, 48 months, 1/1/2016 – 31/12/2019, EDP (PT))

H2020 – projects

- Cost reduction in offshore wind

  - DEMOWIND (Eranet Cofund, IA, max 10.441,788 € funding, 60 months, 1/1/2015 – 31/12/2019, DECC (UK)) combined with national funding of UK, DK, NL, ES, PT and BE total: 31.000.000 €
  - DEMOWIND 2 (Eranet Cofund, IA, max 8.557.865 € funding, 60 months, 1/1/2016 – 31/12/2020, DECC (UK)) combined with national funding of UK, DK, NL, ES, BE and NO total: 25.932.924 €

H2020 – projects

- Small wind
  - Briareo – Implementation of a vertical axis micro-wind turbine capable of working at high efficiency even at a low wind speed (SME-1, 50.000 € funding, 6 months, 2015, Arken SPA)
  - IRWES Integrated Roof Wind Energy System (SME-2, 1.696.381 € funding, 24 months, 2015 – 2017, IBIS Power BV)
  - Omniflow – Next-generation hybrid wind and solar power technology (SME-1, 50.000 €, 6 months, 2015, Omniflow SA (PT))
  - ECIWIND - Cost effective wind turbine of 40 kW of rated capacity (SME-2, 1.307.305 € funding, 24 months, 1/5/2015 – 30/4/2017, ENAIR ENERGY SL)

H2020 – projects

- Airborne Wind
  - AMPYXAP3 – Commercial introduction of the first Airborne Wind Energy system: renewable eneryg at costs below fully depreciated coal fired power plants (SME-2, 2.500.000€ funding, 23 months, 2015, Ampyx Power BV)
  - REACH – Resource Efficient Automatic Conversion of High Altitude Wind (FTIPilot -1, 2.675.132€ funding, 36 months, 2015, ENEVATE BV) Kite Power

H2020 – projects

- Education and training
  - ICONN – European Industrial DoCtorate on Offshore WiNd and Wave ENergy (MSCA-ITN-EID, 845.838 €, 48 months, 2015 – 2019, Trinity College Dublin)
  - AWESOME – Advanced Wind Energy Systems Operation and Maintenance Expertise (MSCA-ITN-ETN, 2.862.074 €, 48 months, 2015 – 2019, CIRCE (ES))
  - AWESCO – Airborne Wind Energy System Modelling, Control and optimisation (MSCA-ITN-ETN, 2.999.015 €, 48 months, 01/01/2015 – 31/12/2018, TU Delft (NL))
  - SPARCARB – Lightning protection of wind turbine blades with carbon fibre composite materials (MSCA-ITN-ETN, 1.093.151 €, 48 months, 01/01/2015 – 31/12/2018, GLPS (DK) and Univ Southampton (UK))
  - AEOLUS4FUTURE – Efficient harvesting of the wind energy (MSCA-ITN-ETN, 3.811.805 €, 48 months, 01/01/2015 – 31/12/2018, LULEA Tekniske Univ (S))

H2020 – projects

- Market uptake
  - RICORE - Risk Based Consenting of Offshore Renewable Energy Projects 1.393.533 (SCA, 1.393.533 € funding, 18 months, 1/1/2015-30/6/2016 2015, Robert Gordon university (UK))
  - INDUSTRE (Grids) - Innovative Business Models for Market Uptake of Renewable Electricity unlocking the potential for flexibility in the Industrial Electricity Use

H2020 – projects

- Varia
  - HPC4E – HPC for Energy (LEIT, RIA, 1.998.176 €, 24 months, 1/1/2016 – 31/12/2017, Barcelona supercomputing centre)
  - Opti-LPS – Optimal Lightning Protection System (SME-1, 50.000 €, 6 months, 2015, GLPS AS (Dk))
  - MEWi-B – More efficient Wind Blades (SME-1, 50.000 €, 6 months, 2015, ETA Srl (IT))
  - FLOATMAST – An Innovative Wind Resource Assessment Tension Leg Platform for combined Anemometer and Lidar reliable and bankable wind measurements for offshore wind parks (SME-1, 50.000 €, 6 months, 2015, ETME Streamlined (EL))
  - Winspector – Advanced shearography kit and a robotic deployment platform for on-site inspection of wind turbine blades
  - EIROS - Erosion and Ice Resistant cOmposite for Severe operating conditions

H2020 – projects

- Varia
  - I-WSN – Intelligent Wireless Sensor Networks for Asset Integrity Monitoring (SME-1, 50.000 €, 6 months, 2015, Inertia Technology BV (NL))
  - EeC WITUR – Efficient energy cleaning robotic platform for wind turbines (SME-1, 50.000 €, 6 months, 2014, Tratamiento Superficial Robotizado SL (ES))
  - CLOUD DIAGNOSIS – Providing Predictive Maintenance for Wind Turbines Over Cloud (SME-1, 50.000 €, 6 months, 2014, ITESTIT (ES))
  - AIRCRANE – New Building methodology for improved full-concrete wind towers for wind turbines (SME-1, 50.000 €, 6 months, 2014, Structural Research S.L. (ES))
  - Aeropaft – Delay of flow separation and stall on Aerofoils using a passive flow control technology which will improve aerodynamic performance and stability of wind turbines increasing their range of operation (SME-1, 50.000 €, 6 months, 2014, Jarilo Limited (UK))

H2020 – projects

- Combined wind/ocean
  - POSEIDON - Market maturation of Floating Power Plant's Floating Wind- Wave- Energy Device (SME-2, 1.144.150€ funding, 24 months, 1/6/2015-31/5/2017, FLOATING POWER PLANT A/S (DK))
  - ICONN – European Industrial DoCtorate on Offshore WiNd and Wave ENergy (MSCA-ITN-EID, 845.838 €, 48 months, 2015 – 2019, Trinity College Dublin)
  - SEAMETEC – Smart Efficient Affordable Marine Energy Technology Exploitation using Composites (SME-1, 50.000 €, 6 months, 2015, Eirecompoisites Teoranta (IE))
  - MARIBE - (CSA, 1.977.951 € funding, 18 months, 1/3/2015-31/8/2016, Cork University (IE))

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REserviceS

A pan European research project success story

Lessons learned from participation

Stephan Wachtel
Senior Engineer, GE Renewables

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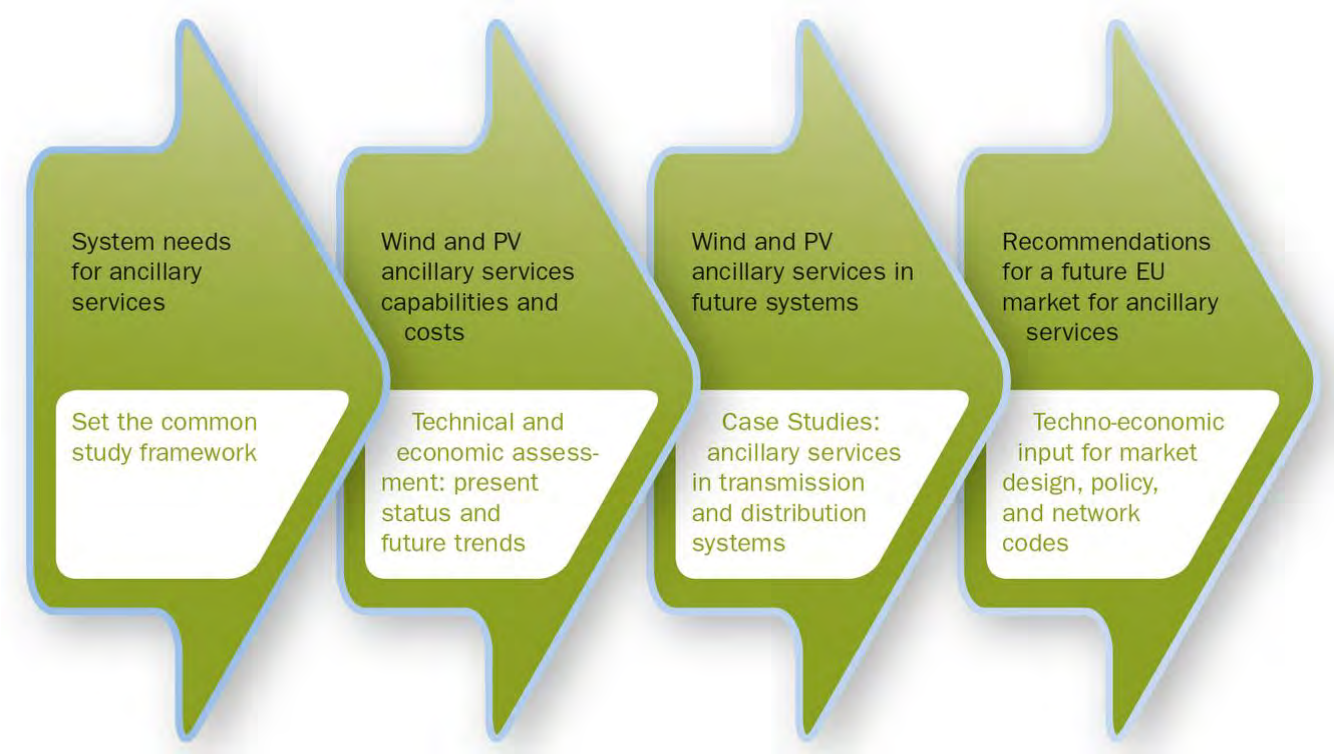
Please note that the presentation is not a statement from the REserviceS consortium and/or EASME and therefore not necessarily reflects their views, opinions and positions. They cannot be held responsible for the use of the information contained therein.

The REserviceS Project

REserviceS (Economic grid support from variable renewables) was the first study to investigate wind and solar based grid support services at EU level.



The REserviceS Project

REserviceS has provided technical and economic guidelines and recommendations for the design of a European market for ancillary services, as well as for future network codes within the Third Liberalisation Package.

REserviceS was funded under the EU FP7 program and ran from Q2 2012 to Q3 2014

Please see also www.reservices-project.eu

Coordinated by: EWEA

Supported by:

In partnership with: 3E, VTT, GE, EPIA, acciona, UCD, DTU Wind Energy, SMA, Fraunhofer IWES, Mainstream Renewable Power, EDSO

Why did GE took part in REserviceS?

- Relevant topic at the right time
  - Renewables system integration is key to achieve high and cost efficient RES penetration
  - RES already do provide system services today and will need to provide more at higher RES penetration levels
  - But which and how and within which framework?
  - This will impact design & operation of RES significantly
- REserviceS broke new ground with realistic objectives
- Leveraging lessons learned from RES integration studies in the European context
- IP development was neither planned nor expected.

Why did GE took part in REserviceS?

- GE had the right staff with the needed skillset
  - … and these resources could be scheduled
- Funding from the EU FP7 funding program
  - Sufficient re amount and schedule
  - Sufficient added value for the business
- The set up of partners in the consortium
  - EU funded projects were new to the set up GE team
  - Most partners with long track record of EU funded projects
  - WindEUROPE as an experienced project coordinator

Lessons learned

- Complex Rules, complex application
  - Understand the funding rules fully
  - In case of doubt: Look for external support
  - Run your business case carefully

- Match internal processes with funding rules
  - Fully understand the degree of freedom in the rules

- Project coordination
  - Large project with 14 partners over several WPs needed good coordination
  - Well align with your project partners

Lessons Learned con'd

- Plan your resources well
  - Project Coordination
  - Dissemination of results
  - Reporting and its deadlines
  - Archiving information
- Manage resources well to fulfill your commitments on time
  - Plan for project management role
  - Carefully manage budget and schedule
  - Prepare for audit
  - How can overhead by minimized?

Summary and Conclusions

- REserviceS had the right team for this project
  - Look for the right partners and …
  - … get full alignment.

- Large projects with long run time drive needs for coordination
  - For each partner
  - For the consortium by a strong coordinator
  - How much efficiency can be gained by having smaller projects?

Summary and Conclusions

- FP7 was the right R&I funding program for the goals of the REserviceS project
  - Project goals matched with the funding rules
  - Enabled a project the partners could not have worked on in such a way as in this R&I project.
  - Incentivize performance in future funding programs?
- Fully understand the funding rules
  - Especially if the program is new for your team
  - Consider external help
- Unbureaucratic funding rules fast & transparent approval processes make EU funding programs attractive.

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