ENERGY CATALYST

Optimisation of Wind Energy O&M Decision Making Under Uncertainty

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Exploitation Plan

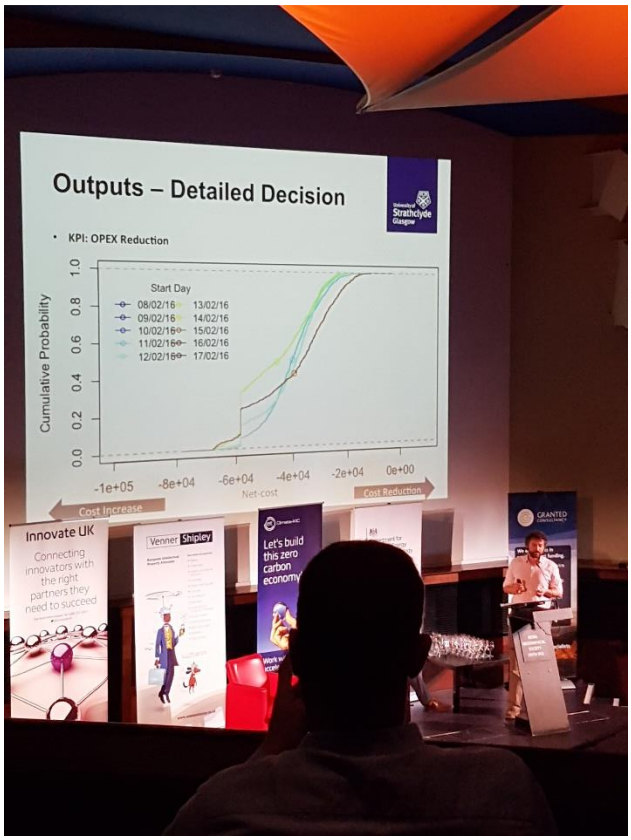
Contents:

- **Individual Dissemination Events & Reports**
- **Re-Test Business Case**
- **Next Steps**
- **Visual Highlights 1: Blade Lift Tool**
- **Visual Highlights 2: Bearing Life Management Tool**
- **Visual Highlights 3: Project Team**

Individual Dissemination Events & Reports

The project has been widely disseminated in the following channels:

Engagement #		
1	Presented work at DTU advanced workshop on wind forecasting applications, Lyngby, DK. http://www.wesc2017.org/	26-29 June 2017
2	Oral presentation and live demonstrations of prototype software tool at All-, Energy Glasgow, UK. http://www.all-energy.co.uk/	10-11 May 2017
3	Rushlight summer showcase Royal Geographical soc, London, UK. http://www.rushlightevents.com/wp-content/uploads/2017/03/Rushlight-Summer-Showcase-2017-Univ-of-Strathclyde.pdf	20th June 2017
4	Presented advances in use of data for decision making to Castrol on, Nottingham, Uk.	29 May 2017
5	WindEurope @ Excel London (software demos)	July 2017
6	Draft paper for journal article focused on methodology being developed, with target journal of IEEE Transactions on Engineering Management.	Oct 2017



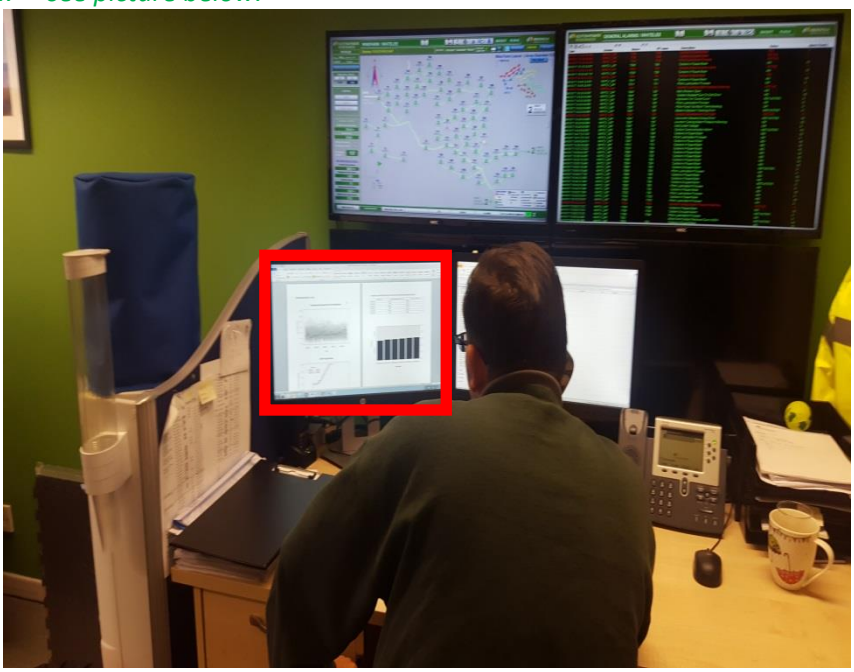
Presentation of Tool Outputs at Rushlight Summer Showcase

Re-visit and test of the initial business case in light of the findings of the project

The text below is taken from the initial application business plan. Italic green text updates the business case in light of the project and new information

Business exploitation plan: From a commercial point of view, the potential exploitable outputs from this project will ultimately be software products that can be used by the wind farm operators to improve their decision making process.

The project delivered a prototype blade lift tool which assisted in a total of 4 blade lifts during the summer of 2017 – see picture below.



Blade Lift Tool used at Whitelee Summer 2017

The software products will be offered in SaaS model to generate recurring revenue and to capture a wider customer profiles from IPPs to large utilities. As Romax is headquartered in the UK and has 12 international offices, it is best positioned to lead the commercial exploitation of the outputs from the project. It has a comprehensive customer base globally across renewable energy, rail, automotive, aerospace, off-highway and marine industrial sectors with well-established sales channel, which can be utilised for upselling the products, and currently manages over 1000 turbines globally.

Discussions are currently underway on how best to take the outputs and tools forward. The non-claiming grant wind farm owners (SPR/ SSE) have both expressed an interest in operationalising the tools (eg by having the weather forecast update regularly). This will be funded by a mixture of Insight (KTP), Datalytics (Scottish Eneterprise) and SSE & SPR (Direct industry funds).

In addition to wind industry, reducing O&M costs becomes increasingly important for rail industry, therefore, it can be the next targeted market that Romax can bring the products and services into. After a successful conclusion of this feasibility project, Romax will continue working with other consortium members to bring the technology to higher TRL level with potential future funding support through later stages of Energy Catalyst funding rounds: mid-stage: Technology development and Late-stage: Pre-commercial technology validation. Romax will be able to commence full

commercialisation and offer the products and services in addition to its existing offerings. It is expected that the full commercialisation of the outcome will start at 5 years post-project (2021).
Strathclyde and Romax have had extensive discussions on the future of the analytics business (leading Romax Insight to be acquired by Castrol). This will be continued via a successful KTP application which will run from January 2018 for a total of 3 years. Castrol committed cash value of over £50,000 to this application.

Datalytics will work closely with Romax on the development and prototyping of the software product. The software product developed by Datalytics can be either integrated into Romax's existing health management software platform, or a stand-alone software product or software module, that Romax can offer to its customers.
Currently the tool is operated in two modes 1) Call down – a request is made to Strathclyde to run a weather case, outputs are sent direct to customer 2) Web interface – tool is run direct from Datalytics web tool (but weather does not update).

Revenue generated from the software products will be shared based on licensing agreements or other commercial agreements.
The modus operandi for this is under discussion.

As this project is still at a feasibility study stage, it is difficult to define the revenue share percentage, hence ROI for each party. However, it is expected that given the potential market, ROI will be orders of magnitude more than the project costs.
At the beginning of the project, heavy lift decisions were not seen as a huge priority (especially at SPR). Since then, SPR have had to enact a total of 4 blade lifts in a single summer (roughly 5% of machines at WHitelee alone). If one takes the total UK installed capacity of 15GW it can be seen that the market for decisions support is perhaps even more promising than that outlined in this initial estimate.

SPR are the key operators in this project consortium, who are best positioned as the end user of the technology and product. This project will enable SPR to take on the technology at an early stage and realise the savings that the technology can generate. The value of the technology can then be demonstrated and disseminated to the wind industry to increase the awareness of the technology and encourage the uptake of the product in the future.
See picture above. In order to bottom out the financial value, a follow-on analysis will be conducted to establish cost savings of full adoption of the tool.

Description of "next steps" post funded project
There are several initiatives ongoing which will progress the project beyond its IUK funding life.

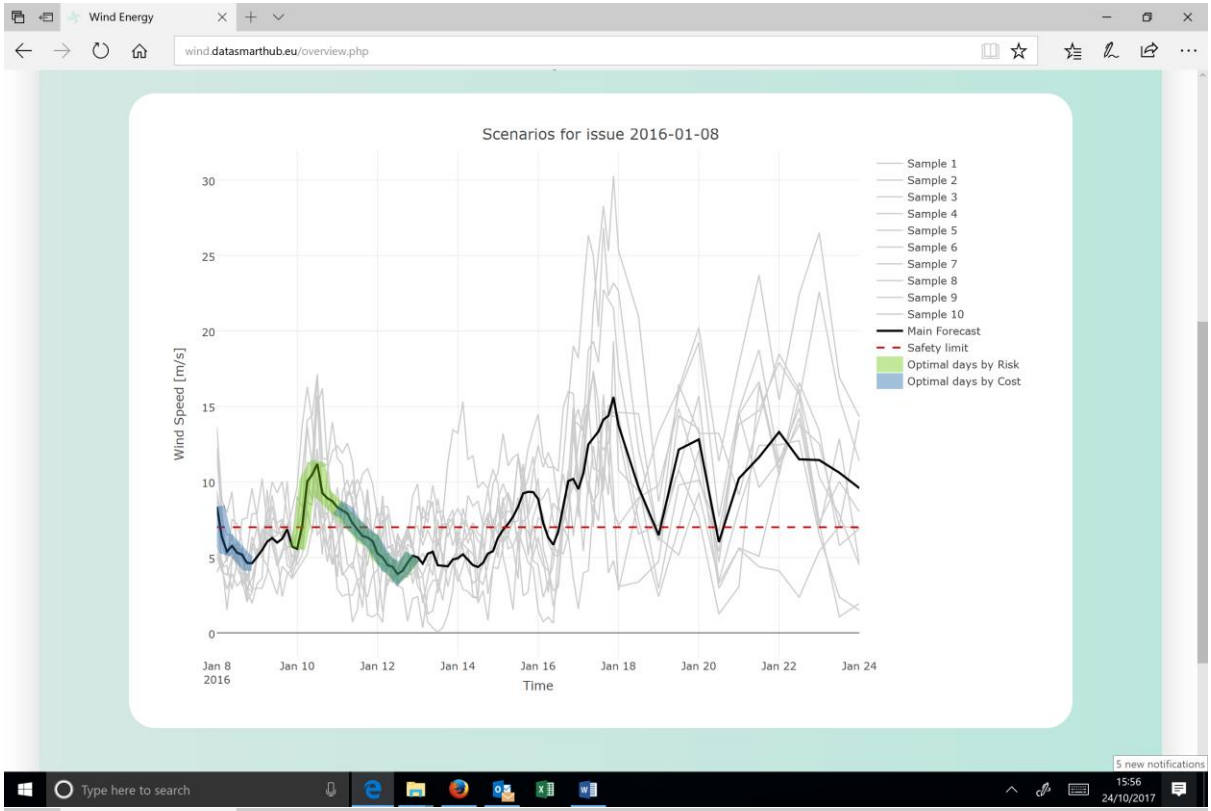
These are outlined below – **red text** indicates secured follow-on funds:

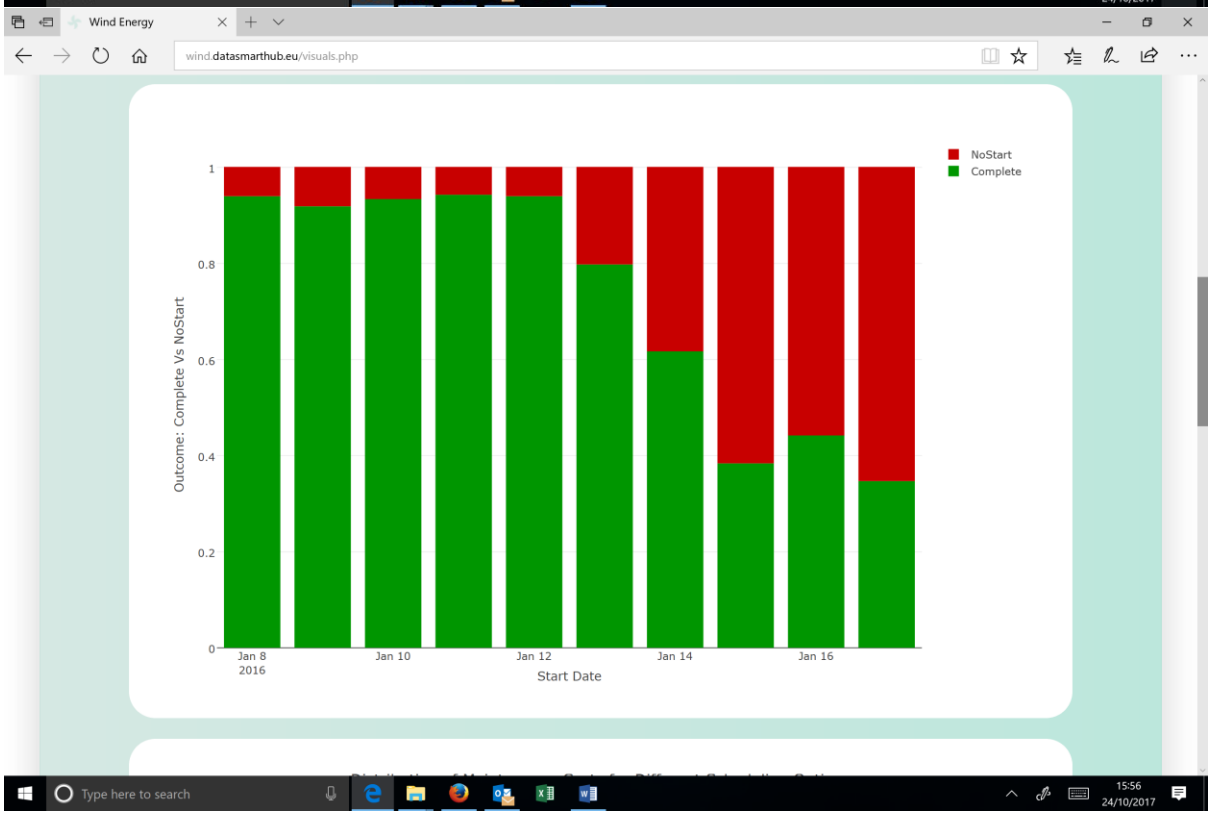
#		
1	Blade lift tool to be used to perform analysis of cost/benefit at SSE Bindoo wind farm	Nov 2017
2	KTP with Insight/ Castrol for 3 years focused on improved delivery of analytics to wind industry - £300k (50/50 Innovate/ Insight)	Jan 2018
3	Discussions with SSE & SPR on possible pooled industrial funds to operationalise tool in next 12 months	Jan 2018
4	Concepts developed on this project to be re-cast for use on Access forecasting EPSRC project funded by Supergen Flexible Funding (starting Q2 2018 working with James Fisher marine) - £120k (EPSRC)	Mar 2018
5	IP discussions to be held with Datalytics & Romax to establish best route to service offering.	Jan 2018

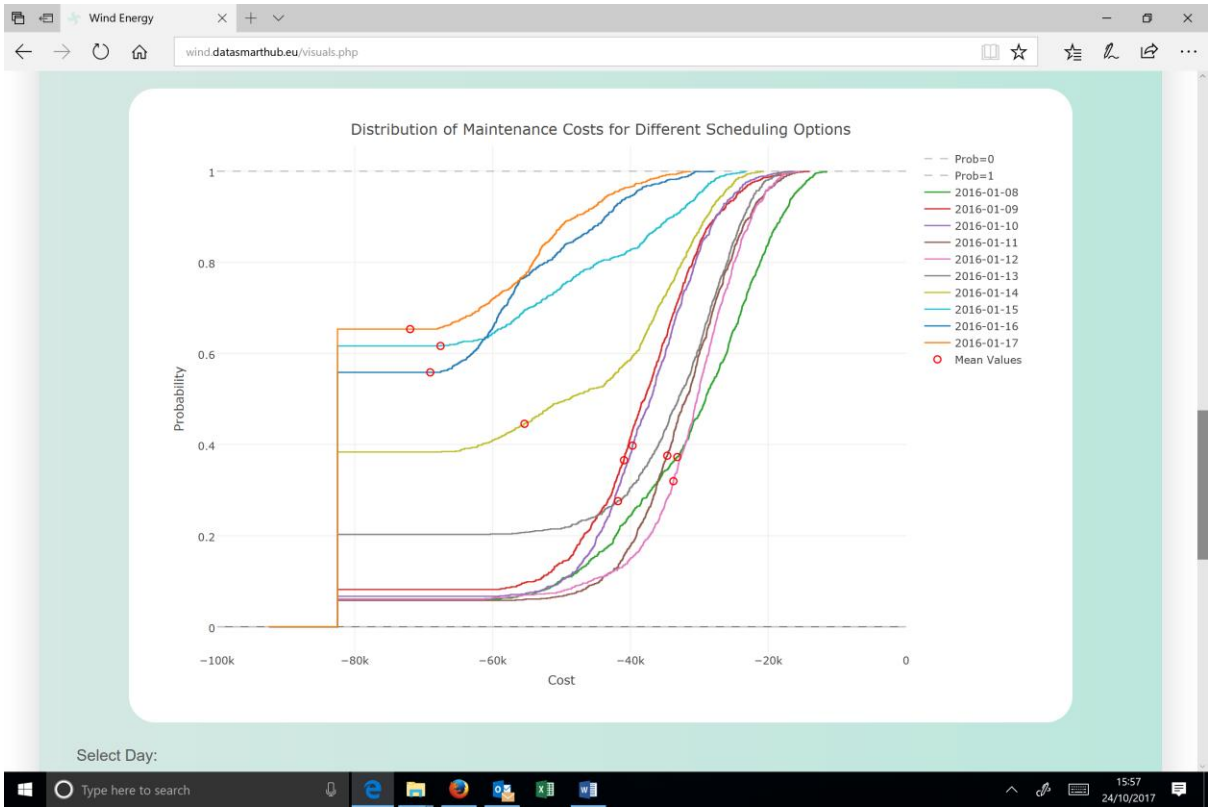
Quote from SPR from closeout presentation:

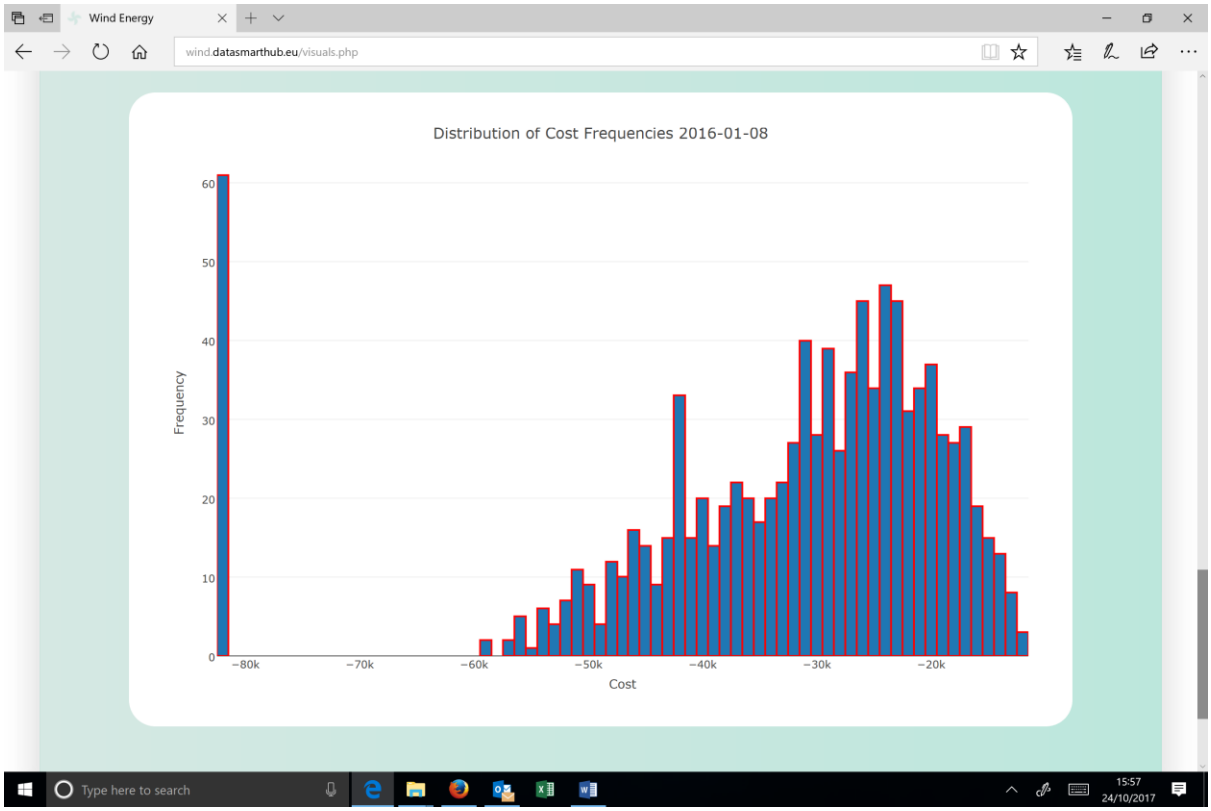
"**The tool also becomes vital in a world of reducing O&M budgets and focus on EBITDA / production. It is perfectly placed to support a decision related to upcoming production and balancing the risk / reward.**"

Visual Highlights 1: Blade Lift Tool http://wind.datasmarthub.eu/overview.php

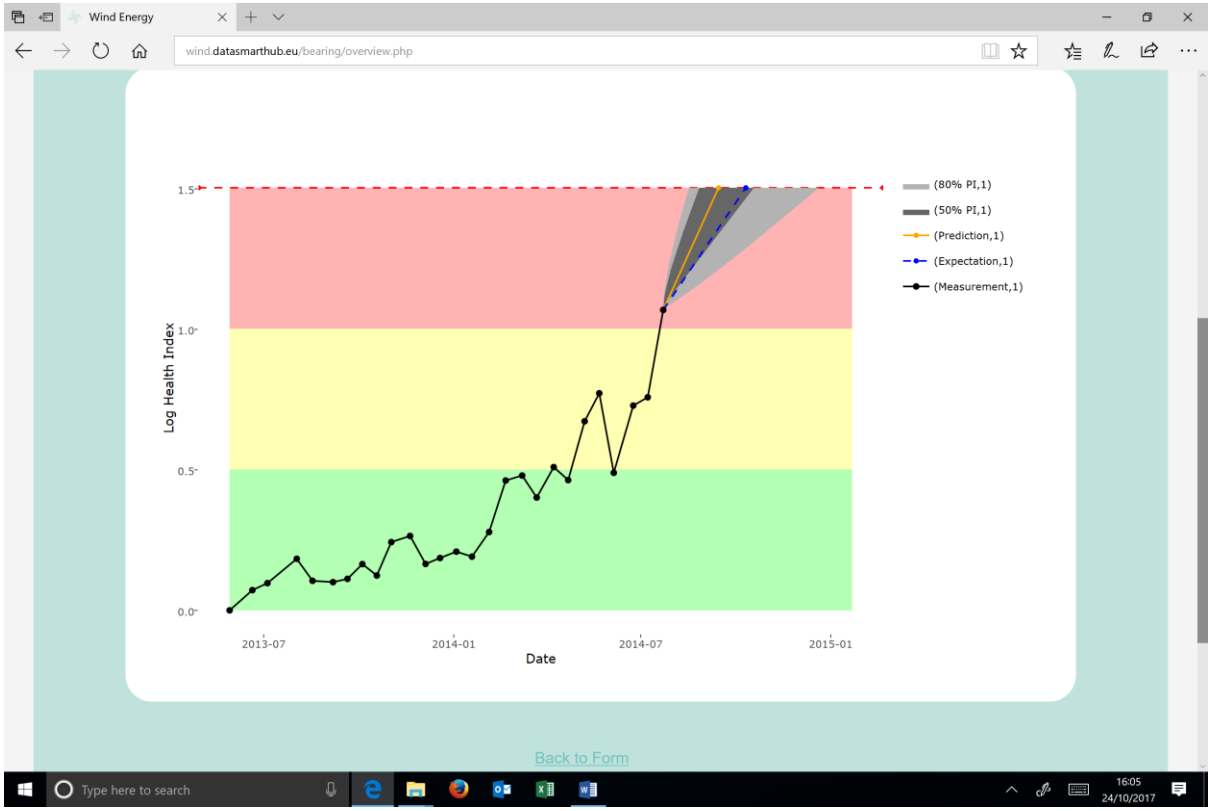


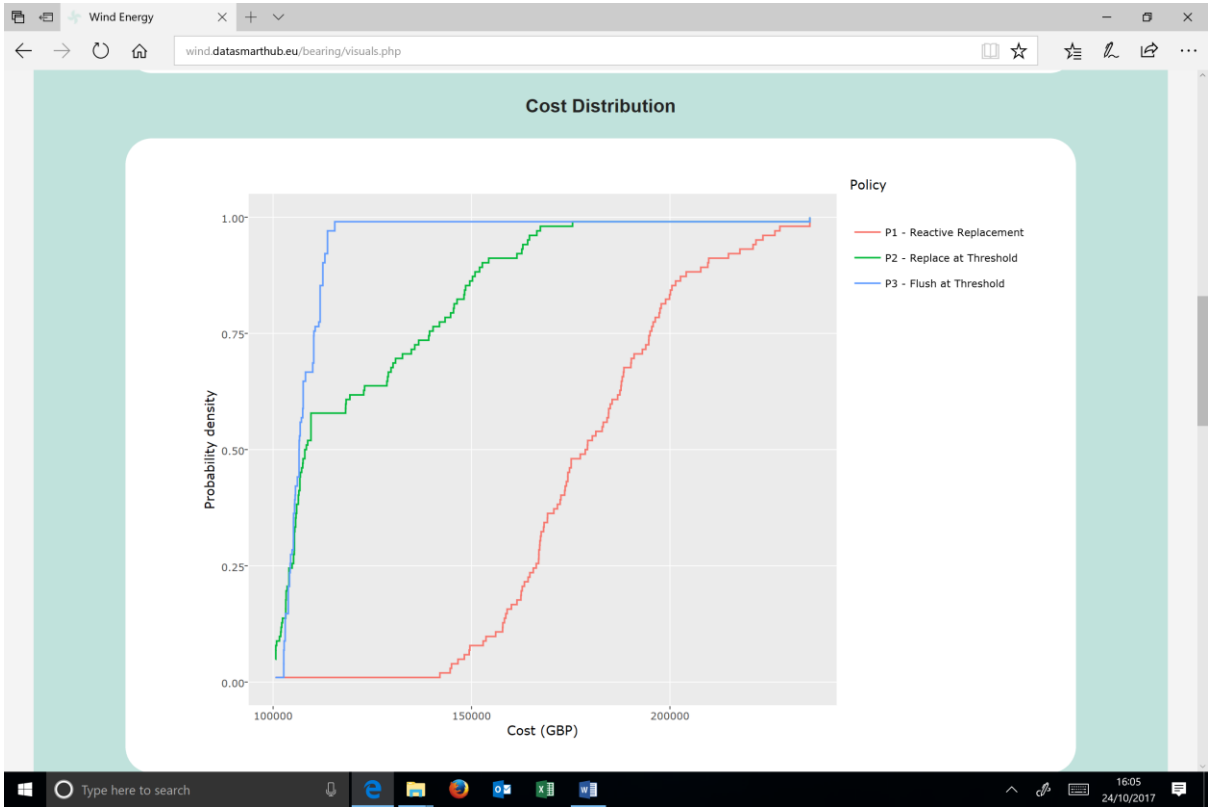


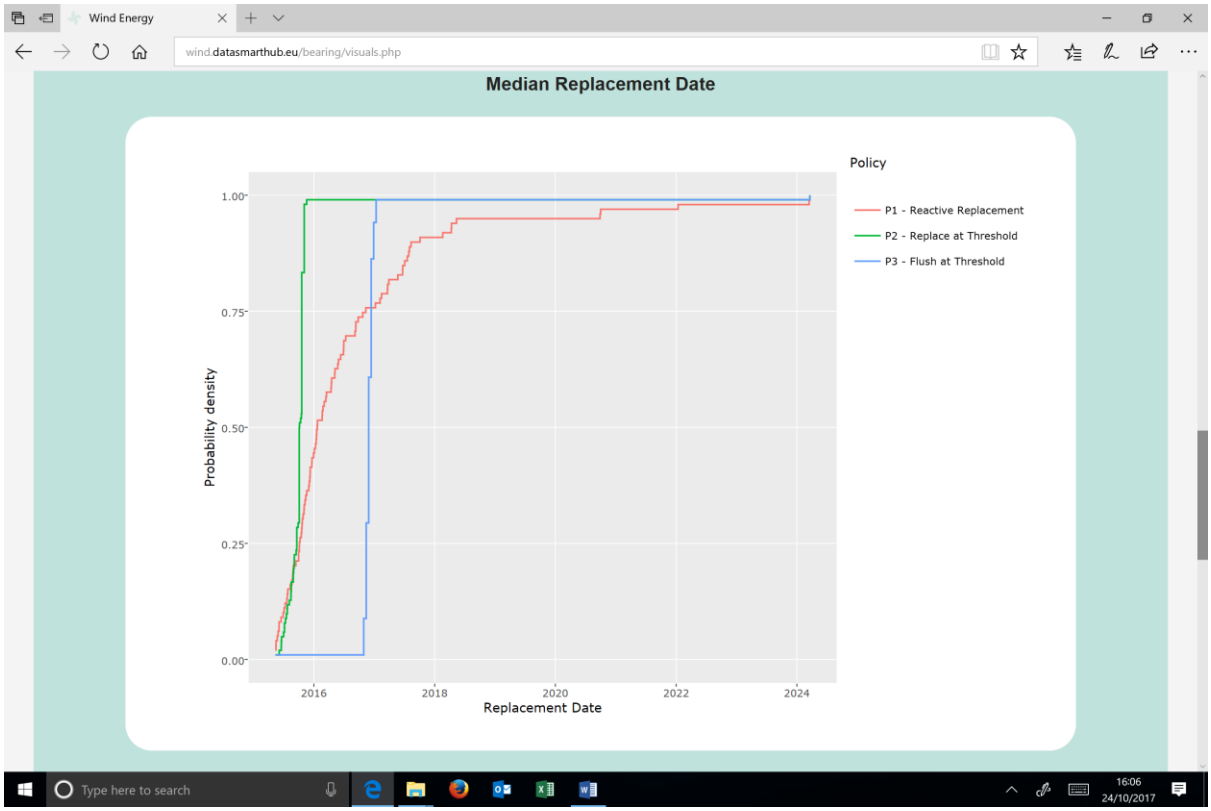

Wind Energy
wind.datasmarthub.eu/visuals.php
Distribution of Maintenance Costs for Different Scheduling Options
Probability
Cost
1
0.8
0.6
0.4
0.2
0
−100k
−80k
−60k
−40k
−20k
0
Prob=0
Prob=1
2016-01-08
2016-01-09
2016-01-10
2016-01-11
2016-01-12
2016-01-13
2016-01-14
2016-01-15
2016-01-16
2016-01-17
Mean Values
Select Day:
Type here to search
15:57
24/10/2017

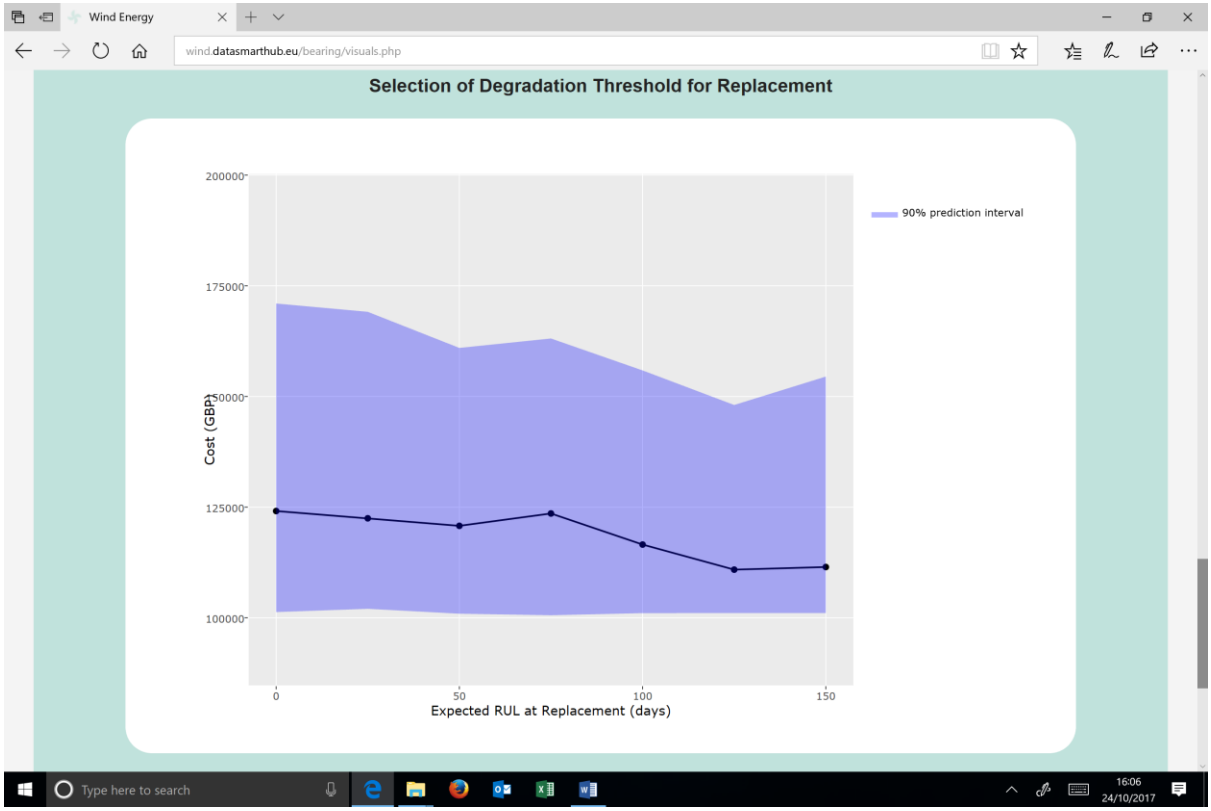

Wind Energy
wind.datasmarthub.eu/visuals.php
Distribution of Cost Frequencies 2016-01-08
Frequency
Cost
60
50
40
30
20
10
0
−80k
−70k
−60k
−50k
−40k
−30k
−20k
Type here to search
15:57
24/10/2017

Visual Highlights 2: Bearing Life Management Tool http://wind.datasmarthub.eu/bearing/






Wind Energy
wind.datasmarthub.eu/bearing/visuals.php
Median Replacement Date
Policy
P1 - Reactive Replacement
P2 - Replace at Threshold
P3 - Flush at Threshold
Probability density
1.00
0.75
0.50
0.25
0.00
2016
2018
2020
2022
2024
Replacement Date
Type here to search
16:06
24/10/2017


Wind Energy
wind.datasmarthub.eu/bearing/visuals.php
Selection of Degradation Threshold for Replacement
90% prediction interval
Cost (GBP)
200000
175000
150000
125000
100000
0
50
100
150
Expected RUL at Replacement (days)
Type here to search
16:06
24/10/2017

Visual Highlights 3: Project Team

Project Kickoff Meeting Project Q1

Workshop 1: Strathclyde Project Q1

Workshop 2: Nottingham Q2