Technology Collaboration Programme
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IEA Wind Task 45: *Wind Value,* End-of-Life Decisions for Wind Farms

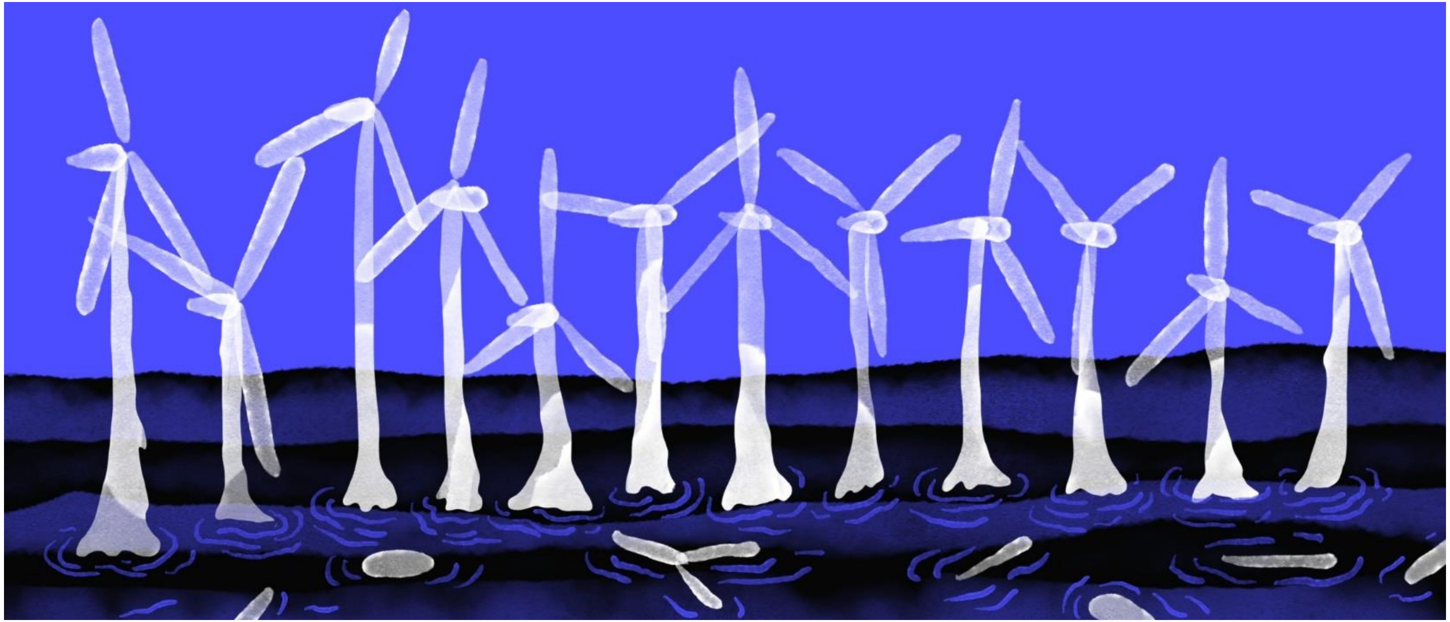

Illustration by: Marie Boye Thomsen

Peter Deeney and Paul Leahy of University College Cork, Ireland

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UCC Coláiste na hOllscoile Corcaigh, Éire University College Cork, Ireland
Environmental Research Institute
IRISH RESEARCH COUNCIL An Chomhairle um Thaighde in Éirinn
seai SUSTAINABLE ENERGY AUTHORITY OF IRELAND
CORK UNIVERSITY BUSINESS SCHOOL
WIND VALUE

End-of-Life Decisions for Wind Farms:
An Opportunity for Climate Action and for Energy Communities

Objectives

1) Decision Support Tool for wind farm owners for decisions at the end-of-life of a wind farm: repowering / life extension / decommissioning.
2) Decision Support Tool for communities wishing to invest in an existing wind farm: risk / reward.

Numbers

A. Budget of €528,000 from the Irish Research Council

B. Four Years with funding for a Principal Investigator and a PhD Student

The Core Research Team

Peter Deeney

Paul Leahy

John O’Brien

Dorcas Mikindani

Wind Value

The Collaborators

Niall Dunphy

Fabian Gogolin

Rebecca Windemer

University College Cork,

Leeds University Business School,

Regen

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Wind Value   The Interns





Luca Bernardi, Claire Ducourtieux, Kevin Campbell, Benoit Mayol, Qianhui Chen

University of Padua, Université Côte d’Azur , University College Cork, Université Côte d’Azur, Minzu University

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What to do at the end-of-life?

Decision Support Tool for Wind Farm Owners

- Expected income from repowering, life extension and cost of decommissioning.
- Financial risks of repowering, life extension compared with decommissioning.

Decision Support Tool for Community Ownership

- Expected value of a wind farm as it approaches end-of-life
- Financial risks of ownership
- Some consideration of risk in the permitting process

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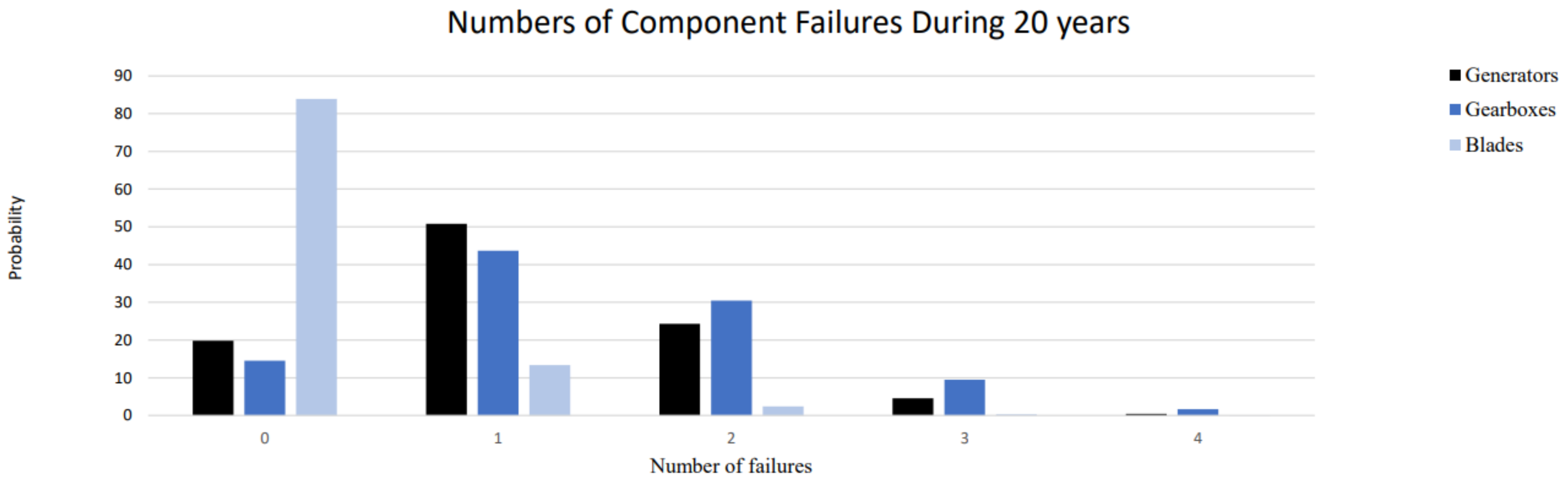
Failure Risk Model

Based on a paper to be submitted by Dorcas Mikindani, PhD Student

- Fits a two factor Weibull Distribution to existing annual failure rates
- Discounts the cash flows
- Considers lost opportunity cost
- Uses a fixed electricity price
- Uses Monte Carlo simulations to generate the distribution of outcomes

Expected number of repairs over 20-year lifespan

Blades are very different from gearboxes or generators.



- Gearboxes fail the most frequently, followed by gearboxes and blades are the least likely to fail.

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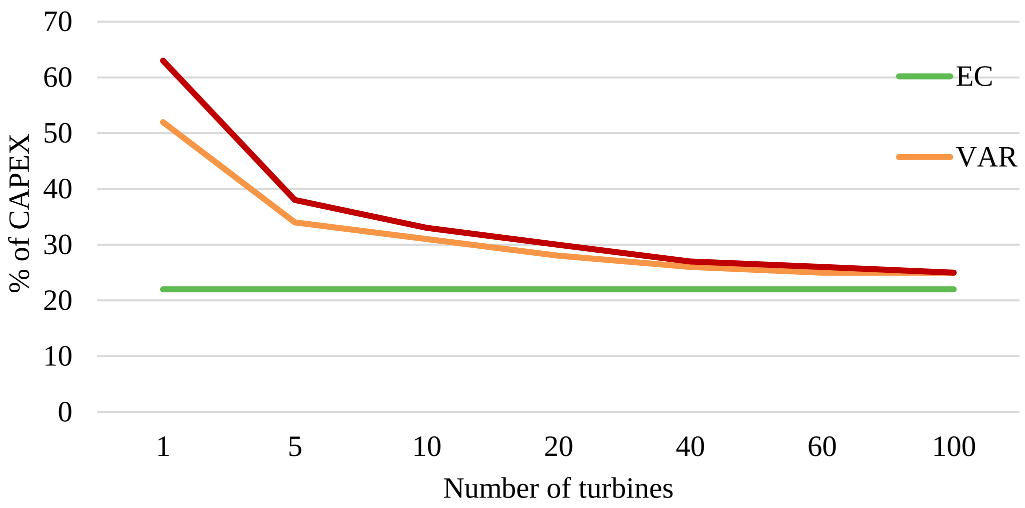
Expected losses in 5% worst cases for different sizes of farms

Farm Size	1	5	10	20	40	60	100
Expected Cost	700	3,400	6,800	13,700	27,400	41,000	68,500
VaR per CAPEX	**51%**	**33%**	**30%**	**27%**	**25%**	**24%**	**24%**
CVaR per CAPEX	**62%**	**37%**	**32%**	**29%**	**26%**	**25%**	**24%**

Estimated Cost (EC), 5% VaR and 5% CVaR, for sizes of farms



Results

- A surprisingly large reduction in worst case situation can be obtained with only 5 turbines
- Communities should avoid owning small numbers of turbines
- Failure rates constantly evolve
- Blades can last a very long time
- The method is applicable outside wind farms

Initial results from Community Investor Sentiment Survey

Wave and Wind Energy Day – Donegal, Ireland (with X-Rotor and SafeWave)

Risk aversion scores were stronger than risk loving scores, there was no significant difference between men and women. Report on windvalue.ie. Survey of Chinese people has been done, Tanzania after Christmas.

	Female	Male
N	6	10
Risk Aversion		
Mean	7.5	7.5
Standard Deviation	2.17	2.17
Risk Loving		
Mean	3.8	4.2
Standard Deviation	3.06	1.87

Table 2: Risk Aversion and Risk Loving Scores by Gender - Note that there was no statistically significant difference.

Industry Meets Academia Summer Seminar (with H-Wind)

Two Topics

– The use of hydrogen as a fuel (Benoit Mayol)

– The use of compliance bonds to finance sustainable end-of-life processing (Kevin Campbell)

- See windvalue.ie

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End-of-life Wind Turbine Blades and a Path to a Circular Economy

Authors: Deeney, Leahy, Campbell, Ducourtieux, Mullally and Dunphy

Submitted to Renewable & Sustainable Energy Reviews (see SSRN soon)

Barriers to best practice:

- No commensurate financial pay off for long lasting blades
- Lack of information on blade design
- All current methods (except co-processing) are loss making

Solutions:

- Pay per use payment structure
- Information exchange as a platform business
- Widespread use of Compliance Bonds

Compliance Bonds pay out when sustainable processing happens

Largely based on the work of Kevin Campbell, intern

- Added to the price of blades at manufacture
- Attached to the individual blade
- Invested at ECB bond rate or better
- Sufficient to bridge the gap now
- Could be quite profitable in the future
- Needs strong regulation
- May have graded payoff depending on the repurposing/recycling/recovery

Pay Per Use

- Good blades are more profitable for OEM
- Blade cost is connected directly to blade productivity
- Reduces initial capital and eases community ownership

Information Exchange - a platform business opportunity

- Connecting blade owners and blade buyers
- Plans of blades, perhaps using Blade Machine, to measure the shape and size of the blades
- Provenance of recycled goods

Work Packages

1 Project Management, Communications and Dissemination, Data Management

2 Wind Energy Generation

3 Operations and Maintenance

4 Electricity Price

5 Wind Farm Valuation

6 Commercial Decision Support Tool

7 Community Decision Support Tool

8 PhD Thesis

Next Steps in Wind Value

Wind Farm Valuation Model including random wind speeds, random failures

Valuations for Decommissioning, Repowering and Life Extension

Risk modelling

Community Investor Appetite for Risk

Publications on Decision Support Tools

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Questions Welcome

https://windvalue.ie/

peter.deeney@ucc.ie PI and Supervisor

paul.leahy@ucc.ie Co-PI, Mentor and Supervisor

j.obrien@ucc.ie Co Supervisor

dorcas.mikindani@umail.ucc.ie PhD Student

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