IEA Wind TCP Task 43 Kickoff: Wind Energy Digitalization

Jason Fields, National Renewable Energy Laboratory

IEA Wind TCP Task 43 kick-off, Boulder, CO USA

Nov 5, 2019

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Acknowledgements

- Berthold Hahn, Co-operating agent

- Organizing Committee:

Mike Purdue, Des Farren, Vijayant Kumar, Alex Clerc, Alex Koltisdopolous, Nikolay Dimitrov, Jan Helsen, Lindy Williams, Shawn Sheng

- Technical Contributors:

Joseph Lee, Steve Clark, John Meissner, Andrew Bray, Heather Doane

Agenda

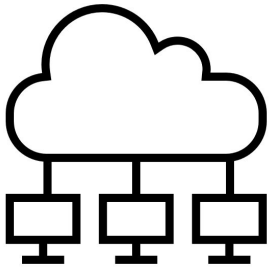
What is Digitalization? Why do we care?

IEA and Task 43 Background

Approach & supporting agenda

Digital Technology: what is it? why now?

compute



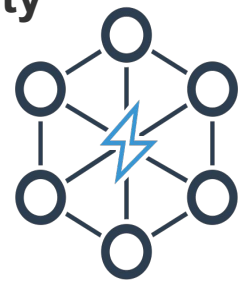
Large and small

Distributed

Cloud

Edge

connectivity



Internet

Mobile

5G

sensors & data

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Proliferation of data

Decreasing cost of sensors

IoT

software

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AI/Machine learning

Blockchain

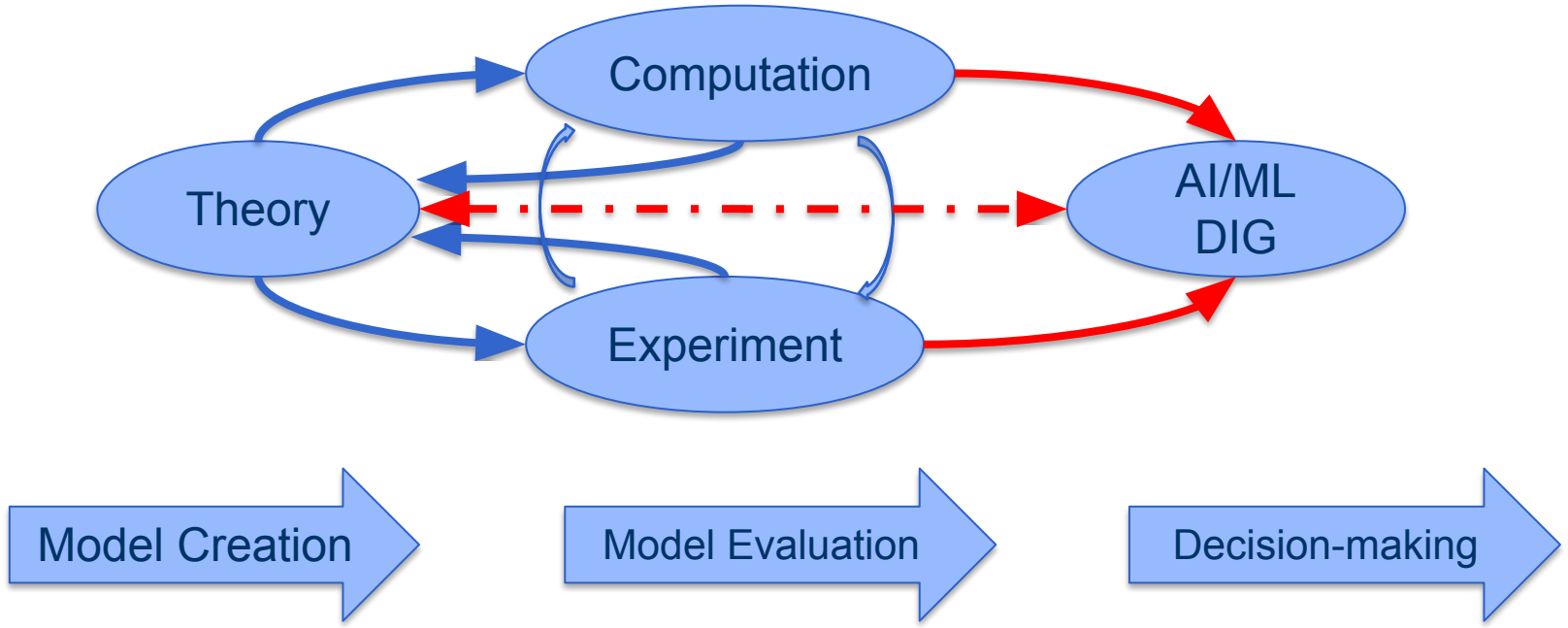
Big data

Open Source

Source: DNV-GL

Artificial Intelligence

AI/ML/Digitalization are emerging as a 4th pillar of scientific inquiry



Credit: Dave Womble, Argonne

Artificial Intelligence

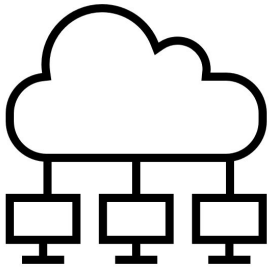
AI is disruptive.

It won't replace the scientist, but scientists who use AI will replace those who don't.

-- Microsoft Report: The Future Computed, 2018

Digital Technology: what is it? why now?

compute



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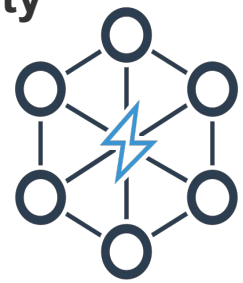

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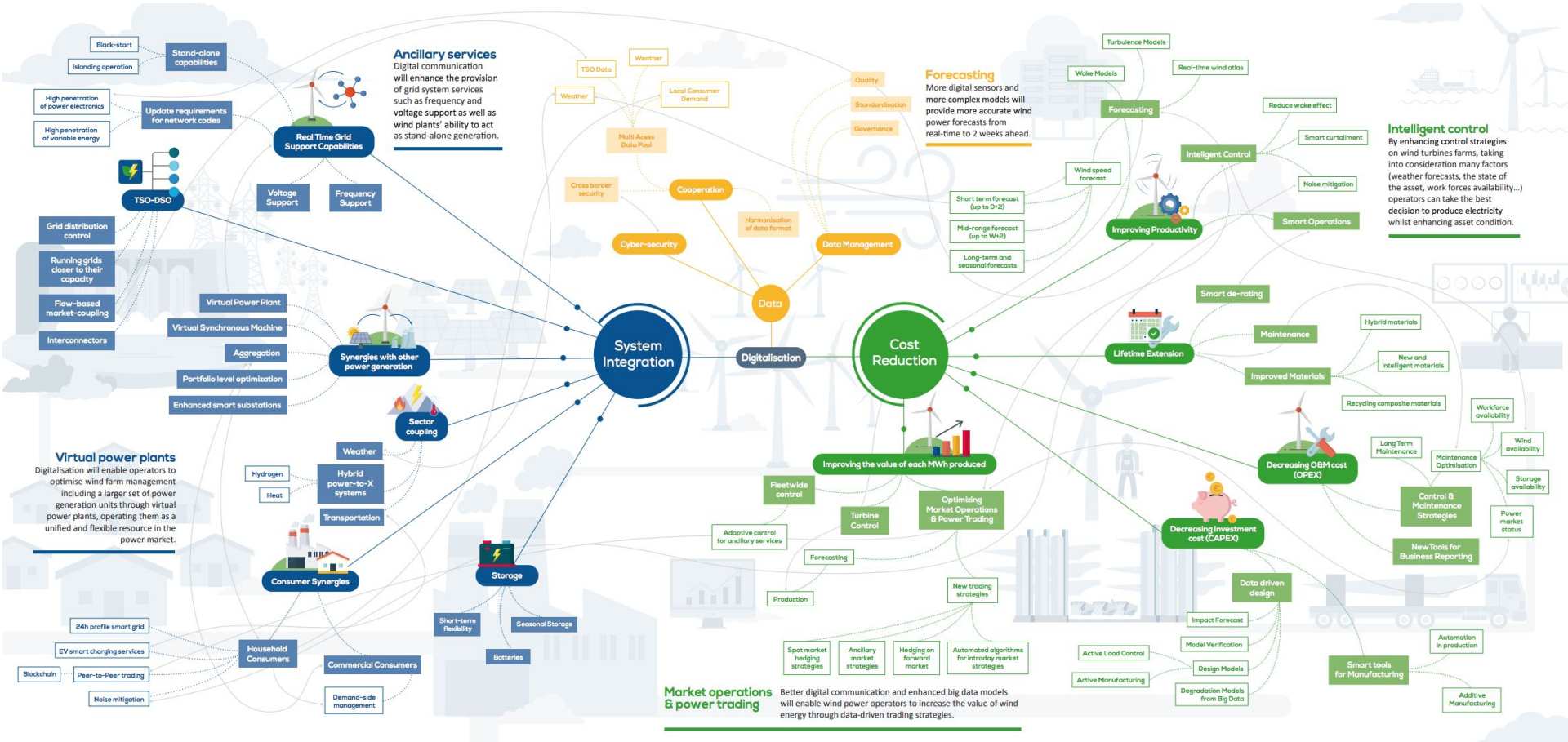
Wind Energy Digitalization: wild eyed possibilities



https://etipwind.eu/wp-content/uploads/When-Wind-Goes-Digital.pdf

Wind Energy Digitalization: why do I care?

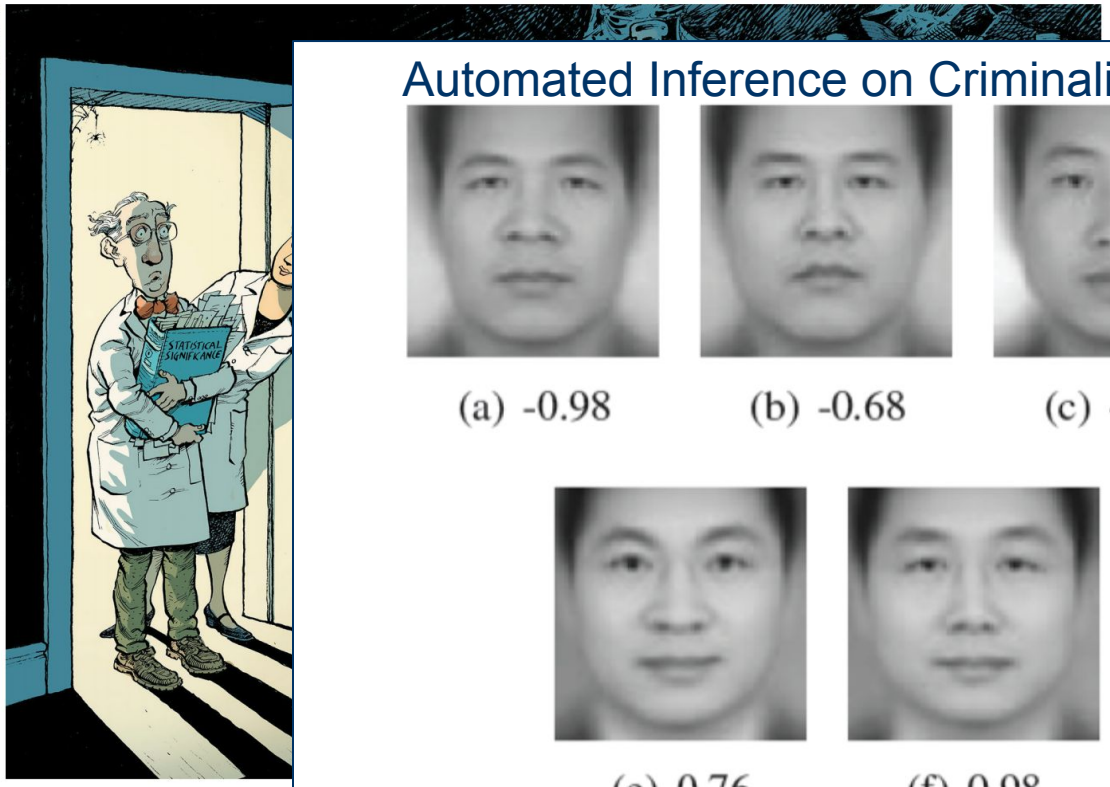
DeepMind AI Reduces Google Data Centre Cooling Bill by 40%

Under Armour: grew revenue $80 million for fitness connected devices with AI fitness app

35% of Amazon.com's revenue is generated by its recommendation engine.

1. https://deepmind.com/blog/deepmind-ai-reduces-google-data-centre-cooling-bill-40/
2. https://www.mckinsey.com/industries/retail/our-insights/how-retailers-can-keep-up-with-consumers
3. https://emerj.com/ai-sector-overviews/5-business-intelligence-analytics-case-studies-across-industry/

Wind Energy Digitalization: be skeptical!



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Valentin Amrhein, Sander Greenland, Blake McShane and more than 800 signatories call for an end to hyped claims and the dismissal of possibly crucial effects.

Journal of

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Share
55:03

Automated Inference on Criminality using Face Images

Figure 5. Purported subtypes of criminal (top) and non-criminal (bottom) faces. From Wu and Zhang (2016).

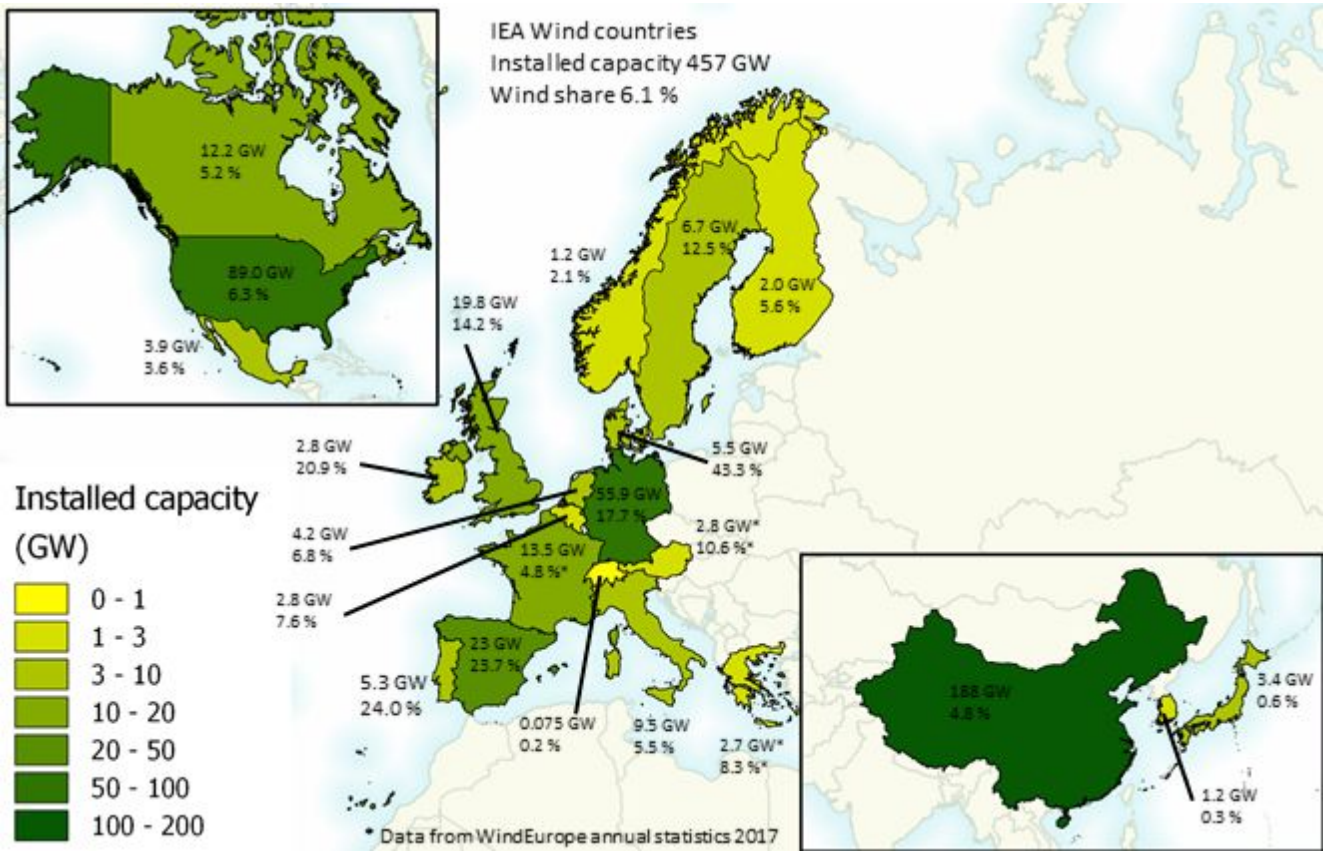
International Energy Agency

*Founded:*1974

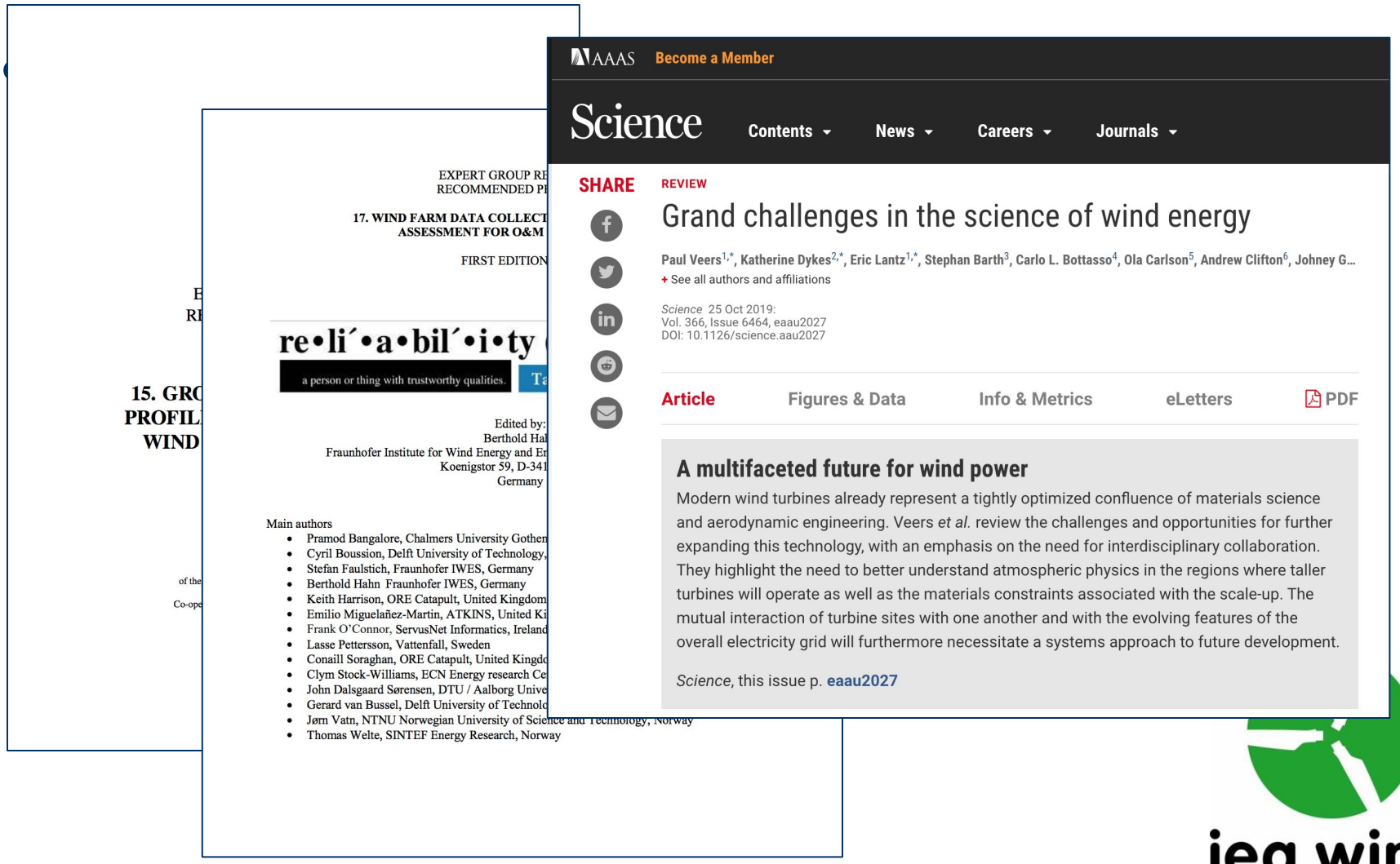
Mission: Facilitate energy security and energy policy co-operation

IEA Wind:

21 countries represent 85% of global installed capacity



IEA Wind Accomplishments



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REVIEW

Grand challenges in the science of wind energy

Paul Veers[1,*], Katherine Dykes[2,*], Eric Lantz[1,*], Stephan Barth[3], Carlo L. Bottasso[4], Ola Carlson[5], Andrew Clifton[6], Johney G...

+ See all authors and affiliations

Science 25 Oct 2019:
Vol. 366, Issue 6464, eaau2027
DOI: 10.1126/science.aau2027

Article Figures & Data Info & Metrics eLetters PDF

A multifaceted future for wind power

Modern wind turbines already represent a tightly optimized confluence of materials science and aerodynamic engineering. Veers *et al.* review the challenges and opportunities for further expanding this technology, with an emphasis on the need for interdisciplinary collaboration. They highlight the need to better understand atmospheric physics in the regions where taller turbines will operate as well as the materials constraints associated with the scale-up. The mutual interaction of turbine sites with one another and with the evolving features of the overall electricity grid will furthermore necessitate a systems approach to future development.

Science, this issue p. eaau2027

re•li´•a•bil´•i•ty

a person or thing with trustworthy qualities.

17. WIND FARM DATA COLLECT
ASSESSMENT FOR O&M

FIRST EDITION

Main authors

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- Lasse Pettersson, Vattenfall, Sweden
- Conaill Soraghan, ORE Catapult, United Kingdo
- Clym Stock-Williams, ECN Energy research Ce
- John Dalsgaard Sørensen, DTU / Aalborg Unive
- Gerard van Bussel, Delft University of Technolo
- Jørn Vatn, NTNU Norwegian University of Science and Technology, Norway
- Thomas Welte, SINTEF Energy Research, Norway

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IEA TEM 92: Wind Energy Digitalization

By the numbers

- 50 participants from 36 companies and 12 countries
  - *One of the largest wind TEMs to date*
- 2 days, 15 presentations, breakout sessions

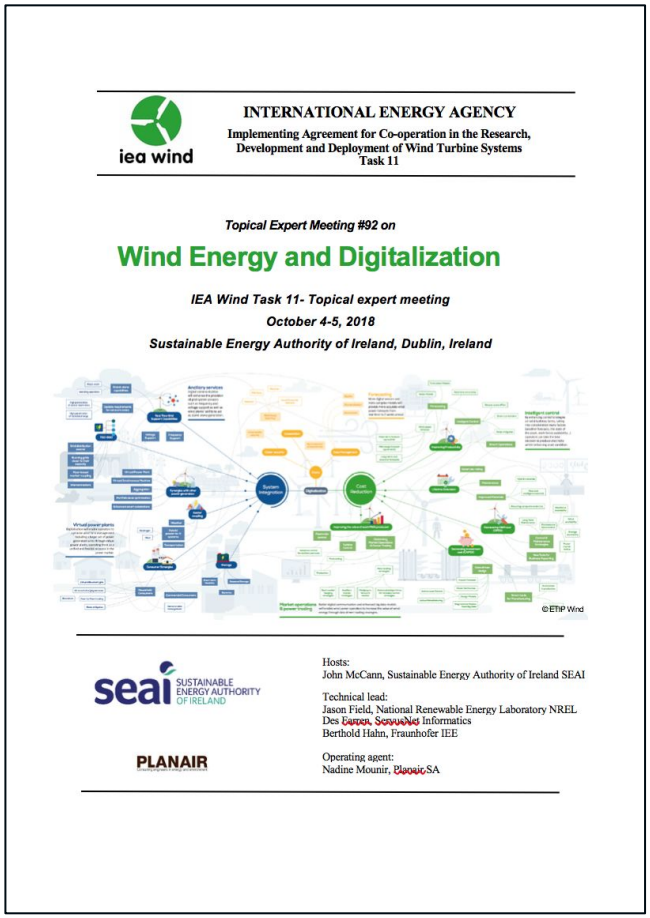
IEA TEM 92: Key Points

- Definition of **wind digitalization broad and ill defined**
- Value proposition seems large/disruptive but unquantified
- Advanced technology like **machine learning and big data held back** by lack of standardized datasets
- **Standards critically important** but under adopted and ill defined patchwork
- **60-80%** of current data analysis effort is data wrangling
- **Open Source tools** drive community engagement, data sharing and data standards

IEA TEM 92:
Proceedings and Presentations

- IEA TEM 92 Proceedings
http://bit.ly/IEA_TEM_92_proceedings

- IEA TEM 92 Presentations
http://bit.ly/IEA_TEM_92_presentations



iea wind

INTERNATIONAL ENERGY AGENCY

Implementing Agreement for Co-operation in the Research, Development and Deployment of Wind Turbine Systems Task 11

Topical Expert Meeting #92 on

Wind Energy and Digitalization

IEA Wind Task 11- Topical expert meeting

October 4-5, 2018

Sustainable Energy Authority of Ireland, Dublin, Ireland

seai SUSTAINABLE ENERGY AUTHORITY OF IRELAND

PLANAIR

Hosts:
John McCann, Sustainable Energy Authority of Ireland SEAI

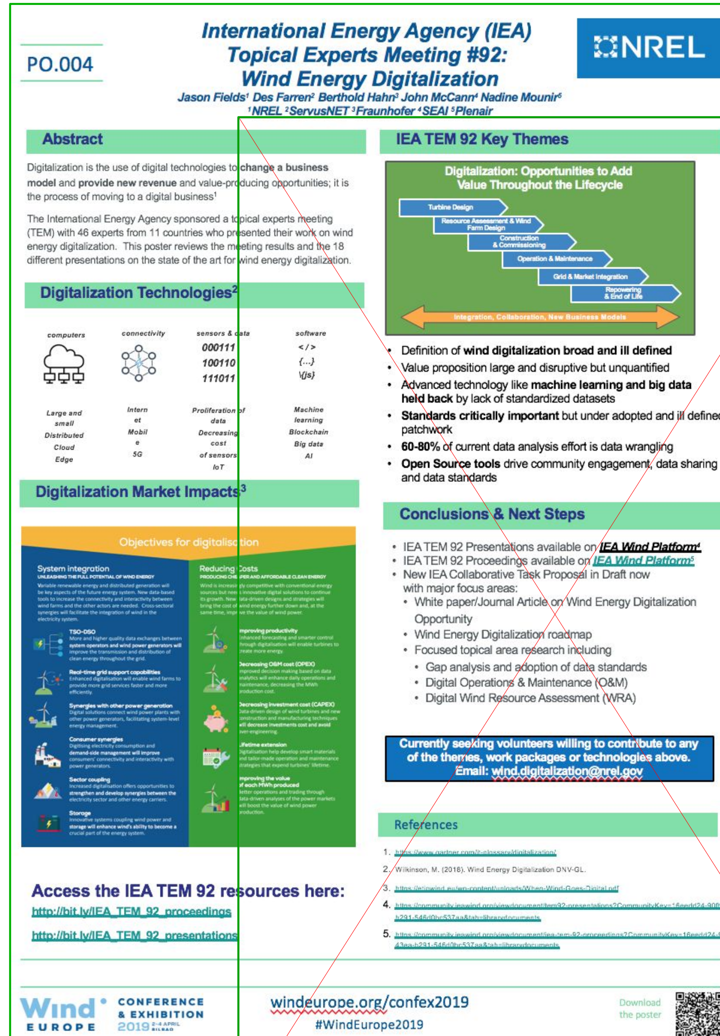
Technical lead:
Jason Field, National Renewable Energy Laboratory NREL
Des Farren, Serveline Informatics
Berthold Hahn, Fraunhofer IEE

Operating agent:
Nadine Mounir, Planair SA

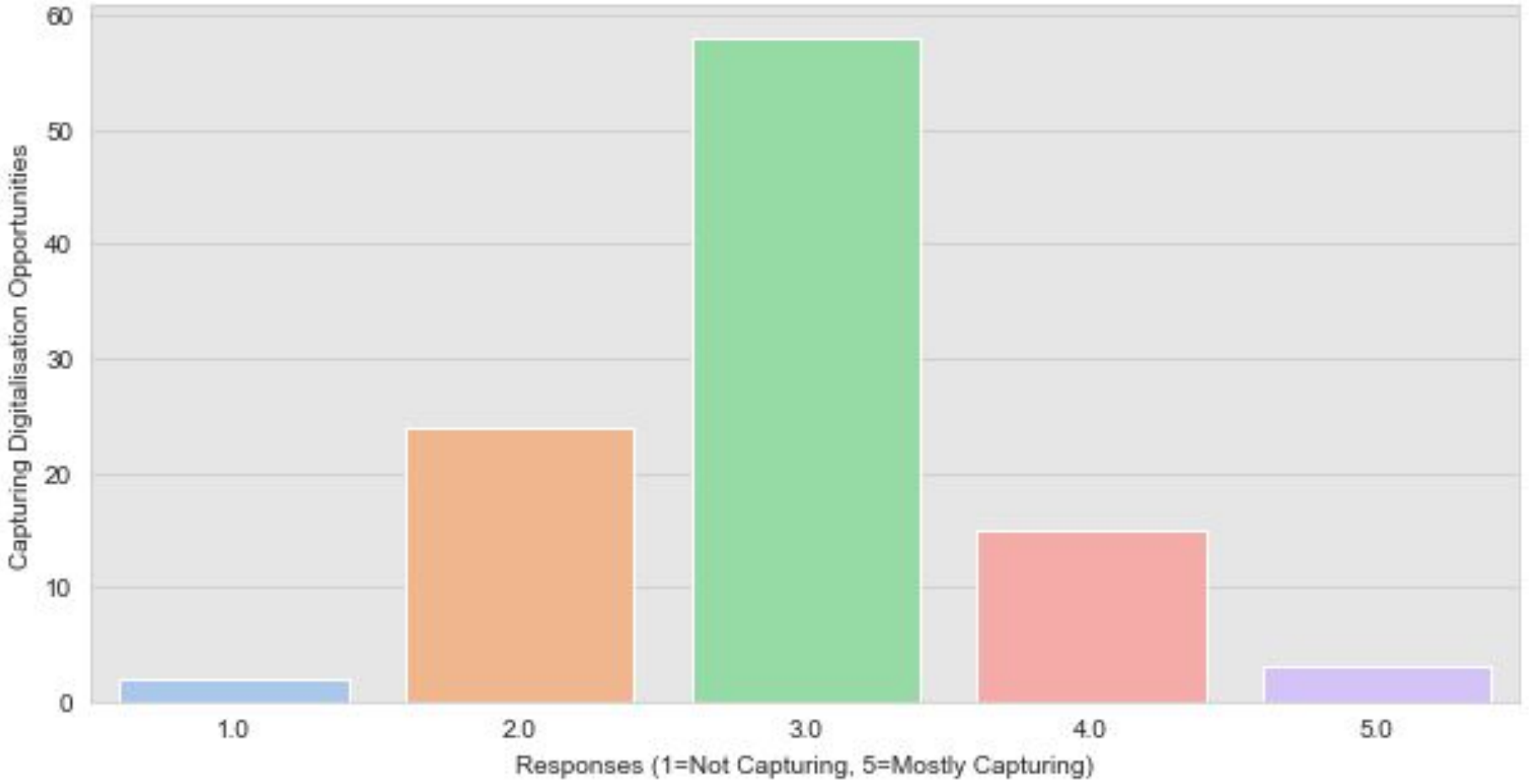
IEA Wind Energy Digitalization: Outreach and engagement

- WindEurope Poster(J. Fields)
- In person meeting:
  April 1, 2019-Bilbao
- Online survey
- AWEA WRA Poster(M. Purdue)

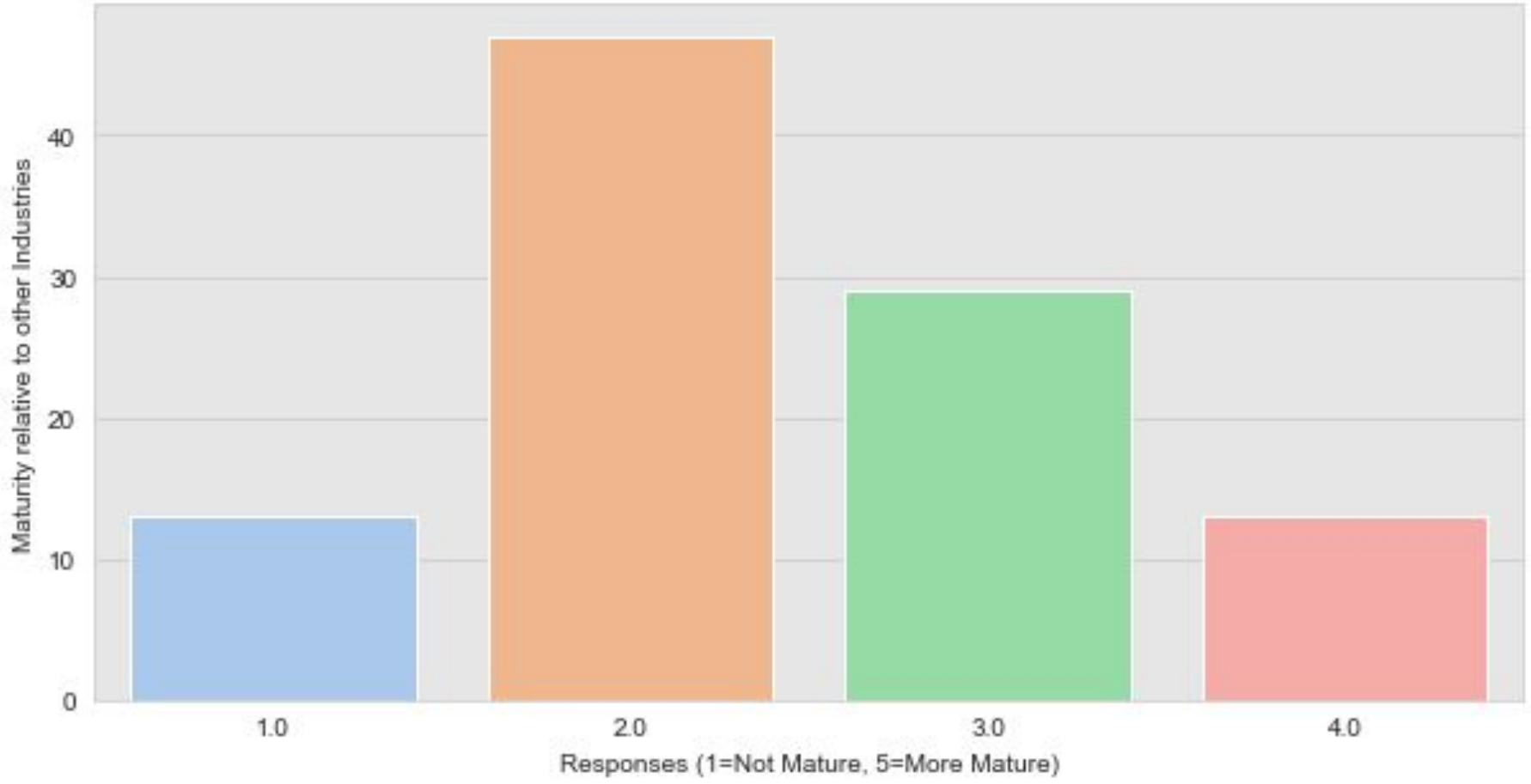
- Kickoff Meeting:
  Nov 5-7, 2019 Boulder, CO



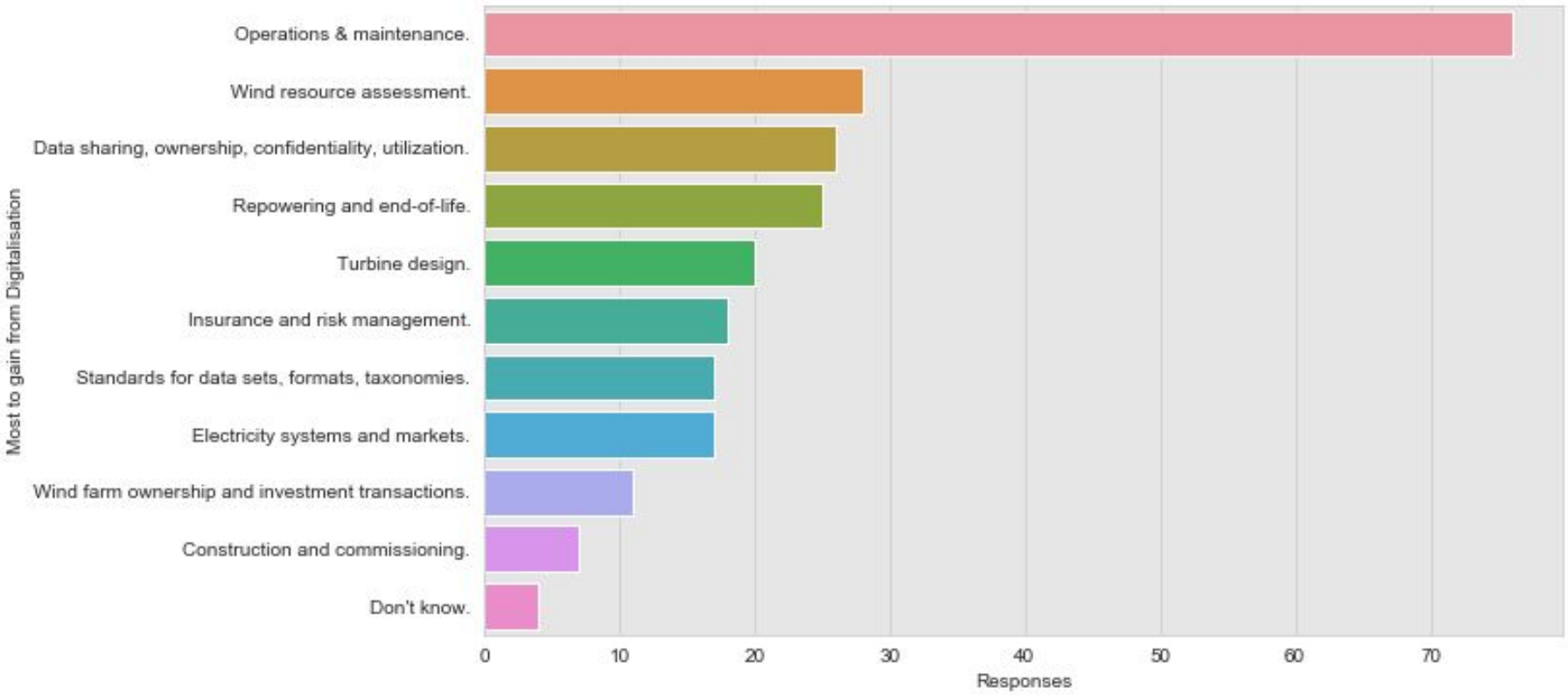
Are we capturing digitalization opportunities?



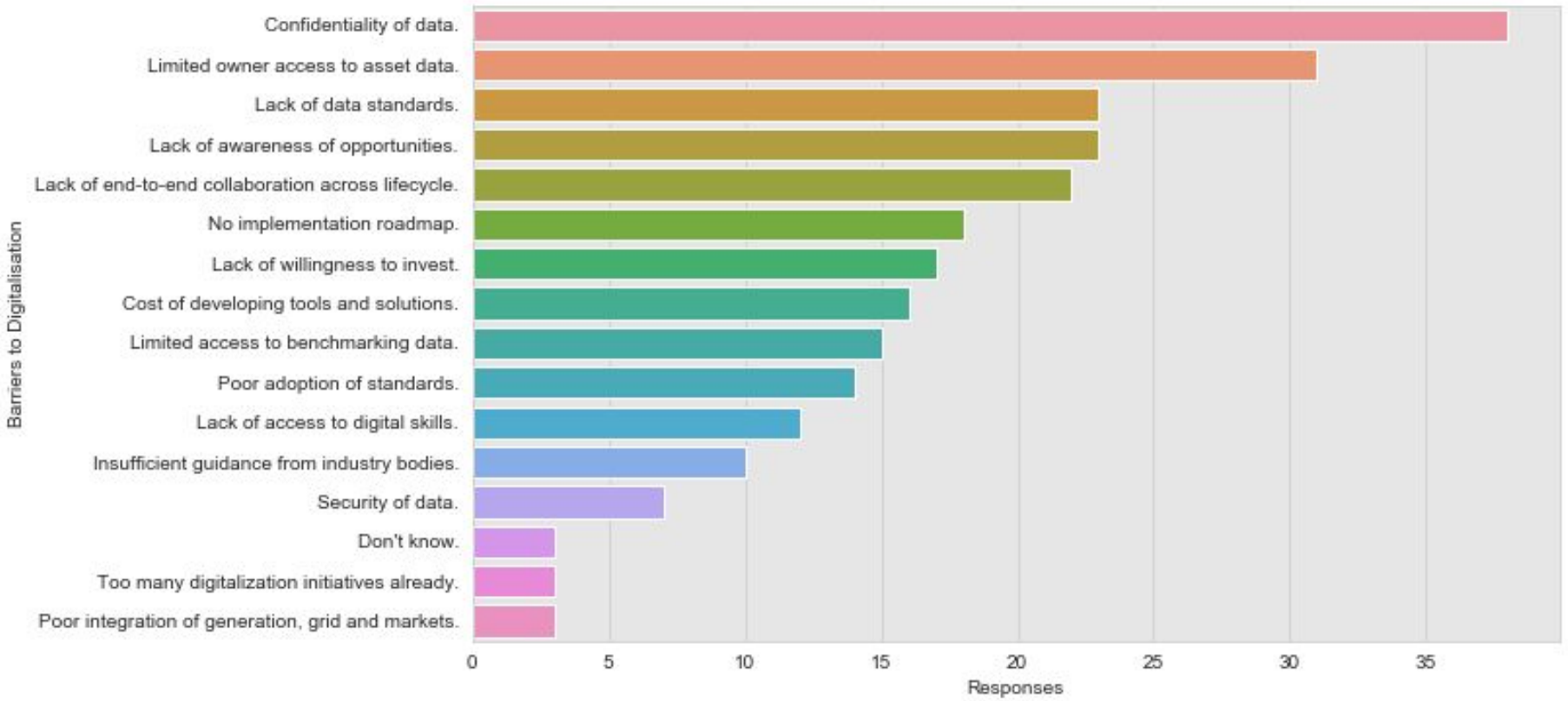
Wind industry relative maturity in digitalization



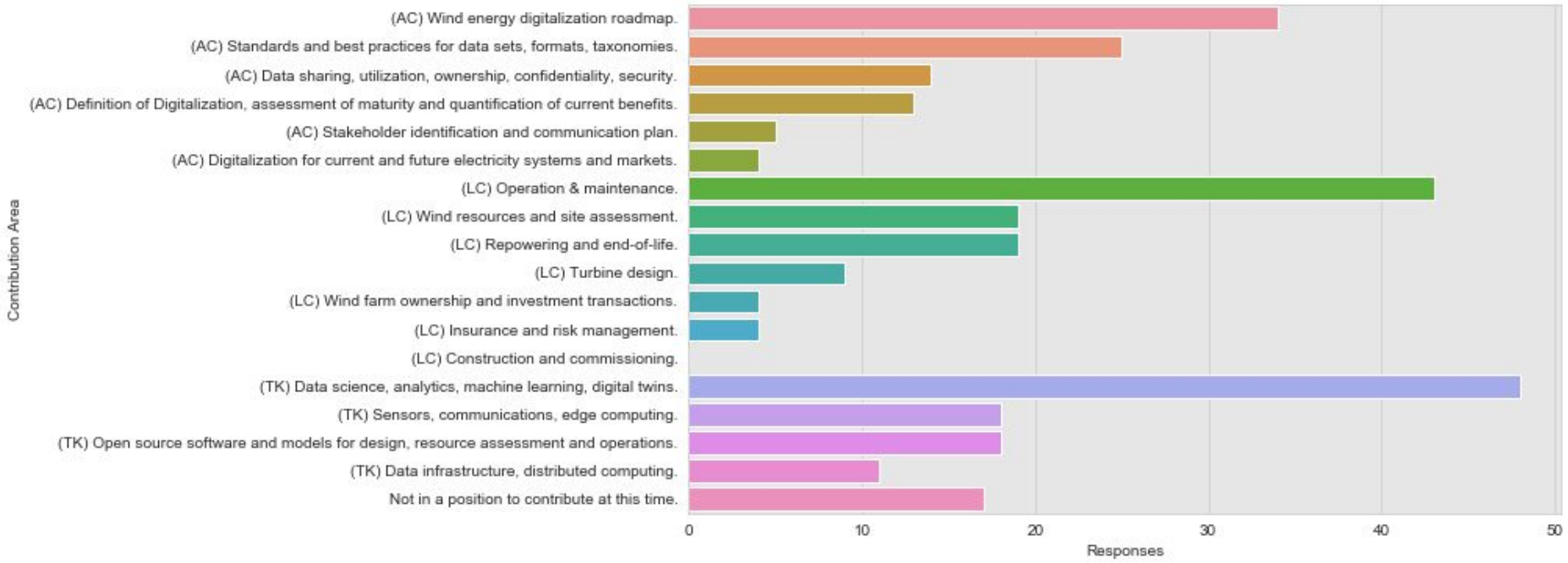
Digitalization opportunities



Barriers to Digitalization



Stakeholder Interest

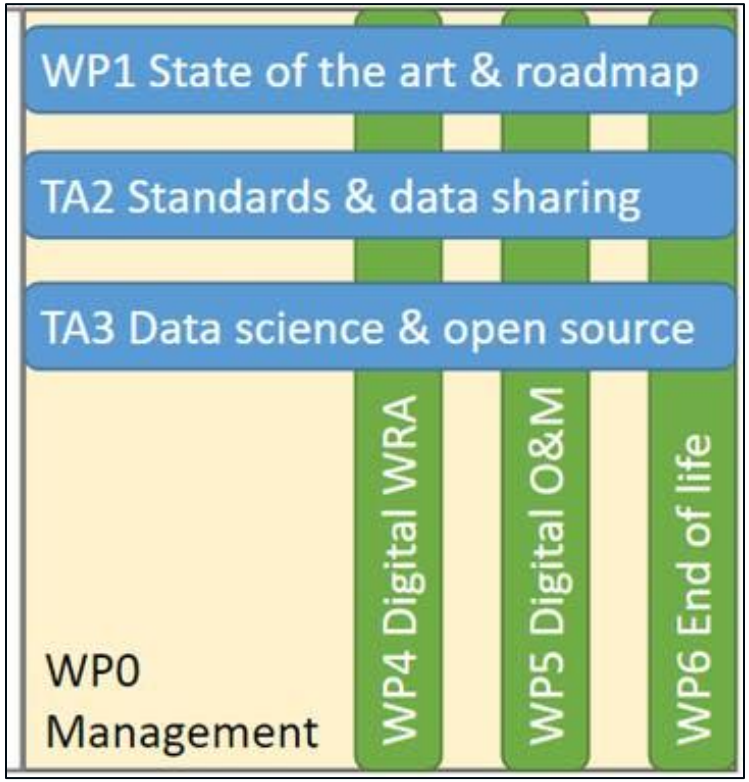


IEA 43: Work Packages

WP1-3: Cross cutting
WP4-6: Application areas

Deliverables:

- Data Standards, Best Practices, and open source tools



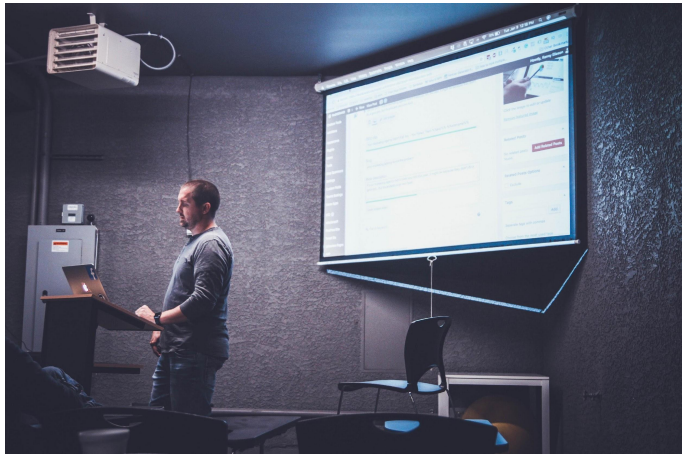
Early Participants: DNV-GL, EDF R&D, EDF Energy, NREL,NRG Systems, Fraunhofer IEE, DTU, RES, Sentient Science, GI-Engineering, OWI-lab/VUB, GE, Siemens-Gamesa

Meeting Goals & Outcomes

- Update stakeholders on current status of IEA Task 43
- Finalize Task 43 work packages
  - Scope
  - Leaders & Contributors
- Start the work & Define next steps
- Create community and collaboration on wind energy digitalization

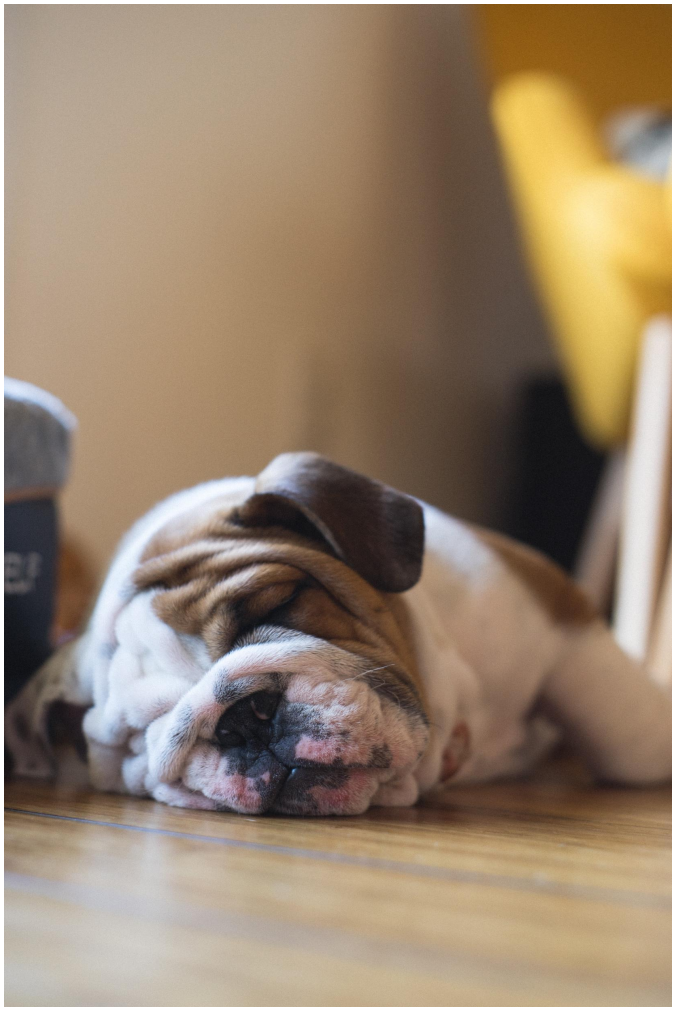
Approach

Some of this . . .



A lot of this . . .

To avoid this. . .



Agenda Day 1

Tue 5th Nov	8:15 AM	*Breakfast*	
	8:30 AM	Welcome Plenary Session *(Purpose, Goals, Agenda Overview, Introductions)*	
	9:00 AM	Task Updates *(Work Package Overview, How We Got Here, Goals- 10min per WP or TA)*	
	10:10 AM	Q&A and Clarifications	
	10:20 AM	*Break*	
	10:30 AM	Parallel Working Sessions, Organization	• WP1 State-of-the-art and Roadmap • WP4 Wind Resource Assessment • WP5 Operations and Maintenance • WP6 End of Life and Repowering
	12:00 PM	*Lunch and networking*	
	1:00 PM	Keynote: Artificial Intelligence: State of the Art *(Vijayant Kumar)*	
	1:30 PM	Parallel Working Sessions, Work to Date	• WP1 State-of-the-art and Roadmap • WP4 Wind Resource Analysis • WP5 Operations and Maintenance • WP6 End of Life and Repowering
	4:15 PM	Plenary Report Out *(Progress, Questions, Issues, Help Needed)*	
	5:00 PM	*Plenum Departs,* Organizing Committee Prepares for Day 2	
	7:00 PM	*No Host Group Dinner: Mediterranean Restaurant*	

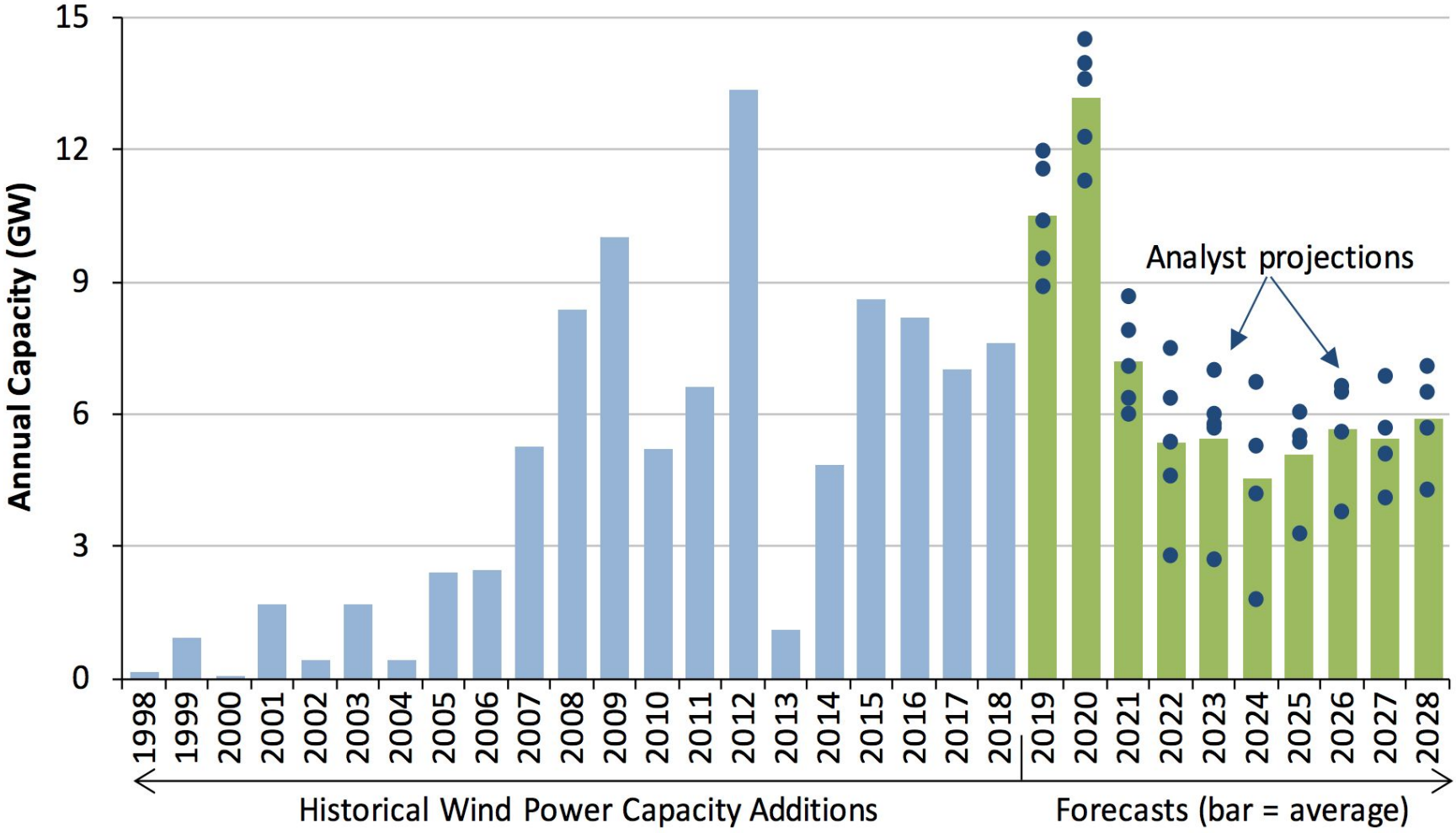
Agenda Day 2

Wed 6th Nov	8:15 AM	*Breakfast*	
	8:30 AM	Plenary Session – Address Questions and Issues from Day 1	
	9:00 AM	Keynote: Artificial Intelligence: Investing in the Future *(David Womble)*	
	9:30 AM	Parallel Working Sessions, Deliverables	• WP1 State-of-the-art and Roadmap • WP4 Wind Resource Analysis • WP5 Operations and Maintenance • WP6 End of Life and Repowering
	12:00 PM	*Lunch and networking*	
	1:00 PM	Keynote: Data Standards: Successes from other industries & how they did it *(Charles Henderson)*	
	1:30 PM	Parallel Working Sessions, Work Toward Deliverables	• WP1 State-of-the-art and Roadmap • WP4 Wind Resource Analysis • WP5 Operations and Maintenance • WP6 End of Life and Repowering
	4:15 PM	Plenary Report Out *(Progress, Questions, Issues, Help Needed)*	
	5:00 PM	*Plenum Departs,* Organizing Committee Prepares for Day 3	
	7:00 PM	*No Host Group Outing: Rayback Collective*	

Agenda Day 3

Thur 7th Nov	8:00 AM	*Breakfast*	
	8:15 AM	Plenary Session – Address Questions and Issues from Day 2	
	8:45 AM	Data standards & sharing plenary discussion (TA2)	
	9:30 AM	Data science & open source plenary discussion (TA3)	
	10:15 AM	Parallel Working Sessions; Ensure Work Continues	• WP1 State-of-the-art and Roadmap • WP4 Wind Resource Analysis • WP5 Operations and Maintenance • WP6 End of Life and Repowering
	12:45 PM	*Lunch and networking*	
	1:30 PM	Plenary Report Out *(Next Steps, Questions, Issues, Help Needed)*	
	2:45 PM	"Thank You!" and Looking Forward	
	3:00 PM	*Plenum Departs,* Organizing Committee Wrap Up	

Market predictions



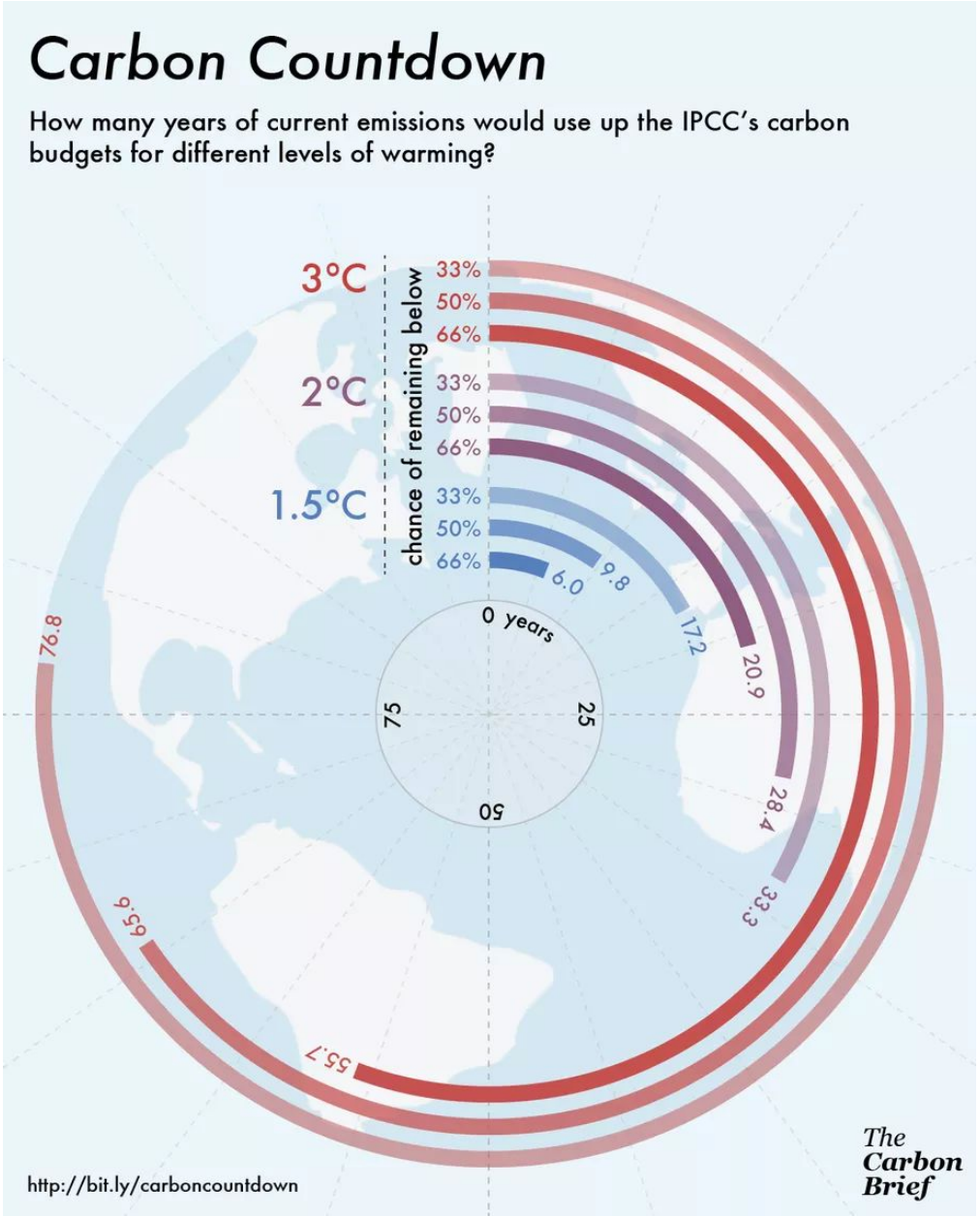
Source: LBNL Market Report

Staying Below 2 degrees

It is widely believed that we are approaching a tipping point for carbon emissions.

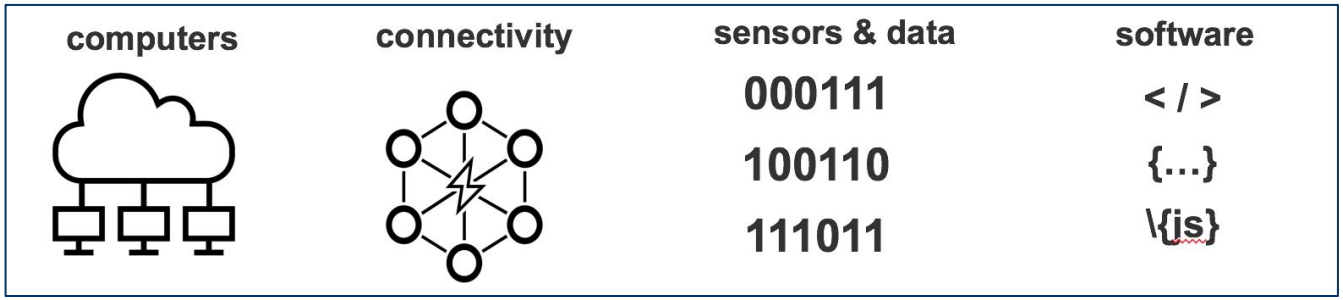
Source:
http://www.cbc.ca/radio/thecurrent/a-special-edition-of-the-current-for-november-30-2-degrees-1.3343179/paris-climate-s

Staying Below 2 degrees

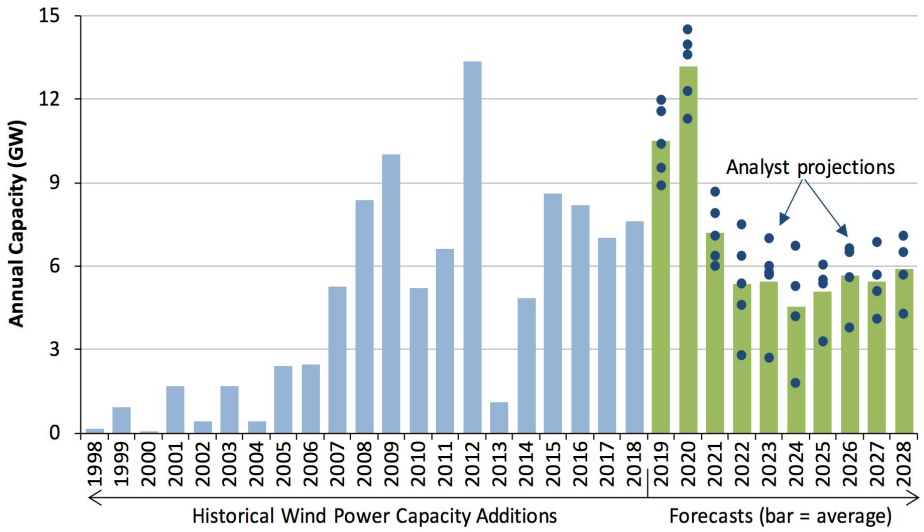


Value of Digitalization

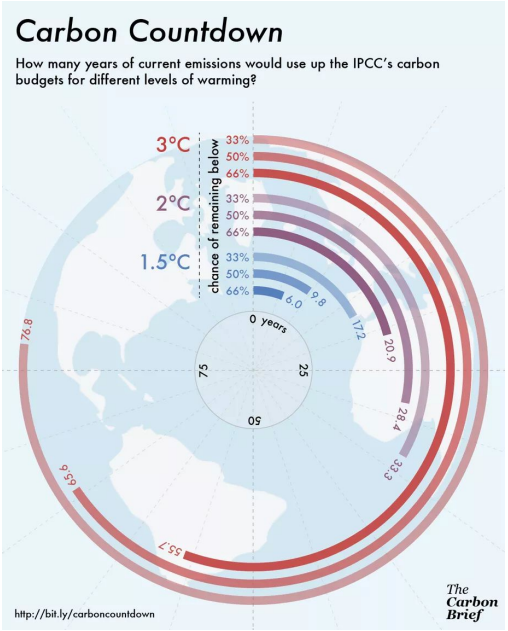
How does this?



Help this?



And this?



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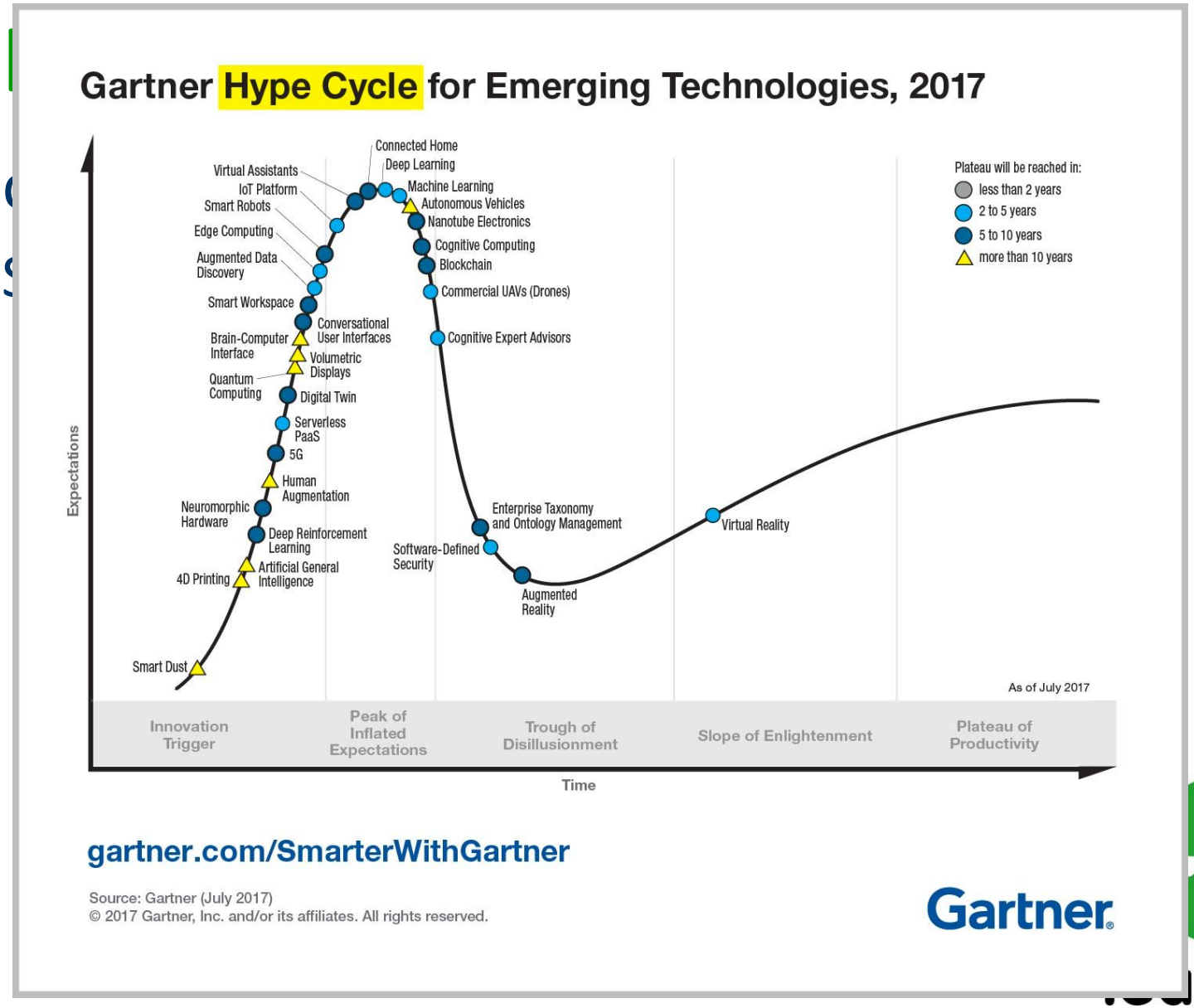

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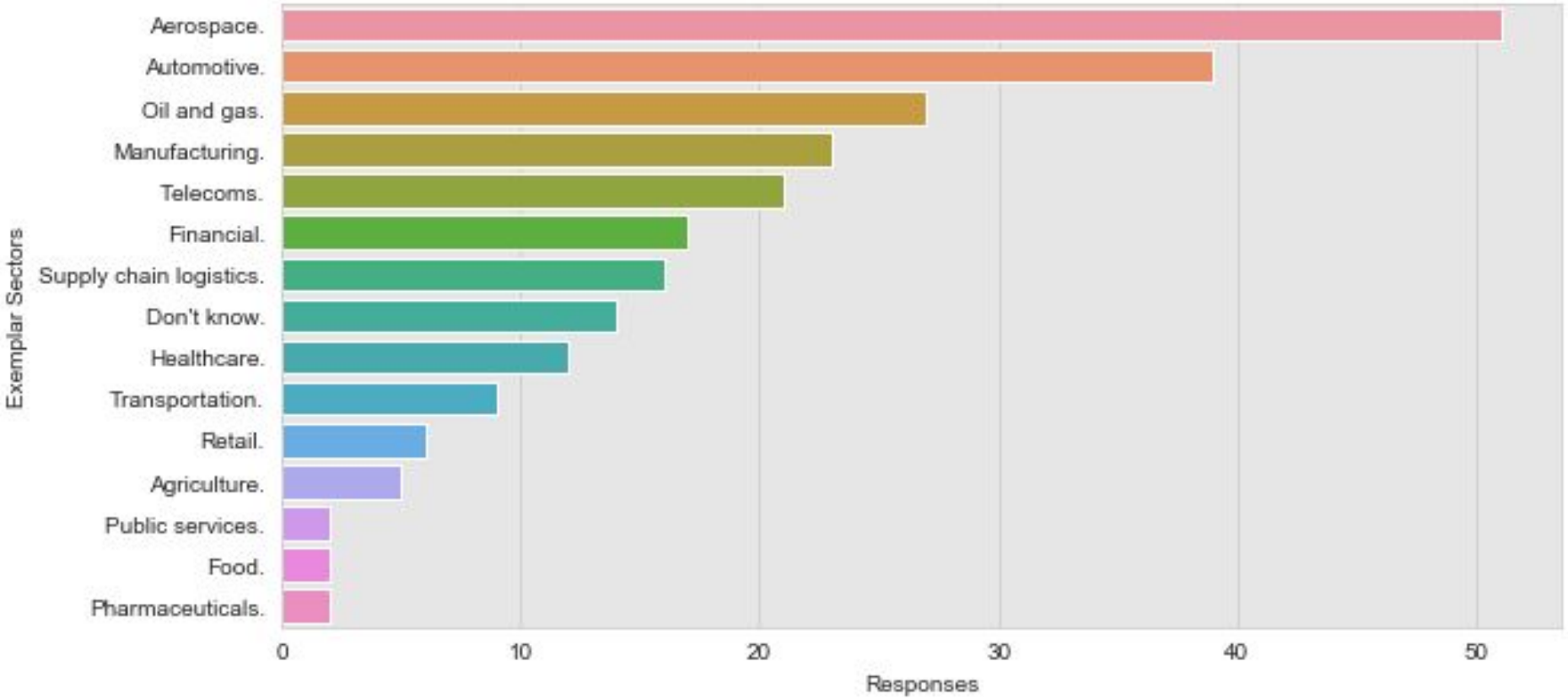
Appendix

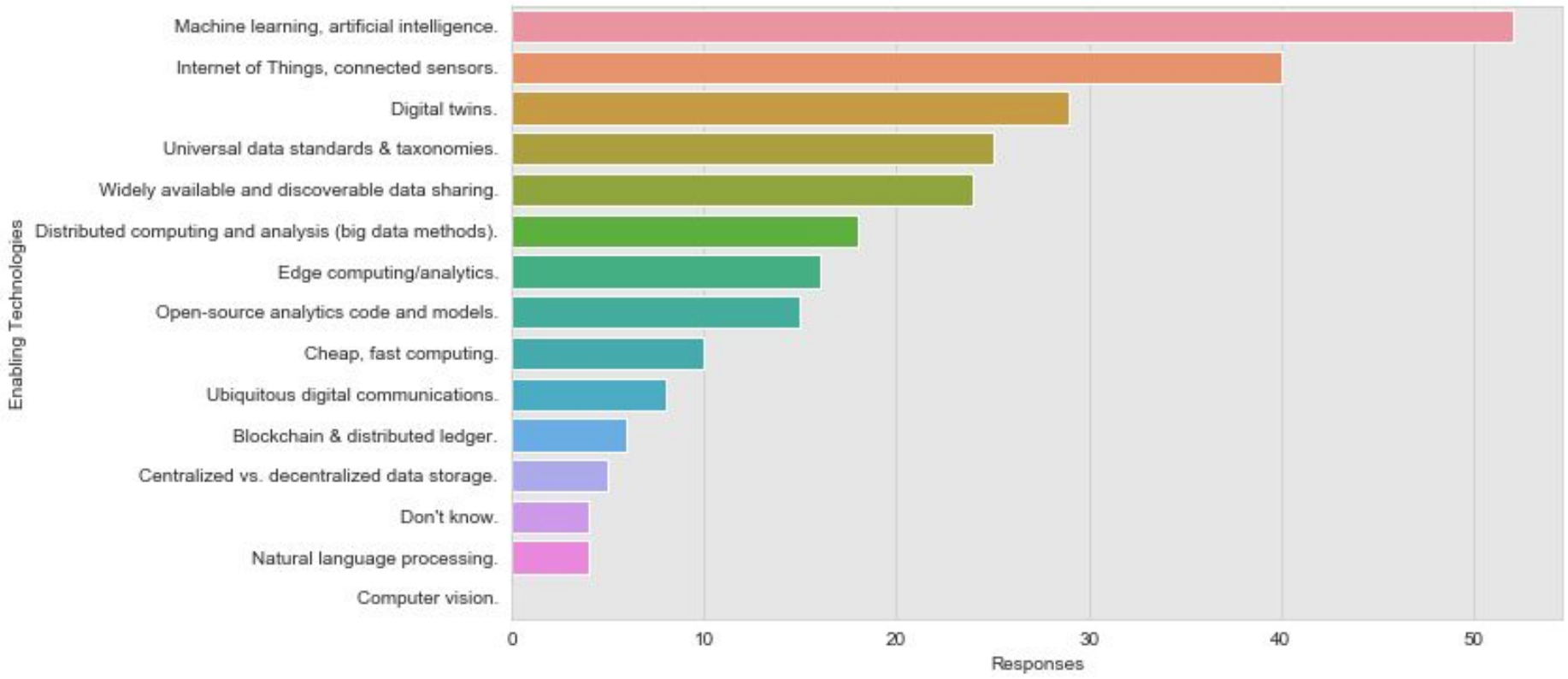
Operations

- Operating Agents:
  - Jason Fields, NREL (US)
  - Berthold Hahn, Fraunhofer (DE)
- Expected budget: ~95,000 € annually
- Annual Cost:
  - 12 countries: €8000
  - 16 countries: €6000
- Joint work packages:
  IEA Tasks, IEC TC88, ESIG, AWEA, WindEurope, RDA, AI for Science

Other Digital industries



Enabling Technologies



Definitions

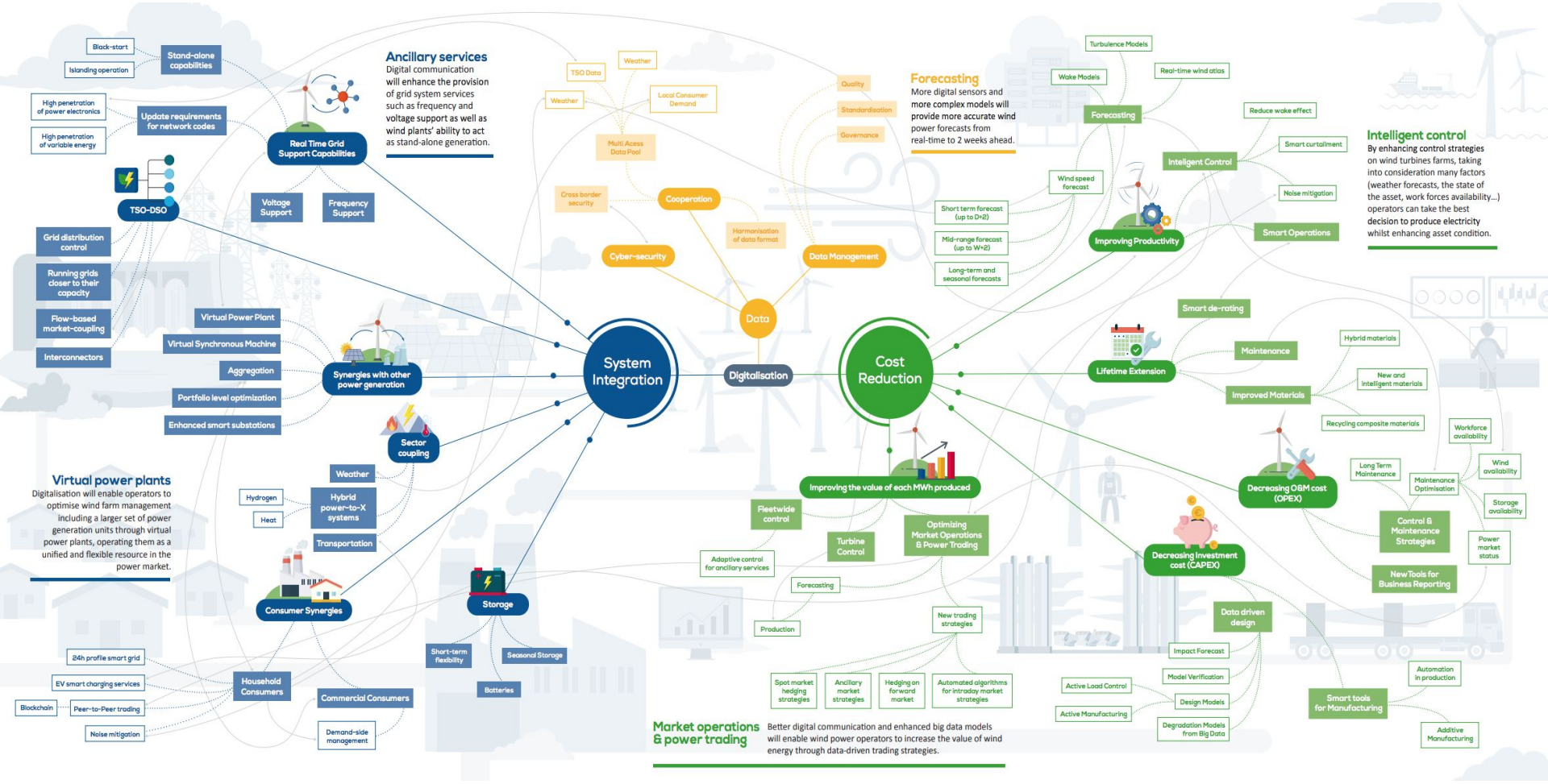
What do we mean by artificial intelligence, machine learning, and Big Data?

Artificial Intelligence (AI) *is the science and engineering of making intelligent machines… intelligence is the computational part of the ability to achieve goals* – John McCarthy

Machine Learning (ML) *is a type of AI that gives computers the ability to learn from data without being explicitly programmed* – Arthur Samuel

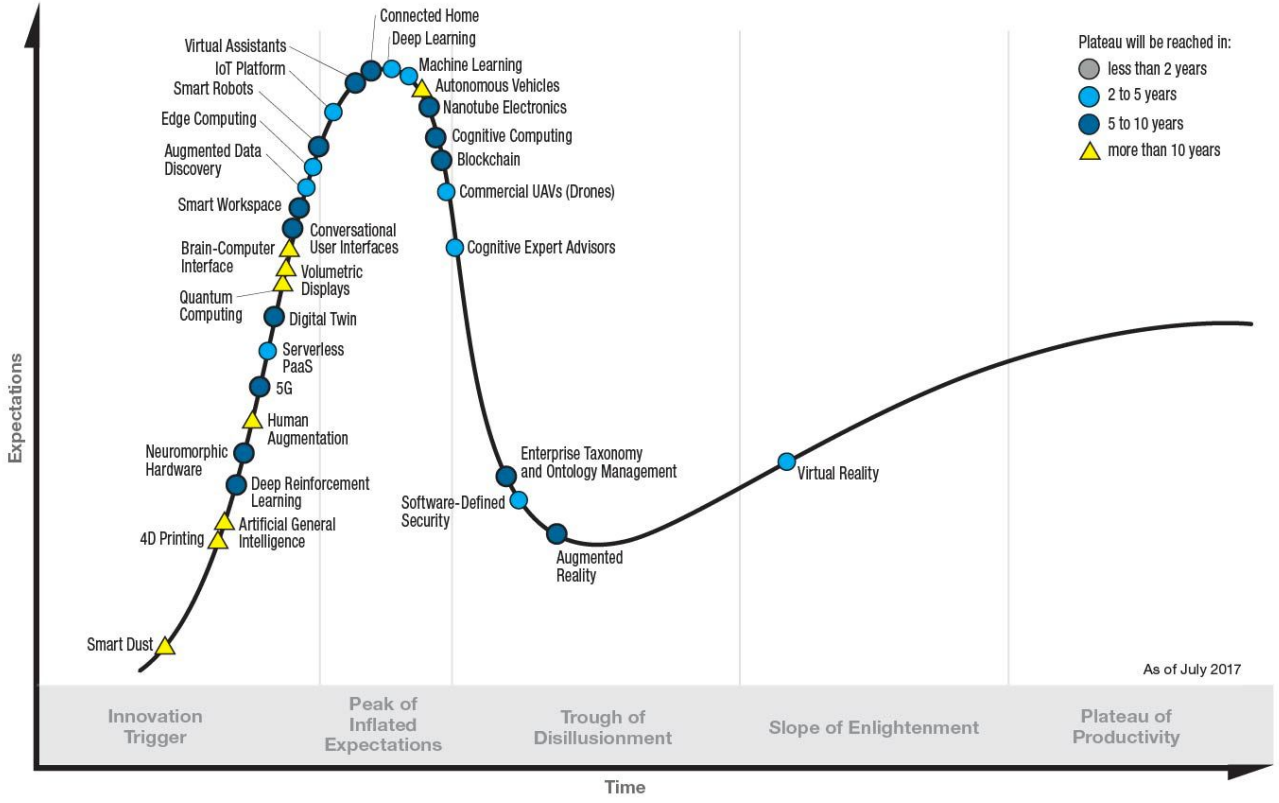
Digitalization refers to creating and curating large datasets that creates an ecosystem where AI/ML can learn predictive abilities

Wind Energy Digitalization: wild eyed possibilities



https://etipwind.eu/wp-content/uploads/When-Wind-Goes-Digital.pdf

Wind Energy Digitalization- be skeptical!



gartner.com/SmarterWithGartner

Source: Gartner (July 2017)

Gartner

Example applications of digital technology in the wind industry

Blockchain

Example applications: decentralised energy transactions, renewable energy provenance, metering and billing

AI / Machine learning

Example applications: enhanced forecasting models, new insights into large operational asset data sets

Platform Business

Example applications: data sharing between asset owners, operators, regulators and investors, automated wind resource assessment

Drones and remote sensing

Example applications: enhance safety through use of drones for wind turbine inspections, mapping using satellite data

Mobile connectivity and tablet devices

Example applications: mobile and tablet devices to standardise field-based workflow and automate data collection

Big Data and data management

Example applications: benchmarking of asset performance, application of machine learning across large numbers of diverse assets.

API and SaaS

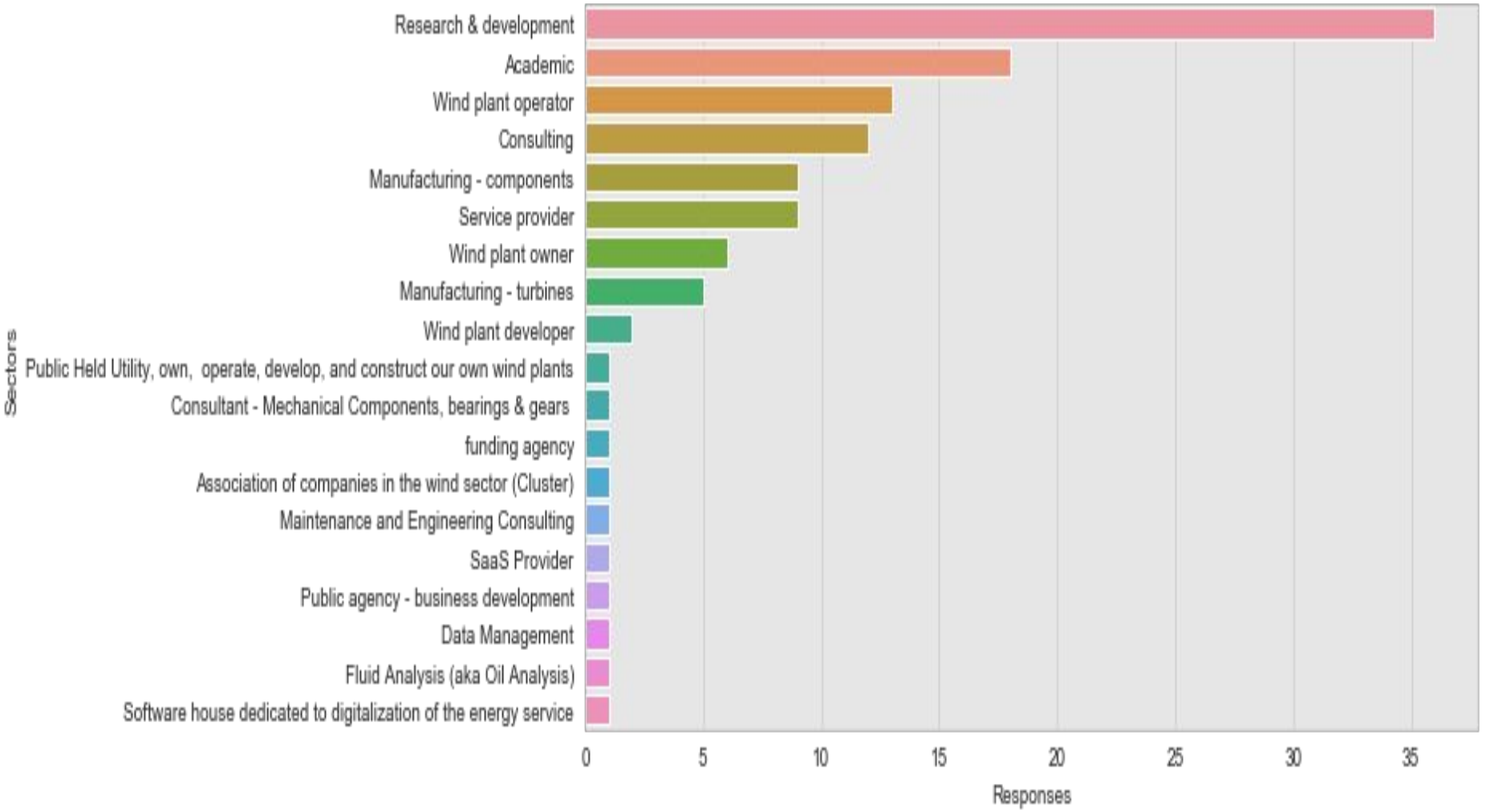
Example applications: engineering and analytical models provided and shared between stakeholders enabling enhanced cooperation between stakeholders

Digital Twins

Example applications: wind turbine digital twin for remaining life calculations, failure and reliability forecasts

Source: DNV-GL

IEA Digitalization Survey (n=120)



Thank You!!

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