Embracing High Penetrations of Offshore Wind

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A presentation to PGES on 08/09/2026

Seamus Garvey

This presentation and supporting materials are available at … www.TinyURL.com/SDG-at-PGES

Contents

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Our best future energy system will be nothing like what has come before.

1. Wind will become the main power source for GB and IE
   The variability of wind will matter a lot in future!
2. Managing variability – not a new problem!
3. *Wind Integrated Storage (WIS)* –
   what it is and why it might be very important.
4. Recommendations

Section #1 : Wind – major generator & variable.

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Wind is largest source of GB generation.

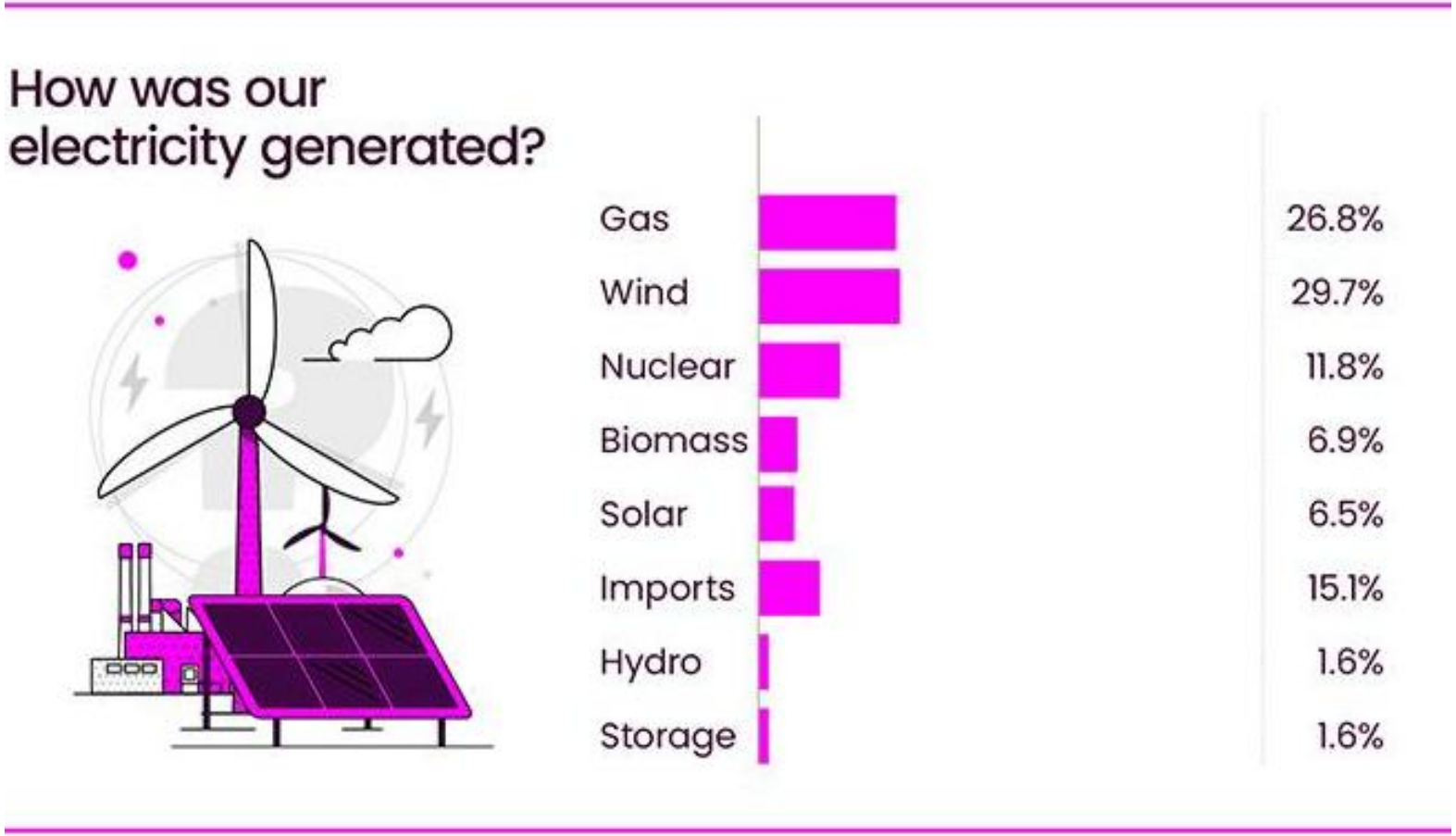
In 2025, GB generated 29.7% of its electricity from Wind in 2025 – 85.6 TWh out of 288 TWh.

This was a larger contribution than from any other generation source!

GB will have “up to 50GW” (rated) of offshore wind turbines by 2030. (Presently it has 16.6 GW)

By 2050, between 100GW & 150GW

https://www.neso.energy/news/britains-energy-explained-2025-review



Section #1 : Wind – major generator & variable.

Wind will shortly dominate generation in IE.

In 2025, IE generated 33% of its electricity from Wind in 2025
- 13.6 TWh out of 41.2 TWh consumed.

IE generated 40% of electricity from gas.

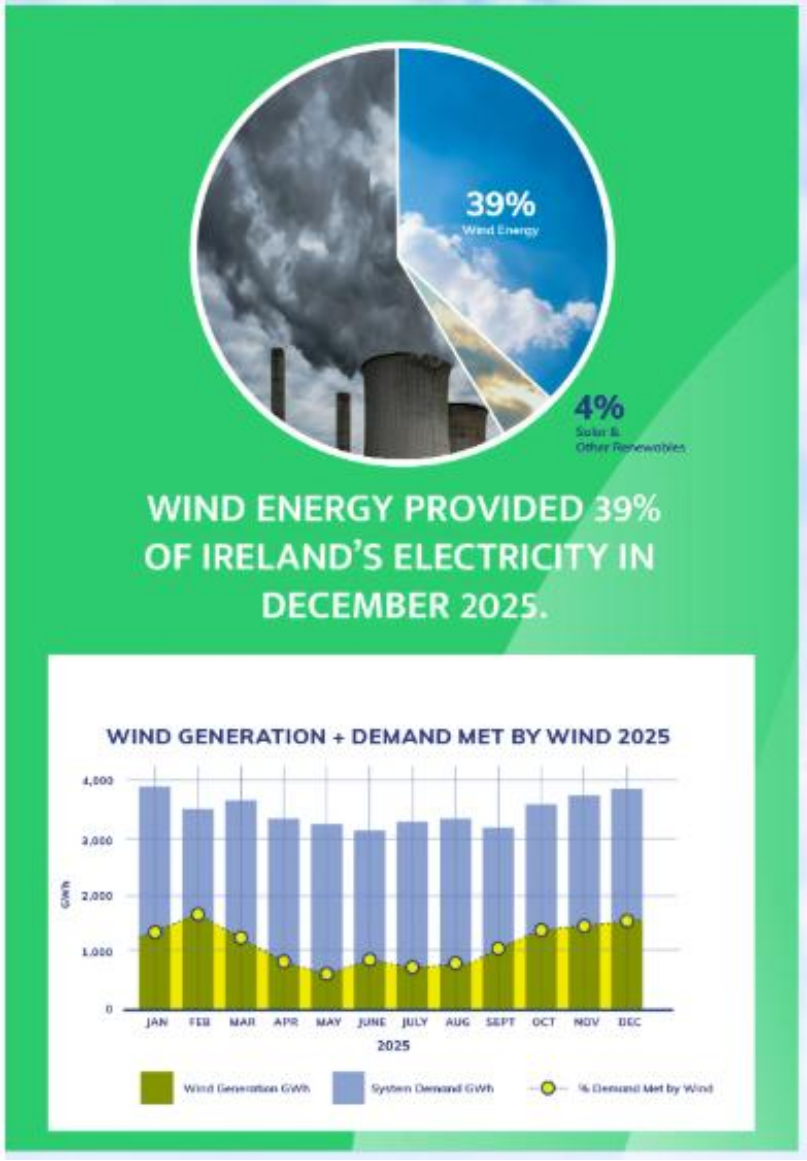
Ireland electricity demand is increasing rapidly (~5%) year-on-year.

Ireland targets:

* 80% of electricity from renewables by 2030
* 9GW of onshore wind by 2030 (currently 5GW)
* 5GW of offshore wind by 2030 (currently 25MW).

https://eibgroup.co.uk/news/irelands-wind-energy-sector-opportunities-and-challenges/

https://windenergyireland.com/blog/irish-wind-farms-provided-a-third-of-our-power-in-2025



Section #1 : Wind – major generator & variable.

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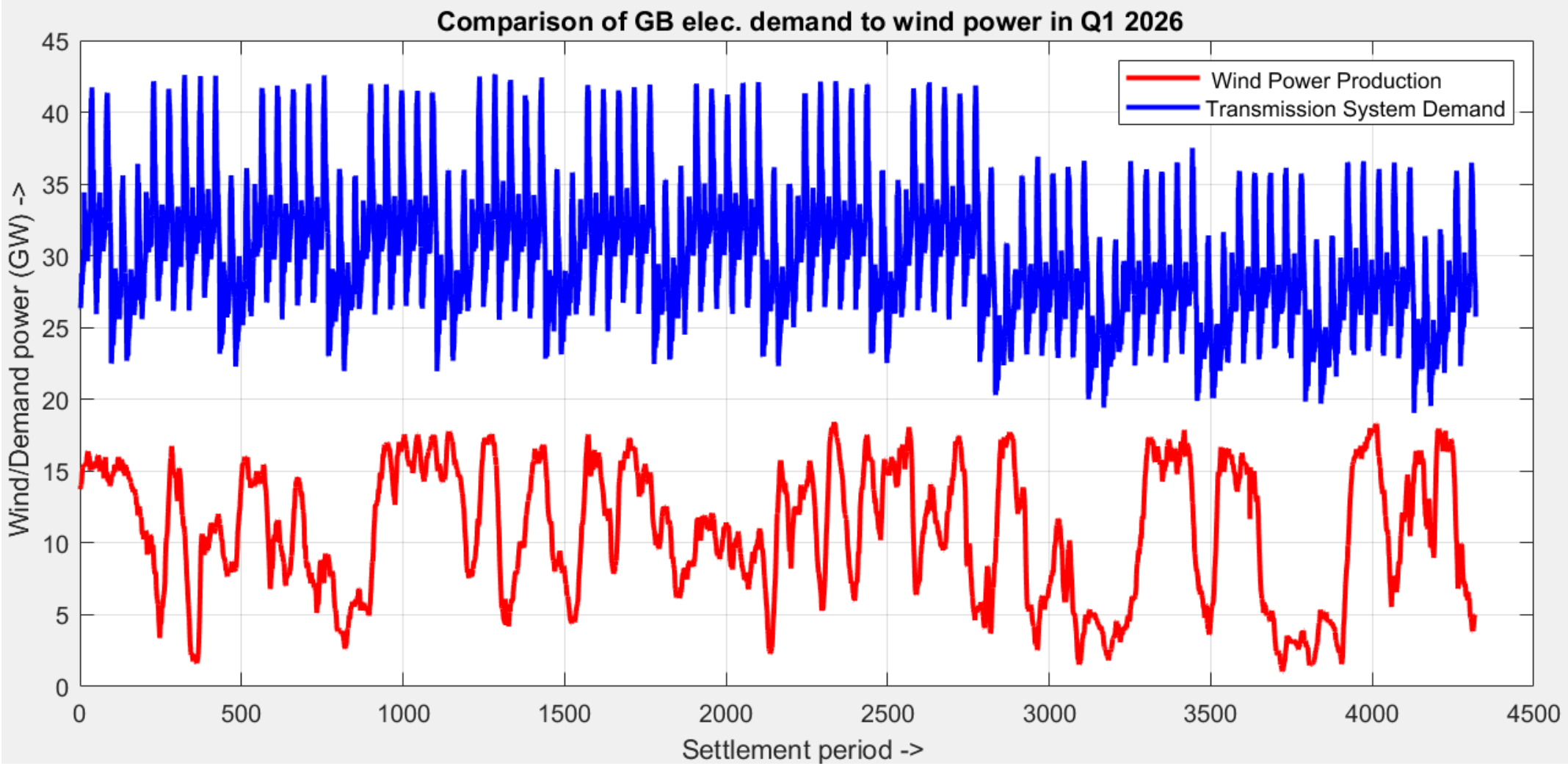
Wind Power is Rather Variable



Wind power in GB has never yet exceeded demand. That is not how it will be in future!

Section #1 : Wind – major generator & variable.

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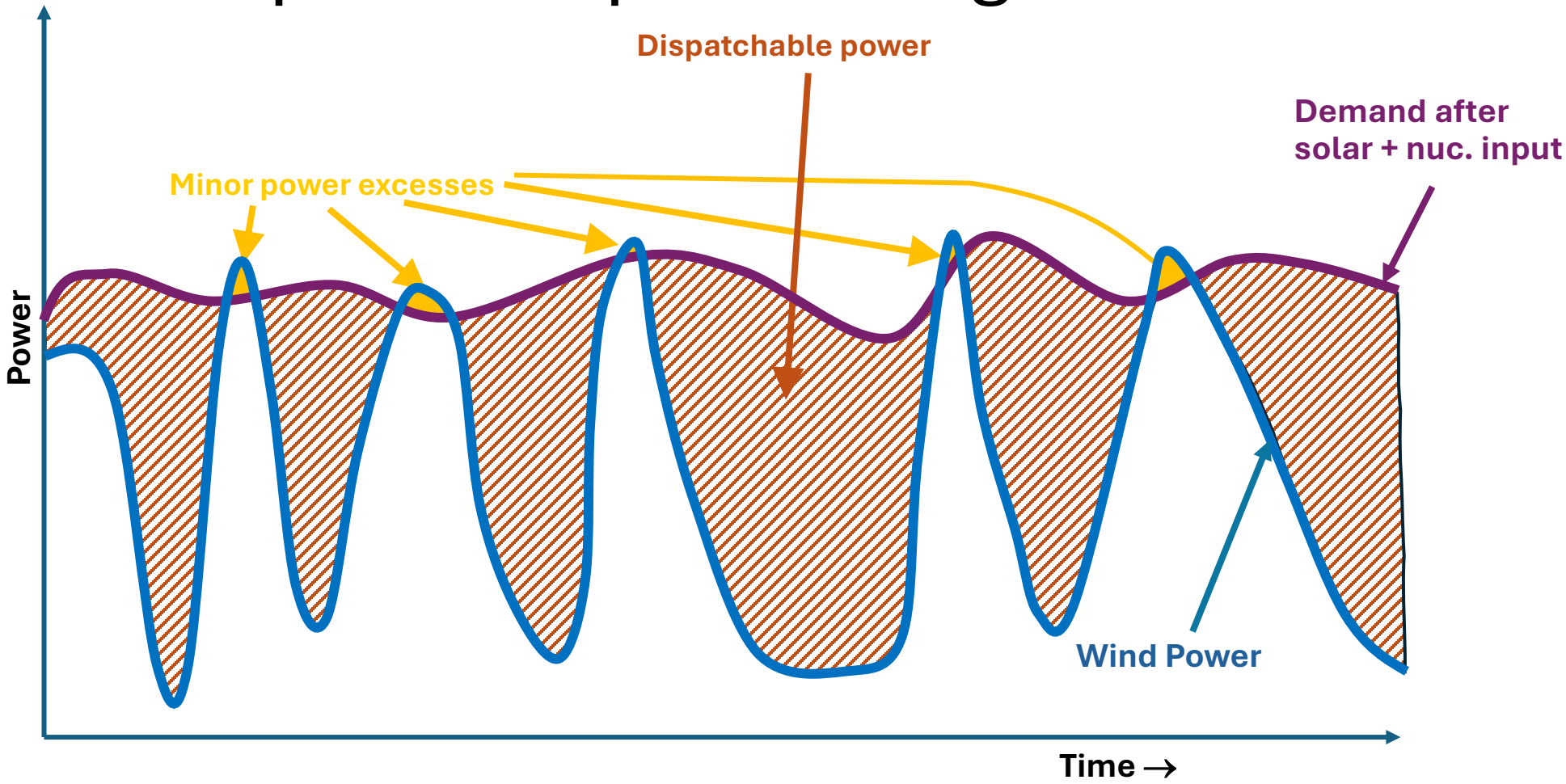
Low wind input ⇒ dispatchable gen$^{n.}$



One Priority: *Keeping the Lights On!*

Section #1 : Wind – major generator & variable.

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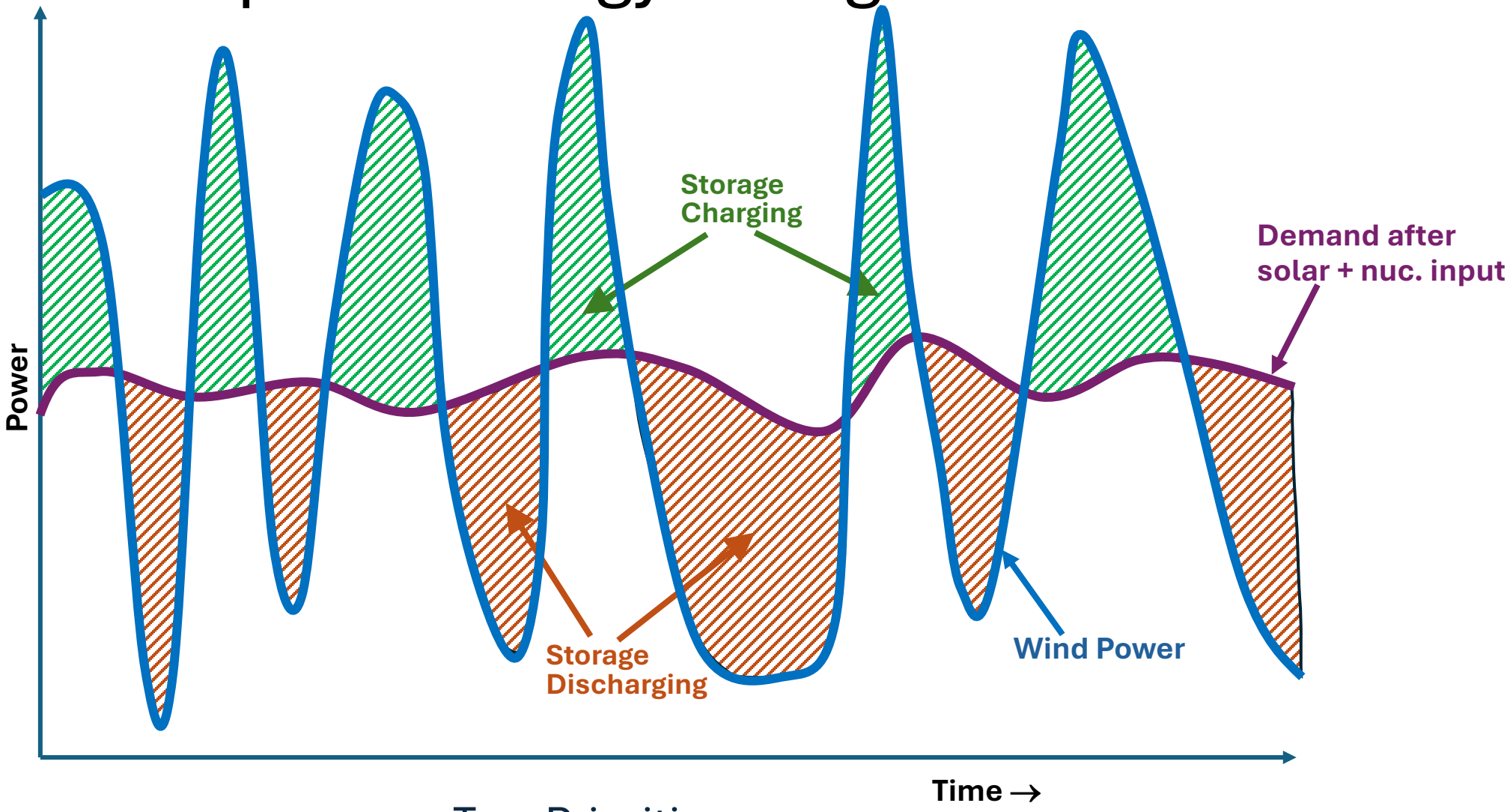
High wind input ⇒ energy storage!



Two Priorities now:

(i) *Keeping the Lights On!* and (ii) *Attaching Value to Every MWh from Wind!*

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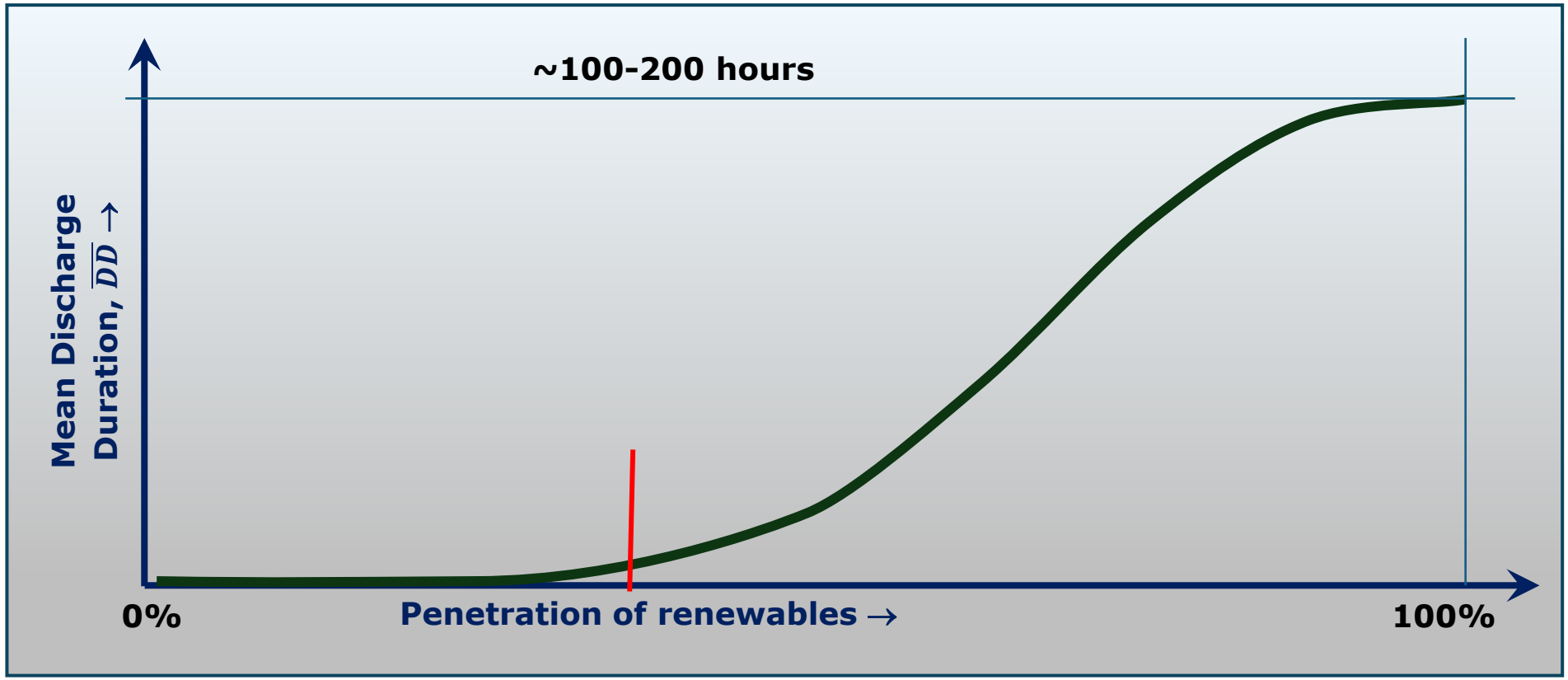
Storage discharge times will rise!



Innovate-UK and the Faraday Institution have recognised this recently!

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Wind power is economically big!

- GB will probably have >100GW (rated) of offshore wind by 2050
- Some £200bn (or more) will be spent to realise that rated power
- Those turbines will generate ~400 TWh of electricity each year
- At ~£100/MWh (current wholesale prices) 400 TWh p.a.= £40bn p.a.
- Around 30% of that wind power will not consumable directly.
- 30% of £40bn p.a. = £12bn p.a. – not negligible by any stretch.
  We absolutely must have a good plan for this “surplus energy”.
- Energy storage would be the perfect solution if it was low-cost, sustainable, long life and high efficiency!

End of Section #1

Section #2 : Managing variability

The Royal Society Report on *Large Scale Electricity Storage.*

3 years old today!

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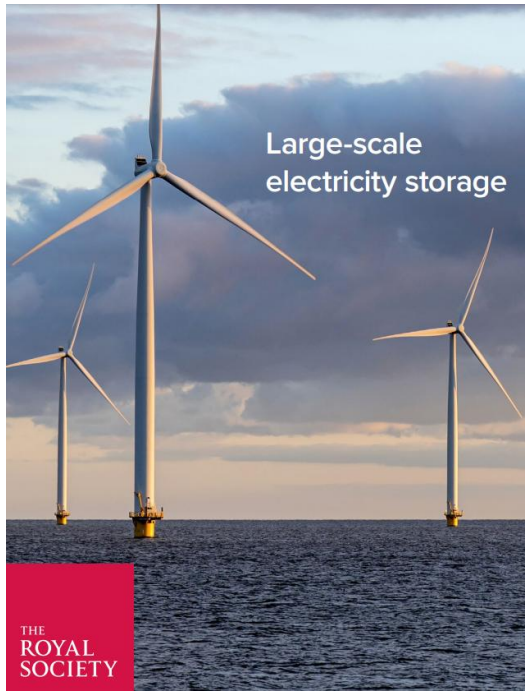
c.f. https://royalsociety.org/topics-policy/projects/low-carbon-energy-programme/large-scale-electricity-storage/



The *baseline case* in the Royal Society Report has …

100% Generation from R.E. … with ~30% over-genn.

Wind:Solar … approximately 80:20 mix by energy.

Storage mainly via H_2 in caverns … >50 days cons[tn].

Storage input power … ~5% above mean generation.

Storage output power … ~peak power consumption

Storage	R.E. £35/MWh	R.E. £40/MWh	R.E. £45/MWh
Hydrogen in Caverns	£57.83 /MWh	£64.48 /MWh	£71.10 /MWh

(Using costs and performance levels thought most likely. $\eta_{RT} = 40.7\%$, £0.71/kWh (e))

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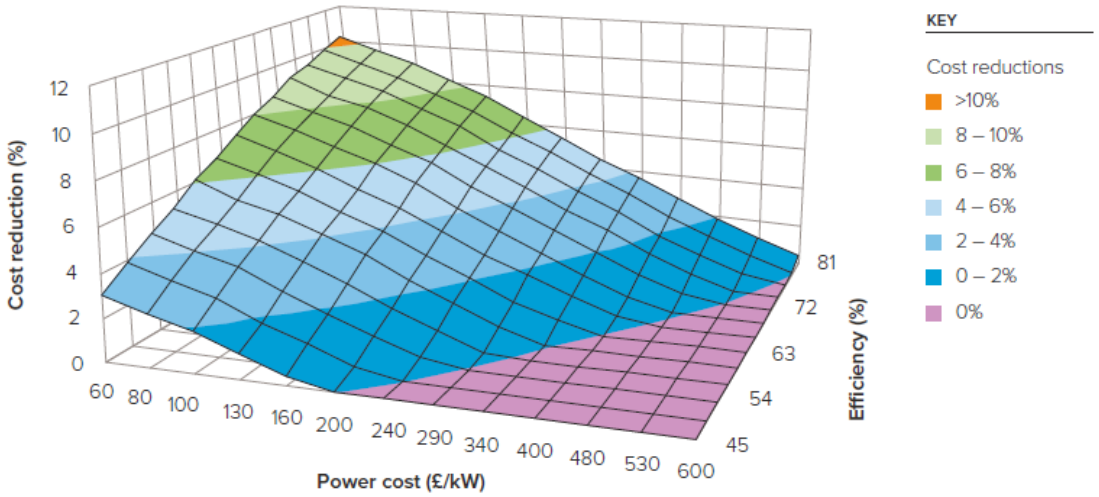
Blending storage types saves money!

FIGURE 26

Percentage reduction in the cost of electricity with ACAES + H_2 storage compared to H_2 storage only.

Reduction in the average cost of electricity with hydrogen storage and ACAES relative to the cost with only hydrogen storage for different assumptions about the costs of compressors and expanders (which are assumed to cost the same) and the round-trip efficiency.



www.nottingham.ac.uk/energy-institute/energy-storage-is-not-whiskey-blends-are-best

A code called *[NStore_Sim]* can optimise blends of storage types for a given *single-node* energy system.

www.era.ac.uk/resources/NStore_Sim

Other forms of flexibility also matter:

- Interconnection
- Demand-side response
- Simple *Turn-Down*

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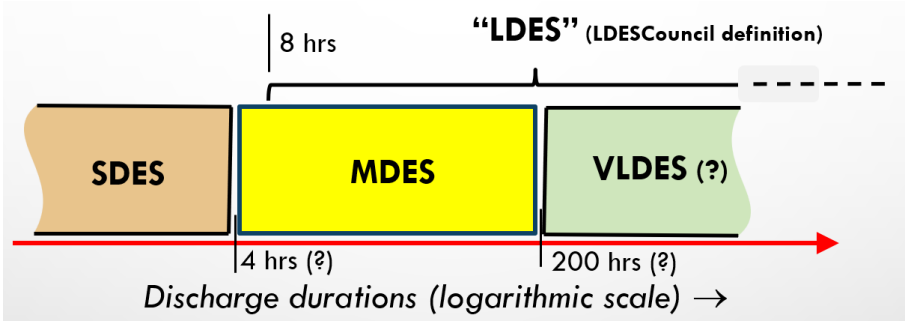
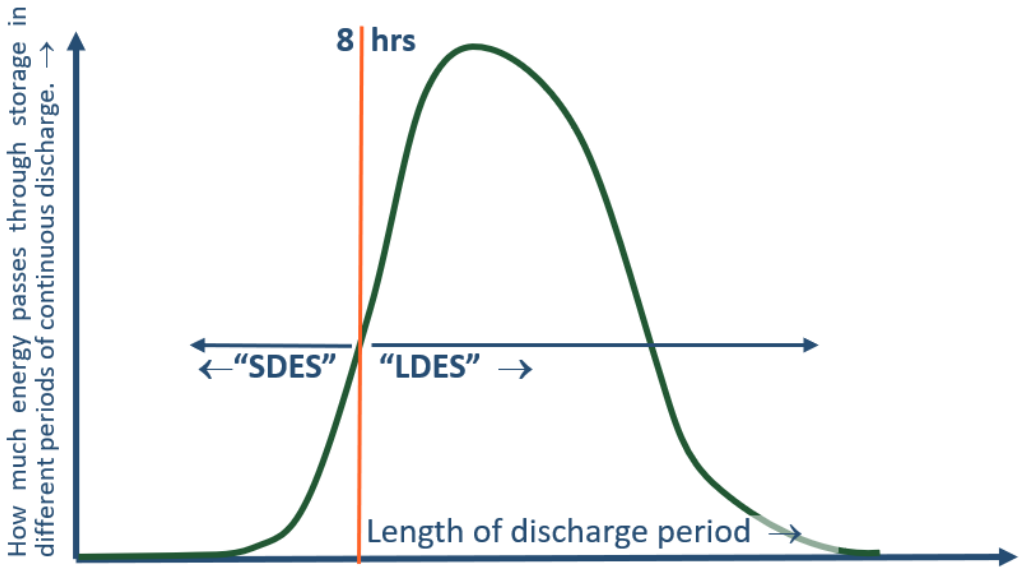
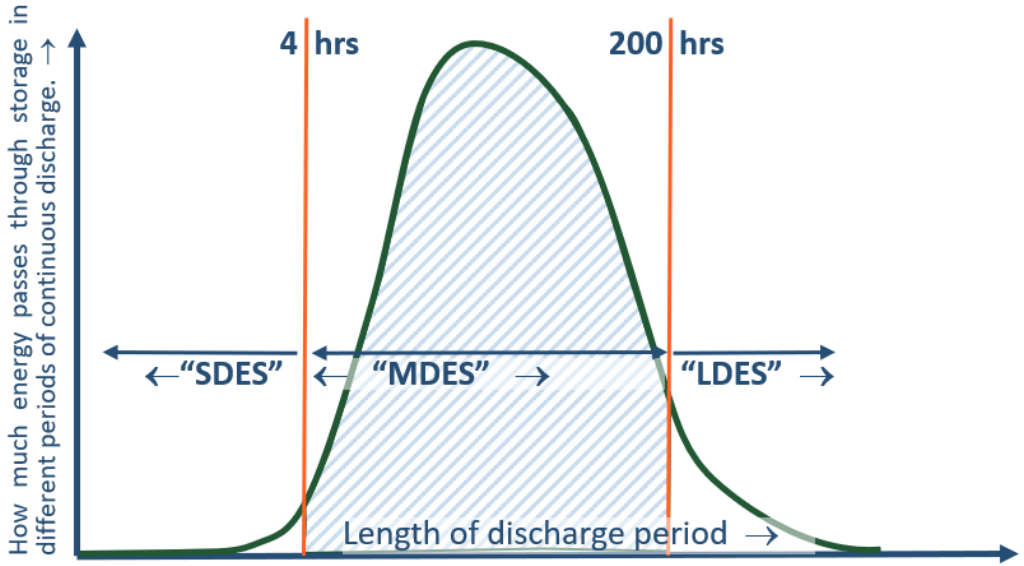
Most storage action will be “MDES”!

- Start with some prediction of expected future demand.
- Pick any “mix” of renewables+nuclear (e.g. 10% from nuclear, 72% from wind and 18% from solar) and scale this up to generate slightly more (e.g. 1.15x more) energy than is required to meet demand.
- Subtract the generation from demand to get *Net Natural Demand*. (This will have slightly negative average).
- Analyse the positive half-cycles and sort them into “bins” … e.g. {$t \leq$ 4hrs, 4hrs < t ≤ 200hrs, 200hrs<t}



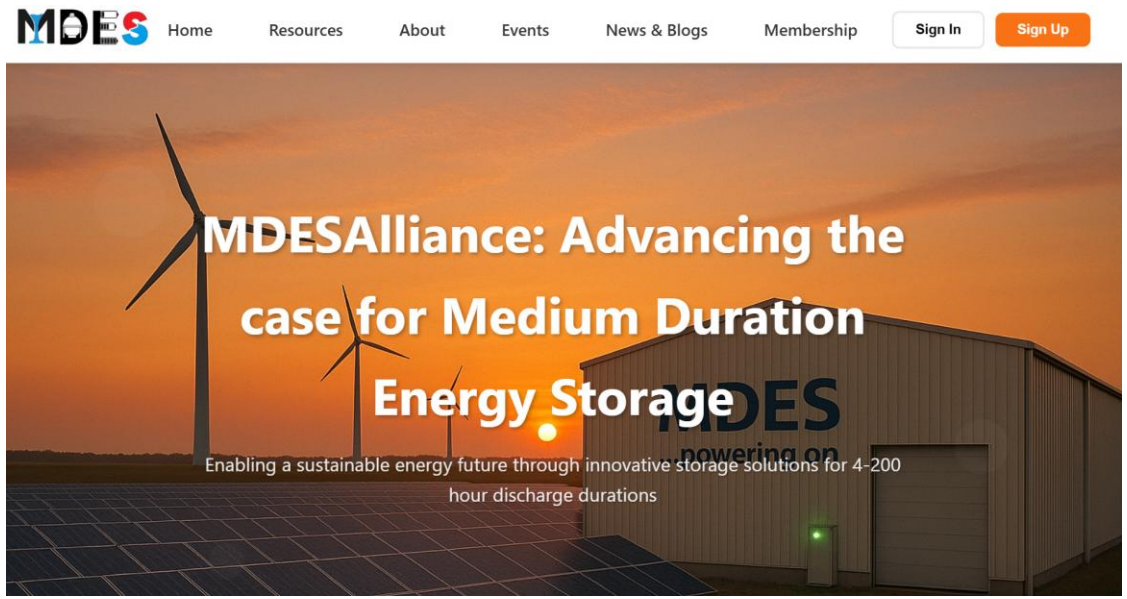


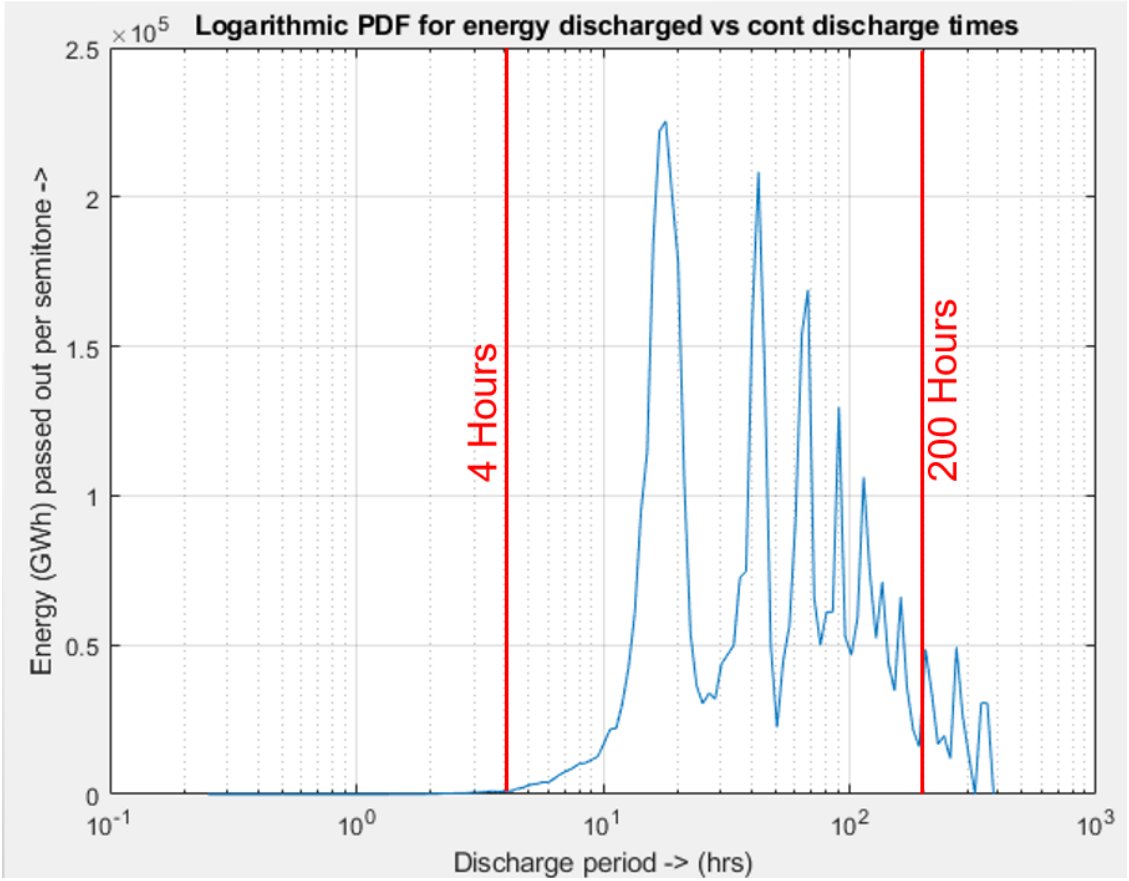


Section #2 : Managing variability

MDES: best solutions are thermo-mech.

- Compressed Air Energy Storage (CAES)
- Pumped-Hydro Energy Storage (PHES)
- Pumped-Thermal Energy Storage (PTES)
- Liquid Air Energy Storage (LAES)
- Reversible CO2 liquefaction/gasific[tn]





The *probability density function* indicating how likely it is that 1 unit of energy will be discharged from storage within a period of continuous discharge of a given length.

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Electricity systems: variability is not new

- Electricity is the ultimate *real-time product*.
- Electrical energy gets consumed within a few ms of being produced.
- Supply and demand must be reconciled second-by-second.
- Energy storage has always been the answer!! (Storing energy before electricity is made)

(Picture courtesy of Clare Ho, via Pexels)

GIES = *Generation-Integrated Energy Storage*.

End of Section #2

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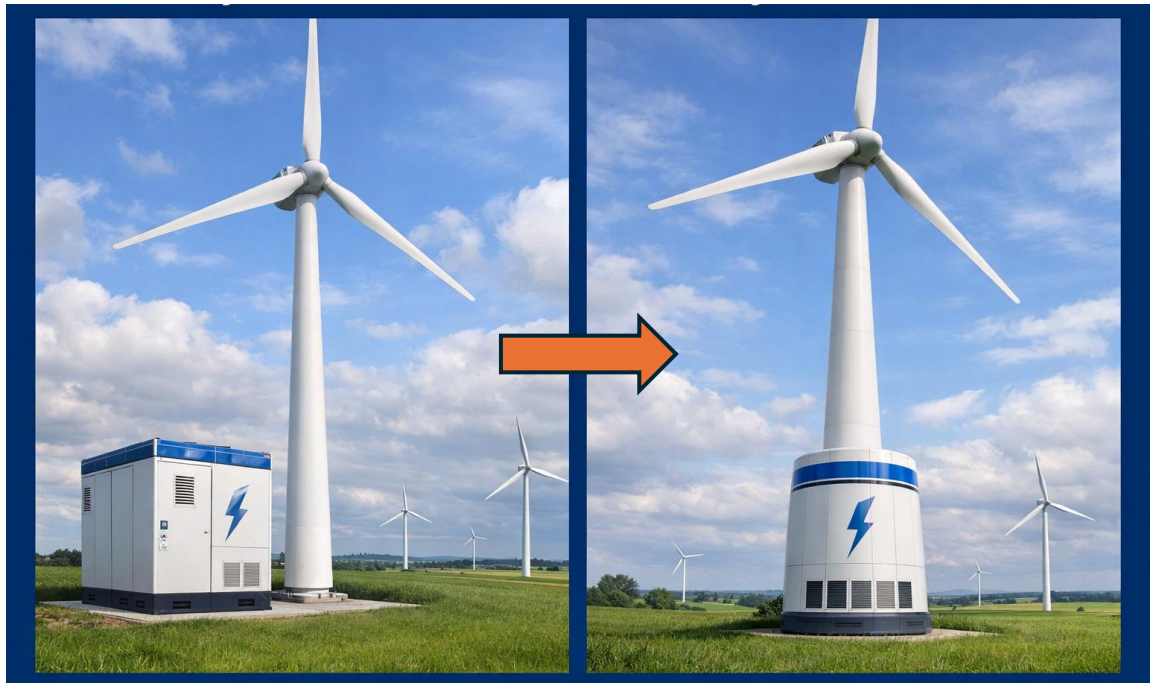
Wind Integrated Storage (WIS)

***Wind Integrated Storage* (WIS)** describes systems in which storage is integrated into wind turbines so that energy storage can be charged directly prior to generating electricity.
WIS potentially has:

- Very high effective roundtrip efficiency (80% - 90%) of the storage
- Very low marginal cost per kW(rated) of energy storage power conversion equipment (input and output)
- Moderate costs per kWh of electricity storage.



Conceptualising ***WIS***

WIS leads towards *Dispatchable Windpower*

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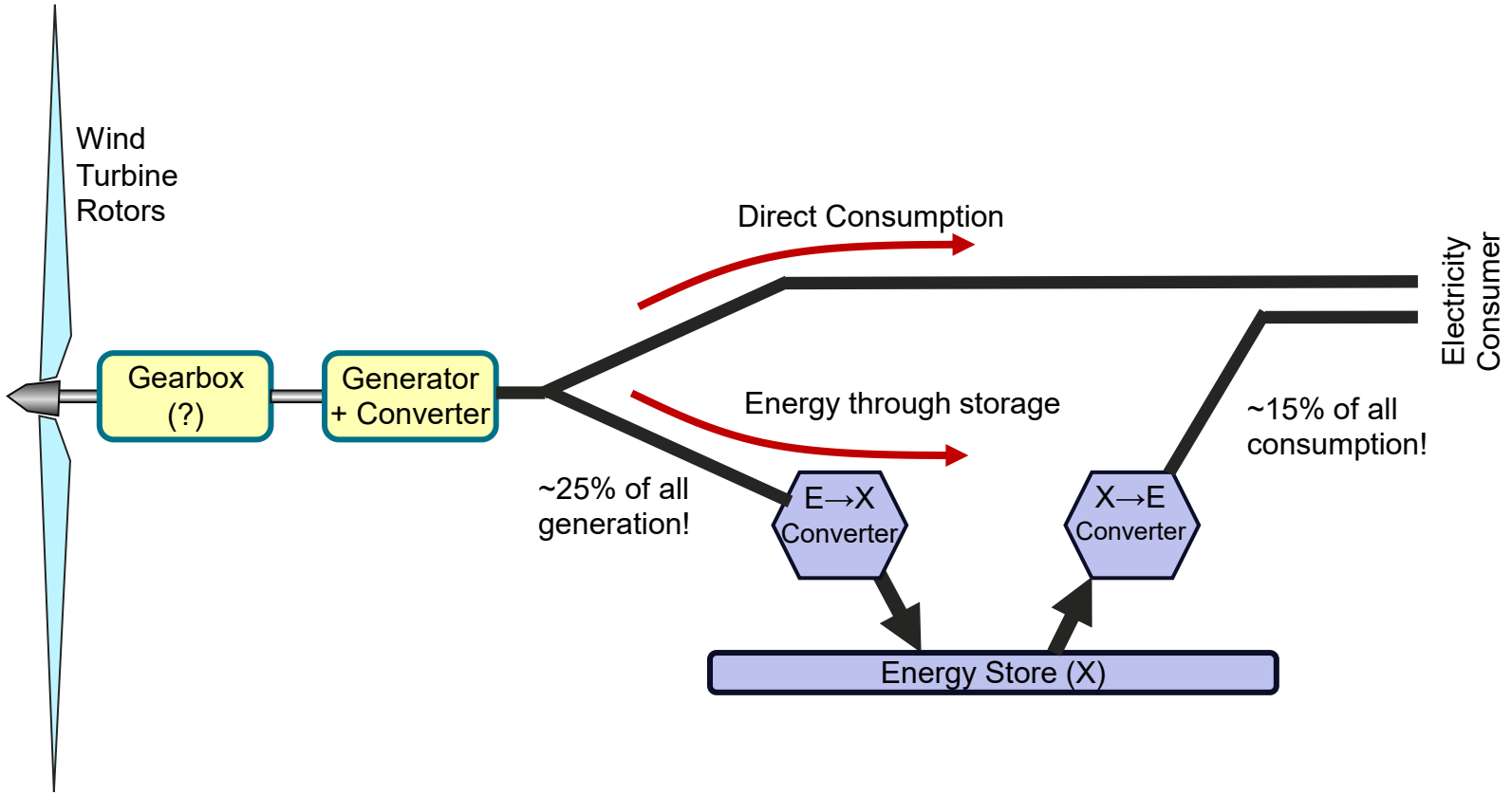
The conventional system view (not WIS)



>30% of all energy collected is transformed …
mechanical → electrical → mechanical → electrical ?

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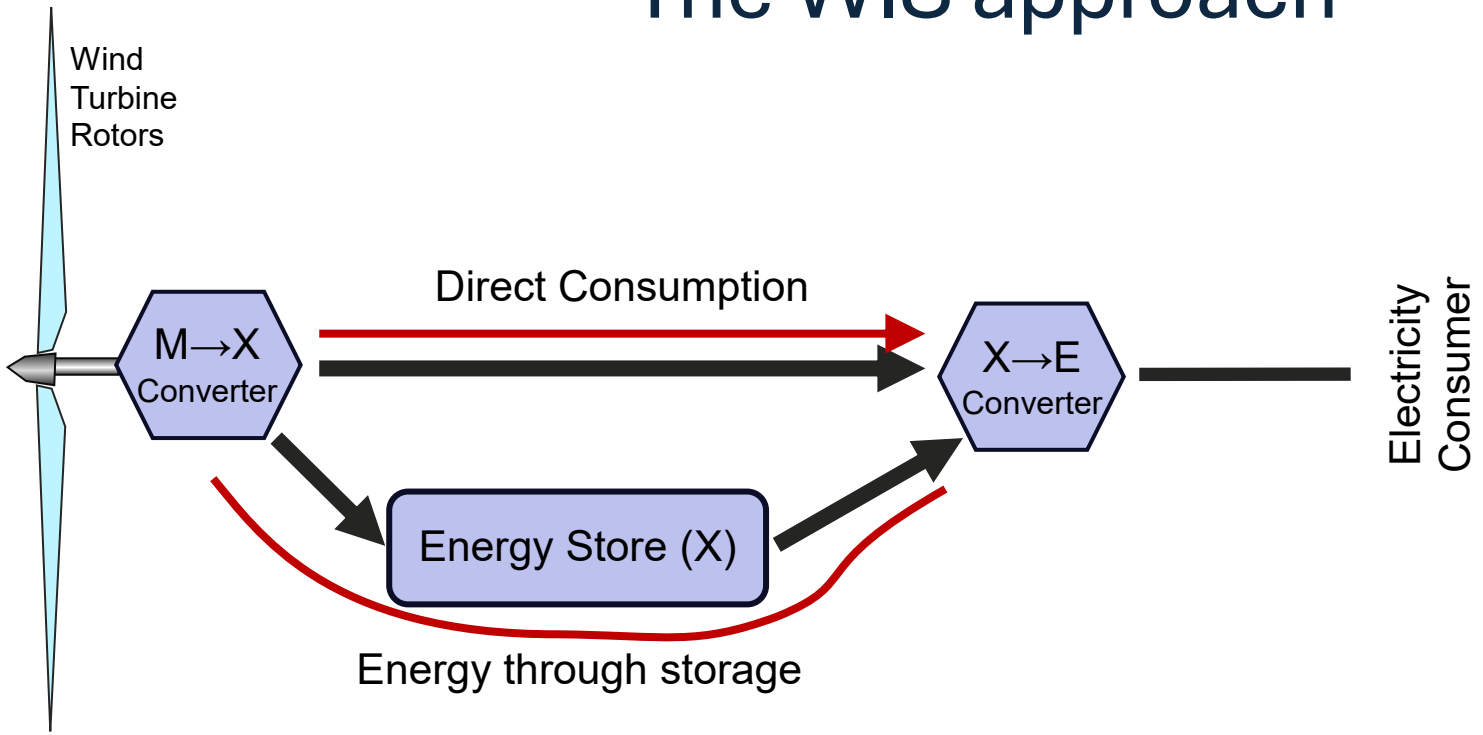
The WIS approach



The storage technology ("X") could be:

- Pumped hydro
- Compressed air
- Pumped thermal
- Liquid air
- Liquefied CO2
- Direct work→heat

- Fewer energy transformations for energy through storage (losses ↓)
- Fewer pieces of power-conversion equipment (CapEx ↓)
- Improved utilisation of transmission lines (CapEx ↓)

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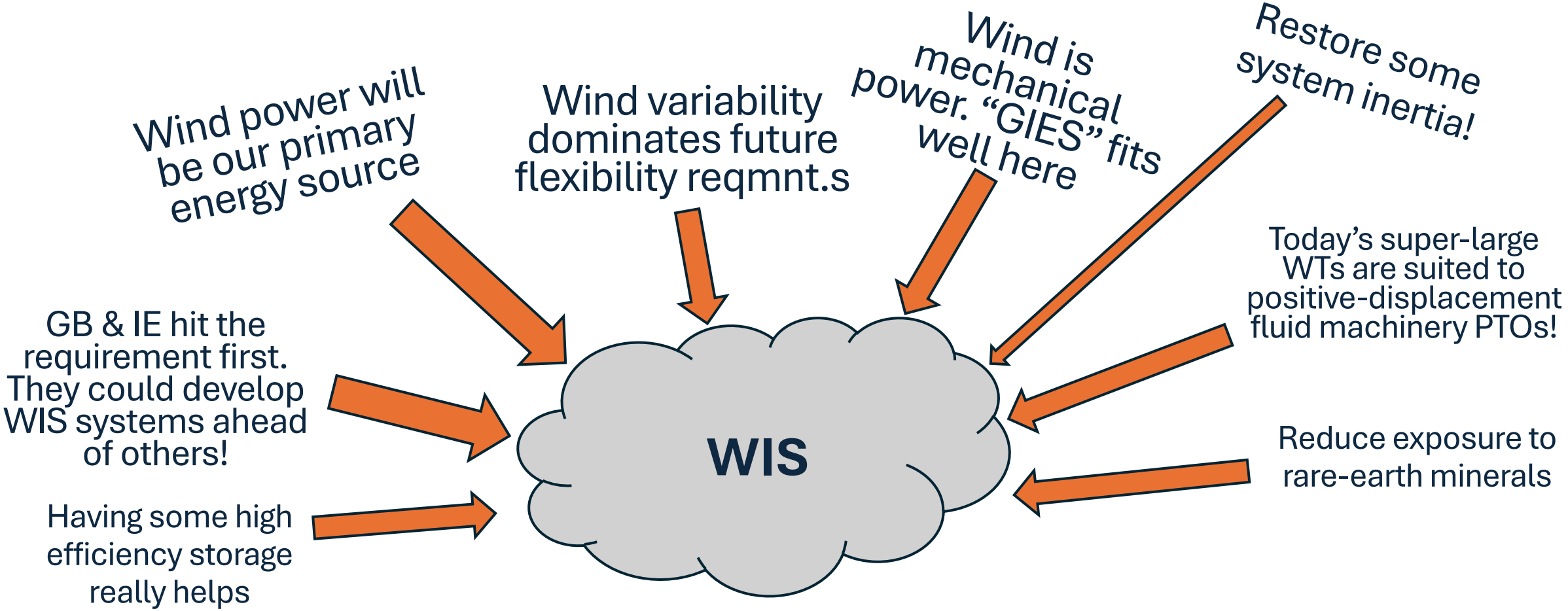
Many different signals point towards WIS



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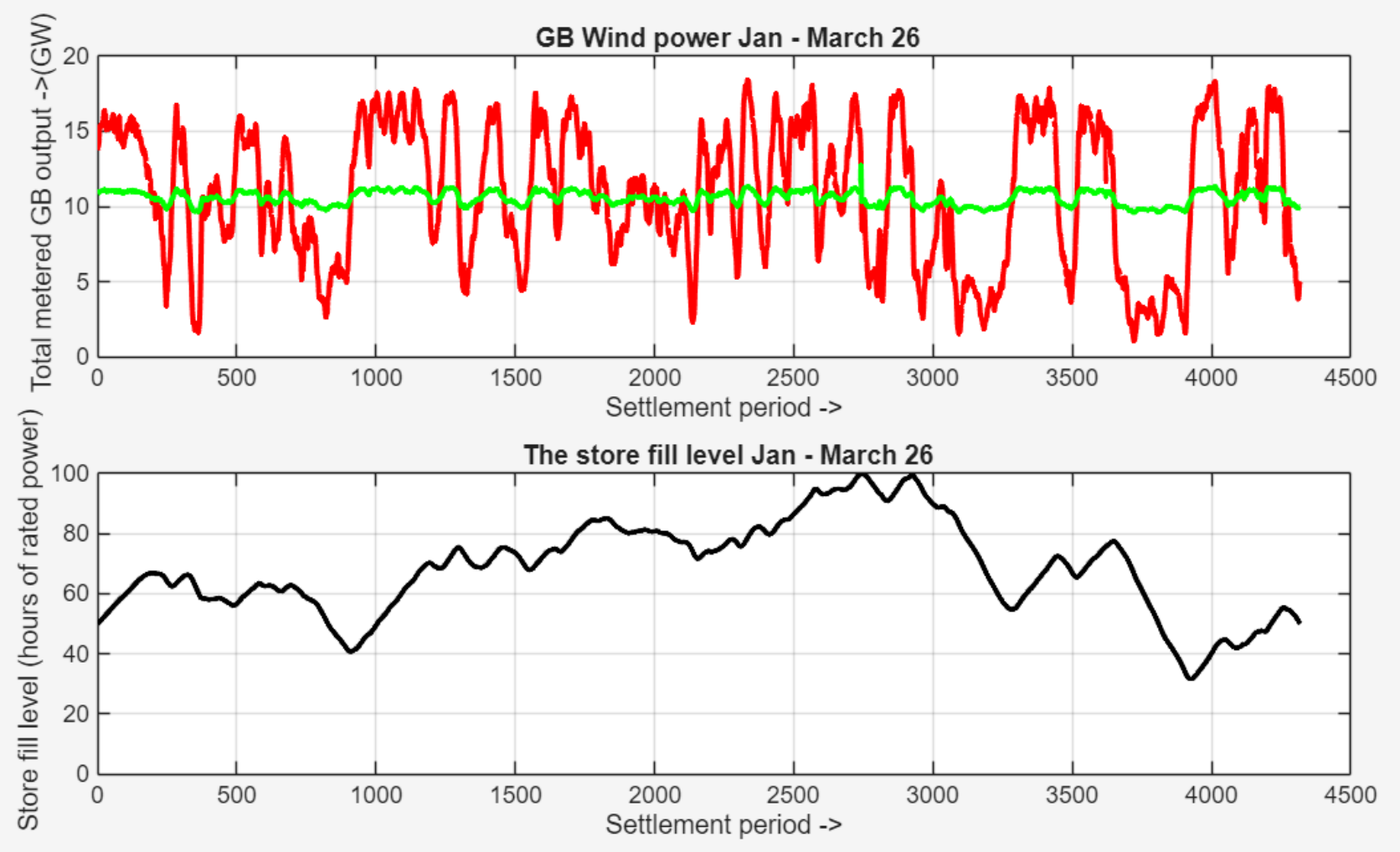
If all wind turbines had WIS (100 hrs)



You could make the total wind power output look like the green line!

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The cost optimum situation:

The cost-optimal solution for GB **is not** to have 100% of the wind turbine fleet equipped with WIS!

Largescale underground hydrogen stores and largescale underground CAES stores can achieve lower cost per kWh(e) of storage. These should be a part of the ideal (cost-optimal) mix of GB infrastructure – with hydrogen managing discharge durations (DDs) in the order of ~2000 hrs and CAES managing DDs ~ 100 hrs.

The cost-optimal solution for GB **is** to have ~30% of the wind turbine fleet equipped with WIS!

The high effective roundtrip efficiency and low marginal cost per unit of power conversion equipment for storage justifies using some WIS transmissions. Then most of the energy from wind turbines that should pass through storage would be handled by this WIS subset.

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[*NStore_Sim*] findings on WIS: (2025)

At UKES2025 in Sheffield[1] (the UK Energy Storage conference in April 2025), an analysis of GB electricity system (using 37-year time-series data with 1-hr resolution) optimised for cost with flexibility provided from three main sources:

(i) $E \rightarrow H_2 \rightarrow E$, (power costs ~ £300/kW, storage cost ~ £0.75/kWh(e), RTE = 41%)

(ii) CAES, (power costs ~ £250/kW, storage cost ~ £3.50/kWh(e), RTE = 68%)

(iii) WIS, (power costs £0/kW, storage cost £10/kWh(e), RTE = 85%).

Presentation and video available via: www.TinyURL.com/SDG-at-UKES2025

[1] Garvey, SD. *The relevance of Wind Integrated Storage (WIS) in Net Zero UK*
A presentation at UK Energy Storage Conference, April 17-19, Sheffield, 2025

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[*NStore_Sim*] findings on WIS: (2025)

Energy Storage System	NPV for 37 years	Cost per MWh	Cost per year (for 800TWh/year)
H2 only	£644.6 bn	£65.79/MWh	£52.63 bn
H_2 + ACAES	£618.6 bn	£63.09/MWh	£50.47 bn
H_2 + WIS	£615.3 bn	£62.79/MWh	£50.23 bn
H_2 + ACAES + WIS	£609.3 bn	£62.33/MWh	£49.84 bn

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[*NStore_Sim*] findings: 45-year datasets (GB)

§1. Great Britain (GB): All cost and performance assumptions used here are reported in Appendix A. Note that the assumed costs for gas-fired generation (see Appendix A), the cost of supplying all demand from gas would be £121.78/MWh.

	Cost of primary R.E. generation (£/MWh)				
Energy Storage Options Available	**50**	**60**	**70**	**80**	**90**
H_2 only	80.82	93.49	106.17	118.54	130.80
H_2 with ACAES	80.10	92.49	104.72	116.54	128.35
H_2 with WIS	79.14	91.42	103.55	115.35	127.03
H_2 with Gas	79.86	91.90	103.71	115.10*	114.27
H_2 with WIS and Gas	78.99	90.94	99.56	107.37	114.70*
H_2 with ACAES and Gas	79.47	91.61	103.48	115.25*	115.11
H_2 with ACAES and WIS	79.54	91.86	103.88	115.45	127.26*
H_2 with ACAES, WIS and Gas	79.39	90.65	99.76*	107.76*	114.39

Table 1. Optimised costs of delivered energy (£/MWh) for different RE costs & storage optⁿs

Recall: www.TinyURL.com/SDG-at-PGES

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[*NStore_Sim*] findings: 45-year datasets (GB)

	Roundtrip Eff	Self-discharge time-constant (hrs)		CapEx per kW(e) or per kWh(e)	OpEx per year as % of CapEx	Asset lifetime (years)
Hydrogen	40.70%	2.00E+05	Cost of energy deficit	*Auto*		
			Input Power	333	1.5	20
			Output Power	315	1.5	20
			Storage Capacity	0.727	1.5	100
ACAES	68.00%	5.00E+06	Cost of energy deficit	*Auto*		
			Input Power	220	4	30
			Output Power	280	4	30
			Storage Capacity	3.911	2	100
WIS	85.00%	4000.00	Cost of energy deficit	*Auto*		
			Input Power	20	3	35
			Output Power	20	3	35
			Storage Capacity	15	2	35
BATTERIES	94.00%	2.00E+03	Cost of energy deficit	*Auto*		
			Input Power	20	2	16
			Output Power	20	2	16
			Storage Capacity	100	4	16
Gas-fired Generation	N/A	0.00%	Cost of energy deficit	£100/MWh(e)		
			Input Power	N/A	N/A	N/A
			Output Power	1200	1.5	25
			Storage Capacity	0	N/A	N/A

Figure A1. The cost and performance assumptions applied to obtain Table 1.

Recall: www.TinyURL.com/SDG-at-PGES

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[*NStore_Sim*] findings: 45-year datasets (IE)

§2. Ireland (IE): All cost and performance assumptions used here are reported in Appendix B. Note that the assumed costs for gas-fired generation (see Appendix B), the cost of supplying all demand from gas would be €168.48/MWh.

	Cost of primary R.E. generation (€/MWh)				
Energy Storage Options Available	**50**	**60**	**70**	**80**	**90**
H_2 only	95.68	109.91	123.27	136.53	149.42
H_2 with ACAES	92.18	105.68	118.58	131.42	144.10
H_2 with WIS	89.28	102.17	114.95	127.52	139.91
H_2 with Gas	90.31	104.77	114.46	126.20	136.84
H_2 with WIS and Gas	84.27	95.46	107.16	117.11	127.32
H_2 with ACAES and Gas	87.38	99.13	110.81	121.82	130.67
H_2 with ACAES and WIS	89.07	102.02	114.85	127.46	139.75
H_2 with ACAES, WIS and Gas	84.85*	96.36*	107.81*	117.62*	127.73*

Table 2. Optimised costs of delivered energy (€/MWh) for different RE costs & storage optⁿs

Recall: www.TinyURL.com/SDG-at-PGES

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[*NStore_Sim*] findings: 45-year datasets (IE)

	Roundtrip Eff	Self-discharge time-constant (hrs)		CapEx per kW(e) or per kWh(e)	OpEx per year as % of CapEx	Asset lifetime (years)
Hydrogen	41.00%	200,000				
			Input Power	550 (€/kW_e)	2	20
			Output Power	500 (€/kW_e)	2	20
			Storage Capacity	1.2 (€/kWh_e)	1.5	100
ACAES	68.00%	5,000,000				
			Input Power	340 (€/kW_e)	2	35
			Output Power	480 (€/kW_e)	2	35
			Storage Capacity	6.5 (€/kWh_e)	1	100
BATTERIES	94.00%	2,000				
			Input Power	25 (€/kW_e)	2	25
			Output Power	25 (€/kW_e)	2	25
			Storage Capacity	150 (€/kWh_e)	6	12
Gas-fired Generation	N/A	∞	Cost of energy deficit	€150/MWh_e		
			Input Power	N/A	N/A	N/A
			Output Power	900 (€/kW_e)	2.5	20
			Storage Capacity	0	1	N/A
WIS	84.00%	4,000				
			Input Power	20 (€/kW_e)	3	35
			Output Power	20 (€/kW_e)	3	35
			Storage Capacity	12 (€/kWh_e)	2	35

Figure B1. The cost and performance assumptions applied to obtain Table 2.

Recall: www.TinyURL.com/SDG-at-PGES

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A vision for WIS in GB (& Ireland)

- Develop new transmission systems for large offshore WTs and type-certify these as options for existing machine designs.
- Build and install WIS transmissions in 35%-40% of the future fleet of WTs around our coasts.
- Sell WIS transmissions abroad into a market that will likely reach >£50bn p.a. by 2050.
- We will still need other flexibility forms including H_2 in caverns, underground ACAES, demand-side response, some interconnection, etc. for a cost-optimal system. *Get on with that*!
- Enjoy energy prosperity like Norway!

End of Section #3

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Recommendations

- There is strong evidence that WIS could be very important for UK. A serious professional study should explore both technical and economic viability of WIS.
- If that study indicates positive … the next step may be a “competition”
- GB and Ireland have very common situation and should collaborate closely. Let’s start talking about that seriously right now.
- Energy policy and markets need to stabilise to facilitate the long-term views that are good for us (and to incentivise actions that help us most). Remove the connection to political cycles (APPGES!) and review how to extend the CfDs.
- Coordinate our initiatives better*! (Several current independent initiatives do not seem joined up).
- Make open the time-series data that is being used to inform energy policy$^{\Upsilon}$.

* See the report called “Grid Energy Storage SESN July 2025” at https://supergenstorage.org/outputs

$^{\Upsilon}$ The speaker was one of >30 energy system experts to co-sign a letter to DESNZ, NESO, Michael Shanks, Ed Miliband and Chris Stark in December 2024 calling for the data that underpins UK energy policy to be made fully open.

THANKS FOR LISTENING
What shall we do about it ?

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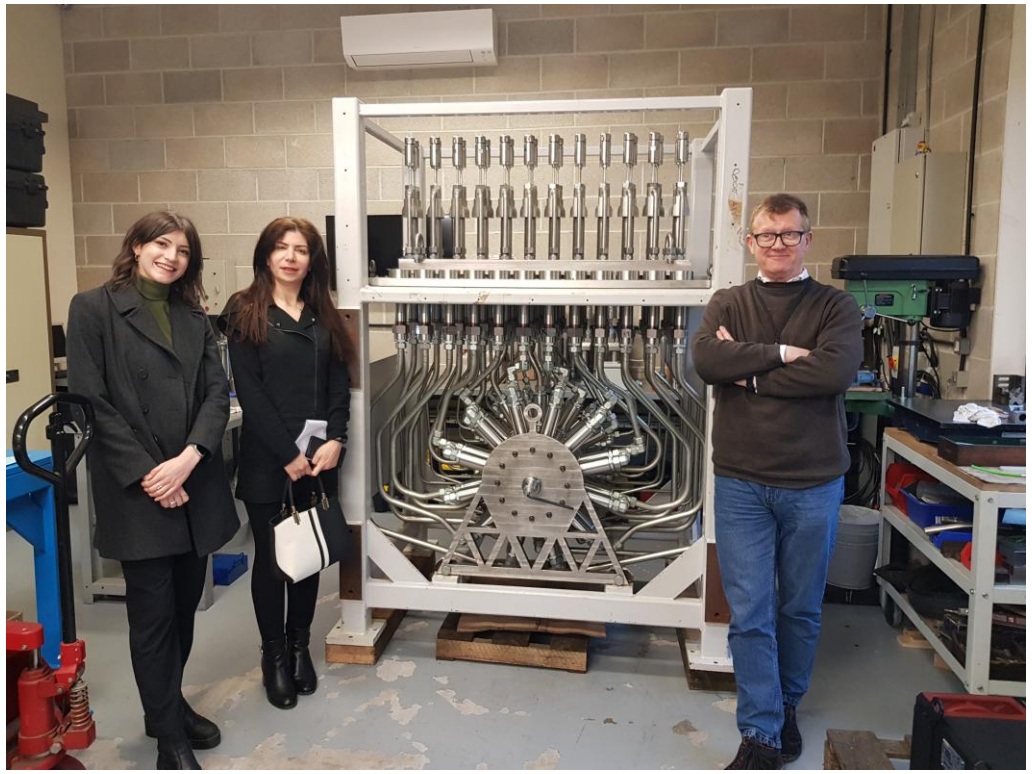

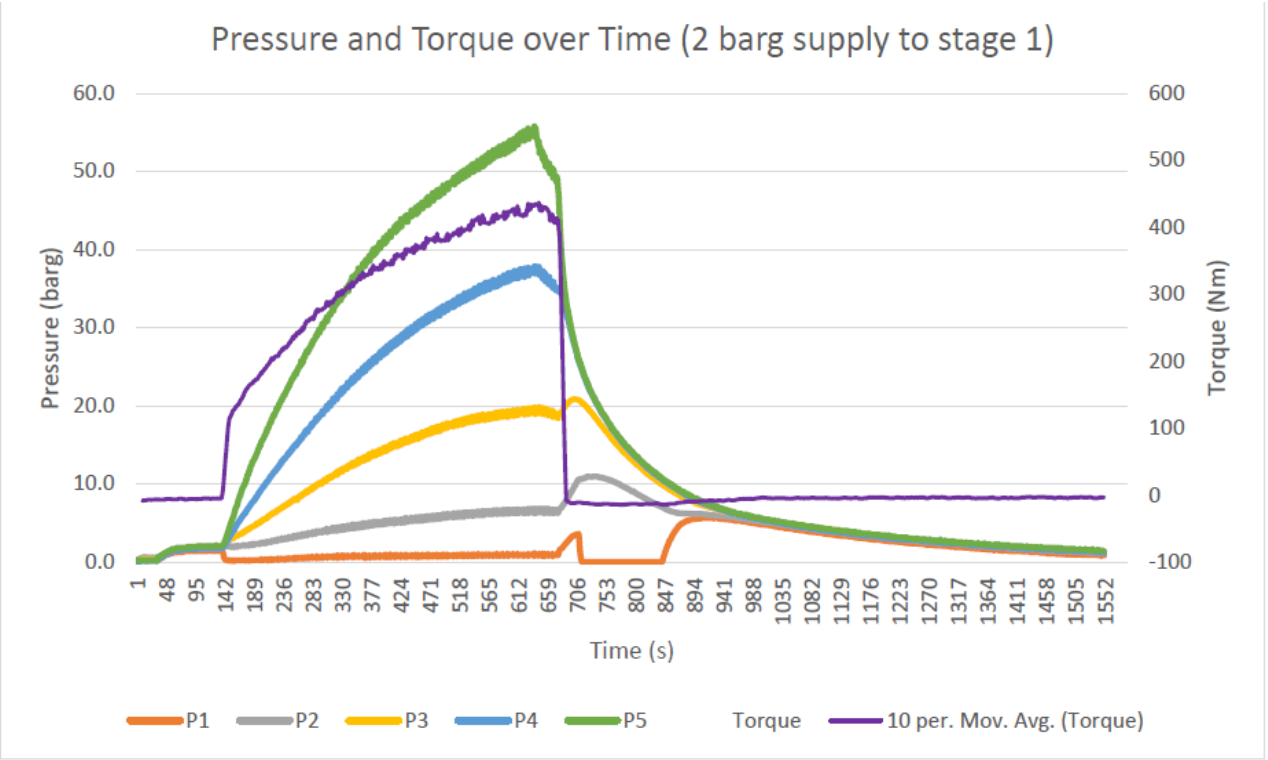

Rem: This presentation and supporting materials are available at … www.TinyURL.com/SDG-at-PGES

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Some events of relevance:

Hydrogen Storage in Caverns
www.era.ac.uk/events/HSiC2021
www.era.ac.uk/events/HSiC2022
www.era.ac.uk/events/HSiC2023
www.era.ac.uk/events/HSiC2024
www.era.ac.uk/events/HSiC2025
www.era.ac.uk/events/HSiC2026

Medium Duration Energy Storage
www.era.ac.uk/events/MDES2020
www.era.ac.uk/events/MDES2022
www.era.ac.uk/events/MDES2024

www.MDESAlliance.com

Decarbonising Heating
www.era.ac.uk/events/Heating2024
www.era.ac.uk/events/Heating2025

UKES Conferences
UKES2024 Conference Chair
(Univ. of Nott'm, April 12-14, '24

OffShore Energy and Storage
www.OSESsociety.com
OSES2014: Windsor, Canada
OSES2015: Edinburgh, Scotland
OSES2016: Valetta, Malta
OSES2017: Cape Cod, MA, USA
OSES2018: Ningbo, China
OSES2019: Brest, France
(COVID Interruption)
OSES2023: St Julians Bay, Malta
OSES2024: New Bedford, USA
OSES2025: Bari, Italy
OSES2026: Delft, Netherlands
OSES2027: Cork, Ireland

Policy Events / Briefings
www.era.ac.uk/event/energy-storage-policy-masterclass
www.era.ac.uk/events/MDES:PnM2026

https://www.nottingham.ac.uk/policy-and-engagement/documents/policy-briefs/renewable-energy-change-cfds-to-reward-flexibility-21290.pdf

Webinars
www.nottingham.ac.uk/energy-institute/energy-storage-is-not-whiskey-blends-are-best
www.nottingham.ac.uk/energy-institute/generation-integrated-medium-duration-energy-storage

SPARE SLIDES FOLLOW

[*NStore_Sim*] findings on WIS: (2026)

University of Nottingham
UK | CHINA | MALAYSIA

At UKES2026 in Edinburgh (UK Energy Storage conf., April 2026), *[NStore_Sim]* was applied [2] to three different “cases” of single-node electricity systems

Presentation and video available via: www.TinyURL.com/SDG-at-UKES2026

[2] Garvey, SD. *The case for GB-IE collaboration on energy storage*
A presentation at UK Energy Storage Conference, April 15-17, Edinburgh, 2026

[*NStore_Sim*] findings on WIS: (2026)

University of Nottingham
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Cost Assumptions (for the GB-IE cases. Prices here are in €_2025.)

	Roundtrip Efficiency	Self-discharge rate (1/hrs)	Cost of Energy Deficit		CapEx per kW(e) or per kWh(e)	OpEx per year as % of CapEx	Asset lifetime (years)
Hydrogen	41%	1E-6	Same as av. cost of energy delivered	Input Power	425 (€/kW_e)	1.5	20
				Output Power	400 (€/kW_e)	1.5	20
				Storage Capacity	1.0 (€/kWh_e)	1.5	100
ACAES	68%	2E-7	Same as av. cost of energy delivered	Input Power	280 (€/kW_e)	4	35
				Output Power	320 (€/kW_e)	4	35
				Storage Capacity	7.0 (€/kWh_e)	1	100
Batteries	90%	2E-4	Same as av. cost of energy delivered	Input Power	50 (€/kW_e)	2	25
				Output Power	50 (€/kW_e)	2	25
				Storage Capacity	120 (€/kWh_e)	6	12
Gas fired gen'n	N/A	0	£150/MWh_e	Input Power	N/A	N/A	N/A
				Output Power	900 (€/kW_e)	1.5	20
				Storage Capacity	0	1.5	N/A
W.I. Storage	84%	2E-3	Same as av. cost of energy delivered	Input Power	20 (€/kW_e)	2	35
				Output Power	20 (€/kW_e)	2	35
				Storage Capacity	15 (€/kWh_e)	2	100

[*NStore_Sim*] findings on WIS: 2026

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Cases with 5 stores (Batteries, ACAES, Hydrogen, Gas-fired gen & WIS) were compared with cases comprising only 4 stores (ACAES, Hydrogen, Gas-fired gen & WIS).

Excluding WIS typically causes a 1.0%-1.5% increase in system cost relative to including WIS.

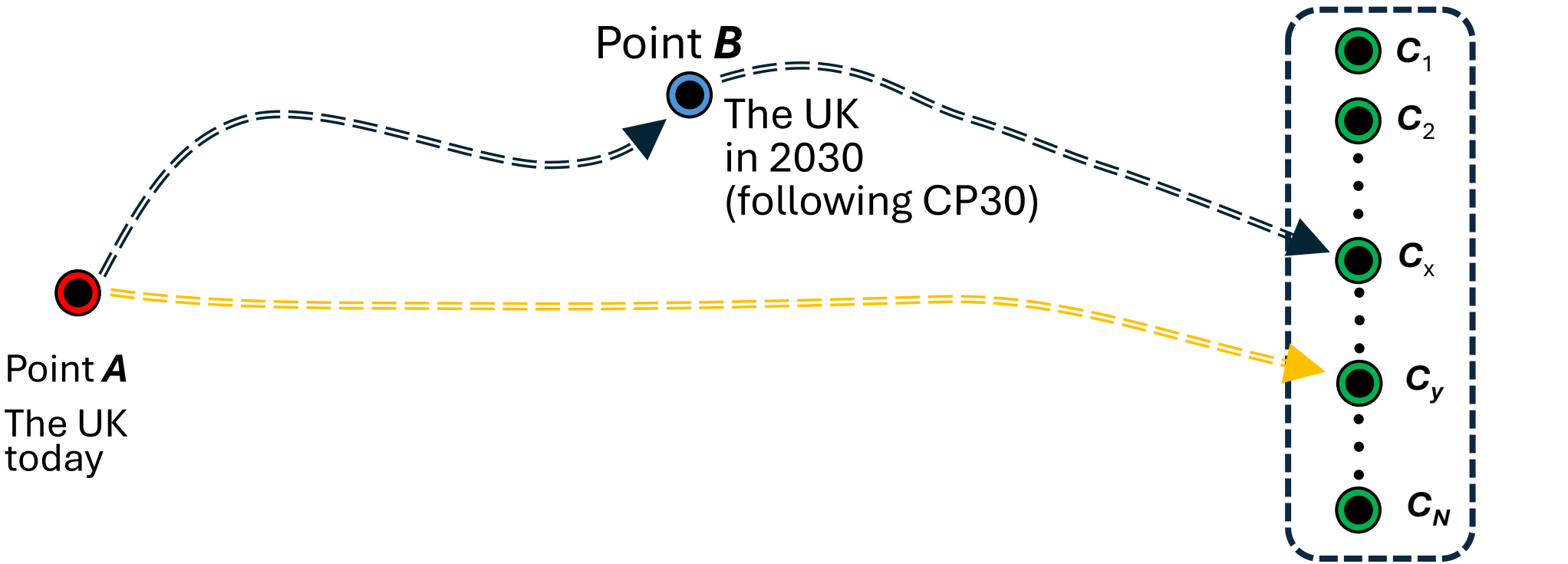
Renewables Cost	€60/MWh	€70/MWh	€80/MWh
Wholesale cost (with no WIS)	€91.90/MWh	€102.84/MWh	€113.30/MWh
Wholesale cost (with WIS)	€90.85/MWh	€101.79/MWh	€112.08/MWh

Results for GB-IE as a tightly-interconnected system

A simple question about UK Energy Policy

Prof. S. D. Garvey, University of Nottingham

(***?)



A simple question about UK Energy Policy

The UK is on a journey between where we are now (represented as point ***A***) and some *Net Zero* future by 2050 (represented as any one of points **C*** in the set of possible *Net Zero* futures … {$\boldsymbol{C}_1$, $\boldsymbol{C}_2$, $\boldsymbol{C}_3$, … $\boldsymbol{C}_x$, $\boldsymbol{C}_y$, … $\boldsymbol{C}_N$}).

We are presently committed to passing through point ***B*** (representing the *Clean Power by 2030* mission). One possible *Net Zero* future, $\boldsymbol{C}_x$, is cost-optimal subject to the constraint of passing through point ***B***. A different *Net Zero* future, $\boldsymbol{C}_y$, would be cost-optimal if we were not constrained to pass through point ***B***.

Do we have a confident estimate of the Net Present Value of the difference in costs to the UK between these two different paths ($\mathbf{A}\rightarrow\mathbf{B}\rightarrow\mathbf{C}_x$) vs. ($\mathbf{A}\rightarrow\mathbf{C}_y$) ?

(… or even an upper-bound on that difference?)

How important could WIS exports be?

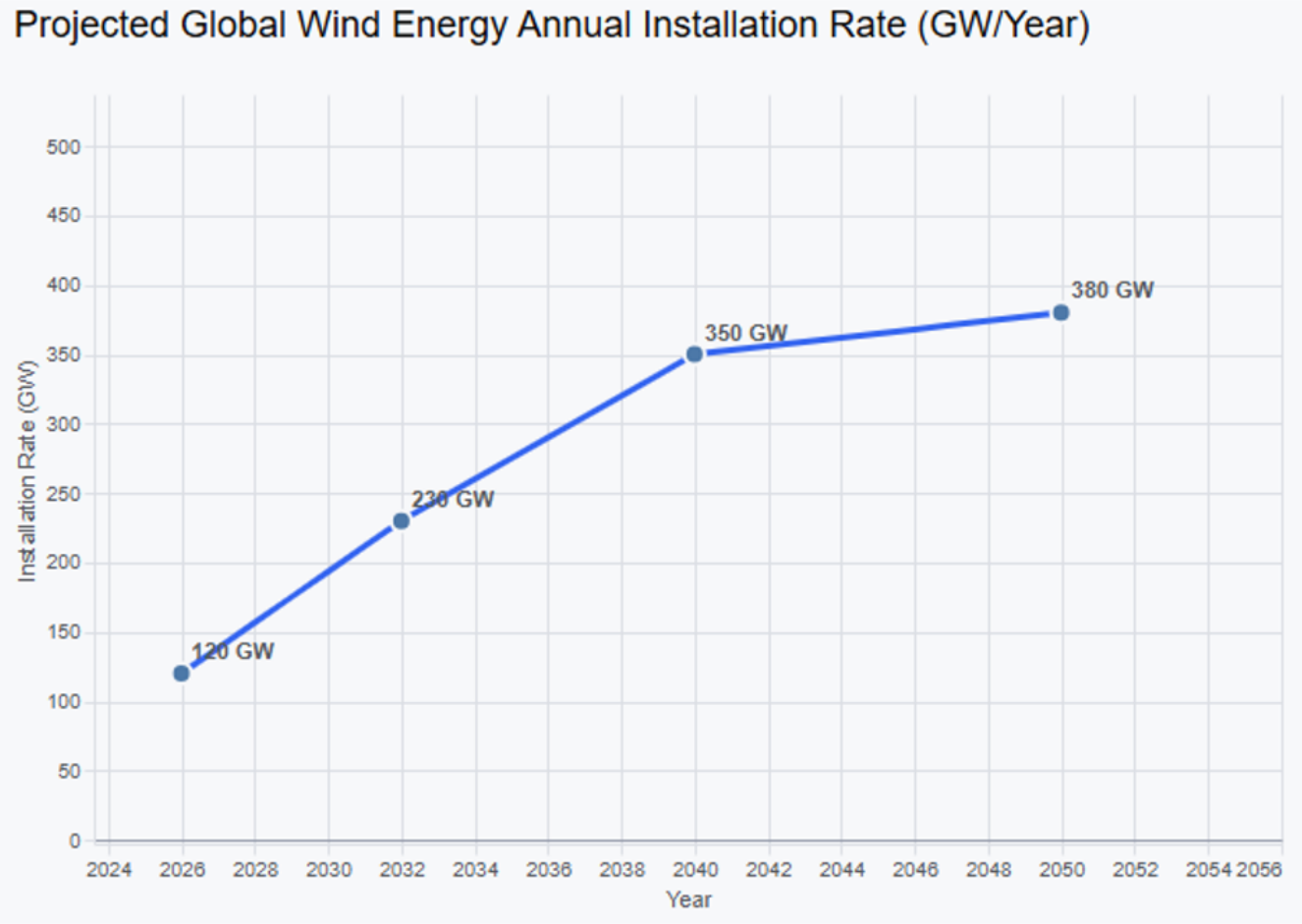


Figure 3. Expected installation rates of WTs globally.

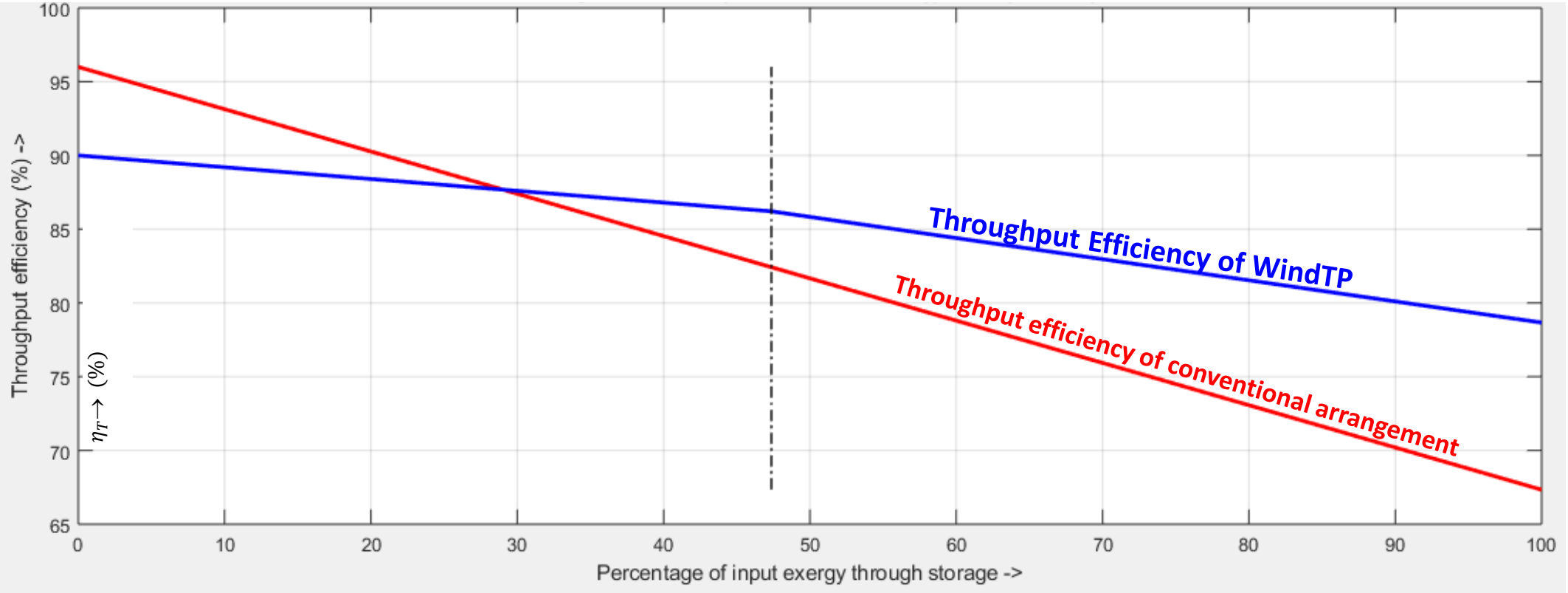
There are two different approaches to assessing the potential aggregate value of WindTP installations in future. In one approach, we reason that for any WT project, the WTX accounts for roughly 10%-15% of total project value. On that basis, WindTP systems could account for at least (10% × 25% × $750bn) per year =~= $20bn per year. That approach values only the transmission function of WindTP.

In another approach, we might assert that because the ES associated with WindTP has a high effective roundtrip efficiency and long lifetime without significant degradation, it can be valued very conservatively at >$10/kWh. Each WindTP-equipped WT would naturally have ES capacity equivalent to >50hrs of rated power and on that basis, the storage capacity alongside each 1MW(rated) would be valued at (50,000 × $10) = $500k. Then, the aggregate value of the ES provided per year by 2050 would be (25% × 380,000 × $500k) =~= $50bn.

The power-conversion and energy storage functions of WindTP have separate value. Thus it is reasonable to expect that, combined, these functions could account for $50bn - $100bn per year globally by 2050.

Section #3

A glimpse into wind-integrated storage (WIS)



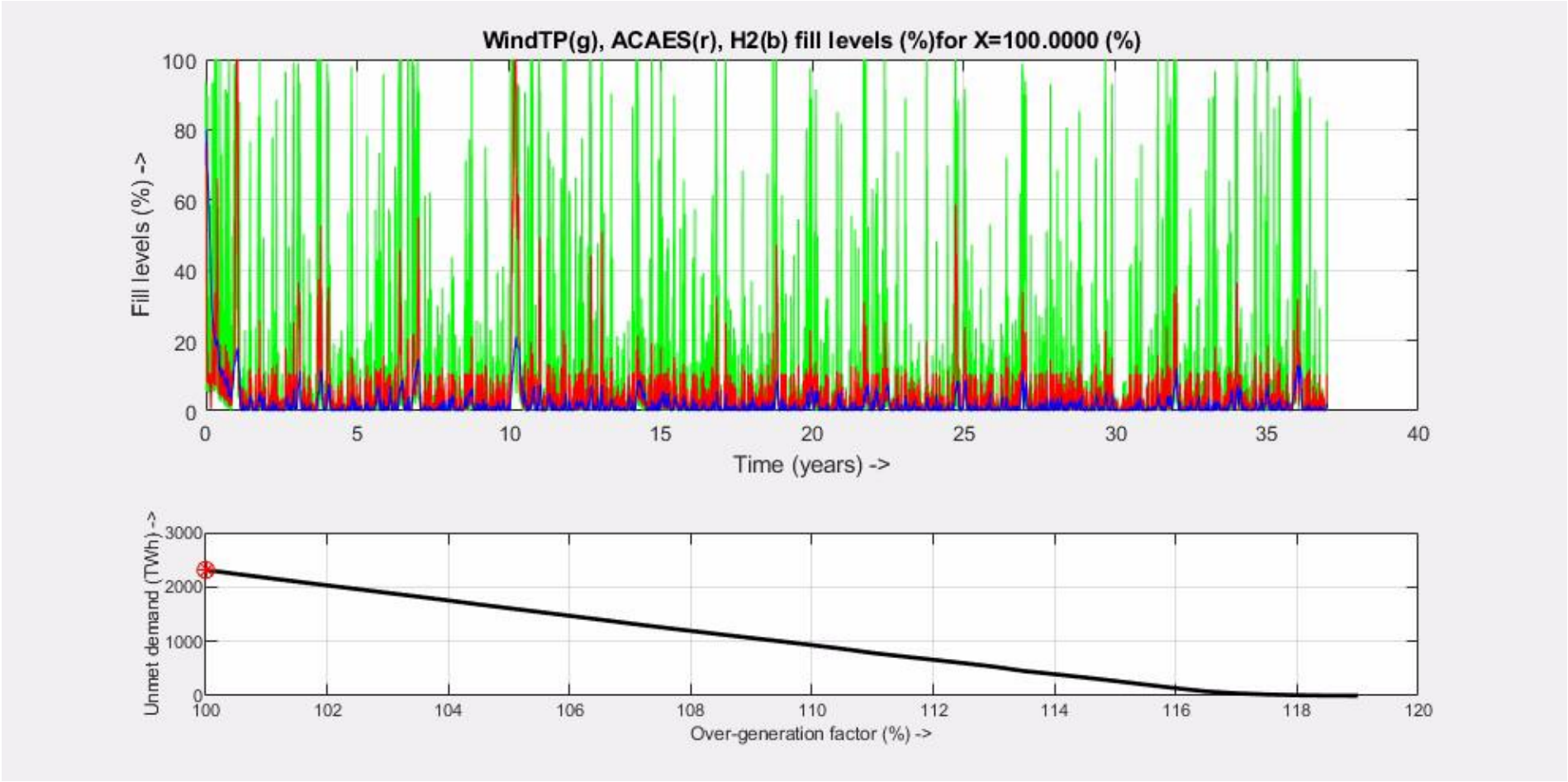
WIS works well when a high fraction of all energy from the wind turbines passes through storage.

Garvey, Eames et. al., *On Generation Integrated Energy Storage*, Energy Policy 86, 2015, pp544-551 http://multiscience.atypon.com/doi/pdf/10.1260/0309-

Section #3

A glimpse into wind-integrated storage (WIS)

#1: Wind-Integrated Storage. G_1=30GW, H_1=20GW, V_1= 1,050GWh, η_1=80%
#2: ACAES. G_2=15GW, H_2=10GW, V_2= 2,800GWh, η_2=65%
#3: Hydrogen Storage. G_3=37GW, H_3=65GW, V_3=80,000GWh, η_3=41%



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A glimpse into wind-integrated storage (WIS)

WINDTP is WIS implemented using thermal pumping. Like all WIS, *WindTP* is a power transmission system for wind turbines that draws power directly from the rotor and delivers output power directly to grid.

WINDTP employs reversible thermal pumping to enable the storage of ~100hrs of rated output capacity at marginal costs much below the cost of the wind turbine itself. This storage capacity with batteries would cost ~10 times as much as the wind turbine (£2/kW vs £200/kWh).

http://multi-science.atypon.com/doi/pdf/10.1260/0309-524X.39.2.149

WIND ENGINEERING Volume 39, No. 2, 2015 PP 149–174

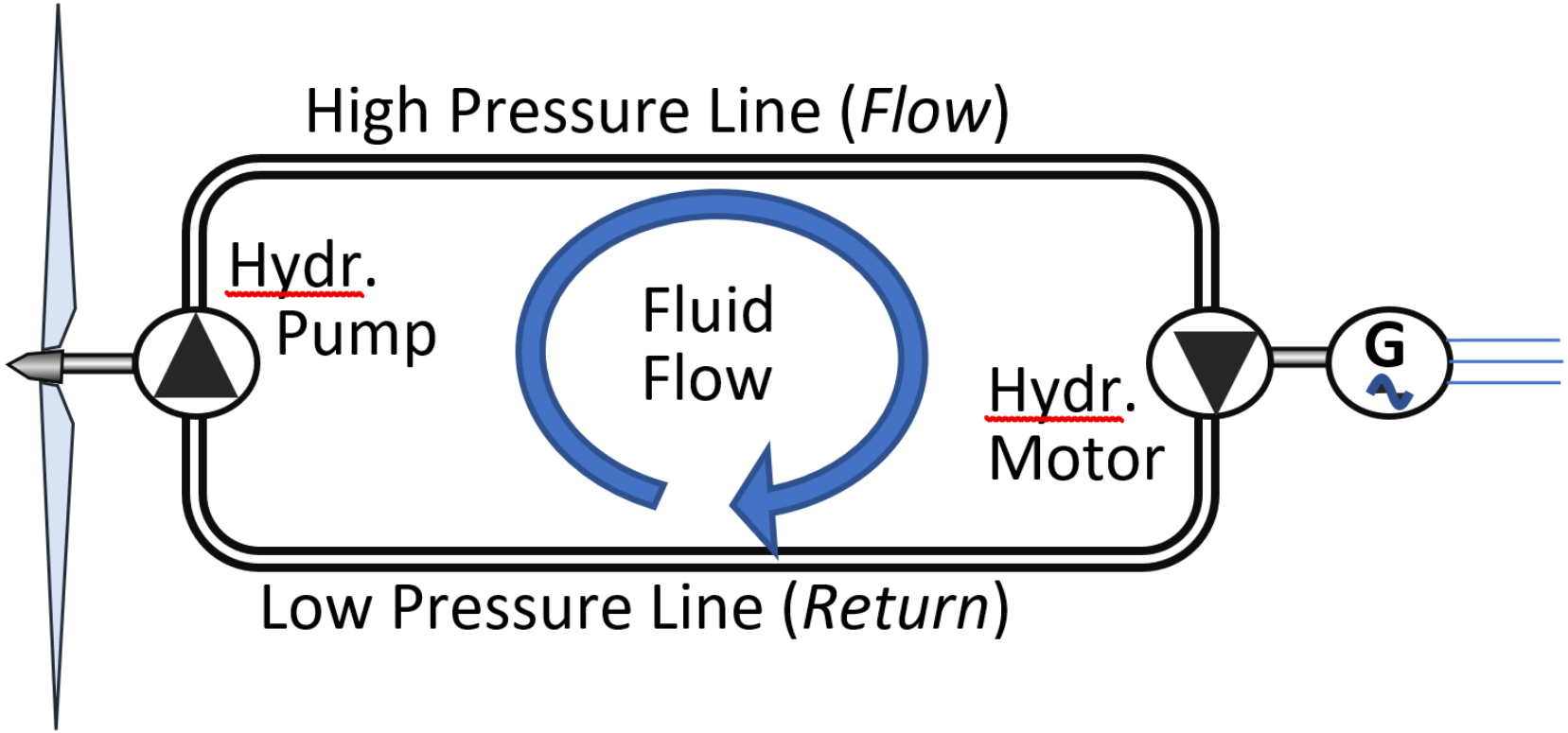
Analysis of a Wind Turbine Power Transmission System with Intrinsic Energy Storage Capability

Seamus D Garvey*[1], Andrew J Pimm[1], James A Buck[1], Simon Woolhead[1], Kai W Liew[1], Bharath Kantharaj[1], James E Garvey[2] and Barrie D Brewster[1]

Section #3

A glimpse into wind-integrated storage (WIS)

Start by understanding a hydraulic transmission between main rotor and generator with a high speed ratio (~×50) …

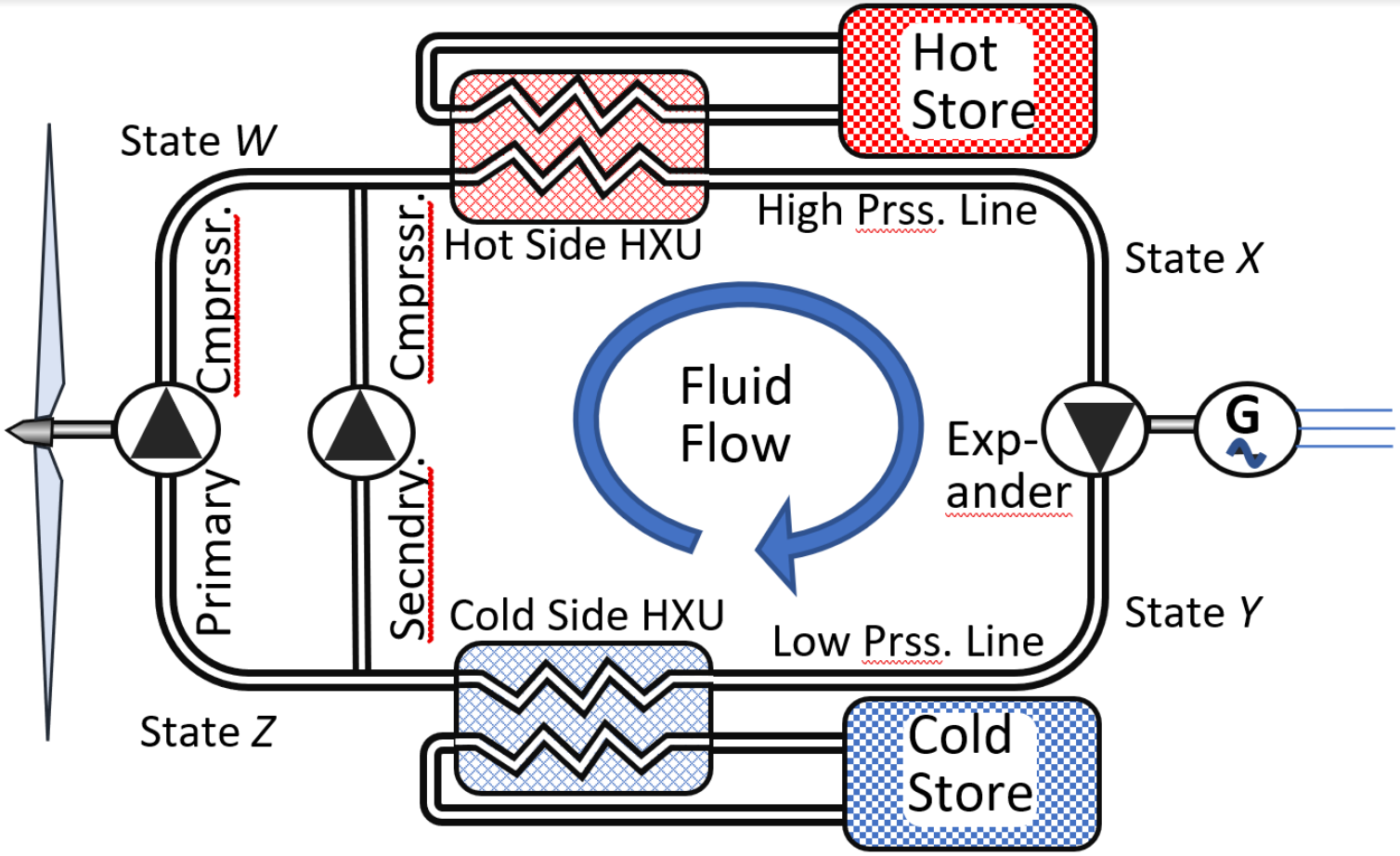


Note: hydraulic transmissions are the natural design choice for *Torque Machines!*

Section #3

A glimpse into wind-integrated storage (WIS)

… and then swap the hydraulic fluid for a gas – the *working gas* … Helium!



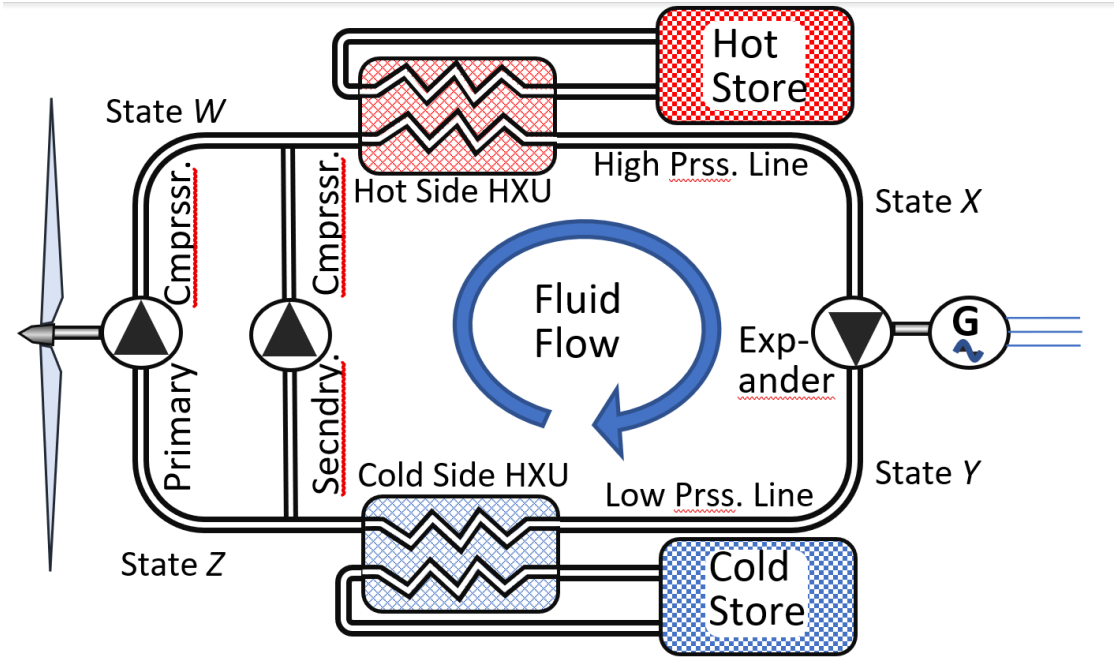
Section #3

A glimpse into wind-integrated storage (WIS)

Together, primary compressor and expander serve 2 functions:

(1) They provide a *variable-speed-ratio gearbox* absorbing power directly from the rotor & delivering it to a medium-speed genertr..

(2) They enable exergy to be passed into storage and recovered from storage



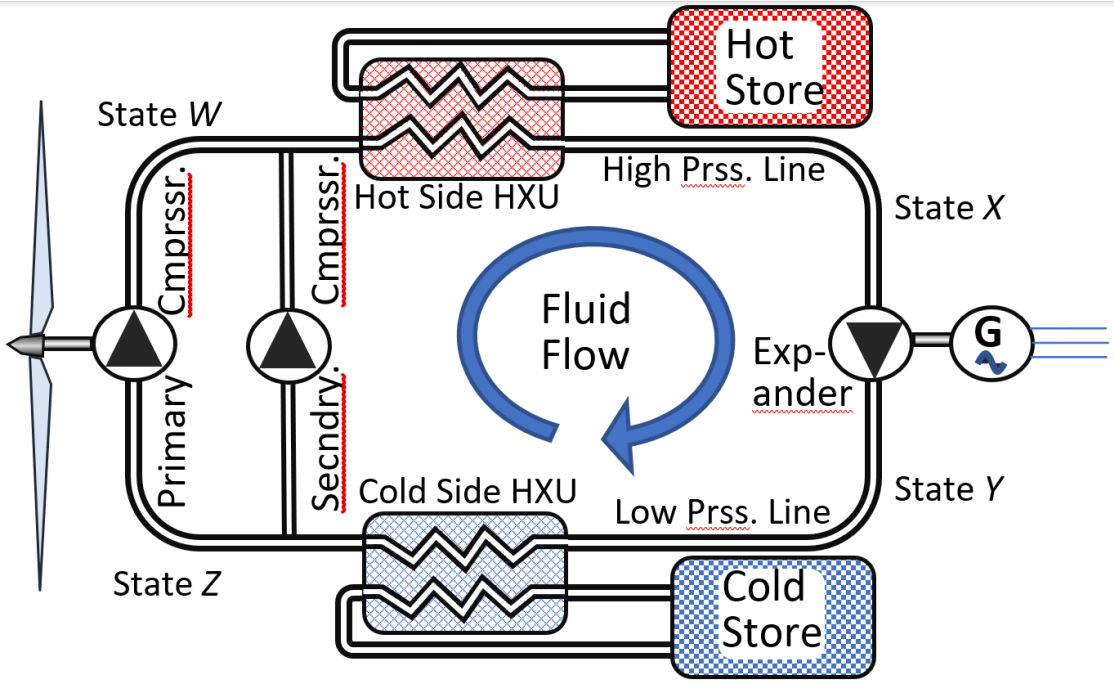
Section #3

A glimpse into wind-integrated storage (WIS)

Very low losses associated with storage because (normally):

(1) The compressor absorbs all main rotor power & no other power.

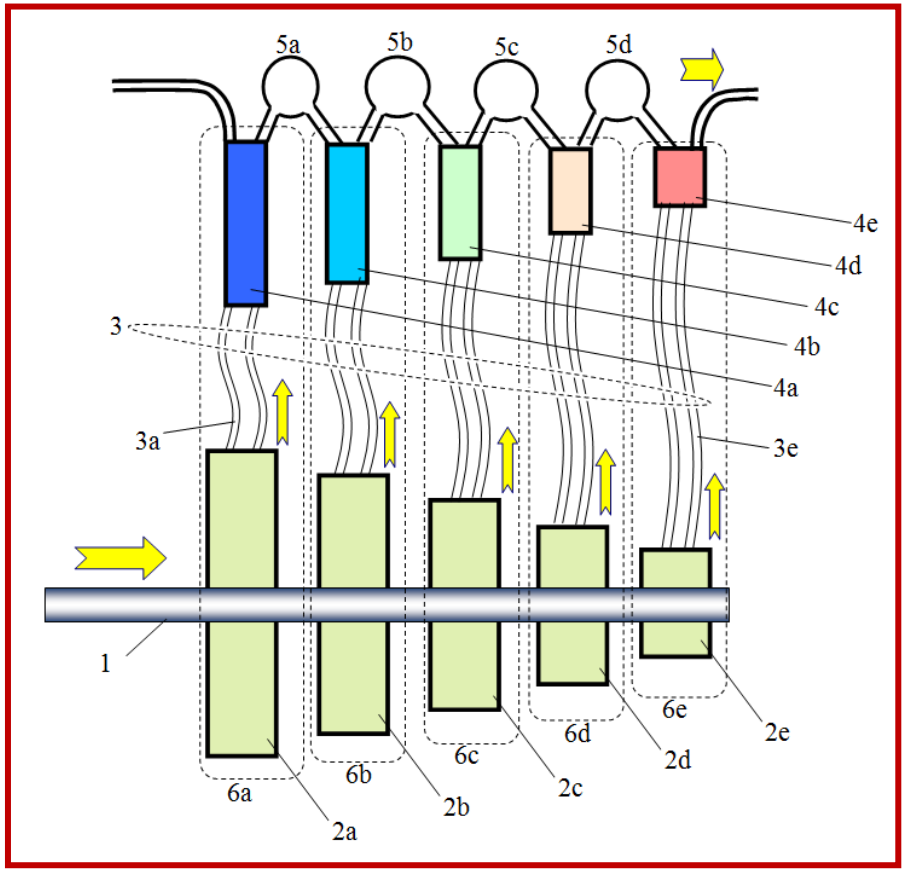
(2) The expander provides all generator power and does not provide any other power.

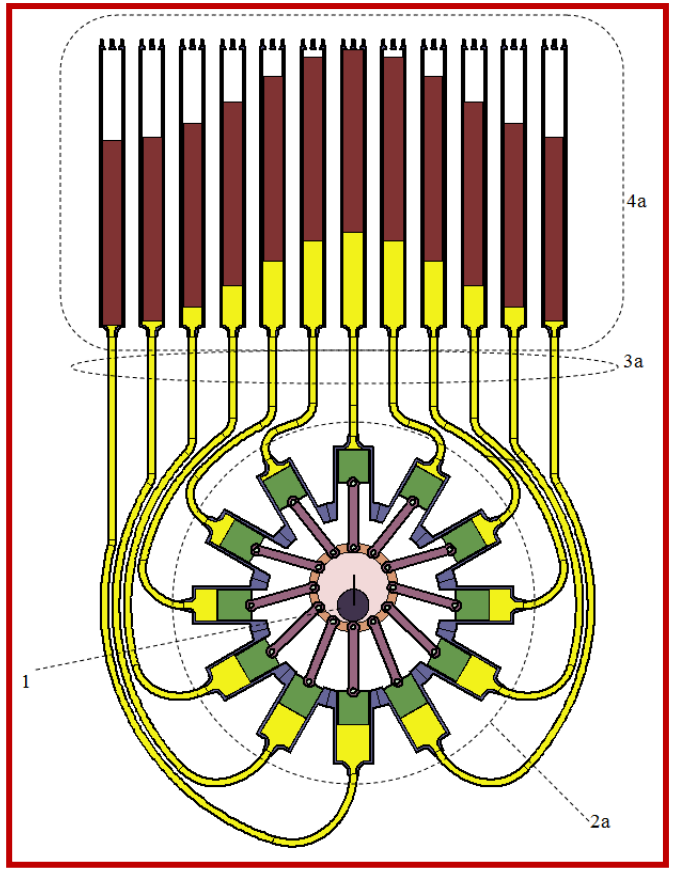


Section #3

A glimpse into wind-integrated storage (WIS)

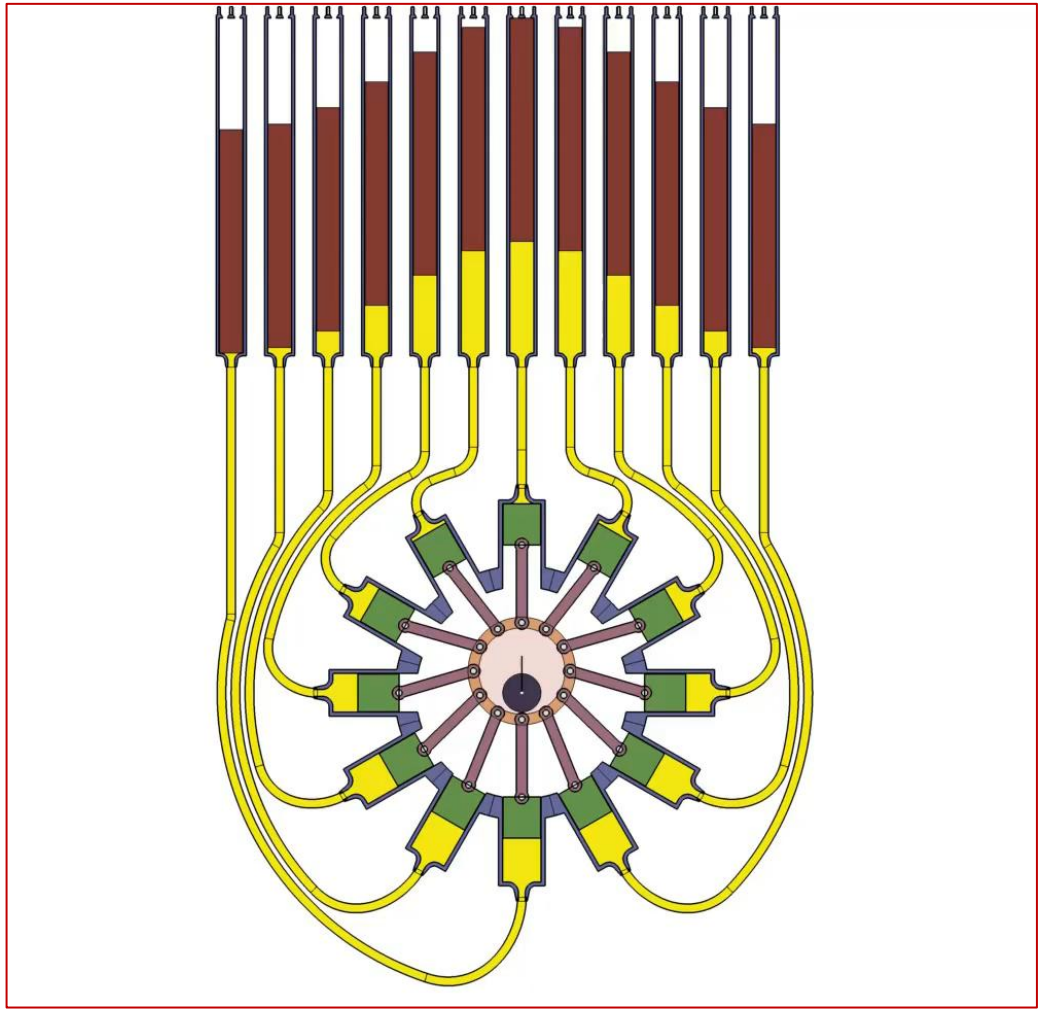
MULTI-STAGE MACHINE. EACH STAGE SIMILAR RATIO, DIFFERENT TEMPERATURE.



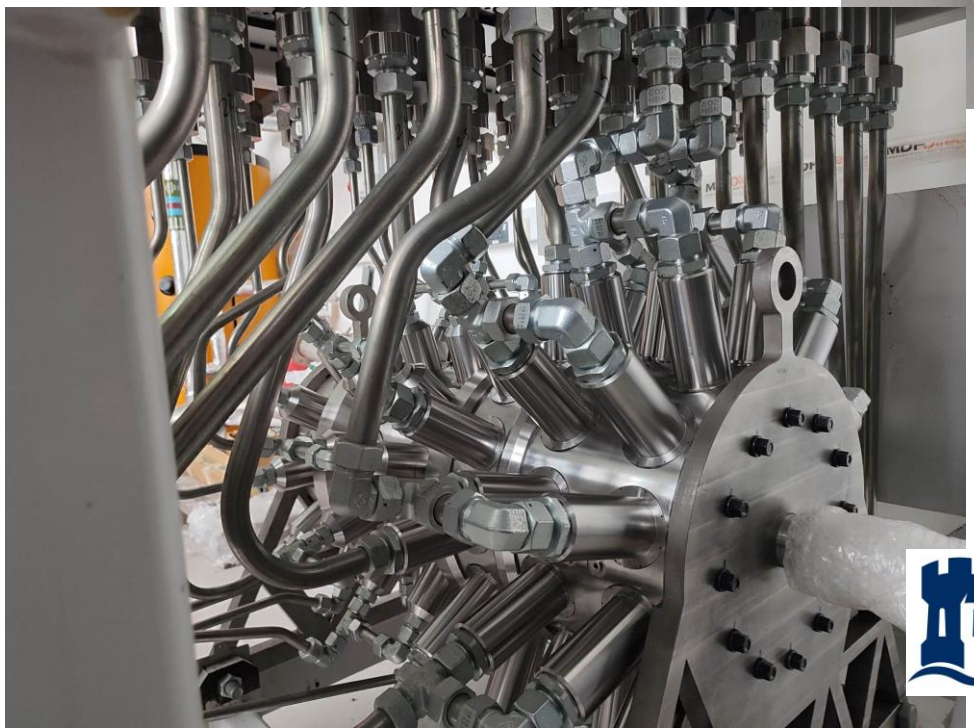


Section #3

A glimpse into wind-integrated storage (WIS)



The machine consists of two parts.
The lower half is the displacer, and the upper half is the converter.
We have oil in the lower half to move backward and forward within pipes and this oil compress the air in the converter pipes.



The University of Nottingham

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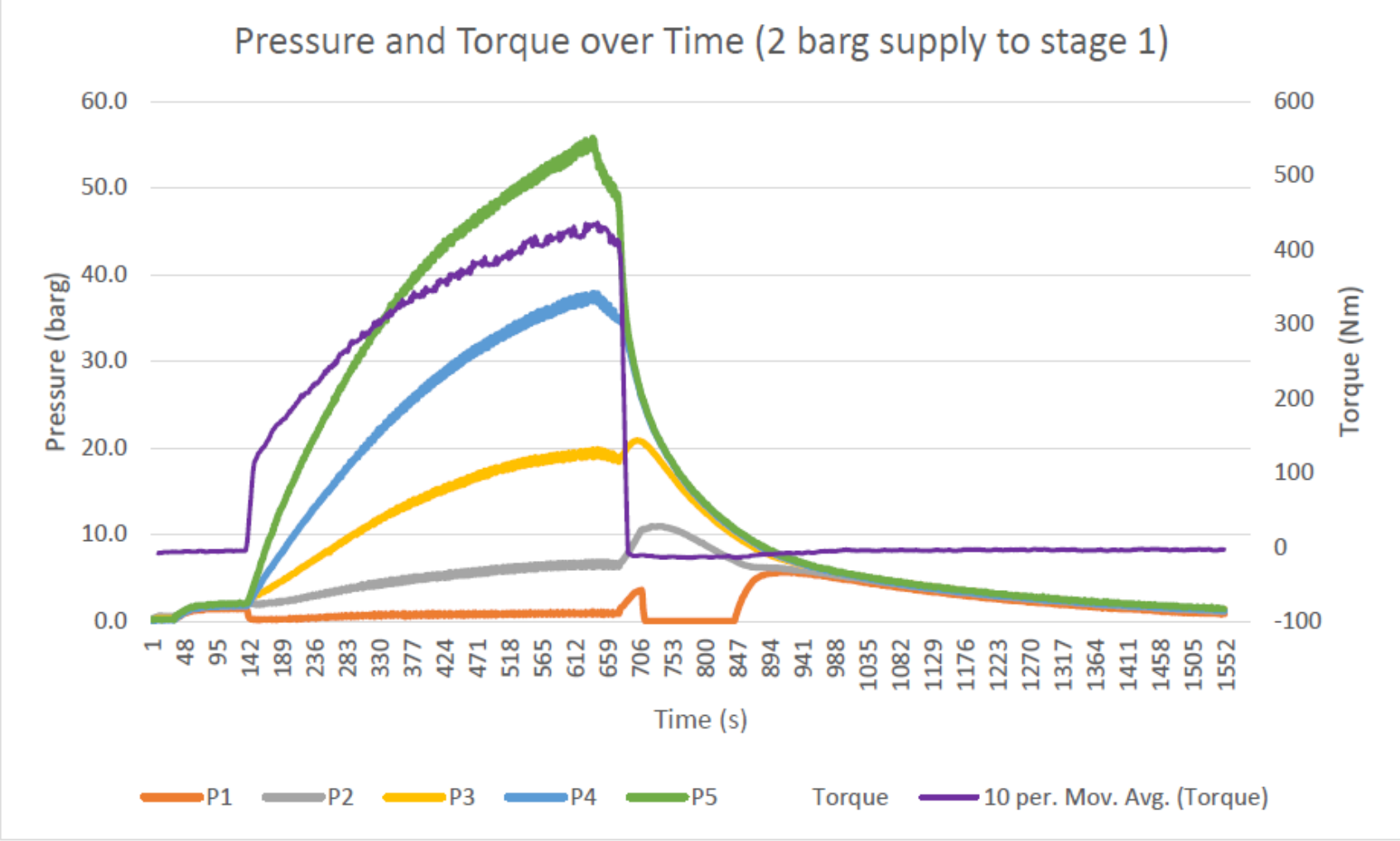
A glimpse into wind-integrated storage (WIS)