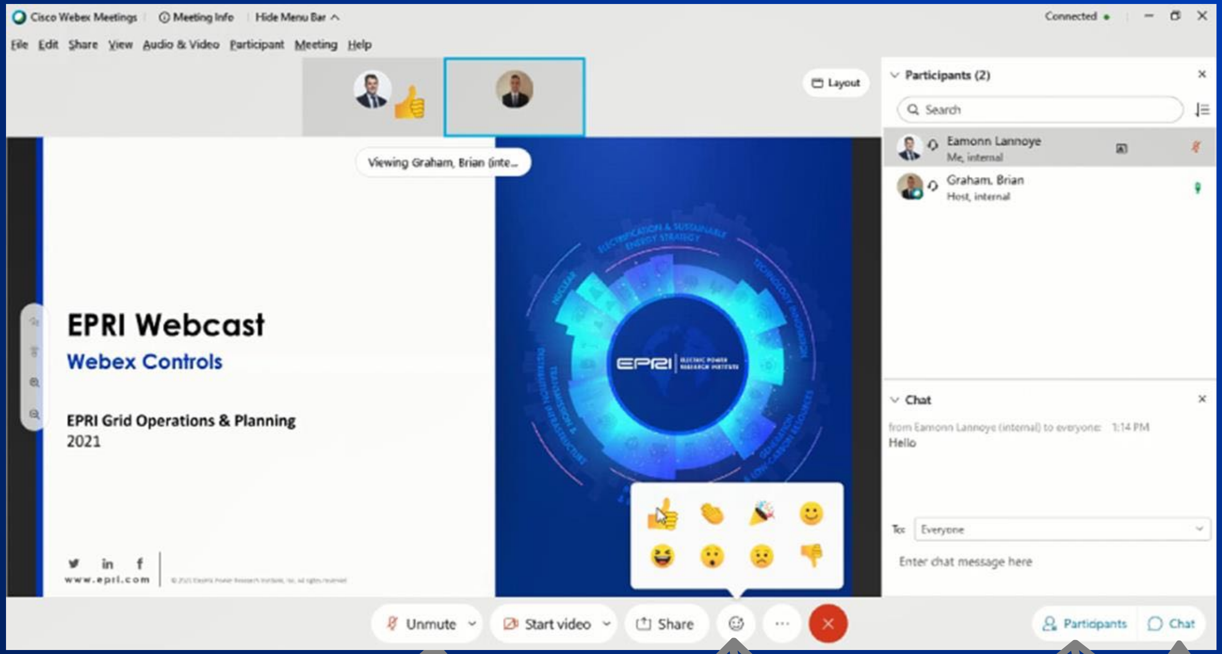
ELECTRIC POWER RESEARCH INSTITUTE

Welcome

EPRI Resource Adequacy Forum

Resource Adequacy for Net Zero Grids

August 9th 2023



Mute & Unmute

Reactions

Participant List

Chat

Please stay on mute unless speaking
Use Call Me for best audio quality

REC This webcast will be recorded

EPRI Resource Adequacy Forum

What is it?

Deep dive series on RA modelling from leading projects and assessments

Who is it for?

Practitioner deep dive on topical study followed by reactions and topical break-out

Format

Practitioner deep dive on topical study followed by reactions and topical break-out

9 August

12:30 EST, 18:30 CEST

Webcast 1: Resource Adequacy for Net Zero Grids

In cooperation with G-PST

18 October

12:30 EST, 18:30 CEST

Webcast 2: Gas Electric considerations for Resource Adequacy

In cooperation with Climate READi

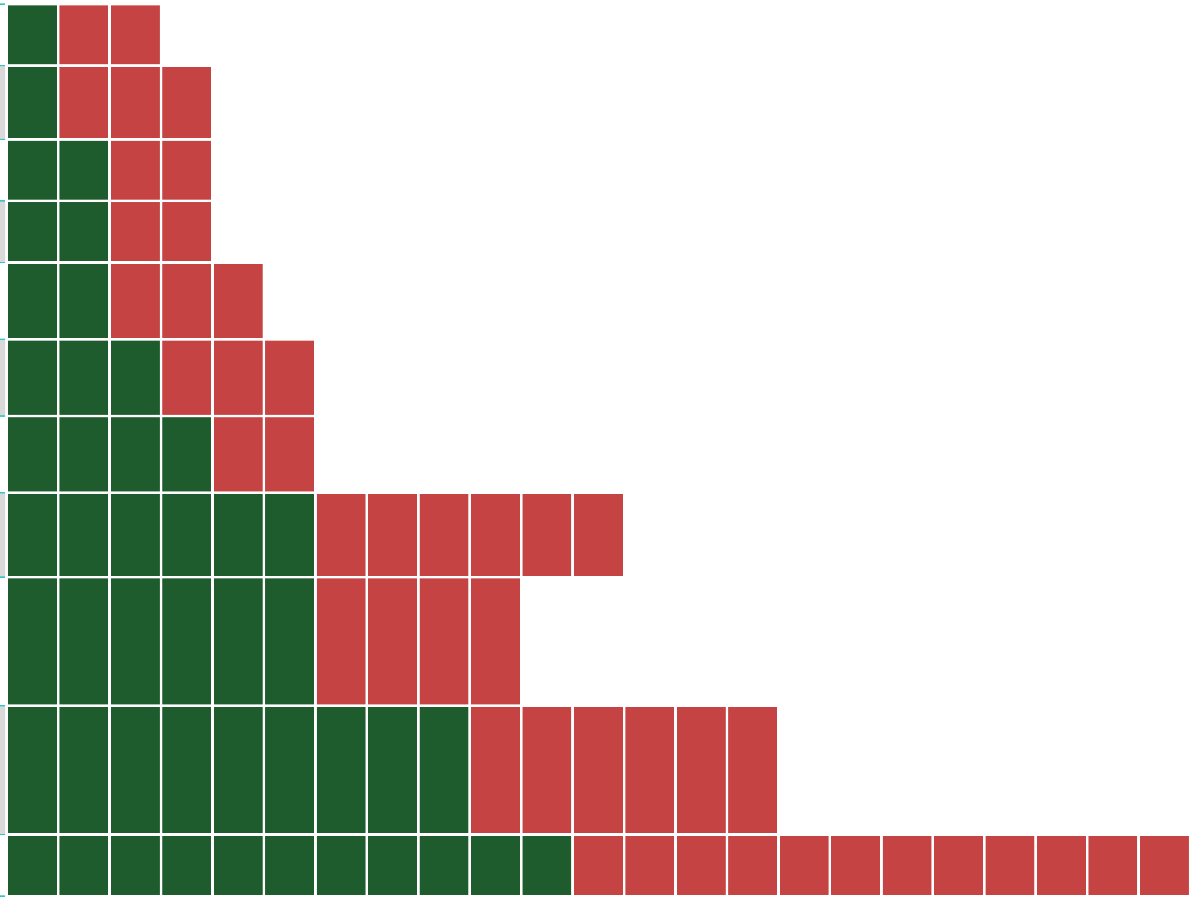
13 December

12:30 EST, 18:30 CEST

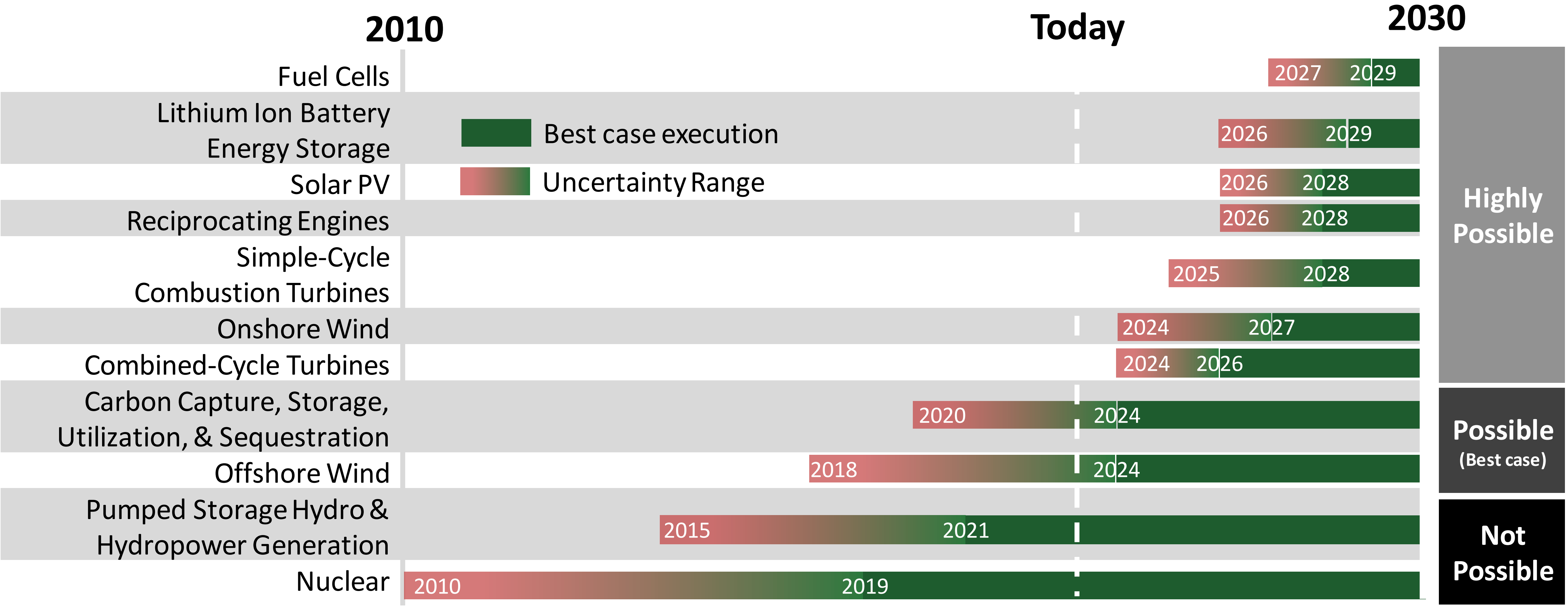
Webcast 3: Load Flexibility in Adequacy Assessments

How Fast Can We Deploy Supply Resources?

Technology	Years to Complete		
	Decision/Pre-Planning	Construction (including commissioning)	Total
Fuel Cells [b]	<1–2	≤1	1-3
Lithium Ion Battery Energy Storage	<1–2	<1–2	1.5-4
Solar PV	1–2	1–2	2-4
Reciprocating Engines	1–2	1–2	2-4
Simple-Cycle Combustion Turbines	1–2	1–3	2-5
Onshore Wind	2–4	1–2	3-6
Combined-Cycle Turbines	2	2–4	4-6
Offshore Wind [a]	4–8	2–4	6-12
Carbon Capture, Storage, Utilization, & Sequestration	3–5	3–5	6-10
Pumped Storage Hydro & Hydropower Generation [c]	5–10 [d]	4–5	9-15
Nuclear [e]	5–10	6–10	11-20



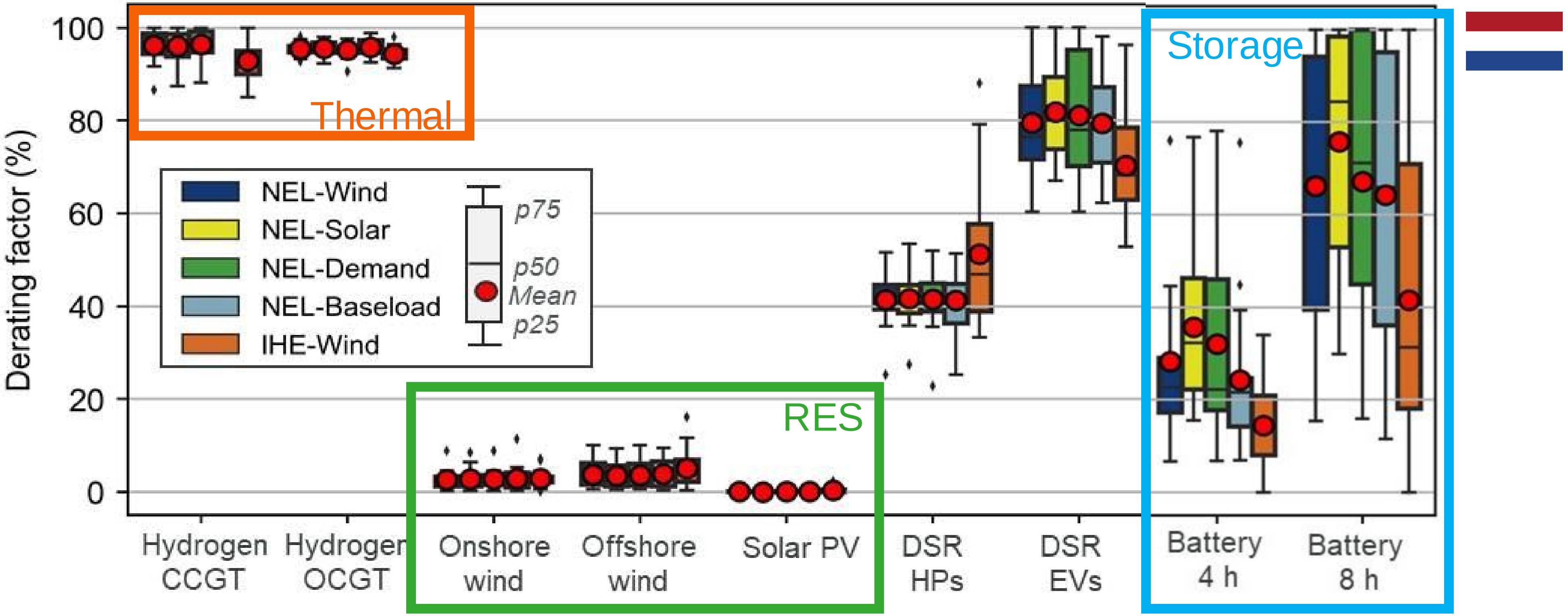
To be operating by 2030, investment decisions need to be taken by…



Reaching critical decision point for post-2030 dispatchable resources

Adequacy results
Firm capacity of different technologies

Calculated derating factors* for selected technologies per scenario for the Netherlands.

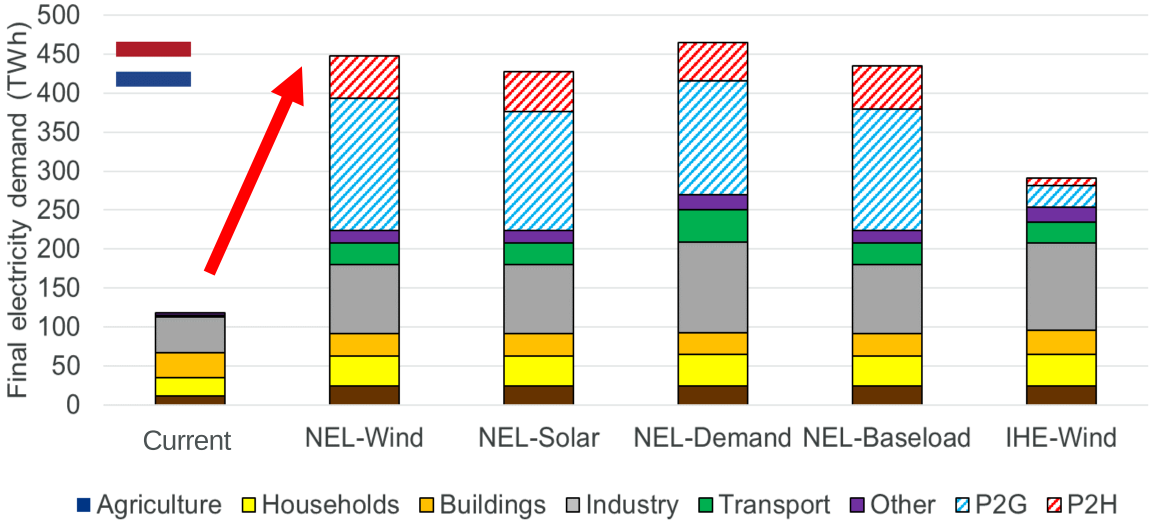


***Derating factor** calculated as the (average) share of the installed capacity of a given technology which is available and contributing to adequacy during scarcity periods*

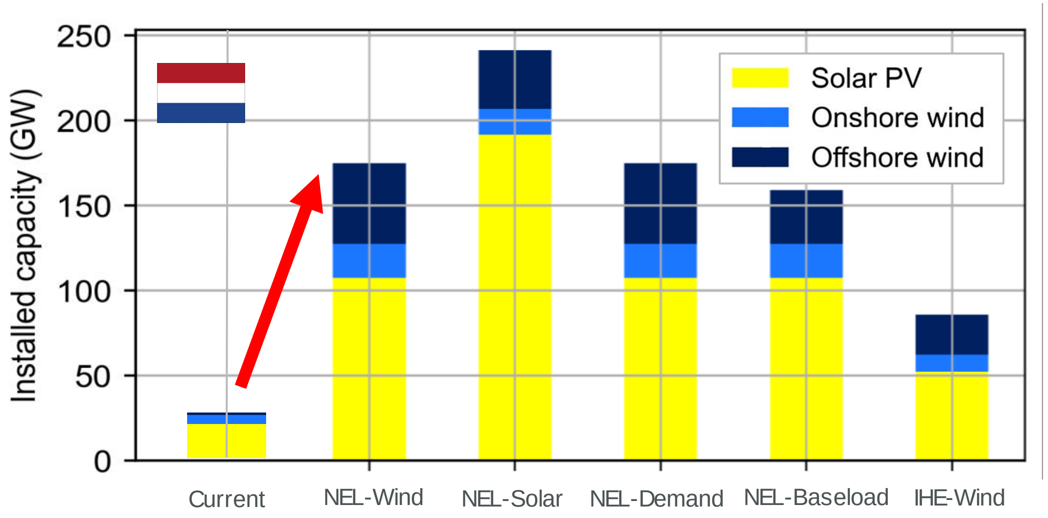
Methodology
Scenarios: Higher load and RES is challenging

- Assuming reliance on low-carbon (RES) electricity for decarbonisation, the challenge for the power system is significant:
  - ➢ Electricity demand: **2- to 4- times higher** than today
  - ➢ RES capacity: **5- to 10- times higher** than today

Electricity demand (TWh/y)



RES capacity (GW)

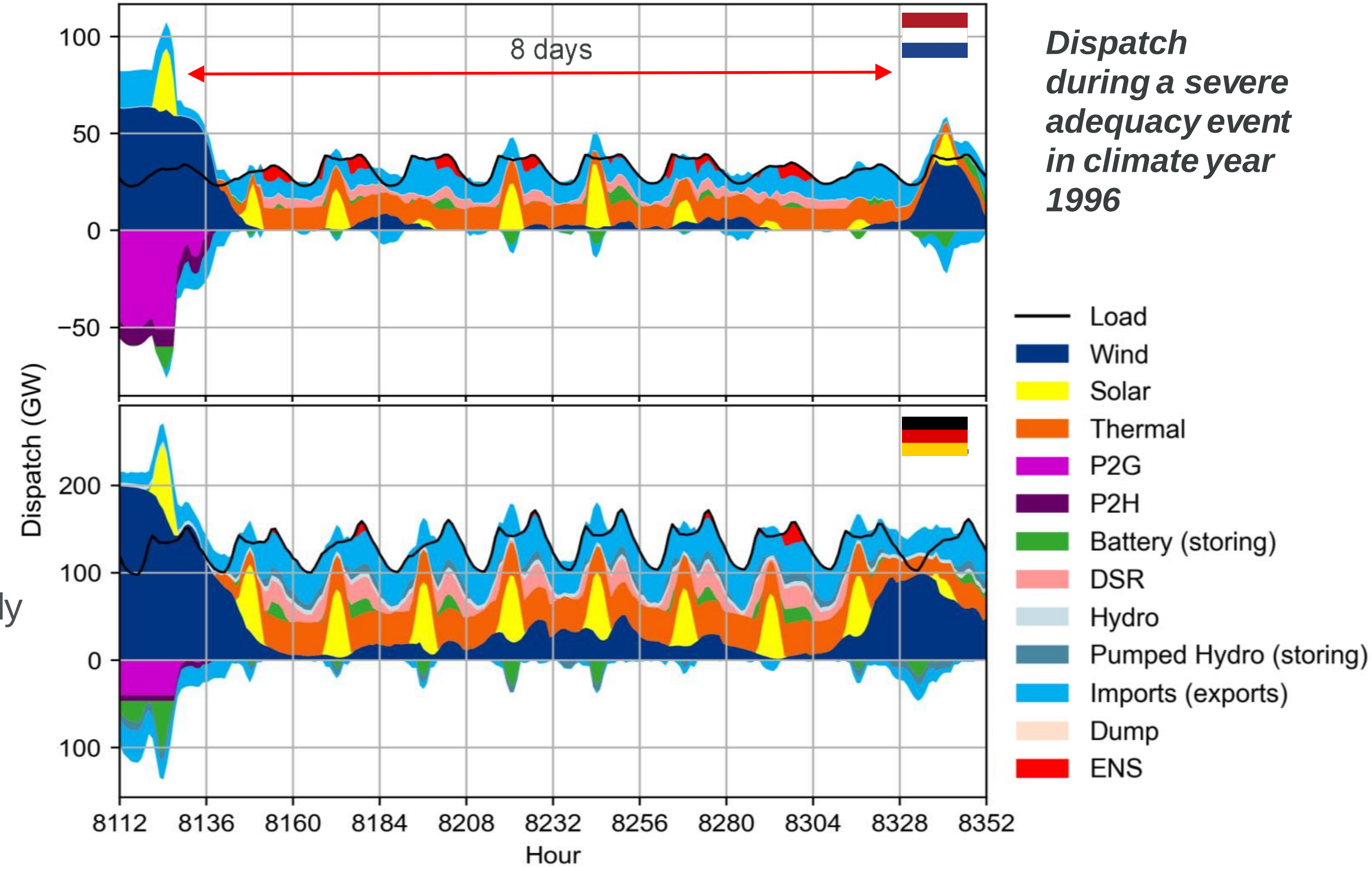


Adequacy results

Major challenge: Long, cold periods with no solar or wind*

Long, cold, dark periods with limited wind are the most challenging for adequacy in the future. Why?

- **Cold**: higher demand for heating
- **Limited RES generation** from solar PV and wind
- **Limited imports**: similar challenges in neighbouring countries
- **Limited storage**: batteries quickly emptied, few charging opportunities
- **All available DSR and thermal** capacity being used



Dispatch during a severe adequacy event in climate year 1996

*Sometimes referred to by the German term 'kalte dunkelflaute': (kalte = cold, dunkel=dark, flaute=low wind)

Summary of the key findings

1

There is no trade off between adequacy and meeting Net Zero but we need to bring forward investment in clean, reliable technologies.

- Even at times of low output from weather-dependent renewable generation, it is possible to operate a fully decarbonised power system and meet customer demand.
- It will require large investment in clean, reliable technologies that are not weather-dependent. This could include: new nuclear, CCS, hydrogen power generation, new electricity storage or other technologies that can deliver energy on a scale of TWh or tens of TWh.
- There is uncertainty in relying upon new technologies. They typically have long lead times and some need to be proven at commercial-scale. Any barriers to delivering this capacity at scale by 2035 should be identified and addressed to reduce dependence on unabated gas.
- This study does not advocate for a preferred technology or combination of technologies in the future resource mix.

2

Understanding risks due to weather patterns will become increasingly important to ensure adequacy in a fully decarbonised system with high levels of weather-dependent generation.

- Weather patterns will be the dominant driver of stress periods in a fully decarbonised power system. This represents a change for the GB system, as tight periods have traditionally been driven by plant availability and high demand.
- New data sets will need to be developed to assess these risks appropriately.
- The most challenging situations are likely to be weather patterns extending across North-West Europe that result in prolonged periods of low wind during winter. Such weather patterns could lead to much longer periods of system tightness compared with those experienced today.
- While batteries play an important role, the nature of these weather patterns mean that adequacy cannot be ensured in a system that relies solely on batteries[1].
- There will be greater inter-dependence with neighbouring countries who may be experiencing similar weather conditions at the same time as us. How reliant we wish to be on imports from other countries is likely to be a GB energy policy decision.

1 This is shown in our study as we considered a case that relies on 6-hour batteries instead of any other new technologies. The case in our study showed a very high capacity (over 120 GW) but could not ensure adequacy, as the batteries could not provide sufficient energy to meet demand during prolonged adverse weather patterns (e.g. 120 GW of 6-hour batteries provides less than 1 TWh of energy).

Summary of the key findings

3

New modelling approaches and metrics will be required to assess risks to adequacy in a fully decarbonised power system.

- Great Britain currently has a statutory reliability standard of 3 hours loss of load expectation (LOLE)
- The GB system is expected to evolve from one where tight periods are relatively short to one where they could be much longer. Even though the duration of tight periods increases, the LOLE of the system remains broadly similar. This means that the inherent risk profile of the system is changing but the key metric is not.
- The modelling suggests that the GB system will be more susceptible to events that have a lower likelihood of occurring but will have a greater impact if they materialise. This is evident from longer-duration weather events becoming increasingly dominant in driving stress periods, for a similar LOLE value. This means that in many years, no tight periods on the GB system would be expected, but occasionally in other years, there could be prolonged tight periods that are more challenging.
- As the electricity system transitions to being fully decarbonised, industry and the government should work together to understand how to improve current approaches to the way that adequacy is measured. This could lead to new metrics that either support or replace existing ones such as LOLE.

4

It will become more important to consider adequacy in the context of developing the right markets, the right networks and future operability challenges to be confident that adequacy is ensured in a cost effective way.

- The economic viability of the resources was not considered in this study. The markets arrangements in which these resources operate in future could be very different to those that are in place today. The right market arrangements will need to be in place to bring forward investment in new resources that are needed to ensure adequacy. This could warrant further investigation through the ESO's work on Net Zero Market Reform[1] and / or the UK Government's Review of Electricity Market Arrangements (REMA)[2].
- The potential impact of network constraints has not been considered in this study. Future work will need to incorporate these considerations, given the current and likely future locations of renewable deployment.
- While the different resource mixes in our study had similar levels of adequacy, there could be significant differences in other related areas such as operability[3]. For example, there may be higher levels of excess energy and curtailment of renewables at other times of the year in a system where resources providing adequacy are less flexible.

1 https://www.nationalgrideso.com/future-energy/projects/net-zero-market-reform
2 https://www.gov.uk/government/consultations/review-of-electricity-market-arrangements
3 https://www.nationalgrideso.com/research-publications/system-operability-framework-sof