

Topical Digest

Large-scale energy storage methods for wind energy

BENCE SOLYMOSI





Topical Digest

Large-scale energy storage methods for wind energy

20 January 2025

This Topical Digest provides a reading list on the issue of utilising large-scale energy storage methods coupled to an intermittent energy source, like wind. First it compiles the relevant international agreements that form the basis of signatory countries' net zero policies and schemes. Afterwards the national strategies and legislation are highlighted of the wider United Kingdom, Northern Ireland specifically, and the Republic of Ireland. Then a technical explanation is given of the most relevant technologies in regards to wind energy and energy storage methods. Finally an excerpt of articles is provided from local media coverage regarding this area.

Should MLAs or their constituency staff have suggestions for information they would like to see in the guide, or have links to useful sources that they would like to share, please feel free to contact the Research and Information Service at:
RaISe_CSU@niassembly.gov.uk

Front cover image: RaISe, using Adobe Stock Images

Introduction

This Topical Digest provides a reading list to support better understanding of wind power as a viable renewable energy source in Northern Ireland. It highlights the integration of wind energy coupled to grid-scale energy storage systems, into Northern Ireland's energy infrastructure. Both wind energy and grid scale energy storage are expected to play crucial roles in the decarbonisation of the transport, industry and power generation of both the United Kingdom and the Republic of Ireland, but especially Northern Ireland, which is one of the windiest regions of Europe.

Note: this Topical Digest draws upon policy documents published under the previous United Kingdom Government. At the time of writing, it is unclear as to what direction the current Government will adopt with regard to energy storage.

Context setting

Without energy storage wind can only be used to satisfy energy demand that occurs at the same time wind energy is harvested. But due to the unpredictably intermittent nature of wind, high energy demand does not reliably coincide with times of high wind energy production. This means that in order to increase the efficiency and effectiveness of harvesting wind energy it should be coupled with some form of energy storage.

This can be done by transforming the kinetic energy of wind into some other form of energy, most commonly mechanical or chemical energy. Mechanical energy storage methods most commonly store energy by bringing a liquid or gas into a higher energy state, and then releasing the stored energy to drive a turbine and thus generate electricity. Two common examples of this are compressed air and pumped hydro energy storage. The former uses surplus energy from renewables to force air into a high pressure vessel or airtight cavern at times of high renewable energy production but low overall energy demand, and then use it to generate electric power at times of high overall energy demand. Pumped hydro energy storage achieves the same aim by pumping water from a lower elevation reservoir to a higher one using surplus energy. The water can then flow back down through a turbine in order to generate electricity.

The most common chemical energy storage methods are the generation and storage of hydrogen and using surplus energy to charge large capacity batteries. The former is

relatively straightforward; electricity can be used to split water into hydrogen and oxygen gases. Hydrogen can then be used as energy source in fuel cells or internal combustion engines or as an industrial resource. The latter shows significant complexity based on what type of battery is used and what supply chain and other implications this has. In general this is no different from charging a smartphone; when renewable energy production is high, the surplus electricity can be used to charge large capacity battery farms. The stored electricity can then be used to power industrial electronics, electric vehicles, heating and cooling systems, etc.

For a more detailed discussion of wind energy and its potential storage methods, please refer to RaiSe Briefing Paper NIAR 111-24, [Large-Scale energy storage methods for wind energy](#) (dated July 2024).

1 Global agreements that serve as the basis of net zero initiatives

- United Nations, [Kyoto Protocol to the United Nations Framework Convention on Climate Change](#) (1997)
- United Nations, [Paris Agreement to the United Nations Framework Convention on Climate Change](#) (2015)

2 National strategies and legislation relating to climate change

Great Britain

- [Climate Change Act 2008](#)
- Department for Energy Security and Net Zero, [Energy Technology List \(ETL\)](#) (May 2015, updated: July 2024)
- Department for Energy Security and Net Zero, [2021 Net Zero Strategy: Build Back Greener](#) (October 2021, updated: April 2022)
- Department for Energy Security and Net Zero, [2021 Heat and buildings strategy](#) (October 2021, updated: March 2023)
- Department for Energy Security and Net Zero, [2021 United Kingdom hydrogen strategy](#) (August 2021, updated: December 2024)
- Department for Energy Security and Net Zero, [Public Sector Decarbonisation Scheme](#) (October 2020, updated: September 2024)
- Department for Energy Security and Net Zero, [2023 Offshore wind net zero investment roadmap](#) (March 2023)

- Department for Energy Security and Net Zero, [Introducing Great British Energy](#) (July 2024)
- Department for Energy Security and Net Zero, [Clean Power 2030 Action Plan](#) (December 2024)

Northern Ireland

- [Climate Change Act \(Northern Ireland\) 2022](#)
- Department for the Economy, [Northern Ireland Energy Strategy 'Path to Net Zero'](#) (December 2021)
- Department for the Economy, [Energy Strategy e-bulletins](#) (June 2020 – October 2024)
- Department for the Economy, [Energy Strategy Action Plan 2024](#) (March 2024)
- Department for the Economy, [Smart meters Cost/Benefit analysis report](#) (June 2023)
- Department for the Economy, [Heat Networks collection](#)
- Department for the Economy, [Energy in Northern Ireland 2024](#) (June 2024)
- Department for the Economy, [Electricity Consumption and Renewable Generation Statistics for the period October 2023 to September 2024](#) (December 2024)

Republic of Ireland

- [Climate Action and Low Carbon Development \(Amendment\) Act 2021](#)
- Department of the Environment, Climate and Communications, [2019 Climate Action Plan](#) (June 2019, updated June 2022)
- European Commission [2021 European Climate Law and the European Green Deal](#)
- Department of the Environment, Climate and Communications, [2023 National Hydrogen Strategy](#) (July 2023)

3 Electricity generation from wind energy

- National Grid, [Energy Explained](#)
- International Energy Agency, [Wind Power Collection](#)
- EnergyData.info, [Global Wind Atlas](#)
- EirGrid, [All-Island Smart Grid Dashboard](#)
- National Grid, [Smart Dashboard](#)
- United States Department of Energy, [Wind Energy Basics](#)
- Energy Systems Catapult, [Floating Offshore Wind Farms](#) (2023)

4 Energy storage

General concepts

- European Association for Energy Storage [Why Energy Storage?](#)
- International Energy Agency, [Demand Response](#)
- Exro Technologies, [Load shifting: What is it and how does it work?](#)

Mechanical energy storage

- Pumped Hydro International Hydropower Association, [Explainer](#)
- United Nations Climate Technology Centre & Network, [Compressed Air Energy Storage](#)

Chemical energy storage

- European Commission, Joint Research Centre, [Current status of chemical energy storage technologies](#) (2020)
- United States Department of Energy, [DOE Explains...Solar Fuels](#)
- National Grid, [Energy Explained – Hydrogen](#) (February 2023)
- United States Department of Energy, [Hydrogen Production: Electrolysis](#)
- European Commission, [Hydrogen](#)
- International Energy Agency, [Hydrogen](#)
- International Renewable Energy Agency, [Hydrogen](#)
- United States Department of Energy, [DOE Explains...Batteries](#)

Electric vehicles as energy storage

- Energy Systems Catapult, [Storage and Flexibility Net Zero Series: Vehicle to Grid](#)
- European Battery Alliance [Vehicle-to-Grid: Energy Storage on Wheels](#) (2020)
- Xu, C, Behrens, P, Gasper, P et al. Electric vehicle batteries alone could satisfy short-term grid storage demand by as early as 2030. Nature Communication 14, 119 (2023) <https://doi.org/10.1038/s41467-022-35393-0>

5 Relevant Westminster research output

House of Commons

- House of Commons Library, [Battery energy storage systems](#) (April 2024)
- House of Commons Library, [Planning for solar farms](#) (May 2024)
- House of Commons Library, [Energy Bill \[HL\] 2022-23: Progress of the Bill](#) (February 2024)
- House of Commons Library, [Floating offshore wind](#) (November 2023)
- House of Commons Library [Where will Britain's future energy supply come from?](#) (May 2022)

House of Lords

- House of Lords Library, ['Investing in energy: Price, security, and the transition to net zero': Economic Affairs Committee report](#) (September 2023)
- House of Lords Economic Affairs Committee Report: [Investing in energy: price, security, and the transition to net zero](#) (July 2022)

Parliamentary Office of Science and Technology (POST)

- POSTnote 602: [Developments in Wind Power](#) (May 2019)
- POSTnote 668: [Longer Duration Energy Storage](#) (December 2022)
- POSTnote 694: [Electricity market reform](#) (May 2023)
- POSTnote 715: [Demand side response: A tool for lowering household energy bills](#) (February 2024)

6 Selection of United Kingdom media coverage

United Kingdom

- Energy Storage News, [UK: Battery storage could help reduce wind curtailment costs by 80%](#) (9 April 2024)
- The Guardian, [Salt, air and bricks: could this be the future of energy storage?](#) (1 April 2024)
- BBC News, [How giant batteries will help power Scotland](#) (12 March 2024)
- The Guardian, [UK's green power industry receives surprise £10bn pledge](#), (7 March 2024)
- The Independent [UK 'not fast enough' on energy transition, says Siemens Energy boss](#) (4 March 2024)

- The Guardian, [Power struggle: fears for UK energy generation as green projects delayed](#) (16 February 2024)
- The National, [Scottish ministers reject plans for wind farm at English Border](#), (5 January 2024)
- BBC News, [Huge jobs growth seen in Scotland's renewables sector](#) (18 December 2023)
- The Energyst, [World's biggest ohm game near Old Trafford: Manchester nets globe's biggest grid-scale battery](#) (24 July 2023)
- The Scotsman, [Power grid boost as two Scottish firms net £14m to work on energy storage systems](#) (28 November 2022)

Northern Ireland

- Renewable Energy Magazine, [Planning application for RES' Shaneragh BESS in Northern Ireland](#) (13 January 2025)
- The News Letter, [Officials unite to hear the vital role of new battery energy storage system in Northern Ireland](#) (19 June 2024)
- The News Letter, [Northern Ireland firm unites with Australian company to develop long-duration energy storage infrastructure](#) (17 June 2024)
- Politico, [How Brexit's fallout doomed climate action in Northern Ireland](#) (16 June 2024)
- The News Letter, [Offshore wind project leader urges policy makers to 'keep Northern Ireland at the front of renewables race'](#) (10 June 2024)
- The Irish News, [Stormont blasted for 'lack of urgency' on Irish Sea floating wind turbine project](#) (10 June 2024)
- Agenda NI, [Renewable energy and net zero in Northern Ireland](#) (May 2024)
- BBC News, [Fewer in NI willing to pay more for greener energy](#) (2 May 2024)
- BBC News, [Green energy support scheme could start next year](#) (9 April 2024)
- Renew, [Belfast reintroduces renewables support scheme](#) (9 April 2024)
- The Planner, [Civil servants blame planning system for lack of renewable energy progress](#) (14 March 2024)
- The Belfast Telegraph, [UK 'not fast enough' on energy transition, says Siemens Energy boss](#) (4 March 2024)
- Renew, ['Stormont's return to kickstart NI floater rollout'](#) (7 February 2024)
- Current, [Northern Ireland: A renewable energy success story?](#) (6 February 2024)
- BBC News, [Wind power: Potential benefits of offshore energy in Ireland set out](#) (30 January 2024)
- Renew, ['Planning appeals delays jeopardise NI wind projects'](#) (23 January 2024)

- Current, [NI saves £243 million from wind power in 2023](#) (22 January 2024)
- BBC News, [Renewable energy: Wind power 'saved Northern Ireland £243m last year'](#) (19 January 2024)
- Renewables, [Wind saves Northern Ireland £243m on gas](#) (19 January 2024)
- BBC News, [Net zero: NI has 'no powers' to meet decarbonisation goals](#) (17 January 2024)
- BBC News, Wind farm application in County Antrim recommended for refusal (10 January 2024)
- BBC News, [Call for action after dip in renewable energy generated in NI](#) (7 December 2023)
- The Belfast Telegraph, [Amazon opens new wind farm in Co Antrim](#) (12 October 2023)
- The Irish Farmer's Journal, [RES exploring potential for new wind farm in Northern Ireland](#) (28 August 2023)
- The Belfast Telegraph, [Millions of pounds ploughed into renewable energy projects for NI](#) (26 June 2023)

Republic of Ireland

- The Irish Examiner, [Battery energy storage systems are a vital piece of Ireland's renewable energy puzzle](#) (16 May 2024)
- The Irish Examiner, [Wind energy showing signs of momentum, but problems persist](#) (16 May 2024)
- The Irish Times, [Infrastructure, innovation and speed needed to hit renewables targets](#) (25 April 2024)
- The Irish Times, [ESB's investment in renewable energy grows significantly; ESB Group invested more than EUR 1 billion in critical energy infrastructure this year](#) (29 December 2023)
- ElectroRoute, [Guest Blog: The Potential for Energy Storage in Ireland](#) (20 July 2023)
- The Irish Times, [Batteries, hydrogen and storage: Flexibility is new frontier of zero-carbon electricity](#) (5 January 2023)

This information is provided to MLAs in support of their Assembly duties and is not intended to address the specific circumstances of any particular individual or organisation. Inclusion of a resource does not imply endorsement of any particular viewpoint. Whilst we strive to ensure that the information provided here is up to date, the information on external websites referred to may change frequently. This leaflet should not be relied upon as providing legal or professional advice, nor as a substitute for it. A suitably qualified professional should be consulted if specific advice or information is required.

The Research and Information Service is available to discuss the content of this briefing with Members and their staff, but not with the general public.

For more information, please use the following weblink or QR code: <http://www.niassembly.gov.uk/assembly-business/research-and-information-service-raise/>

