Transparent Grids for All

Grid(un)lock: Hosting Capacity Maps

Published: 24 July 2024 | Authors: Zsuzsanna Pató, Elisabeth Cremona, and Chris Rosslowe

Introduction

Power grids have finite capacity. As renewables thrive and consumers electrify away from fossil gas, pressure on the grid is mounting. Lack of grid capacity is already a key barrier to deploying new renewables and connecting new consumers, and capacity is likely to continue to lag behind what is needed for several years to come. This is exacerbated by inefficient grid connection procedures that are unable to keep up with the surge in requests. The resulting long connection queues and delayed projects risk holding back Europe's accelerating energy transition.

Grid hosting capacity maps

One solution in the portfolio is the publication of grid hosting capacity maps by grid operators. These maps provide information about the available space on the power grid for new capacity at a certain location, according to the current and expected future status of the grid.

While some users, such as existing industries or households, have no or limited options to choose the location of their grid connection; others do, such as project promoters looking to develop new renewables, electrolysers, data centres or large electric vehicle chargers. Having visibility on available capacity at various locations would enable these users to factor it into their decisions and make smarter applications. This could bring multiple benefits:

- Certain grid users can select the location of their installations according to capacity availability, reducing the time spent in grid connection queues, potentially speeding up investment decisions and thus the deployment of critical clean technologies.
- It could alleviate the number of grid connection requests submitted to the TSO/DSO, as project promoters would not need to desperately 'fish' for locations, submitting multiple grid connection requests for various locations (as is common practice, currently).
- It would enable users to make the best use of the existing network, both through identifying where new capacity can be connected and where flexibility solutions such as storage and demand-side flexibility are in high demand.

These hosting capacity maps are not entirely new. Utilities in 24 US states have provided grid capacity maps for years, and third-party service providers also offer this information. Some European system operators have been following suit (see Table 1 below for some examples), and this has now become mandatory for both TSOs and DSOs under the recently revised EU electricity market legislation.

The Electricity Market Regulation (articles 50 and 57) and the Electricity Market Directive (article 31) require TSOs and DSOs to:

- Publish information on the capacity available for new connections in their areas of operation with high spatial granularity, including the capacity under connection request and the possibility of flexible connection in congested areas.
- Update this information on a regular basis, which is at least every month for TSOs and at least every quarter for DSOs.
- Publish the criteria used to determine the available grid capacities.

Related to these new requirements, the Grid Action Plan assigns two tasks to ENTSO-E and the EU DSO Entity under Action 6. Firstly, to agree on harmonised definitions for available grid hosting capacity for system operators. Such consistency would facilitate the search for available capacity by grid users. Secondly, to establish a pan-EU overview of available grid hosting capacities by mid-2025 to give visibility to project developers when conceptualising their projects. The pan-European overview should consider the capacity mappings already developed by TSOs and DSOs as some of them already are ahead of the curve.

What would be an "ideal" map?

While EU legislation sets out a number of criteria for providing information on grid hosting capacity, specifics are lacking. Additionally, existing maps show great variety in terms of the information categories provided for grid users (generation only, renewables only, or both generation and load), the voltage level, granularity and the scope of information they present. This makes it difficult for the grid operators who have yet to develop these maps, and risks that not all the information necessary for users will be made available.

This is where our research seeks to contribute, providing recommendations on the necessary components of an "ideal" grid hosting capacity map.

These recommendations bring together the needs of grid users, gathered through structured interviews with a variety of project promoters from both the supply and demand sides, with best practices from existing hosting capacity maps and interviews with grid operators. These are presented in a map graphic, split into one that represents the minimum level of detail necessary and another that includes more advanced features. These are also listed in Table 2 below.

Developing an ideal hosting capacity map

Example map for the fictional Gridlandia

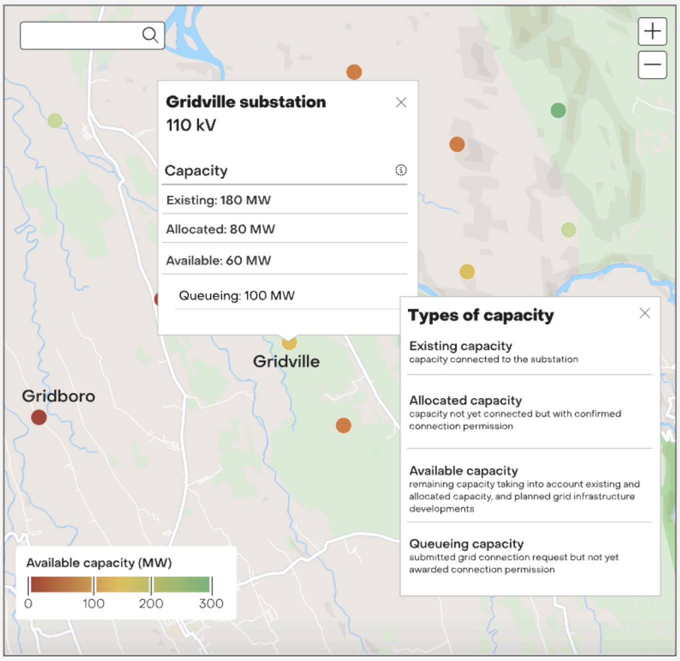
Choose map type based on features

Minimum requirements

Advanced features

Minimum requirement

The minimum level of detail necessary for grid users



Resource: Prod | Load | Battery

Flexibility: 0% | 5%

Year: 2024 | 2029

Last update:
Q2 2024, updates quarterly (for DSO)
July 2024, updates monthly (for TSO)

Download data

Mockup map created by Ember and RAP.

Developing an ideal hosting capacity map

Example map for the fictional Gridlandia

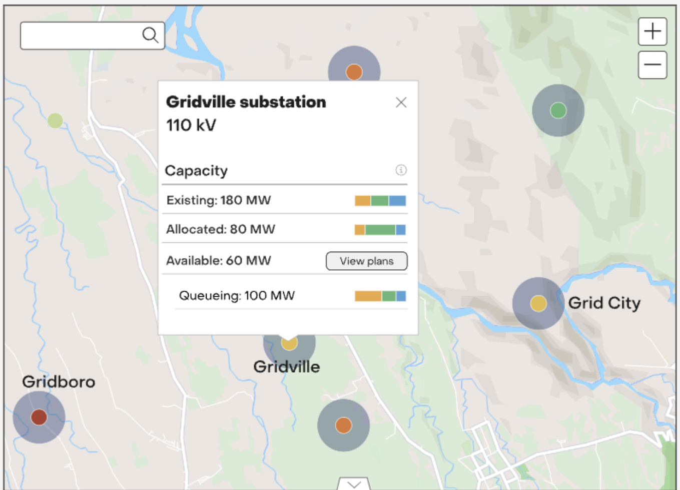
Choose map type based on features

Minimum requirements

Advanced features

Advanced features

Supplementary information and map features that would offer significant added value for both grid users and grid operators.



Planned grid upgrades

Investment type	Name	Length (km)	Expected completion	Max capacity (MW)
Overhead line – thermal upgrade	Gridville – Grid City	22.9	2025	73
Transformer – new	Translink		2027	95
Overhead line – new 1x240 line	Gridville – Gridboro	23.8	2029	110

*This example is based on information provided by Elering (TSO of Estonia) per substation.

Resource: Prod | PV | Wind | Other; Load | Battery

Flexibility: 0% | 5% | 10%

Year: 2024 | 2029 | 2034

Voltage level (kV): 36 | 70 | 110 | 380

Maximum distance from substation: 5km

Last update:
July 2024, updates monthly
(for DSO and TSO)

Download data | API access

Mockup map created by Ember and RAP.

Additionally, we recommend that ENTSO-E and the EU DSO Entity, alongside their mandate to harmonise definitions for capacity maps, provide support for the development of these maps through consideration of common technologies or hosting platforms. Grid companies should be allowed to develop common maps if it would minimise the complexity and costs for each grid operator to separately set up these capacity maps.

The ideal hosting capacity map should:

- Have a substation-level granularity.
- Be based on transparent assumptions concerning planned grid development (including through grid enhancing technologies), assumed growth in electricity demand and renewable generation. Information on planned grid upgrades is a key gap in most existing maps.
- Publish the existing, allocated and queuing resources per type (while remaining mindful of data confidentiality for investors) to enable and encourage matchmaking of complementary sources, such as battery storage in locations with large solar capacities.
- Be accompanied by an open-source database, enabling applicants to overlay this on other important geospatial data such as land availability, transport infrastructure, resource potentials, and others. In this way, hosting capacity maps can also be integrated with other existing energy geospatial data such as the registers of distributed generation, network elements and flexibility tenders (similar to the Open Data Portal of UK DSOs).
- Cover the whole territory of the system operator.
- Integrate the various levels of grid governance - distribution grid capacity data should be factored into transmission availability, and transmission grid capacity forecasts should take into account distribution level developments.
- Optimise the benefit of the marginal unit of information (for grid users) and the cost of generating that information (by system operators), and balance between the scope of information and its robustness.

<u>Conclusion</u>

Data availability and transparency on power grids are no longer a 'nice-to-have' but a 'must' to manage the energy transition efficiently. Grid users require a detailed and accurate picture of the grid and its planned evolution, to identify the best opportunities to connect and build solid business cases while enabling the maximisation of the existing network. Transparency is a no-regret tool.

Table 1: Examples of hosting capacity maps in Europe

TSO/DSO	**Name of TSO/DSO**	**Information categories for grid users** *(note: terminology from the individual maps is maintained)*
TSO	TenneT (NL)	Not specified
TSO	Elia (BE)	Demand, onshore wind, offshore wind, solar, large-scale batteries
TSO	Elering (EE)	Consumption, production
TSO/DSO	RTE (FR) with DSOs	All generation (more on RES)
TSO/DSO	Cyprus	Minimum load, PV, biomass, total RES
DSO	Fluvius (BE)	Consumption, production, current status, not future outlook
DSO	EG.D (CZ)	PV only
DSO	SSEN (UK)	Minimum load, maximum load, generation, available capacity
DSO	UK Power Networks (UK)	Demand headroom
DSO	SP Energy Networks (UK)	Distributed generation
DSO	Electricity Northwest (UK)	2 demand, 3 generation, storage
DSO	ESB (IE)	Generation, demand
DSO	i-DE (ES)	Generation only
National map of DSOs	Austria	Feed-in only
National map (TSO and DSO)	Denmark	Generation, consumption coverage, technology distribution

Table 2: The components of an “ideal” capacity map

Design element	Minimum Requirement	Advanced Features	Notes
Granularity	Substation level	Same as minimum requirement	
Coverage	Entire territory of the grid operator	Same as minimum requirement, with option for joint development to reduce fragmentation and development cost	
Integration between	The various levels of grid governance to factor in capacity limitations/projections from the other level	Same as minimum requirement	
Frequency of update	Quarterly for DSOs Monthly for TSOs	Monthly for DSOs Monthly for TSOs	Frequency of update to match lead time of project idea development and the pace of new permit issuance
Data access	Open source data	Open source data and API	Open-source data publication is a must but the use of APIs have added-value for seamless data integration.
Information content: MW capacity available	Per type of resource (generation, load, and storage)	Per type of resource and type of generation (wind, PV, other)	
	Per level of curtailment (0 and 5%)	Higher curtailment levels as well	
	Per target year	Longer time horizon	

	(5-year step)	(until 2034/35) and possibly yearly	
Visualisation		With adjustable maximum distance from substation (km)	
	All substations with voltage level indicated	All substations, with the option to filter by voltage level	Grid users connect to substations. The required capacity defines the typical voltage level to which it needs to connect.
Underlying assumptions /data	Planned grid investment per substation in terms of additional capacity for the years showing available capacity	Planned investments and upgrades, and the resulting yearly capacity additions	Future grid users are mainly interested in the additional capacity after new grid investment but smaller upgrades and more granular forecasts can facilitate smaller capacity requests and better planning. All planned investment on the map must be consistent with the actual network development plan.
	Contracted, allocated and queuing capacities per substation	Same as minimum requirement, with each capacity category indicating resource type for matchmaking	A connection capacity can be best utilised if the aggregate profile of the various resources connected complement each other. Hence matching applications at the same location has an efficiency benefit to the whole system. It can even be incentivised.

About

Regulatory Assistance Project (RAP) is an independent, global non-governmental organisation with a mission of advancing policy innovation and thought leadership within the energy community.

Ember is an independent, not-for-profit energy think tank that aims to shift the world to clean electricity using data.