



Grid planning with digital twinning

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List of Abbreviations and Acronyms

Acronym	Meaning
API	Application Programming Interface
CR	Customer Request
DERs	Distributed Energy Resources
DSO	Distribution System Operator
IGP	Intelligent Grid Platform
SaaS	Software-as-a-Service
TSO	Transmission System Operator

Executive Summary

The transformation of Europe's electricity system requires innovative digital solutions to ensure that distribution and transmission networks can reliably accommodate growing volumes of renewable generation and electrification. Deliverable D6.5 presents the results of the TwinEU project's efforts to develop a harmonized, pan-European framework for hosting capacity assessment, enabled through the use of digital twins and the Intelligent Grid Platform (IGP). This deliverable addresses one of the eight use cases of the German pilot, hosting capacity and grid connection processes; the other seven are reported in Deliverable D6.4. Its scope is therefore intentionally focused, and it is best read together with D6.4.

The focus of this work lies on the development of hosting capacity maps—interactive tools that visualize the available grid capacity for connecting new generation units, particularly renewables. These tools address a critical bottleneck in the energy transition: the lack of transparent and timely information on where new grid connections are technically and economically viable.

The work reported here operates on two distinct tracks with different levels of maturity: a national implementation within the German pilot at Westnetz, which has reached operational status, and a pan-European conceptual framework, which remains in a preparatory phase and focuses on establishing the foundations for future harmonization.

As part of the working implementation that has been achieved within the German pilot project at Westnetz, automated processes for hosting capacity assessments and interactive map-based interfaces have been introduced. These allow project developers and stakeholders to receive near-instant feedback on grid connection possibilities, reducing manual workload and improving decision-making. Standardized APIs and automated validation processes have enhanced efficiency and accuracy in connection handling.

At the pan-European level, this deliverable provides a conceptual framework for harmonizing hosting capacity assessment methodologies and enabling cross-border interoperability and identifies the key challenges for future harmonization - including the diversity of national grid codes, regulatory differences, and the need for standardized data exchange formats. This contribution does not stand alone: the pan-European concepts were developed jointly within parts of work package 4 (pan-European scenarios), to which the German pilot feeds in as a detailed national implementation. Accordingly, the work presented in this section is intentionally preparatory - its goal was to map the problem space and establish a feasible path forward in coordination with work package 4, not yet to deliver an operational cross-border solution. Addressing these challenges is essential for building a scalable, interoperable platform that supports energy system integration across Europe.

Digital twin technology plays a central role in this development. It enables real-time simulation of grid states, supports automated response to connection requests, and lays the foundation for future integration of flexibility and forecasting into grid planning. The demonstrator activities also highlight the importance of aligning technical solutions with broader EU digitalization and grid planning policy goals.

In summary, the work presented in this deliverable confirms the technical feasibility of hosting capacity maps and digital twin-enabled assessment tools at national level and sets a clear direction

for the future development of a harmonized European framework. The results provide both a practical foundation and strategic insight for the next project phase, where scaling, standardization, and integration will be key to success.

1 Introduction

1.1 Task 6.5

The transformation of Europe's energy system is placing increasing demands on electricity grids, particularly at the distribution level. As decentralized renewable generation grows and electrification accelerates across sectors, Distribution System Operators (DSOs) face mounting pressure to integrate new connections while maintaining system reliability and planning certainty.

Digital tools are becoming essential in this context, enabling DSOs to gain better visibility into grid conditions, automate operational tasks, and make informed planning decisions. One promising digital solution lies in the use of digital twins—virtual representations of physical grid systems—which provide a foundation for innovation across use cases such as hosting capacity assessment, congestion management, and flexibility integration.

This document focuses on the development and application of hosting capacity maps in the context of grid connection requests and online connection checks. Building on one of the pilot use cases (Ge08) defined in Deliverable 2.2 [1], it explores the relevance of this topic in the evolving energy landscape and highlights how digital twin technologies can support its implementation and future harmonization across Europe.

Within the German pilot of TwinEU, eight use cases were defined across three tasks, as set out in the project's use-case framework (Deliverables D2.2). Seven of these use cases—covering grid monitoring, end-to-end flexibility activation, and TSO–DSO–Aggregator coordination—are assigned to Tasks 6.4 and 6.6 and are reported in Deliverable D6.4. The present deliverable (D6.5) covers the remaining use case, hosting capacity and grid connection processes (Ge08), which is assigned to a separate task. This report is therefore intentionally focused on that single use case and should be read alongside D6.4 for the complete picture of the German pilot.

1.2 Objectives of the Work Reported in this Deliverable

This document outlines the objectives and scope of work related to the further development of the IGP to support the creation of a harmonized, pan-European approach to hosting capacity maps. The immediate focus is on implementing and demonstrating this functionality within the grid area of Westnetz. However, the overarching aim is to design a scalable and interoperable solution that can be adopted by DSOs across Europe.

The work described here builds upon existing digital twin technologies and addresses key challenges in visualising and sharing real-time capacity information. In doing so, it supports faster and more transparent grid connection processes for renewable generation and large consumers, and contributes to European policy goals on digitalisation, grid planning, and energy system integration.

1.3 Outline of the Deliverable

This deliverable is structured to provide a coherent overview of the business needs, technical developments, and implementation efforts related to the use of digital twins for hosting capacity analysis within the IGP.

- Chapter 2 introduces the overarching business need behind the development of hosting capacity maps, specifically in the context of increasing connection requests for renewable generation and large loads. It also outlines the role of digital twins in improving transparency, automation, and efficiency in grid connection processes, and sets the European context by highlighting the relevance of a harmonized approach across DSOs.
- Chapter 3 presents the implementation activities, focusing on Use Case 8 of the German pilot of the TwinEU project. It details the current challenges related to hosting capacity assessment, the solution approach developed within the IGP, and results from the Westnetz demonstration. The chapter concludes with an outlook on next steps towards scaling and integrating the solution more broadly.
- Chapter 4 provides the conclusions, summarising key insights gained from the work and outlining the potential impact on future European grid planning and digitalisation initiatives.

1.4 How to Read this Document

This document builds upon previous work conducted in the TwinEU project and is intended for readers who are already familiar with the foundational concepts, objectives, and architecture of the IGP.

In particular, it is recommended that readers have reviewed, although not all concepts described in these documents are relevant and considered within the scope of the German pilot:

- Deliverable D2.2 – which introduces the concept of Digital Twins within TwinEU and outlines the project's overall architectural approach.
- Deliverable D5.1 – which defines the use cases of the TwinEU project, including Use Case GE08, focusing on hosting capacity and grid connection processes.

This deliverable (D6.5) builds on these earlier documents by describing the business context, technical implementation, and results related to hosting capacity mapping, as developed within the German demonstrator. It should be read as a focused report on the application of digital twin technologies to improve grid connection transparency and efficiency—within the broader scope of achieving a harmonized, pan-European solution.

1.5 Scope and regulatory context clarification

The activities in this deliverable span different maturity levels: a national implementation at the German pilot (Westnetz), which has reached operational status, and a pan-European harmonization framework, which remains at a conceptual, preparatory stage by design.

To assess the full potential of digital twin-based hosting capacity assessment, some assumptions extend beyond current operational practice—in particular enhanced cross-border data exchange and harmonized assessment methodologies across DSOs. These are research and validation assumptions and do not necessarily reflect the present regulatory framework, national grid codes, or market arrangements; implementation at scale would require regulatory evolution, harmonized data formats, and secure, privacy-compliant data sharing.

The pan-European results should therefore be read as a proof-of-concept of technical feasibility, not applicable to the components already in operational use at Westnetz, whose reported performance reflects live deployment.

2 Business need and role of digital twins

2.1 Grid Challenges regarding connection requests

The rapid integration of renewable energy sources and the electrification of sectors such as transportation and heating are intensifying the demand on existing power grids. DSOs and TSOs face significant challenges in accommodating new generation and load without compromising grid stability. A primary bottleneck is the limited visibility into real-time grid capacity, leading to delays in connecting new Distributed Energy Resources (DERs) and increased costs for developers.

Hosting capacity maps have emerged as a critical tool to address these challenges. They provide spatial representations of the grid's ability to accommodate additional DERs without necessitating significant infrastructure upgrades. By offering insights into available capacity at specific locations, these maps enable more informed decision-making for developers and grid operators alike. However, the effectiveness of hosting capacity maps is often hindered by outdated data, lack of standardization, and limited granularity.

2.2 Business Need: Enhancing Grid Connection Processes

The current grid connection process is often characterized by lengthy approval times, complex procedures, and a lack of transparency. Grid operators have reported average connection study durations of up to several years. Such delays not only impede the deployment of renewable energy projects but also increase financial risks for developers.

To streamline the connection process, there is a pressing need for tools that can provide real-time, accurate, and accessible information about grid capacity. Hosting capacity maps, when integrated with advanced analytics and automated feedback mechanisms, can significantly reduce the time and resources required for connection assessments. This approach aligns with initiatives like the EU Action Plan for Grids [2], which emphasizes the importance of transparent and harmonized data on available capacity at both transmission and distribution levels.

2.3 Role of Digital Twins in Hosting Capacity Analysis

Digital twins—virtual replicas of physical systems—offer a transformative approach to managing and optimizing power grids. By simulating the behaviour of the grid under various scenarios, digital twins enable operators to predict the impact of new connections, identify potential bottlenecks, and plan infrastructure upgrades more effectively.

In the context of hosting capacity maps, digital twins can enhance the accuracy and timeliness of capacity assessments. Looking further ahead, they could also draw on time-varying data, such as load variations and DER outputs, pointing to how an even more comprehensive understanding of grid capabilities might evolve over time.

The integration of digital twins into hosting capacity analysis also supports wider policy goals. For example, the TwinEU project aims to develop a pan-European digital twin framework that enhances transparency and efficiency in grid operations, aligning with the EU Digitalization Action Plan for Energy Markets [3].

2.4 Advancing Towards a Harmonized European Framework

While individual DSOs have made progress in developing hosting capacity maps, there is a lack of standardization and interoperability across different regions. This fragmentation limits the scalability and effectiveness of these tools. A harmonized European framework, underpinned by digital twin technology, could address these challenges by providing standardized methodologies for capacity assessments and facilitating data exchange between TSOs and DSOs.

Such a framework would not only improve the efficiency of grid connection processes but also support long-term planning and investment decisions. By offering a unified view of grid capacities and constraints, it would enable stakeholders to coordinate more effectively, optimize resource allocation, and accelerate the integration of renewable energy sources.

3 Implementation, results and outlook

The hosting capacity and grid planning use case focuses on two main aspects: national implementation and a potential pan-European expansion. At the national level, the primary goal is to develop efficient systems for assessing grid hosting capacity for renewable energy integration and managing connection requests from project developers. This includes implementing standardized processes for capacity assessment and developing automated tools for request handling.

On the pan-European level, there is a vision to create a unified hosting capacity mapping system across European countries. This ambitious goal aims to standardize the assessment and visualization of grid capacities across borders, though the specific implementation path is still under development.

Within the TwinEU project, horizontal work packages coordinate across the multiple national pilot projects to demonstrate use cases with applicability beyond individual pilots—referred to as pan-European use cases. In line with this approach, a pan-European hosting capacity workstream was developed as a parallel activity to the German pilot's core use case 8 implementation. In this parallel workstream - developed together with TwinEU project partners outside the German pilot - hosting capacity data is transmitted via a TwinEU Data Space connector and visualized on a shared pan-European map maintained by those partners. The main focus of the German pilot's UC8 work - and the primary subject of this deliverable - is the national implementation described in the following sections.

3.1 Complications in Hosting capacity

The implementation of hosting capacity assessment and grid planning faces distinct challenges at both national and pan-European levels. At the national level, managing grid hosting capacity involves dealing with significant uncertainties in future grid development scenarios, particularly given the rapid expansion of renewable energy installations. The integration of real-time data and maintaining current status updates presents a substantial technical challenge in a dynamic grid environment. Grid operators must handle an increasing number of connection requests, each requiring complex load flow calculations. The accuracy and reliability of capacity assessments are crucial, as incorrect assessments could lead to grid stability issues or missed opportunities for renewable energy integration.

The pan-European expansion introduces additional layers of complexity. A primary challenge lies in the integration of different national grid standards and technical requirements, which vary significantly across countries. The standardization of data formats across various regions presents technical hurdles, as different operators may use different systems and protocols. Regulatory requirements vary between European nations, making it difficult to establish unified assessment criteria. The task of creating common assessment methodologies across diverse grid infrastructures is particularly challenging, as each country's grid has unique characteristics and operational parameters.

Furthermore, the coordination between transmission and distribution system operators adds another dimension of complexity, requiring careful consideration of cross-border power flows and capacity allocation. The need for real-time data sharing and synchronized operations across national boundaries presents both technical and organizational challenges that must be addressed for successful implementation.

3.2 Solution and Implementation

The solution for use case 8 is built on the IGP, a SaaS platform developed by Envelio. The IGP serves as the digital twin environment for the Westnetz distribution grid, among other DSOs. It maintains a comprehensive digital model of the grid through structured initial data onboarding and continuous synchronization with operational data sources and asset management systems. The platform provides multiple functional modules for grid analysis, planning, and customer interaction. For use case 8, the two most relevant modules are: (1) the hosting capacity visualization layer—an internal colour-coded map view for DSO planning teams showing available capacity across the grid—and (2) the Grid Connection Navigator, a module that digitizes and automates the grid connection request workflow, giving project developers structured, data-driven feedback on available hosting capacity and feasible connection options, while reducing manual effort for DSO planning teams.

The solution approach encompasses both national and pan-European implementations. At the national level, the focus is on developing practical tools and systems for immediate grid management needs. This includes creating interactive hosting capacity maps that provide different assessments of grid capabilities, implementing standardized APIs to streamline the connection request process, and integrating digital twin technology for precise calculations. A key component is the automation of validation processes for connection requests, which significantly reduces processing time while maintaining accuracy.

Building on this distinction, the pan-European approach is more strategic and forward-looking cross-national approach. The primary focus is on developing a standardized framework that can accommodate different national grid systems while maintaining consistency in hosting capacity mapping across Europe. This involves creating standardized interfaces for cross-border data exchange, implementing common assessment methodologies that can work across different national systems, and developing multi-language support with region-specific adaptations to ensure accessibility across all participating countries.

The implementation strategy carefully considers the technical complexities of integrating various national grid systems while maintaining the specific requirements and regulatory frameworks of each participating country. The solution prioritizes scalability and adaptability, ensuring that the system can evolve with changing grid requirements and technological advancements. This concept is currently under evaluation to determine its feasibility and practical implementation potential, considering technical, organizational, and regulatory constraints.

It is important to distinguish two complementary perspectives on pan-European hosting capacity mapping. The pan-European scenario developed in Task 4.6 takes a method-agnostic view: it harmonizes and visualizes the resulting hosting capacity figures from different operators without prescribing how each value was obtained — what matters is the comparability of the final figures across borders. The second perspective of the use case reported in this deliverable follows a different logic: the hosting capacity map is generated directly by the digital twin embedded in the IGP, where all national regulatory and technical requirements are accounted for within the calculation itself, and the visualized map is essentially a graphical user interface on top of these digital-twin-based results. The two approaches are complementary: the IGP produces regulatory-compliant, DT-based capacity values at the national level, which can then feed into the method-agnostic pan-European scenario. This division of roles becomes concrete in the push mechanism described below, where each

participating DSO computes and renders its own capacity data within its digital twin and pushes the result into a jointly managed map service — rather than a central scenario recalculating capacities in an agnostic manner.

3.3 Results

The national implementation has shown significant progress in automating and streamlining grid capacity assessment processes. The implementation of interactive capacity maps and standardized APIs has provided a more user-friendly interface for stakeholders while maintaining high accuracy standards.

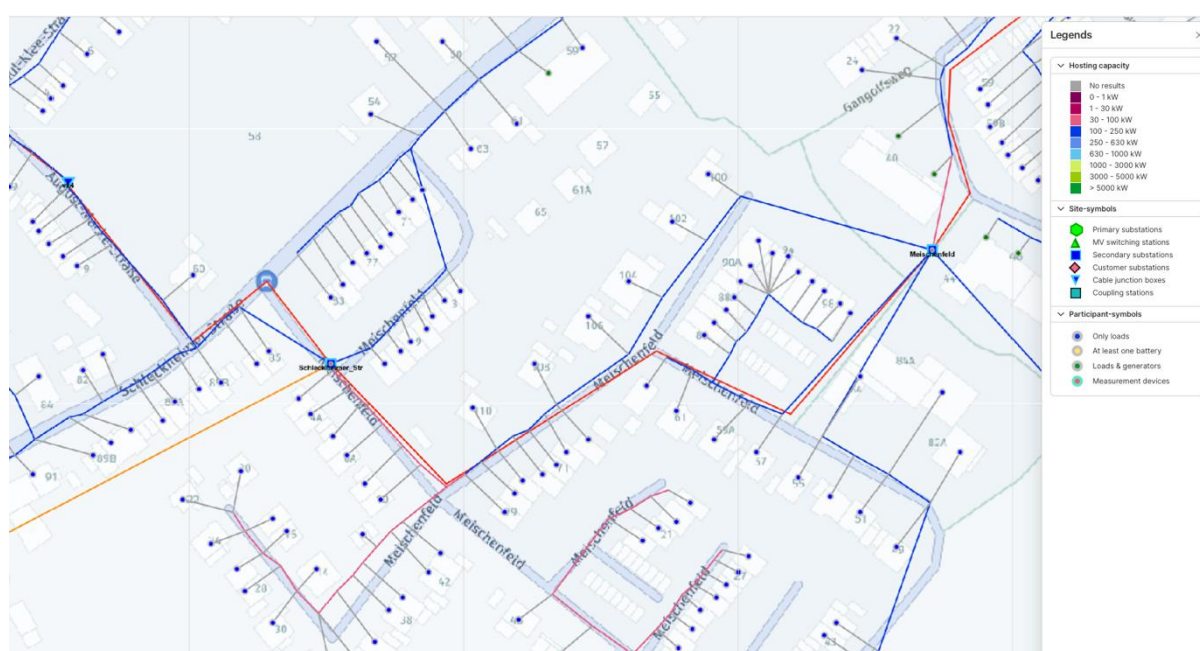


Figure 1: The hosting capacity layer in Grid Transparency (internal view)

For the DSO internal view, the hosting capacity layer in Grid Transparency (see Figure 1) provides a visual representation of available grid capacities through an intuitive heat map interface. The layer offers the visualization of capacities via colour-coded areas representing the available hosting capacity in different grid sections.

The layer helps users to:

- quickly identify available grid capacities within the DSO's grid area
- Navigate and compare different areas more effectively through the interactive map interface
- Identify optimal locations for new connections and understand grid capacity distribution across different areas.

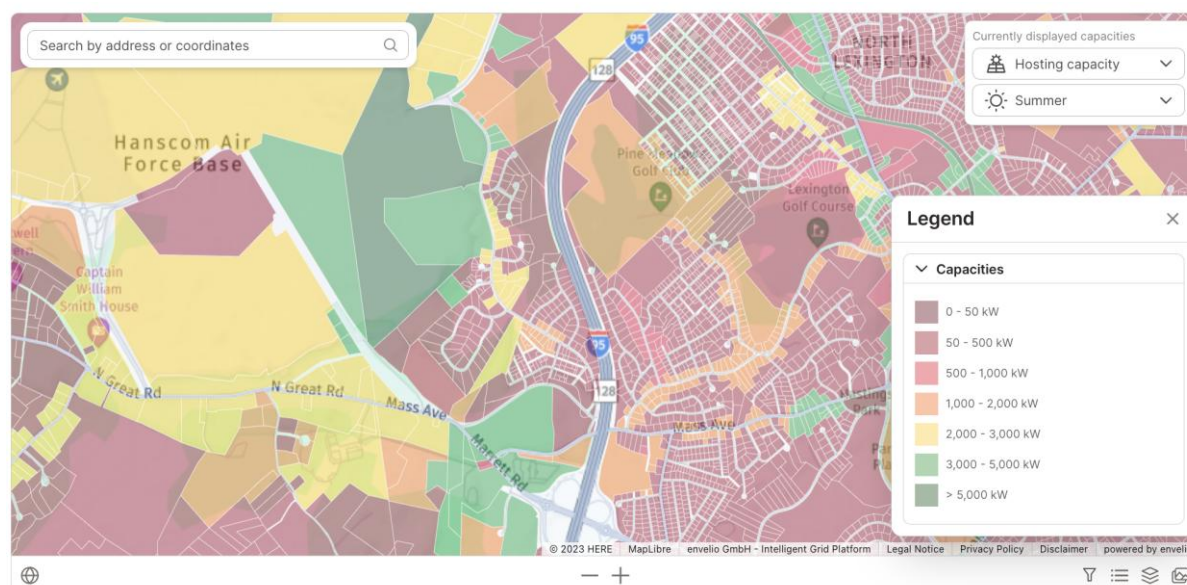


Figure 2: The hosting capacity map for end customers

The Grid Connection Navigator (see Figure 2) is a decision-support tool for end customers that streamlines the grid connection process for new generation and flexibility assets. It guides users through the end-to-end workflow—from initial project screening and site assessment to selecting feasible connection options—by combining available grid data, planning assumptions, and technical constraints in a structured, transparent way. It shows no electrical grid data or other DSO internal data.

By standardizing inputs and making key dependencies visible (e.g., capacity limits, required reinforcements, timelines, seasons, and regulatory requirements), Grid Connection Navigator reduces manual effort and uncertainty, improves comparability of alternatives, and enables faster, better-informed coordination between project developers and grid operators.

The successful deployment of an automatic connection request application system has markedly reduced processing times and manual effort required in request handling. This automation has not only increased efficiency but also improved the accuracy of capacity assessments through better data integration and standardized validation processes. The end customer is redirected from the hosting capacity map to a binding connection request form. All requests are then sent to the API of the connection request app (see Figure 3), which supports utilities and project teams in managing the Customer Request (CR) process for grid connection and grid-related service inquiries in a consistent, traceable way. It structures incoming requests, captures all required information, and guides users through standardized review and clarification steps—helping ensure completeness, compliance, and a smooth handover between involved roles. By providing clear status tracking, responsibilities, and documentation in one place, the CR App reduces manual coordination effort and improves transparency across the process.

In addition, the Fast Track module enables an accelerated handling path for well-defined, low-complexity requests. It uses predefined criteria and streamlined checks to shorten cycle times while maintaining quality standards and auditability.

ICF Connection Request Requests Statistics Demo System

New: Queue management
The new queue management feature in the Connection Request app is now available for activation. Try it out and share your feedback until July 1, 2026. After this date, the new queue-based workflow will become the new default. Learn more in the ICF Docs.
[Go to settings](#)

New request

Requests

- Active **22**
- Open **14**
- In progress **8**
- Closed **15**
- Reserved **0**
- Not reserved **13**

Filters

Requests

Q Search X

Last month

Editor

☐ Assigned to me

☐ Unassigned

Editor

Select editor

Region

☐ My regions

Request number	Name	Type	Repetition number	Status	Creation date	Finish date	Due date	
2026_auto_5343	2026_auto_5343	Non-binding	0	Calculated	21.04.2026	-	02.06.2026	... >
2026_auto_5340	2026_auto_5340	Non-binding	0	Calculated	21.04.2026	-	02.06.2026	... >
2026_auto_5337	2026_auto_5337	Non-binding	0	Calculated	21.04.2026	-	02.06.2026	... >
2026_auto_5334	2026_auto_5334	Non-binding	0	Calculated	21.04.2026	-	02.06.2026	... >
2026_auto_5331	2026_auto_5331	Non-binding	0	Calculated	21.04.2026	-	02.06.2026	... >
2026_auto_5304	2026_auto_5304	Non-binding	0	Editing	19.04.2026	-	31.05.2026	... >
2026_auto_5283	2026_auto_5283	Non-binding	0	Editing	19.04.2026	-	31.05.2026	... >
2026_auto_5262	Ladesäule 26 kW Schule	Non-binding	0	Editing	17.04.2026	-	29.05.2026	... >
2026_auto_5259	PV 26 kW Schule	Non-binding	0	Calculated	17.04.2026	-	29.05.2026	... >
2026_auto_5256	Ladesäule 22kW Schule	Non-binding	0	Calculated	17.04.2026	-	29.05.2026	... >
2026_auto_5239	2026_auto_5239	Non-binding	0	Calculated	16.04.2026	-	28.05.2026	... >
2026_auto_5230	2026_auto_5230	Non-binding	0	Editing	14.04.2026	-	26.05.2026	... >
2026_auto_5227	2026_auto_5227	Non-binding	0	Editing	09.04.2026	-	21.05.2026	... >
2026_auto_5218	2026_auto_5218	Non-binding	0	Calculated	07.04.2026	-	19.05.2026	... >
ExamplePostItemRequestAPI123Dossier	Name of process	Binding	0	Calculated	02.04.2026	-	30.04.2026	... >
2026_auto_5215	PV-Aufdach-Anlage	Non-binding	0	Calculated	31.03.2026	-	12.05.2026	... >

Figure 3: The binding connection assessment

For the pan-European aspects, development remains in the conceptual phase, focusing on establishing fundamental frameworks and standards for future implementation. The primary emphasis has been on developing standardized approaches that can accommodate different national grid systems while maintaining consistency in hosting capacity mapping across Europe. This preparatory work is essential for creating a unified platform that can effectively manage cross-border grid capacity assessment and planning. Hosting Capacities can be sent to an external pan-European hosting capacity map via the data space connector. This interface was tested successfully during the project, where synthetic capacity data was exchanged with the Iberian demonstrator. This was achieved by using the newly introduced push mechanism in the TwinEU dataspace, in which data processing and rendering are started by the data provider. This enables every data space participant that has successfully subscribed to the hosting capacity map service to push new data and update the map service, which is an interesting approach for a hosting capacity map that is managed by multiple DSOs.

3.4 Outlook

The next steps (as part of follow-up activities based on this project) for the hosting capacity and grid planning initiatives are structured along two main tracks: national implementation enhancements and pan-European development. At the national level, the focus will be on improving technical capabilities through enhanced calculations within the existing hosting capacity process and refining assessment concepts. This includes expanding automated solution capabilities and implementing standardized data exchange protocols to streamline operations. The emphasis is on practical improvements that can be implemented in the short to medium term to enhance current grid management capabilities.

For the pan-European development track, the approach is more strategic and long-term oriented. The primary focus is on developing a unified hosting capacity platform that can operate across European borders, though this remains contingent on further feasibility assessments. This includes enhancing cross-border coordination mechanisms and integrating advanced forecasting tools to improve capacity planning across regions. A key aspect is the standardization of assessment methodologies across countries, which requires careful consideration of different national regulatory frameworks and technical standards.

The implementation of these next steps will require close collaboration between grid operators, regulatory bodies, and technology providers to ensure that both national and pan-European objectives can be achieved while maintaining grid stability and reliability. The success of these initiatives will depend on the ability to balance local grid requirements with broader European integration goals.

4 Conclusions

This deliverable presents the results of work within Task 6.5 of the TwinEU project, focusing on the development of digital twin-based solutions for hosting capacity analysis and grid planning. The findings reflect the implementation achieved within the German pilot, and they point to one conclusion that runs through the work at both the national and the pan-European level: digital twin technology itself is no longer the limiting factor for transparent, automated hosting capacity assessment—organisational and regulatory alignment across operators.

At the national level, this conclusion is supported by what worked well. The implementation activities carried out in the German demonstrator, particularly within the Westnetz grid area, show that decomposing the connection process into specialised, interoperable digital-twin-based modules—rather than building a single monolithic system—significantly improves the transparency, speed, and reliability of grid connection processes. The hosting capacity layer in Grid Transparency gives DSO planning teams an internal, colour-coded view of available capacity across grid assets. The Online Connection Check and the Grid Connection Navigator extend this into self-service, customer-facing tools that give project developers real-time, data-driven feedback without exposing internal grid data. And the Connection Request App, including its Fast Track module for low-complexity cases, automates the intake, validation, and status tracking of the resulting connection inquiries. For these three different components, there is one consistent pattern: once the underlying digital twin provides a reliable capacity assessment, automation and transparency follow comparatively easily.

Moving this pattern beyond a single DSO is where the picture changes. The interface enabling hosting capacity data to be transmitted to a pan-European hosting capacity map via the TwinEU Data Space connector has been implemented and successfully tested, confirming that cross-border data exchange is technically feasible within the project architecture. However, technical feasibility for a single connector is not the same as readiness for a genuinely shared, multi-DSO view—such as a pan-European Grid Connection Navigator that several stakeholders have already asked for. A shared map of this kind is only as useful as the comparability of the data feeding it: it requires harmonised assessment methodologies and standardised data exchange formats before figures from different DSOs and countries can be combined or even displayed side by side.

This is not a hypothetical concern: in its own product work on a shared multi-DSO capacity map, envelio has identified the same precondition—data needs to be harmonised and standardised before it reaches a shared layer, and not all DSOs have an existing channel for the necessary data exchange in place. This mirrors, at company level, the same root cause that limits scaling within a single country: heterogeneous data, processes, and exchange channels across operators.

This shared root cause runs through each of the open points identified in the course of this work:

- The national implementation has made notable progress, but scalability across other grid areas and DSOs remains an open task, since data quality and internal processes still vary between grid areas and need to converge before scaling can proceed.
- A harmonized European approach to hosting capacity assessment is still at a conceptual stage. Differences in national regulations, data availability, and system architecture pose significant obstacles to integration, and experience from the German pilot indicates that harmonisation is likely to be an incremental path rather than a single unifying framework, with country-specific regulatory analysis needing to precede—not follow—the definition of cross-border use cases.

- Standardization of assessment methodologies and data exchange protocols is critical for achieving the envisioned cross-border interoperability but has yet to be fully addressed in practical terms; this is precisely the precondition that would need to be met before a shared, multi-DSO Grid Connection Navigator could move from concept to practice.
- Securing active engagement from European partners for joint hosting capacity map development proved more difficult than anticipated, suggesting that future pan-European initiatives need stronger incentive structures and governance arrangements for participation, alongside technical readiness and data standardisation, if comparable cross-border results are to be achieved at scale.

Addressing this shared root cause, rather than further digital twin development, is therefore the recommendation this deliverable would offer to follow-up projects and the wider industry, rather than a set of next steps for this project itself, as TwinEU concludes with this report. Three directions seem most promising:

- DSOs and technology providers could refine and scale the implemented tools at the national level, with a particular focus on harmonising the underlying data and processes that any future shared view would depend on.
- Standardization bodies, EU-level institutions, and national regulators could explore the feasibility of a unified pan-European platform—including a possible shared Grid Connection Navigator—in closer alignment with regulatory and technical requirements across Member States, treating standardised data exchange formats as a precondition rather than an afterthought.
- All involved actors (DSOs, TSOs, regulators, and market parties) would benefit from deepening stakeholder collaboration and strengthening incentives for participation, to ensure that any future solution meets real-world planning, operational, and market needs.

In summary, the results confirm the potential of digital twins to transform hosting capacity analysis and grid connection processes at the national level, and demonstrate that cross-border data exchange is technically feasible. The central conclusion of this deliverable, however, is that organisational and regulatory alignment—not digital twin technology itself—is now the limiting factor for cross-border scaling, and that this is the same alignment a shared, multi-DSO hosting capacity view would require before it could be built. This is directly relevant to the European Union’s broader grid digitalisation agenda: automated hosting capacity assessment and streamlined connection processes are preconditions for accelerating renewable energy integration at scale, a goal reflected in the EU Action Plan for Grids and the Digitalisation Action Plan for the Energy Sector. By combining digital twin infrastructure with standardized APIs and a tested cross-border data interface, D6.5 demonstrates a replicable model that DSOs across Member States can adopt and adapt to their national contexts, while showing precisely where the harmonisation work still needs to happen. With TwinEU concluding with this report, the move from the national demonstrator towards European-scale applicability—enabling transparent, data-driven grid connection decisions across borders—will be carried forward by follow-up projects, private initiatives, and the wider industry.

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