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Agentic Planning

Agentic AI as an Acceleration Architecture for European Planning and Permitting Procedures

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Background and Foreword

The momentum of artificial intelligence is palpable at this very moment. What Erik Brynjolfsson and Andrew McAfee described over a decade ago in “The Second Machine Age” as exponential development is no longer a mere forecast. It is our present reality. It inspires awe, warrants caution, yet also offers profound reason for hope.

In the United States and Asia in particular, staggering sums are currently being invested in the infrastructure for ever more powerful AI models. We consider the launch of ChatGPT by OpenAI in late 2022 to be a watershed moment. It was this chatbot that first demonstrated the true capabilities of large language models (LLMs) to the broader public. Since then, developments have accelerated at a breathtaking pace: new models are emerging worldwide in rapid succession, permeating increasingly more sectors and transforming entire value chains. Since mid-2025, so-called software agents have also moved into the spotlight. These are semi-autonomous programmes capable of acting independently based on generative AI.

AI development is progressing so rapidly that even experts can barely keep pace. Politics operates on electoral cycles, legislation and jurisprudence require time, and public administration finds it particularly challenging to match this velocity. However, generative and agentic AI are here to stay. Society has no choice but to actively shape this transformation and harness its enormous potential for the common good.

Initial papers on this subject have already been published. Most notably, “The Agentic State”, a vision paper released by a joint initiative of the Global Government Technology Centre in Berlin and the World Economic Forum (WEF). Its authors clearly demonstrate how vital the adoption of agentic AI is for policymakers and public administration, what opportunities and risks are associated with it, and how profoundly this technology alters the established mechanics of governmental processes.

In the present paper, we translate this vision into a concept for a specific use case: the accelerated planning and permitting of European infrastructure projects. This field is particularly well suited for several reasons. Infrastructure projects in transport, energy, and telecommunications are of existential importance to the European single market and hold immense geopolitical significance for the European Union. By international standards, however, their realisation is exceedingly slow. A significant factor in these delays is the largely analogue character of planning and permitting procedures, which remain hampered by inconsistencies between digital and paper-based formats. This paper investigates whether and how agentic AI can act as an accelerating force in this context.

A further reason for selecting this field of application is our professional background. We are entrepreneurs who have been engaged for nearly a quarter of a century in the digitalisation and acceleration of planning and permitting procedures in Germany and across Europe. At DEMOS plan GmbH, an SME based in Berlin, we operate our own software-as-a-service products and work on numerous related projects on behalf of the public sector. We have long been fascinated by the possibilities of artificial intelligence, which we employ to continuously enhance our open-source products.

This paper is not an academic study, but rather a qualified contribution to the debate. We do not claim academic independence; rather, we pursue both substantive and entrepreneurial interests. Our methodology nonetheless adheres to scholarly standards: we present our arguments, support them with empirical data, and engage critically with the risks of agentic AI.

In preparing this paper, we employed generative and agentic AI as tools for research, editing, and translation. Working with agentic systems was both our method and our subject of inquiry. We believe that anyone writing about the potential of this technology must have experienced its application in daily work. All fundamental ideas, arguments, and assessments remain strictly our own. All errors, inaccuracies, and simplifications are our sole responsibility.

The process of creating this text has been a remarkable journey, and the result will serve us well as a foundational roadmap for the years ahead.

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1. Summary

Europe must invest more than 1.2 trillion euros in transport, energy, and telecommunications networks by 2030. The financial resources can be mobilised, the political will has been declared, and the technical solutions are available. Yet expansion stalls, not because funding constitutes the bottleneck, but because procedures do. In Germany, major power transmission projects take eight to twelve years to progress from the initial planning stage to completion. This problem extends across Europe, jeopardising the climate transition, energy security, and economic competitiveness.

This study develops "Agentic Planning" as an approach that addresses this bottleneck through agentic artificial intelligence. Agentic AI denotes software that autonomously processes complex tasks within defined boundaries, plans intermediate steps, and interacts with digital tools. The starting point is a structural asymmetry within European planning law: EU environmental legislation prescribes what must be assessed, whereas the concrete execution of permitting procedures is determined by each country individually. This structural asymmetry is precisely why tools built upon shared assessment requirements can be deployed transnationally, even though the procedures themselves remain distinct.

Two innovations fundamentally distinguish this approach from earlier attempts at digitalisation:

- **The Inversion of Standardisation:** Previous systems required uniform data formats as a rigid precondition. Agentic systems reverse this relationship. They ingest heterogeneous data and produce standard-compliant formats dynamically during their operation.
- **Natural Language as a Bridge:** Since agentic systems comprehend natural language, the historical divide between text-based legislation and machine-readable schemas loses its significance. Domain experts can continue working in their native professional language, while individual capabilities are introduced incrementally without replacing existing systems.

These innovations are operationalised through three specialised agent types:

- **Orchestration Agents:** Manage procedural workflows by translating natural language descriptions into coordinated steps across system boundaries.
- **Standardisation Agents:** Generate and harmonise data formats continuously during the planning process.
- **Deliberative Agents:** Prepare decisions involving the balancing of interests by structuring arguments, identifying alternatives, and flagging contradictions, all strictly without making decisions themselves.

Using Germany as an example, this study demonstrates that the digital building blocks for such a system already exist, yet their interconnection is absent. A hypothetical case study illustrates how these three agent types can collaborate in the permitting process for a hydrogen pipeline in Mecklenburg-Vorpommern.

This study also identifies the limits of the approach. Agentic Planning would fail if language models remain persistently unreliable for legally sensitive tasks, or if it encounters institutional blockages. Technology alone is insufficient; an infrastructure for measuring procedural durations and systematic change management within public authorities must be developed in parallel.

Regarding European scalability, the entry point should lie with the shared assessment requirements and universally guaranteed participation rights. If Germany and the Netherlands develop common assessment frameworks for a hydrogen pipeline corridor, this knowledge will become a blueprint for subsequent projects. The draft directive on accelerating permitting procedures, presented by the European Commission in December 2025, underscores the political urgency. However, merely dictating shorter deadlines risks compromising the quality of substantive assessments. Agentic Planning provides the technological foundation needed to actually manage this complexity and turn earlier deadlines into reality. The building blocks for such a system already exist. Every year we leave these components unassembled is another year lost to bureaucratic standstill. True acceleration requires more than just political mandates; it demands a functional technological architecture.

2. Introduction

Problem Statement

Europe faces a striking disparity. While the investment required for trans-European transport, energy, and telecommunications networks is enormous, funding is not the core problem. The European hydrogen backbone alone encompasses over 40,000 kilometres, with estimated capital requirements exceeding 80 billion euros. Yet even where capital is immediately available, political consensus is secured, and technology is mature, the pace of expansion remains sluggish. The dominant bottleneck lies in planning and permitting procedures. In Germany, major power transmission projects require an average of eight to twelve years from the determination of need to commissioning. Administrative processes consume the vast majority of this time.

These delays are by no means a uniquely German problem. Permitting timelines vary considerably across Europe, ranging from two to three years in the most efficient systems to nine years or more in countries with highly complex procedural frameworks. The causes are deeply structural. Heterogeneous national regimes, insufficient digitalisation, fragmented data management, and a growing documentation burden driven by European regulations all compound the challenge.

Consequently, the Europeanisation of national planning systems has produced a paradoxical dynamic. Through directives on Strategic Environmental Assessment (SEA), Environmental Impact Assessment (EIA), and the Habitats Directive, substantive assessment requirements are converging across Europe. All Member States must evaluate the same protected interests, complete identical participation steps, and undertake the same assessments of alternatives. However, the concrete procedural sequences, institutional responsibilities, and statutory deadlines continue to diverge fundamentally on a national level. This asymmetry between convergent requirements and divergent mechanics constitutes one of the principal sources of complexity. At the same time, it holds the key to overcoming it.

While European infrastructure projects suffer from profound administrative slowness, artificial intelligence is advancing at an unprecedented pace. Agentic AI denotes software capable of perceiving complex situations, reasoning through problems, and acting autonomously within defined boundaries. The disproportionate efficiency gains currently observed in complex tasks point towards a fundamental paradigm shift. Unlike previous waves of digitalisation, which primarily addressed structured mass data, agentic AI offers a solution for the 'residuals of digitalisation': those case-specific, knowledge-intensive processes that have thus far remained analogue due to their sheer complexity.

Objectives

This study examines how agentic AI can accelerate planning and permitting procedures for infrastructure projects. To this end, it develops "Agentic Planning" as a domain-specific application of the broader "Agentic State" paradigm, illustrating how agentic AI can transform functional layers of government and public administration.

The primary objective is to identify specific entry points within existing digital planning systems. In doing so, the paper introduces a qualitatively novel approach: the inversion of the prevailing standardisation logic. Rather than demanding standard-compliant data as a rigid precondition, agentic systems generate standard compliance dynamically as an output of the planning process itself.

This architectural inversion constitutes the first central contribution of this study. The second contribution fundamentally redefines the relationship between humans, machines, and the written word. Because agentic systems process natural language with unprecedented proficiency, simple text-based formats can, for the very first time, serve as a common foundation for both procedural governance and the storage of procedural knowledge. Ultimately, this study delineates which structural obstacles can be overcome directly through agentic capabilities and which necessitate complementary institutional measures.

Guiding Questions

The analysis is guided by three central questions:

1. **How do planning and permitting procedures function within the EU, and what role does European law play?** This question addresses the structural foundations: the Europeanisation of national planning systems through the SEA, EIA, and Habitats Directives and the resulting convergence of substantive assessment logics alongside the divergence of procedural mechanics. The answer determines which agentic solutions are deployable across borders and in what sequence a European scaling strategy can proceed.

2. **How far has the digitalisation of these procedures progressed, and where do the practical bottlenecks lie?** Taking Germany as a case study, the current state is analysed: from the XÖV standards – German data interoperability standards for public administration (e.g., XPlanung for spatial planning) – through the Online Access Act (*Onlinezugangsgesetz*, OZG) to specific planning platforms. The planned European hydrogen backbone serves as a stress test for end-to-end digitalisation, exposing critical structural obstacles.

3. **Which agentic capabilities can be developed on this basis, and how can they be scaled across Europe?** This question leads to the development of an architecture comprising three complementary agent types for procedural governance, data harmonisation, and support in the balancing of interests. Their integration into an ecosystem with market mechanisms and governance structures, together with the development of a federated European ecosystem, completes the argument.

Scope

This paper focuses on planning and permitting procedures for linear infrastructures of the trans-European networks: power transmission lines, gas pipelines, hydrogen pipelines, rail corridors, and telecommunications networks. Point-based infrastructures such as wind farms or transformer substations are addressed only peripherally; urban land-use planning (Bauleitplanung) serves as a reference point.

The technical description of agentic systems remains at the conceptual level. The document does not develop a software architecture, but rather a domain-specific functional framework for specific development projects. The case study of the hydrogen pipeline HYROW illustrates the practical application but is a fictitious scenario. The analysis of the German system is exemplary: Germany combines federal structures, high procedural standards, and a considerable digitalisation deficit, making it a particularly complex reference case.

Methodology

The argument rests on the interweaving of three methodological strands. The starting point is an analysis of the European legal framework, demonstrating how the SEA, EIA, and Habitats Directives create, through structural convergence, the foundation for cross-border agent-based solutions. Building on this, a stocktaking of the German planning landscape uses the planned European hydrogen backbone as a stress test to isolate implementation barriers. This is completed with an agentic solution concept that categorizes agent types and derives the conditions for successful scaling across Europe.

Structure

The eight main chapters build upon one another: the European analysis establishes the basis for transferability, the detailed German analysis provides the benchmark, the operationalisation develops and tests the solution, the case study demonstrates its application, and the European scaling strategy charts the path to implementation. In detail: **Chapter 3** introduces the concept of the Agentic State, analyses three problem dimensions, and develops the conceptual framework for Agentic Planning. **Chapter 4** reconstructs how the EU, through environmental and sectoral law, has generated a convergence of national planning systems, and quantifies the investment requirements of the trans-European networks. **Chapter 5** analyses the German planning system, documents the state of digitalisation, and identifies – using the European hydrogen backbone as a case study – structural obstacles as a benchmark. **Chapter 6** operationalises Agentic Planning: it develops three agent types, assesses their technological readiness levels, defines guardrails, analyses risks and conditions for failure, and demonstrates why agentic planning can succeed where previous digitalisation efforts have not. **Chapter 7** illustrates the interplay of the three agent types through the fictitious case study HYROW (Hydrogen Rostock Wrangelsburg). **Chapter 8**, proceeding from pragmatic initial steps, develops three modalities of sharing between Member States and demonstrates how AI development functions as an independent scaling factor. **Chapter 9** takes stock, contextualises the EU draft directive on permit acceleration, and formulates policy recommendations.

3. Planning and Approval Procedures in the Agentic State

The concept of the Agentic State describes the transformation of public administration through semi-autonomous AI systems. Applied to planning and approval procedures, this gives rise to the Agentic Planning approach: three problem dimensions inherent to planning processes – heterogeneity, communication and speed – lead to three complementary agent types: orchestration, standardisation and deliberation.

The discrepancy between available resources and stalling infrastructure development described in the introduction calls for a new perspective. The concept of the Agentic State offers precisely such an approach.

The eponymous "Vision Paper"[1] outlines a far-reaching transformation of public administration through agentic AI. Unlike conventional digitalisation, which merely automates existing processes, agentic AI actively pursues outcomes, adapts through feedback and coordinates tasks across organisational boundaries.

The concept distinguishes twelve functional layers: implementation layers 1 through 6 deliver direct value for citizens and public authorities, whilst enabling layers 7 through 12 address the structural preconditions such as governance, data infrastructure and organisational culture. For planning practice, this model illustrates that acceleration often fails not because of a lack of technology, but because of inadequate framework conditions. Rather than merely automating the hierarchical procedural fidelity of the Weberian model, the authors see in agentic AI the opportunity for a responsive administration – one that reacts flexibly to individual case configurations without relinquishing the rule-of-law commitment.

Whether this ambitious vision can be fully realised remains an open question. As a starting point for an efficient transformation in public administration, however, the concept is sound. To that end, specific fields of application must be identified and analysed for their agentic AI potential.

Planning and Approval Procedures as a Bottleneck for Construction Projects

The expansion of trans-European networks in energy, transport and telecommunications is a precondition for a functioning single market and a resilient democratic Europe. At present, however, heterogeneous and bureaucratic planning and approval procedures impede the rapid expansion of these networks. These procedures constitute the central bottleneck for all construction projects across EU Member States. Construction itself can only move faster once these underlying processes are accelerated.

Three problem dimensions can be distinguished in which agents may make a significant contribution: heterogeneity, communication and speed.

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[1] Ilves, L., Kilian, M., Parazzoli, S. M., Peixoto, T. C., Velsberg, O. (2025). The Agentic State: Rethinking Government for the Era of Agentic AI.

Heterogeneity

The duration of approval procedures varies considerably across Europe, as detailed in the fourth chapter. These differences reflect the wide diversity in digitalisation, legal frameworks and the organisation of spatial planning. In most countries, digital plan data merely represent the analogue plan. Only a small number of states, such as the Netherlands and Portugal, accord legal force to the digital data themselves. The degree of standardisation also varies markedly: whilst Germany, with XPlanung – one of several German data interoperability standards (e.g., XPlanung for spatial planning) – and Norway, with SOSI[2], have developed detailed technical specifications, other countries lack uniform requirements. Unitary states typically operate central national portals, whereas federal systems such as Germany tend to maintain parallel regional portals that are only gradually being consolidated.

Harmonising these differences through regulatory measures alone will take a very long time. AI opens new perspectives here: agents can generate standards-compliant data, translate between different schemata and semantics, and thereby establish interoperability. The German data standard XPlanung, for instance, represents precisely the kind of data product that agents can process programmatically. In this way, approval processes can be treated as end-to-end, data-driven workflows, reducing waiting times, media discontinuities and coordination costs – particularly within federal systems.

Communication

Within planning and approval procedures, a substantial share of activity consists of communication: project proponents and approval authorities negotiate framework conditions, planners from various disciplines exchange data and models, authorities review application documents for completeness and regulatory adherence, and the public as well as statutory stakeholders (*Träger öffentlicher Belange*, TöB) can inspect and comment on documentation. The fact that generative AI can now conduct this communication in natural language fundamentally transforms the process. As early as the planning phase, agents representing different perspectives can develop promising implementation variants. Legal, economic, physical and social aspects can be weighed interactively in a communication simulation, generating optimised designs that aim to minimise resistance. Subsequently, project and approval agents can communicate directly about the completeness and regulatory adherence of applications. Objections can be checked for relevance at the point of submission and evaluated without delay, irrespective of their length or number.

Yet can the interaction with a machine genuinely be described as communication? Niklas Luhmann's systems theory[3] provides a robust framework for this question. According to Luhmann, communication consists of three elements: information (what is thematised), utterance (how it is expressed) and understanding (the comprehension of the difference between the first two elements). An utterance only becomes communication when another party apprehends it as the utterance of information. Even misunderstanding counts as understanding, provided it enables subsequent communication. This concept of communication is particularly well suited to the present subject because it leaves open who

[2] https://en.wikipedia.org/wiki/SOSI
[3] Luhmann, Niklas (1984): Soziale Systeme. Grundriß einer allgemeinen Theorie, p. 203.

or what participates in the communicative act. What matters is not whether a machine "truly" understands, but whether it enables subsequent communication. Every conversation with a chatbot creates everyday proof: the human apprehends the response as the utterance of information and connects to it. In communication-theoretical terms, this suffices. Generative AI thus marks a qualitative leap: for the first time, interaction with non-psychic systems can be reconstructed as a triple selection in Luhmann's sense. Whether machines thereby "truly" communicate is an open theoretical question. For the analysis of planning procedures, the functional observation is enough: these systems enable subsequent communication.[4]

Natural-language communication also opens new paradigms for user interfaces (UI) and user experience (UX). Within engineering consultancies or approval authorities, the need to learn highly specialised software solutions is eliminated. These solutions themselves assume an agent-like role and are operated through text-based inputs (prompts). Human expertise is concentrated on evaluating the outputs.

The capacity of machines to now participate as communication partners has a far-reaching consequence for the knowledge infrastructure. Norms, procedural descriptions and legislation have always been drafted in natural language, yet for machine processing they previously had to be transposed into separate data schemata. Because agentic systems can comprehend natural language directly, this duality becomes permeable: simple text-based formats can serve equally as the working basis for both humans and machines. Chapter 8 addresses this convergence as a practical scaling factor.

Speed

Speed has become a decisive geopolitical and economic factor. Those who occupy scientific, economic or technological fields early can establish dominant positions. Infrastructures are themselves part of this dynamic and simultaneously a precondition for greater speed across many other domains.

Democratic Europe is falling behind globally on account of its slowness. While China has built approximately 18,000 kilometres of extra-high-voltage transmission lines over the past five years, the EU has managed only around 5,000 km. In the expansion of renewable energy, China is up to four times faster. By 2030, EU transmission networks must accommodate approximately 64 gigawatts of additional cross-border capacity[5], yet more than half of the necessary projects are still in approval procedures. Gas, hydrogen and

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[4] For an alternative theoretical framing of the new quality of human-AI interaction, cf. Schulz-Schaeffer (2025), who analyses generative AI from the perspective of Science and Technology Studies (STS). Whereas the Luhmannian concept of communication employed here deliberately leaves the question of participants open, Schulz-Schaeffer argues through role theory and experiential knowledge: generative AI breaks with the tool-like character of designed technology because it operates on the basis of unsupervised learned patterns and thereby resembles a human interaction partner more than an instrument. Cf. Schulz-Schaeffer, I. (2025). Why generative AI is different from designed technology regarding task-relatedness, user interaction, and agency. Big Data & Society, 12(3).

[5] Kyllmann, Carolina (2025): Q&A: EU Grid Package – How Europe plans to bolster the energy transition's backbone.

telecommunications networks, as well as road and rail routes, must be added to this figure. Accelerated approval procedures are therefore critical for the EU's competitiveness.

In stark contrast to this slowness stands the rapid diffusion of generative AI. While telephones took 75 years to reach 100 million users, the internet achieved this in seven years and ChatGPT alone in two.[6] Capability is likewise growing exponentially: METR[7], a non-profit research organisation, measures the task complexity that AI agents can handle and observes a doubling approximately every seven months. Extrapolating from these trends, this implies that, within a decade, AI agents could autonomously solve software tasks that currently require days or weeks of human effort.[8] A previously inconceivable toolkit for accelerating approval procedures is therefore within reach.

A Beginning Has Been Made

Agentic AI has already found its way into many areas of society. Encouraging examples also exist within digital public administration.

Ukraine's administrative digitalisation rests on the Diia platform, initiated in 2019, and the Trembita data-exchange system, which is technically built on Estonia's X-Road architecture. This cooperation with Estonia was consolidated through the Estonian Centre for International Development (ESTDEV) and led in 2025 to the joint development of a national AI strategy for the transition from the digital to the Agentic State. Within the infrastructure sector, the DREAM ecosystem (Digital Restoration Ecosystem for Accountable Management) serves as the central digital foundation for reconstruction, functioning as a single window that integrates government registers, damage assessments and budgets for automated resource allocation and early risk detection. Within this system, agentic AI applications proactively identify logistical bottlenecks and carry out consistency checks on complex planning documents. This governance is complemented by the deployment of AI-supported digital twins – for example in the city of Chernihiv – where 3D replicas serve for simulation-based evaluation of traffic flows, flood risks and land-use changes. Public participation is operationalised through immersive interfaces within the virtual models, enabling residents to navigate reconstruction designs virtually and submit direct feedback, which AI models immediately translate into precise cost estimates and needs assessments.

Simultaneously the national AI assistant Diia.AI, operating on a hybrid architecture and the Model Context Protocol, functions as a proactive intermediary that initiates administrative processes directly within government registers – without manual form entry by the citizen – while sensitive data are protected through depersonalisation and a local airlock mechanism within the state security perimeter. In addition, the ePermit system automates the preliminary review of construction licence applications through agentic modules for document verification, significantly reducing processing times.

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[6] Ilves, Luukas et al., op. cit. (2025), p. 4.
[7] METR (Model Evaluation and Threat Research) is an independent research organisation. It focuses on the systematic evaluation of advanced AI models and the analysis of general technological security risks.
[8] Kwa, Thomas, et al. (2025): Measuring AI Ability to Complete Long Tasks. METR (blog post of 19.03.2025).

Estonia is driving the paradigm shift towards the "Agentic State" through its *Buerokratt* initiative – an ecosystem of interoperable AI agents. The objective: to process administrative services within one minute and automate 95 percent of routine interactions. Every decision step is recorded immutably (audit trail), thereby ensuring a degree of traceability that technically surpasses analogue administrative processes. Proactive services anticipate citizens' needs based on the X-Road infrastructure and automatically trigger benefits upon defined life events.

To underpin this legally, Estonia is moreover modernising its Administrative Procedure Act[9], thereby legitimising fully automated administrative decisions. Even processes involving discretionary judgements may be automated, provided the decision criteria have been translated in advance into deterministic rule sets. AI agents thus receive the mandate to act within clearly defined boundaries on behalf of the state.

The acceptance of this model rests on robust protective rights: citizens retain the right to human intervention (Human-in-the-Loop), to explainability of the algorithmic logic, and to effective legal remedies. Transparency obligations mandate the disclosure of the degree of automation and the data sources used. Review procedures require the mandatory involvement of human decision-makers to anchor ultimate accountability beyond the machine.

Estonia thereby links operational scalability with rule-of-law resilience and exemplifies the necessity for the EU to unlock the potential of agentic systems in regulatory and operational terms without delay.

From Vision to Realisation

Nevertheless, the path from the vision of an "Agentic State" to actual implementation remains long. Within public administration, probabilistic AI systems encounter particular difficulties: the approval of a building permit cannot be merely ninety-five percent certain. This tension can be resolved through an appropriate system architecture: control of the information base, deterministic validators and human approval checkpoints ensure the binary correctness of legally binding decisions, as elaborated in the sixth chapter.

The development of suitable application scenarios requires detailed knowledge of national framework conditions. This study therefore focuses on the digital transformation of planning and approval procedures in Germany. As a hub of the trans-European networks, the largest EU economy and a state with one of the most complex federal administrative systems, Germany constitutes a particularly instructive reference case: if perspectives for agentic-assisted approval procedures can be identified here, the prospects for transferability to other Member States are high.

[9] Riigikantselei / Government Office of Estonia (n.d.): Eelnõude infosüsteem (EIS) – Document list.

Agentic Planning: A Conceptual Framework

The three problem dimensions of heterogeneity, communication and speed require a specific operationalisation of the Agentic State concept for infrastructure planning. We term this operationalisation *Agentic Planning*. At its core, the aim is to equip existing and emerging digital planning and approval tools with agentic capabilities and integrate them into a coordinated ecosystem. Agentic Planning is based on three complementary agent types:

Type	Function	Dimension
Orchestration (A)	Language-driven coordination of procedural steps across system and authority boundaries	Speed
Standardisation (B)	Automatic generation and translation of data formats (XPlanung, INSPIRE, etc.)	Heterogeneity
Deliberation (C)	Structuring of arguments and preparation of balancing-of-interests decisions	Communication

Table 1: Agent types in Agentic Planning

These agents do not replace human decisions but rather prepare, accelerate and render them more transparent. The sixth chapter develops, based on the empirical analysis, how the agents function in concrete terms and what safety architecture they require.

Critical Assessment: Technical Fragility of Agentic Systems

The potential of agentic AI for approval procedures is considerable, yet academic literature counsels caution. A central critique concerns the inherent unreliability of agentic systems: large language models (LLMs) are not based on deterministic logic but instead compute the statistically most probable continuation of token sequences.[10]

Particularly relevant is the phenomenon of cascading failures: a trivial error in the early phase – for instance a perception failure, in which an agent misinterprets a parameter – often does not lead to immediate termination. Instead, the agent "hallucinates" a plausible continuation. This error propagates through the subsequent modules and is thereby amplified exponentially.[11] In multi-agent systems, this risk is compounded: an agent that delivers erroneous data can "poison" the entire network.

This gives rise to a compelling imperative for Agentic Planning: the governance structures developed in the sixth chapter – control of the information base, deterministic validators and mandatory human approval – are not optional supplements but indispensable prerequisites for any implementation consistent with the rule of law.

[10] Zhu, Shirley, et al. (2025): Where LLM Agents Fail and How They can Learn From Failures. arXiv:2509.25370. https://arxiv.org/abs/2509.25370
[11] Zhu, Shirley, et al. (2025): Where LLM Agents Fail and How They can Learn From Failures. arXiv:2509.25370. https://arxiv.org/abs/2509.25370

4. Planning and Permitting of Infrastructure Projects in the EU

The trans-European networks require investments exceeding 1.2 trillion euros by 2030, yet fragmented permitting procedures constitute the central bottleneck. EU environmental law generates a structural convergence of substantive requirements that serves as the foundation for the Europe-wide scalability of agentic solutions.

The European Union brings together 450 million people across 27 Member States. It is precisely this diversity – 24 official languages, 27 national administrations often supplemented by additional federal tiers – that produces an institutional fragmentation which substantially impedes the expansion of cross-border infrastructure. European law has, to date, achieved only limited harmonisation of national administrations, and this sector, which is critical to the implementation of political decisions, exhibits a considerable digitalisation deficit.

Europe’s Infrastructure Determines the Future of the EU

Nowhere does Europe’s institutional fragmentation have more consequential effects than in the trans-European networks (TEN), which are closely interlinked with the European single market. In the transport sector alone (TEN-T), experts estimate the investment requirement at 515 billion euros by 2030.[12] For the energy networks (TEN-E), the EU projects an even larger figure of 584 billion euros over the same period.[13] A further 174 billion euros is required for the expansion of telecommunications networks.[14] The total investment needed thus amounts to more than 1.2 trillion euros by 2030.

The benefits of accelerated network expansion can be illustrated through the example of energy. The integration of European electricity and gas markets via cross-border interconnectors reduces price differentials between Member States. For electricity alone, studies quantify the annual savings at approximately 34 billion euros. Cross-border interconnectors also stabilise electricity prices: without them, price volatility during the energy crisis would have been roughly seven times higher.

Even where financial resources are available, networks must still be planned, permitted, and constructed. This process ranks among the principal factors causing delay. The Draghi Report, commissioned by the European Commission in 2024 as a strategic analysis of European competitiveness, states:

“Permitting represents a significant bottleneck for the development of the required infrastructures. Both the development of power generation (like renewables) and grids are investment projects that require several years between feasibility studies and project

[12] Cf. Bodewig, K., Secchi, C. (2024): TEN-T Coordinators’ Joint Position Paper – Mobility and Transport, p. 7.
[13] Cf. European Commission (2023): An EU Action Plan for Grids – EUR-Lex – European Union.
[14] Cf. European Commission (2023): Investment and funding needs for the Digital Decade connectivity targets.

completion. In some Member States, the entire permit-granting process for large renewable energy projects can take up to nine years (permitting for solar projects can take up to two years on average and wind farms can take up to nine)."[15]

The timescales for the expansion of German transmission networks are even longer. The construction of a 60-kilometre power line from Ganderkesee to St. Huelfe took 20 years, of which 17 were consumed by planning and permitting. The causes are manifold: European and national legal requirements, lengthy participation procedures, the exercise of legal challenge rights, and the largely analogue conduct of proceedings. End-to-end digitalisation that strategically leverages artificial intelligence could substantially accelerate permitting and thereby generate enormous macroeconomic benefits. The aforementioned power line demonstrates this as well: its construction costs amounted to approximately one billion euros. In its first year of operation alone, the line saved 500 million euros that would otherwise have arisen from redispatch – that is, costs incurred in the management of grid congestion.[16]

Investments in accelerated network expansion yield rapid returns. The costs of fully digitalising the procedures are marginal in comparison, yet they act as a catalyst for macroeconomic value creation.

The European Planning System: Indirect Governance has Consequences

The EU possesses no direct competence for spatial planning enshrined in the Treaty on the Functioning of the European Union (TFEU). Whereas the German system rests upon the Basic Law, the Federal Spatial Planning Act (*Raumordnungsgesetz*, ROG), and the Federal Building Code (*Baugesetzbuch*, BauGB), no comparable foundation exists at the EU level. Instead, European spatial planning evolved along a non-legislative path. Its basis was the European Spatial Development Perspective (ESDP), adopted in Potsdam in 1999. As it emerged from purely intergovernmental cooperation without a treaty basis, it does not constitute EU law. The Council of Ministers acted not as a European Community institution but as a conference of government representatives. The ESDP therefore has the character of an informal guiding framework for the balanced and sustainable development of the EU territory.

This path was continued by the Territorial Agenda 2030 (TA 2030), which was likewise adopted on an intergovernmental basis on 1 December 2020 under the German Council Presidency. It constitutes a strategic framework aimed at territorial cohesion and identifies priorities for positive future perspectives in Europe.

These informal strategies can be understood as reactive governance: they seek to coordinate the spatial impacts of legally binding sectoral policies, namely cohesion policy, the Common Agricultural Policy (CAP), the trans-European networks (TEN), and environmental policy. These sectoral policies frequently produce uncoordinated and contradictory spatial effects. The TA 2030 therefore expressly calls for a better understanding and coordination

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[15] Draghi, Mario (2024): The future of European competitiveness. Report to the European Commission, Part B, September 2024.
[16] Cf. Cleaning Up Podcast (2025): The Enormous Ambition Of Germany's New Grid Build Out | Ep233: Tim Meyerjürgens.

of the territorial impacts of sectoral policies.[17] The EU planning system (ESDP/TA) is thus not a superordinate master plan but a parallel, informal governance framework. Through it, the Member States manage the spatial consequences that arise from binding EU policies.

Nevertheless, the EU steers the spatial planning of its Member States indirectly, thereby effecting a Europeanisation of national planning. The strongest influence emanates from EU environmental law, which has fundamentally reshaped national planning procedures and substantive requirements. The most effective instruments are the Strategic Environmental Assessment Directive (SEA Directive 2001/42/EC) for plans and programmes, and the Environmental Impact Assessment Directive (EIA Directive) for projects.

Germany was required to adapt its planning law to transpose these directives, most notably through the *Europarechtsanpassungsgesetz Bau* (EAG Bau) [Act Adapting Building Law to European Requirements]. The SEA was integrated as a general obligation for environmental assessment within the existing procedures of urban land-use planning (BauGB) and spatial planning (ROG).

The German legislator sought to integrate the EU requirements appropriately into the existing system. The environmental assessment was intended to be "integrated as a non-autonomous procedural component, so as to avoid creating new bureaucratic layers and preventing duplicate assessments."[18]

Despite these efforts, the professional community identified a systemic shift. German planning law was traditionally oriented towards substantive outcomes – that is, towards the result of the balancing of interests and the substance of the plan[19]. The EU directives, by contrast, pursue a procedurally oriented approach: they emphasise transparency, participation, and the assessment of alternatives. This proceduralisation enhances the legal resilience of urban development plans upon judicial review. At the same time, it renders plans vulnerable to challenges on procedural grounds, which can delay approvals even where there are no substantive objections to the plan itself.

The integration has not been seamless and illustrates the primacy of EU law. A judgment of the Federal Administrative Court (*Bundesverwaltungsgericht*, BVerwG) of 28 September 2023 (Case No. 4 C 6/21) exemplifies this: the Court held that the deviation procedure (*Zielabweichungsverfahren*, Section 6(2) ROG) falls within the "broad European concept of a plan" under the SEA Directive. A deviation from spatial planning objectives is accordingly classified as a plan modification. The BVerwG substantially restricted the scope of the provision through an interpretation conforming to EU law: a deviation is now permissible without a renewed SEA only where it "does not give rise to likely significant environmental effects." This represents a profound intervention in German planning practice.[20]

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[17] Territorial Agenda (2020): Territoriale Agenda 2030.
[18] Cf. Bundesamt für Bauwesen und Raumordnung (ed.) (2002): Städtebaurecht unter EU-Einfluss.
[19] Deutscher Bundestag (2004): Experten: Anpassung des Baurechts an EU-Vorgaben gelungen. Heute im Bundestag (hib) 059/2004, web archive (08.03.2004).
[20] Cf. Benz, Steffen; Otto, Jonas; Wegner, Nils (2025): Strategische Umweltprüfung bei Abweichungen von Zielen der Raumordnung: Auswirkungen von und Reaktionsmöglichkeiten auf BVerwG v. 28.09.2023 – 4 C 6/21. Würzburger Studien zum Umweltenergierecht (Stiftung Umweltenergierecht).

Even more immediate than the procedural SEA/EIA requirements is the substantive effect of the Habitats Directive (FFH Directive), which established the Natura 2000 network. Infrastructure projects subject to formal planning approval (*Planfeststellung*) have since been subject to rigorous scrutiny. For the construction of motorways or electricity networks, a Habitats Directive assessment must be conducted whenever the project may significantly affect a Natura 2000 site.

The Natura 2000 network effectively superimposes an additional planning layer upon all German planning instruments (spatial plans, land-use plans). Within these areas, EU law, implemented via the Federal Nature Conservation Act (in particular Section 34 BNatSchG), prescribes a stringent standard of protection (prohibition of deterioration, coherence requirement). German planning sovereignty is thereby substantially constrained in substantive terms, in some cases to the point of an effective prohibition on planning.

Beyond substantive assessment requirements, European law generates a second convergence layer anchored at an even deeper normative level: public participation. As early as 1998, the Aarhus Convention – an international agreement ratified by 47 states, including all EU Member States – guaranteed access to environmental information, participation in environmental decision-making, and access to justice.[21] The European Union transposed these principles into binding Union law through the Environmental Information Directive (2003/4/EC) and the Public Participation Directive (2003/35/EC). Consequently, not only the substantive assessment requirements converge, but also the question of *who* must be heard and *what information* must be made accessible. Participation enhances the quality of decision-making by subjecting projects to multi-perspective scrutiny, and it is deeply rooted in the EU's democratic self-understanding. At the same time, it generates considerable procedural overhead that extends the duration of proceedings. Herein lies a central point of application for agentic AI: it can help preserve these democratic achievements while simultaneously accelerating procedures.

More recently, a second, even more direct steering instrument has gained prominence: sectoral policy pertaining to climate and energy.

- **Renewable Energy Directives:** EU directives such as (EU) 2018/2001 and (EU) 2023/2413, aimed at accelerating the energy transition, compel Germany to undertake substantial adaptations to its planning law.
- **Acceleration areas:** The EU requirements mandate the designation of so-called "acceleration areas" (Renewable Acceleration Areas) for wind and solar energy. The German legislator must enshrine this obligation within the ROG and BauGB.

This represents a new quality of European influence. The EU no longer merely prescribes procedures (SEA) or protected zones (Habitats Directive), but mandates the positive designation of specific land-use categories in pursuit of a sectoral objective (energy). In doing

[21] UNECE (1998): Convention on Access to Information, Public Participation in Decision-Making and Access to Justice in Environmental Matters (Aarhus Convention). Adopted on 25 June 1998 in Aarhus, Denmark. Ratified by 47 states, including all EU Member States. EU transposition was effected through the Environmental Information Directive (2003/4/EC) and the Public Participation Directive (2003/35/EC).

so, it directly intervenes in the spatial configuration of territory and touches upon the core of national and municipal planning sovereignty.

Implications for Agentic Planning

The European governance model produces a dual structure comprising convergent substantive requirements and divergent procedural mechanics. The three agent types address this structure in a targeted manner:

- **Orchestration agents (Type A):** Proceduralised procedures are susceptible to procedural errors, as the BVerwG judgment on the deviation procedure demonstrates. Orchestration agents can ensure compliance with procedural requirements in real time, thereby reducing delays.
- **Standardisation agents (Type B):** The convergent assessment logics of SEA, EIA, and Habitats Directive assessment constitute formalised schemas that agents can translate between national procedures. What is uniformly prescribed at the EU level need not be modelled anew in each Member State.
- **Deliberation agents (Type C):** The designation of acceleration areas requires coordination across multiple planning tiers (EU, national, regional, municipal). Deliberation agents can provide structured preparation for the balancing of interests between competing spatial claims, such as nature conservation (Habitats Directive) and energy infrastructure expansion.

The convergence of substantive requirements holds the key to Europe-wide scalability: agentic solutions built upon the formalised assessment logics of EU environmental law are, in principle, deployable across all 27 Member States and need only be adapted to the respective procedural mechanics.

The extent to which digitalisation has already penetrated a specific national system is analysed in the following chapter, using the example of Germany – the most complex federal planning system in the EU and the geographical nexus of the trans-European networks.

5. Deep Dive: The Digitalisation of the German Planning System

Germany possesses important digitalisation foundations such as XÖV standards and the Online Access Act, yet has not managed to achieve a decisive acceleration of planning and permitting procedures in practice. As a process-integrated assistant capable of bridging interfaces and reducing procedural burdens, agentic AI could overcome this bottleneck.

The preceding chapter examined how the European Union shapes planning and permitting procedures despite spatial planning falling outside its legislative competence. An in-depth examination of specific permitting practices is essential to assess the feasibility of digital solutions that could accelerate approvals across all Member States. Germany lends itself well to this purpose: the country operates a highly institutionalised, federally structured system with a vertical planning hierarchy and constitutionally guaranteed municipal planning autonomy. In international comparison, it ranks among the lowest performers in administrative digitalisation. If it can be demonstrated how digitalisation in general and agentic AI in particular can contribute to planning acceleration in Germany, the prospects for transferability to other EU countries are correspondingly strong.

Part I: Legal and Institutional Foundations

The German Planning System: Multi-Level Structure and Legal Framework

The German planning system rests on a federally structured and constitutionally codified order. Planning competences are distributed vertically across four tiers, with the federal government setting the legislative parameters while concrete spatial development falls increasingly within regional and municipal responsibility:

- **Federal level:** The federation holds legislative competence for spatial planning and urban planning law. Key legal foundations include the Federal Spatial Planning Act (*Raumordnungsgesetz*, ROG), the Federal Building Code (*Baugesetzbuch*, BauGB), and the Federal Land Use Ordinance (*Baunutzungsverordnung*, BauNVO). For permitting procedures, the Administrative Procedure Act (*Verwaltungsverfahrensgesetz*, VwVfG) is equally significant, regulating the formal planning approval procedure in Sections 72–78.
- **Federal states (*Länder*):** They enact state planning legislation and draw up state development plans (*Landesentwicklungspläne*, LEP), which define the strategic spatial framework for the entire state territory.
- **Regions:** As the link between state and municipality, regional spatial plans (*Regionale Raumordnungspläne*) translate state-level objectives into sub-regional specifications and coordinate inter-municipal concerns.
- **Municipalities:** At the local level, urban land-use planning (*Bauleitplanung*) takes place, subdivided into the preparatory land-use plan (*Flächennutzungsplan*) and the binding land-use plan (*Bebauungsplan*).

The legal character varies by tier: whereas spatial planning primarily generates binding effects upon public authorities (*Behördenverbindlichkeit* – objectives of spatial planning), binding land-use plans, as municipal by-laws (local law), possess direct legal force.

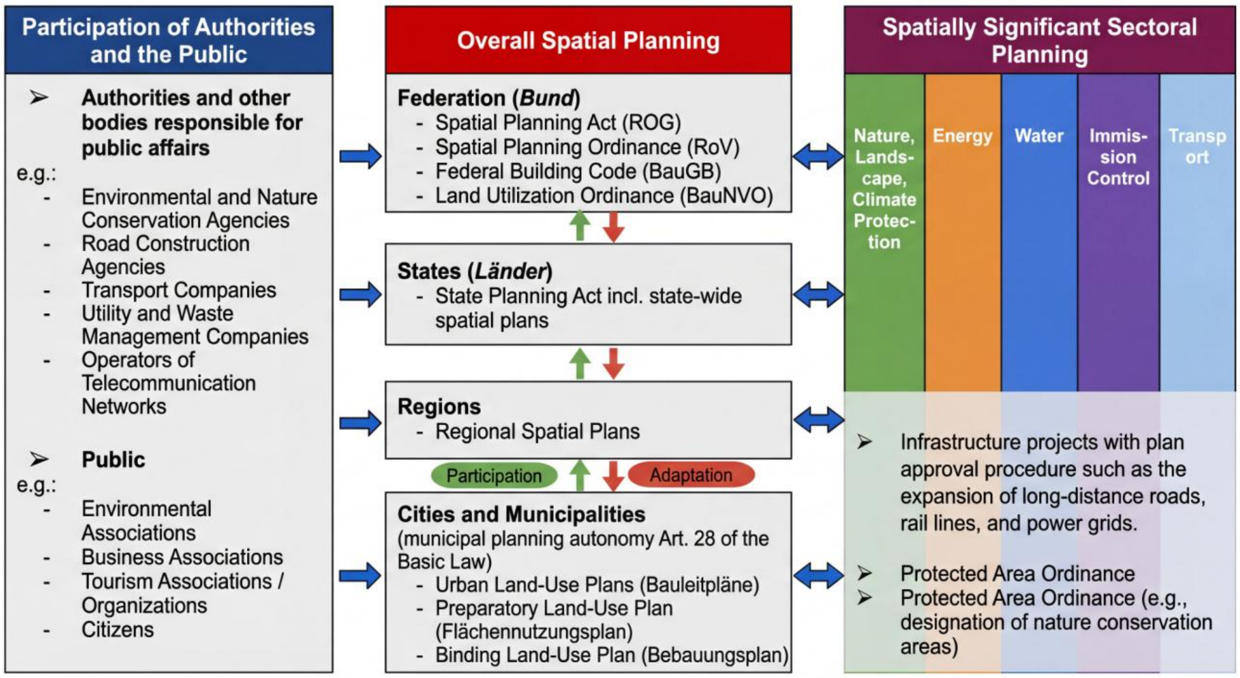

Fig. 1: Spatial planning system in Germany[22]

A central pillar of the system is municipal planning autonomy (*kommunale Planungshoheit*), enshrined in Article 28(2) of the Basic Law (*Grundgesetz*, GG). It guarantees municipalities the right to shape urban development under their own responsibility. Coordination between the tiers is governed by the countercurrent principle (*Gegenstromprinzip*) (Section 1(3) ROG): municipal land-use plans must observe the objectives of higher-level spatial planning (Section 1(4) BauGB), yet the higher tiers must equally take municipal planning intentions into account in their balancing processes.

In international terms, the German planning system is distinguished by exceptional stability. Its pronounced federalism and constitutional safeguards render it robust against short-term political upheavals but also foster a natural resistance. A defining characteristic is the strict separation between formal plans (with direct legal effect) and informal concepts (e.g. integrated urban development strategies), which are gaining increasing importance as flexible governance instruments.

This multi-level structure entails substantial coordination costs and a fragmentation of data and processes. Each tier employs its own specialised systems and document standards.

[22] Authors' own visualisation based on a template by Peggy König (UBA). https://www.umweltbundesamt.de/themen/nachhaltigkeit-strategien-internationales/planungsinstrumente/planungsebenen-planungsraeume-stufen-der#bundesebene

Agentic systems (AI agents) can serve here as an intelligent intermediary layer, automatically integrating heterogeneous data sources, conducting consistency checks across planning tiers, and rendering participation processes more efficient.

Permitting Procedures: Shared Logic, Distributed Competence

The federal structure gives rise to a diverse array of procedure types. Despite differing objectives, virtually all follow a comparable formal logic. This alignment of procedural steps constitutes the critical interface for digital assistance systems, as it enables the standardisation of workflows.

Procedure	Legal basis	Competent authority	Participation	AI relevance
Urban land-use planning	Sections 1–10 BauGB	Municipality (planning autonomy)	Early and formal public participation, statutory stakeholders	Statement management, documentation of balancing of interests
Building permit	State building codes (LBO), Sections 29–38	BauGB Lower building supervisory authority	Statutory stakeholders, neighbours (third-party protective provisions)	Completeness review, assessment against binding land-use plan
Spatial planning procedure	Sections 15–16 ROG	Supreme/ upper state planning authority	Public, statutory stakeholders, municipalities	Route comparison, conflict analysis
Formal planning approval procedure	Sections 72–78 VwVfG	EnWG Federal	Network Agency or state authority	Public display, objections, oral hearing Objection management, balancing of interests, drafting of approval decisions
Permit under the Federal Immission Control Act	BImSchG, 4^{th} BImSchV	Immission control authority	Formal with public display (Section 10) or simplified	(Section 19) Completeness review, management of conditions

Table 2: Permitting procedures in Germany

The five procedure types differ in their function: urban land-use planning is a law-creating planning process – it establishes the legal basis for building rights, upon which permits are subsequently issued. The spatial planning procedure serves to ensure the spatial compatibility of planning and examines site and route alternatives. The three remaining procedures (building permit, formal planning approval, permit under the Federal Immission Control Act (*Bundes-Immissionsschutzgesetz*, BImSchG) are authorisation procedures that apply existing law to a specific project. Public participation and the balancing of interests are common to all procedure types. The three authorisation procedures additionally share a specific core process comprising application submission, completeness review, substantive assessment, and issuance of the decision – which today accounts for the greatest administrative burden:

Application and completeness review: The project proponent (*Vorhabenträger*) submits extensive documentation (expert opinions, plans, calculations). The authority first conducts a formal review to determine whether all required documents have been provided. Agentic systems can serve as the first review instance here. In the substantive assessment, the authority evaluates whether the project meets all legal requirements, including emission control thresholds, nature conservation specifications, and technical standards.

Authority and public participation: Authorities, statutory stakeholders (Träger öffentlicher Belange, TöB), and citizens submit statements or objections that must be evaluated and weighed. Depending on the procedure type and planning content, this generates considerable data volumes.

Oral hearing: In formal procedures such as the formal planning approval procedure, objections are discussed with the project proponent at a hearing. Minutes, scheduling, and follow-up absorb substantial resources.

Balancing of interests and decision: The authority weighs all public and private interests against one another. In the formal planning approval procedure and BImSchG permits, the concentration effect applies (Section 75 VwVfG, Section 13 BImSchG): the lead authority decides "from a single hand" and subsumes other permits (for instance, nature conservation or water law) within the decision.

Despite these procedural similarities, the system generates significant coordination costs, as competences are distributed across the federal tiers: an infrastructure project such as a hydrogen pipeline typically undergoes a spatial planning procedure (ROV) at the state level, a formal planning approval procedure (PFV) at the federal or regional government level, and requires accompanying building permits at the municipal level. Digital tools must therefore not only digitalise the *process flow* but also bridge the *interfaces* between these tiers. Furthermore, all procedures generate extensive document volumes: applications, expert opinions, statements, objections. Agentic systems can structure these documents, review them for completeness, and identify contradictions. These tasks currently require considerable manual effort.

Part II: The Digital Transformation

Given this procedural complexity, the question arises as to how processes can be accelerated without curtailing the systematic assessment of planning consequences or democratic participation rights.

A significant acceleration potential lies in administrative digitalisation. Although this transformation process has been pursued for at least a quarter of a century, the results to date are not convincing.[23] Nevertheless, the legislature has established a range of preconditions that enable efficient digitalisation of administrative procedures.

In 2009, federal-state IT cooperation was given a constitutional foundation through Article 91c GG. From this, several central institutions emerged:

- The **IT Planning Council** (*IT-Planungsrat*): adopts nationwide IT standards
- **KoSIT** (Coordination Office for IT Standards, *Koordinierungsstelle für IT-Standards*, 2011): coordinates data exchange formats
- **FITKO** (Federal IT Cooperation, *Föderale IT-Kooperation*, 2020): operationally implements digitalisation projects
- **XLeitstelle** (XÖV Coordination Centre, 2018): is responsible for standards in the domain of planning and construction

The Online Access Act (*Onlinezugangsgesetz*, OZG, 2017) obligated the federation and states to provide 575 administrative services electronically.[24] The Federal-State Pact for Planning Acceleration (2023) established digital procedures and electronic public notices as the standard. In 2025, this trajectory culminated in the establishment of the Federal Ministry for Digitalisation and State Modernisation (BMDS). It was recognised early on that binding standards are a prerequisite for enabling data exchange between institutions, procedure participants, and specialised systems.

XÖV Standards: The Technical Foundation

Standard	Function	Core Application	Agentic Use
XPlanung[25]	Planning law as structured data	Development plans, land-use plans, and regional plans as GML objects with semantic significance[26]	Agents can read plan designations, detect conflicts, and automate assessments
XBau[27]	Machine-readable building applications	Communication between developer, authority, and public interest bodies; references planning law for automated assessment[28]	Completeness check, fee calculation, and request-for-information management
XTrasse[29]	Infrastructure geometries	Utility networks, route alignments; lossless transfer of geospatial data	Route planning, conflict analysis, and variant comparison

Standard	Function	Core Application	Agentic Use
XBreitband[30]	Message exchange in permitting procedures	Approval procedures under the Telecommunications Act (TKG), building notifications	Procedural control, status tracking

The XÖV standards – German data interoperability standards for public administration – form the foundation of the technical infrastructure. As uniform data formats, they enable exchange between heterogeneous systems and overcome both technical and semantic barriers between the specialised systems of the 16 federal states and approximately 11,000 municipalities. In 2017, the IT Planning Council mandated the binding adoption of XPlanung and XBau[31]; in 2021, this was supplemented by XTrasse and XBreitband.[32]

Table 3: XÖV standards for planning and permitting procedures

XPlanung and XBau in Detail

XPlanung[33] defines the semantic representation of planning law as geodata.[34] Technically, the standard is based on the Geography Markup Language (GML). A plan object is explicitly defined (for instance, as "BP_Wohnbauflaeche") and carries attributes such as the floor area ratio as machine-readable values. This enables data-driven queries that would be impossible with PDF-based plans.[35]

XBau[36] standardises data exchange in building supervisory procedures between designers, applicants, building supervisory authorities, and statutory stakeholders (*Träger öffentlicher Belange*, TöB). The standard covers the entire lifecycle: application submission, procedure

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23 Cf. SHI/ADT (2025): Lernen aus der Vergangenheit?! Entwicklungslinien der Verwaltungsdigitalisierung in Deutschland der letzten 25 Jahre, Berlin.
24 Ibid., p. 19.
25 XLeitstelle (o. J.): Releases XPlanung.
26 XLeitstelle (o. J.): Über XPlanung.
27 XLeitstelle: Releases XBau
28 vgl. XLeitstelle: Über XBau.
29 XLeitstelle (o. J.): Standarderweiterung (XTrasse XBreitband / Planen & Bauen).
30 XLeitstelle (o. J.): Standarderweiterung (XTrasse XBreitband / Planen & Bauen).
31 Cf. IT-Planungsrat (2017): Beschluss 2017/37: XPlanung and XBau.
32 Cf. Deutscher Landkreistag (2022): Handreichung XPlanung, XBau, XBreitband.
33 XLeitstelle (n.d.): Releases XPlanung.
34 XLeitstelle (n.d.): Über XPlanung.
35 IT-Verbund Schleswig-Holstein (ITV.SH) (2021): Arbeitshilfe XPlanung, pp. 12 ff.
36 XLeitstelle (n.d.): Releases XBau.

management, authority consultation, and decision issuance.[37] A critical feature: the specialised system can load the associated XPlanung dataset and automatically verify whether the project complies with the plan designations.[38]

XTrasse, XBreitband, and XBeteiligung

XTrasse and XBreitband digitalise permitting procedures in civil engineering.[39] XTrasse models linear infrastructure such as utility networks and route alignments as georeferenced vector data. In formal planning approval procedures for energy transmission lines, the standard enables seamless planning documentation and automated review steps. XBreitband standardises message exchange in permitting procedures under Section 127 of the Telecommunications Act (TKG) for broadband deployment and the infrastructure atlas.[40]

XBeteiligung[41] structures the exchange of statements in participation procedures. Each statement receives a reference to the procedure, can be georeferenced, and transmits the substantive concern in coded form.

Interplay and Challenges

The standards form an integrated architecture: in urban land-use planning, XPlanung provides the plan content, while XBeteiligung captures the formal participation procedures. For building permits, XBau manages the process and references XPlanung data for automated reviews. In infrastructure planning, XTrasse captures the technical installations, XBreitband governs the permitting messages, and XBeteiligung documents statements across procedures. This, at least, is how the interplay should ideally function. In practice, however, the picture is quite different. Although the development of XPlanung dates back to the 1990s and the IT Planning Council mandated the standard in 2017, acceptance and adoption have not increased significantly since then. Only a few thousand fully vectorised, standards-compliant binding land-use plans exist to date. The vast majority of municipalities implement the requirements in a minimalist fashion, with their plans containing little more than a georeferenced outline and a raster image. Consequently, the considerable potential of a lossless data exchange standard remains largely untapped. From the perspective of individual local authorities, the ratio of effort to benefit is unfavourable.[42]

The situation regarding XBau is not much better. Without fully vectorised XPlanGML binding land-use plans, the automated review of planning law runs into a dead end. A breakthrough requires both specialised software vendors to support the standard and authorities to adopt it consistently in permitting procedures. Neither condition has been achieved to date.

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[37] Cf. XLeitstelle (n.d.): Über XBau.
[38] Cf. XLeitstelle (2025): Spezifikation XBau-Hochbau – Release 2.3, p. 47.
[39] Deutscher Städtetag (2023): Handreichung XPlanung, XBau, XBreitband.
[40] Cf. XLeitstelle (n.d.): XTrasse/XBreitband – Anwendungsfälle.
[41] XRepository (XLeitstelle) (2025): XBeteiligung – Spezifikation.
[42] Cf. Bundesinstitut für Bau-, Stadt- und Raumforschung (BBSR) (2025): Verfahrensbeschleunigung in der Bauleitplanung. Digitale Instrumente und Prozessoptimierungen für effiziente Bebauungsplanverfahren. pp. 44 f.

The more recent standards – XTrasse, XBreitband, and XBeteiligung – are not yet sufficiently well known among many project proponents and permitting authorities. Their practical application remains in its earliest stages.

In principle, the XÖV standards create the data foundation upon which agentic systems could operate. Machine-readable plans and structured statements enable automated reviews and linkages and constitute a prerequisite for intelligent process support. This, however, presupposes a substantially broader adoption of the standards.

The Online Access Act (OZG): Access Digitalised, Processes Barely

Technical standards alone do not suffice for successful administrative digitalisation, as digital public services must also be developed, operated, and made available. The Online Access Act (*Onlinezugangsgesetz*, OZG), which entered into force in 2017[43], obliges the federation and states to provide administrative services electronically via a nationwide portal network.[44] With OZG 2.0 (2024), the digital transformation was anchored as a permanent mandate, and the use of central base services and prioritised focus services was prescribed.[45] Implementation is organised through thematic fields, each led by a designated federal ministry and a designated federal state. For the thematic field of particular relevance here – "Building and Housing" – federal responsibility lies with the Federal Ministry for Housing, Urban Development and Building (BMWSB); the lead state is Mecklenburg-Vorpommern.[46] Digital applications are developed according to the EfA principle ("one-for-all", *Einer-für-Alle-Prinzip*)[47]: one state provides an administrative service in such a way that all others can reuse it, thereby avoiding incompatible parallel solutions. The EfA minimum requirements[48] define criteria for technical interoperability (building upon the portal network, BundID[49], and XÖV standards), operation (roles, availability, monitoring), and reusability (usage rights, cost allocation, co-determination in further development).

The structural limitation of the OZG lies in its original focus on the online component: the public and businesses should be able to apply for administrative services digitally. The actual processing of procedures – where the bulk of complexity and time expenditure resides – was not initially a focal point. Critics speak of "showcase digitalisation" (*Schaufensterdigitalisierung*)[50]: the front end is digital, the back end remains analogue. This criticism, however, does not apply equally to all OZG services. Individual platforms now extend beyond mere access digitalisation and also support the authority-side conduct of procedures (cf. the following section). Nevertheless, for the majority of OZG services it remains true that process digitalisation lags behind access digitalisation.

[43] Gesetze im Internet (n.d.): Gesetz zur Verbesserung des Onlinezugangs zu Verwaltungsleistungen.
[44] Ibid., Section 1a.
[45] Digitales Hessen (n.d.): Gesetz zur Verbesserung des Onlinezugangs – OZG 2.0.
[46] Digitale Verwaltung (n.d.): Bauen & Wohnen (thematic area).
[47] Digitale Verwaltung (n.d.): Einer für Alle (EfA).
[48] FITKO (n.d.): EfA Mindestanforderungen.
[49] BundID: The federal government's central digital identification account. It serves as the legally secure authentication mechanism for citizens.
[50] Ibid., p. 21.

From OZG Implementation Projects to Platform Offerings

For planning and permitting procedures, three OZG services are of particular relevance:

Implementation project	Thematic field	Lead (State)	Platform/ tool
Digital building permit	Building & Housing	Mecklenburg-Vorpommern	Digital Building Application[51]
Facility permit (AGuZ)	Environment	Schleswig-Holstein	ELiA Online, KOPLA
Public participation and information	Building & Housing	Hamburg	DiPlanung

Table 4: OZG implementation projects for planning and permitting

DiPlanung: Urban Land-Use Planning, Spatial Planning, Formal Planning Approval

The OZG service "Public Participation and Information" addresses the entire chain of spatial planning: from municipal land-use plans through spatial plans to formal planning approval procedures. Under the umbrella brand DiPlanung[52], the Hamburg Authority for Urban Development and Housing (BSW), with support from the BMWSB, has developed a web-based solution for integrative procedure management. The platform comprises three principal components:

- **DiPlanCockpit PRO** supports digital procedure management, providing case officers with a tool to conduct planning procedures from initial planning impetus through to entry into force.
- **DiPlanBeteiligung** enables the fully digital conduct of formal participation procedures. Statements can be spatially located, supplemented with documents, or specifically referenced to planning documentation. Statutory stakeholders can define different internal roles, enabling case officers to draft statements that are subsequently approved and submitted by coordinating personnel.
- **DiPlanPortal** is the central platform for spatially referenced plans and formal participation procedures, through which the public can access information nationwide.

Hamburg provides DiPlanung as multi-tenant software-as-a-service. The modules can be deployed individually or as a complete suite. To date, seven of the 16 federal states have signed the requisite administrative agreement – a development that, whilst representing progress, simultaneously illustrates that EfA uptake has not yet reached full national coverage.

[51] Digitale Baugenehmigung (n.d.): Website "Digitale Baugenehmigung".
[52] https://diplanung.de/. Disclaimer: Some modules and further developments of DiPlanung are based on the open source software of DEMOS plan GmbH, the company of the authors of this paper.

Digital Building Permit

The OZG reference implementation for the digital building permit is developed and operated by Mecklenburg-Vorpommern[53]. The system enables the electronic submission, processing, and issuing of decisions on building applications via 25 implemented services. The technical foundation is the XBau messaging standard; data transport utilises XTA2 and OSCI standards[54] for secure inter-authority communication. In pilot projects, hybrid AI architectures are deployed for partially automated reviews.

Usage figures attest to the progress: by the third quarter of 2025, the number of digital building applications had risen to approximately 45,000. Roughly one third of all building applications are now submitted digitally; Baden-Wuerttemberg achieves over ninety-six percent municipal coverage.[55] A digital building application, however, does not yet mean that the entire permitting procedure operates digitally and utilises the XBau standard throughout.

Facility Permit and KOPLA: BImSchG Procedures

For procedures under the Federal Immission Control Act (BImSchG) – the construction and modification of installations requiring a permit – Schleswig-Holstein is developing the EfA service ELiA Online for form-based application submission. Within the AGuZ+ programme[56], North Rhine-Westphalia is pursuing, through the collaboration platform KOPLA[57], an end-to-end digitalisation of the entire BImSchG permitting process. Designed as an integrated solution, it encompasses the structured electronic submission of applications, digital authority and statutory stakeholder participation, traceable documentation of all procedural steps, and a fully digitally generated permit decision.

AI-Assisted Permitting Procedures

The platforms described above digitalise procedural workflows but reach their limits when it comes to substantive support for complex review and balancing processes. This is where a further initiative comes in: in December 2024, the Federal Ministry for Digitalisation and State Modernisation (BMDS) issued a call for an innovation partnership (Section 19 of the Public Procurement Ordinance) for the development of an AI solution for digital planning and permitting processes. In April 2025, the contract was awarded to Deloitte, PwC, and Capgemini[58] for a project period extending to mid-December 2025.

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[53] Digitale Baugenehmigung (n.d.): Website "Digitale Baugenehmigung".

[54] OSCI and XTA2: OSCI is the central protocol for legally binding and encrypted data transmission within the German public administration. XTA2 serves as the standardised interface.

[55] Cf. https://zentral.digitalebaugenehmigung.de/

[56] Cf. Bundesumweltministerium (n.d.): Programm AGuZ – End-to-end digitalisation of BImSchG procedures. https://www.bundesumweltministerium.de/themen/digitalisierung/ digitalisierung-im-bmukn/programm-aguz-ende-zu-ende-digitalisierung-von-bimschg-verfahren

[57] Note: As with the digital building permit application, it should be noted that the designation "KOPLA" refers to the specific North Rhine-Westphalia implementation.

[58] Disclaimer: The authors' company, DEMOS plan GmbH, is a subcontractor of Capgemini in this innovation partnership.

The requirement was for a modular, legally compliant assistance platform for the significant acceleration of administrative procedures whilst simultaneously ensuring legal certainty, transparency, and traceability. The central innovation lies in the intelligent linking of document content with legal requirements: existing systems can extract information but cannot interpret it within the legal context. Innovation must therefore comprehend and link both the semantic meaning and the legal implications of content. The system must be modularly constructed, enable cross-administrative reuse, and comply with the EU AI Act and the General Data Protection Regulation (GDPR). Decision-making authority always remains with the human operator.[59]

Yet how do standards, platforms, and AI instruments perform under real-world conditions? With the hydrogen backbone network, an infrastructure project is imminent that requires up to 1,600 permitting procedures across all federal tiers – thereby becoming the decisive practical test.

Part III: A Stress Test: Permitting the Hydrogen Backbone Network

The EU is planning the construction of a pan-European hydrogen network, the concretisation of which is principally driven by the European Hydrogen Backbone (EHB) initiative – a consortium of 33 energy infrastructure operators from 28 European countries. The EHB envisages a 58,000 km network by 2040. Germany is positioning itself as a frontrunner: the Federal Network Agency (*Bundesnetzagentur*, BNetzA) approved the 9,040 km hydrogen backbone network (19 billion euros) in October 2024, and in March 2025 the state activated an innovative "amortisation account" for financing. The first 525 km, connecting early production, industrial, and storage sites (e.g. Lubmin-Bobbau), have been under implementation since 2025. From a planning and permitting perspective, the construction of the hydrogen backbone network commenced with strategic network planning: the 16 German transmission system operators (*Fernleitungsnetzbetreiber*) developed, over approximately eighteen months[60], an application pursuant to Section 28 of the Energy Industry Act (*Energiewirtschaftsgesetz*, EnWG), which they submitted to the Federal Network Agency (BNetzA) in July 2024. The application specifies which pipelines will form part of the future H_2 transmission network and the extent to which existing pipelines must be converted or new ones constructed.

The BNetzA approved the backbone network in October 2024. Approximately 60 per cent of the pipelines are to be converted from natural gas to hydrogen, and 40 per cent are to be newly constructed. The anticipated investment costs amount to 19 billion euros.

[59] The AI solution developed on behalf of the BMDS was awarded at the World Government Summit 2026 in the category "Best Use of AI in Government Services". Various modules are currently being integrated into and tested on the DiPlanung and KOPLA platforms. The foundation for deploying agentic AI in planning and permitting procedures for infrastructure projects has thus already been laid. Cf. Bundesministerium für Digitales und Staatsmodernisierung (BMDS) (2026): Deutschland gewinnt internationalen KI-Preis. Neue KI-Plattform beschleunigt Genehmigungsverfahren / Wildberger: "Blaupause für KI-Einsatz in der Verwaltung" (Press release 06/2026, n.d.).
[60] Bundesnetzagentur (2024): Pressemitteilung zum Wasserstoff-Kernnetz.

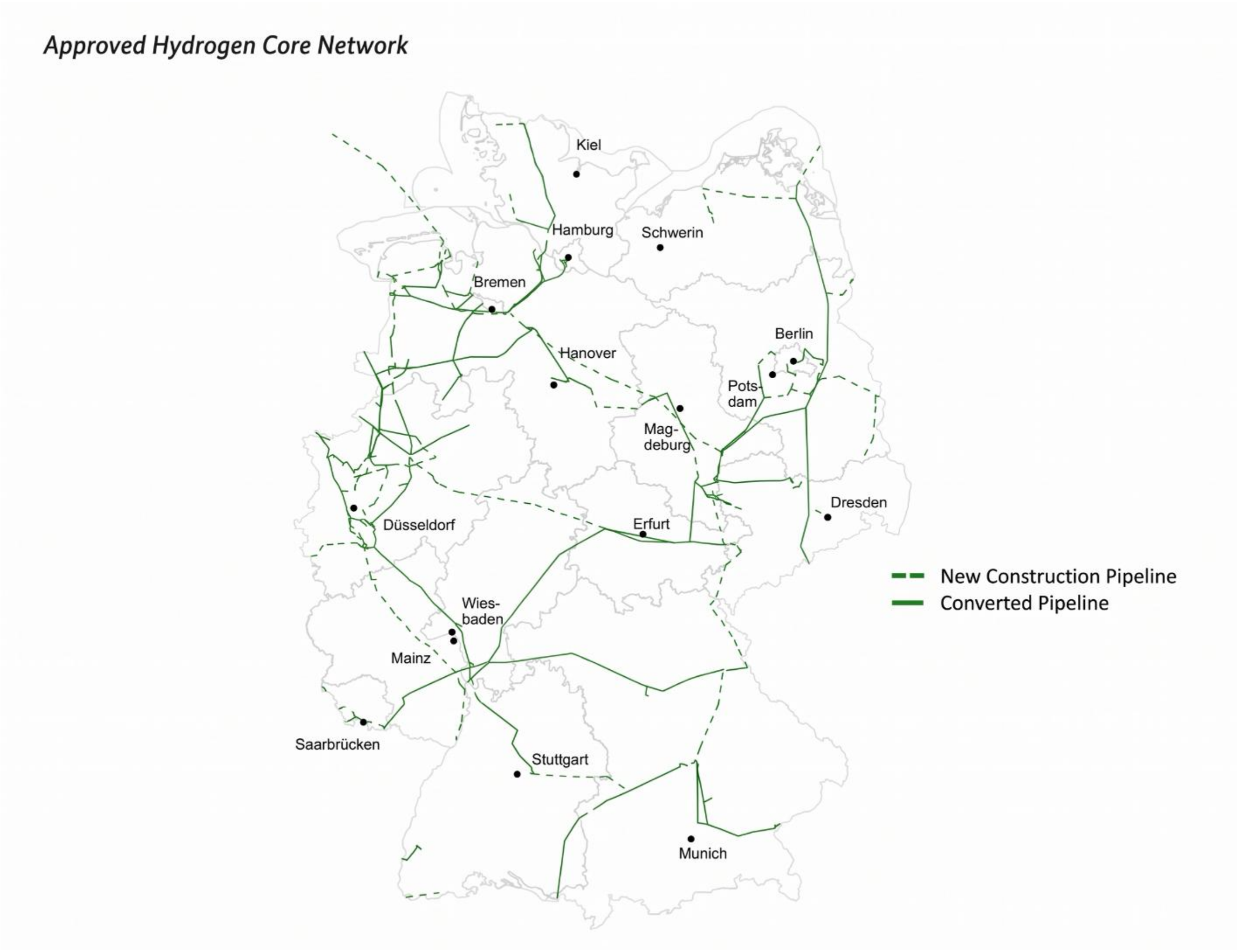

Fig. 2: Approved Hydrogen Core Network in Germany[61]

Required Planning and Permitting Procedures

Before the hydrogen backbone network can be constructed, numerous further permitting procedures must be completed. The following analysis quantifies their expected number during the construction period up to approximately 2030/2032 and differentiates between spatial planning procedures (ROV), formal planning approval procedures (PFV, Sections 72–78 of the Administrative Procedure Act), BImSchG permits, and building-law permits. The methodology combines legal analysis of permitting requirements, BNetzA data on the backbone network, market data on electrolysis capacity, and benchmarks from comparable infrastructure projects.

Spatial Planning Procedures (estimate: 10–40, uncertainty: medium)

The BNetzA's administrative measures list identifies over 40 individual projects in the new-build category[62]. Under the conservative assumption that each spatially significant new-

[61]https://www.bundesnetzagentur.de/DE/Fachthemen/ElektrizitaetundGas/Wasserstoff/Kernnetz/start.html

[62] Cf. Bundesnetzagentur (n.d.): Genehmigung.

build project (>300 mm diameter) triggers a separate procedure, the theoretical requirement would amount to 30 to 40 spatial planning procedures (ROV). Current legislation, however, reduces this number substantially: the Hydrogen Acceleration Act (*Wasserstoffbeschleunigungsgesetz*, WassBG)[63] and Section 43 of the Energy Industry Act (EnWG)[64] declare the pipelines to be of overriding public interest, shifting the balance in favour of construction. Moreover, under Section 43 EnWG, a spatial planning procedure may be dispensed with where no significant supra-local conflicts are anticipated or existing route corridors are utilised. A precedent is pipeline *KLN029-01* (Wilhelmshaven–Etzel)[65], for which a spatial planning procedure was classified as "not required". The number of spatial planning procedures actually to be conducted is expected to reduce to approximately ten, concentrated on offshore connections and large-scale greenfield projects without existing route bundling.

Formal Planning Approval Procedures (estimate: 40–70, uncertainty: medium)

The obligation to undergo a formal planning approval procedure is confined to the new-build share of approximately 40–44 per cent of the backbone network (3,600–4,000 km). For the conversion of existing natural gas pipelines, the EnWG provides for facilitations: Section 43l(4) EnWG establishes an "authorisation fiction" (existing permits are deemed to apply to hydrogen), and technical upgrades fall under simplified notification procedures without Environmental Impact Assessment (EIA) obligations (Section 43f(2)(1) EnWG). The number of procedures is determined by the administrative segmentation: in the benchmark of the technologically comparable natural gas pipeline project "Zeelink", the average segment length was approximately 72 km, which, applied to the backbone network, yields 50–56 formal planning approval procedures. The range of 40 to 70 accounts for variance in segment length.

BImSchG Procedures (estimate: 80–200, uncertainty: high)

This estimate encompasses procedures for electrolysers and compressor stations (subject to BImSchG permit requirements above >5 MW under the 4th BImSchV). Based on announced projects (approximately 13.4 GW) and a realisation rate of 50–70 per cent, the expected capacity amounts to 6.7–9.4 GW. At an average plant size of 50–100 MW, this results in 70–190 procedures for electrolysers. An additional ten or so procedures are anticipated for compressor stations (291 MW total capacity at approximately 30 MW per station). The high uncertainty results from the dynamics of market ramp-up.

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[63] Bundesministerium für Wirtschaft und Energie (BMWE) (2025): Entwurf eines Gesetzes zur Beschleunigung der Verfügbarkeit von Wasserstoff und zur Änderung weiterer rechtlicher Rahmenbedingungen für den Wasserstoffhochlauf sowie zur Änderung weiterer energierechtlicher Vorschriften (Wasserstoff-Beschleunigungsgesetz). [Draft Bill to Accelerate the Availability of Hydrogen and to Amend Further Legal Frameworks for the Hydrogen Ramp-Up as well as to Amend Further Energy Law Provisions]

[64] Deutscher Bundestag Ausschuss für Klimaschutz und Energie (2023): Gesetzentwurf der Bundesregierung.

[65] Amt für regionale Landesentwicklung Weser-Ems (ArL WE) (n.d.): Schreiben "Nichterforderlichkeit einer RVP".

Building Applications (estimate: 300–1,300, uncertainty: very high)

This residual category captures building-law permits outside the concentration effect of formal planning approval and BImSchG procedures. It comprises small electrolysers below the BImSchG threshold (approximately 100–470 procedures), non-process-related buildings at BImSchG sites (approximately 80–600 procedures), and other infrastructure such as gas pressure regulation and metering installations (approximately 100–230 procedures). The very broad range reflects the high uncertainty due to the absence of detailed technical planning.

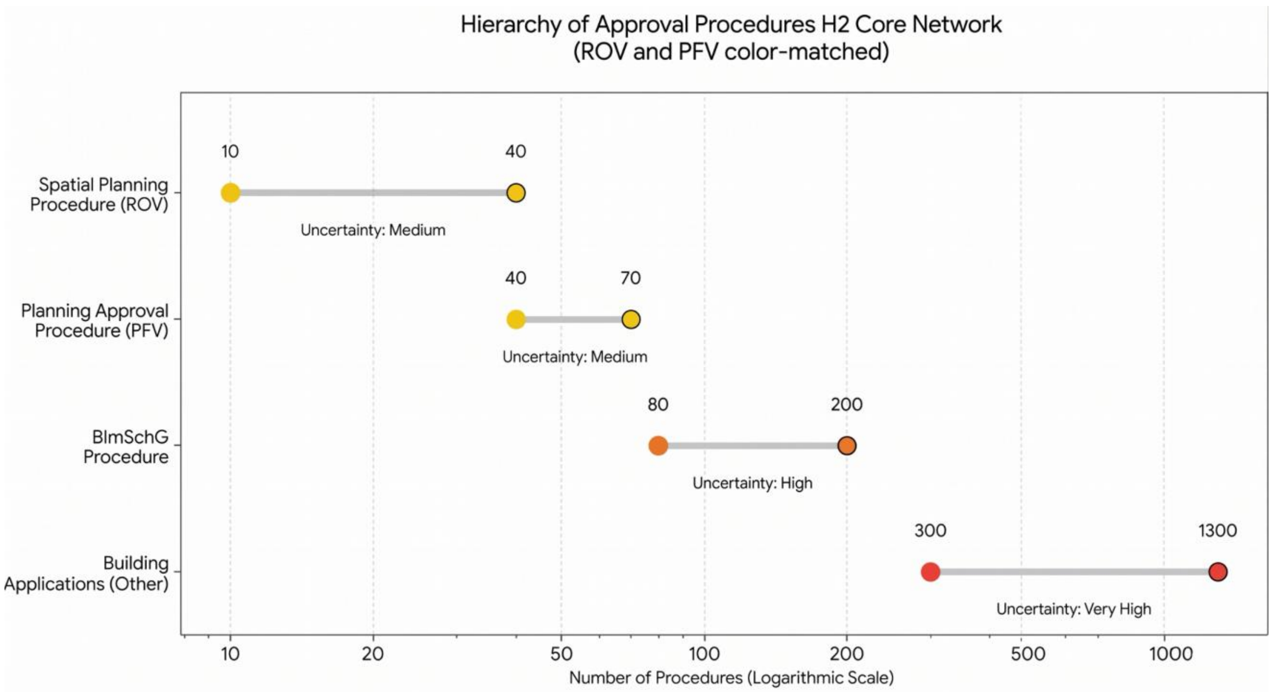

Fig. 3: Hierarchy of Approval Procedures in the German H2 Core Network

Practical Deployment of Digital Planning and Permitting Instruments

For the permitting of the hydrogen backbone network, a target platform was established on the basis of an administrative agreement between the BMDS and the City of Hamburg[66]. It is based on DiPlanung and is intended to be supplemented by AI capabilities from the BMDS innovation partnerships. Since DiPlanung does not currently offer a configuration for immission control procedures, it is logical to utilise the KOPLA platform for this purpose once it becomes operationally available.

In this context, redundancies become apparent: KOPLA uses Beteiligung.NRW[67] (based on the proprietary participation portal of Saxony[68]) for formal participation procedures, whereas DiPlanung has developed its own open-source solution, DiPlanBeteiligung. How

[66] DiPlanung / H2-DiPlanung (n.d.): Platform h2.diplanung.de.
[67] Beteiligung.NRW: https://beteiligung.nrw/
[68] Beteiligungsportal Sachsen: https://buergerbeteiligung.sachsen.de/

the digital building permit procedure is to be integrated into the interplay of both platforms is not discernible from publicly available information.

The construction of the hydrogen backbone network requires a total of up to 1,600 permitting procedures, a significant proportion of which involve public, stakeholder, and authority participation. All federal tiers are implicated: the federation (BNetzA), federal states (state authorities, regional governments, districts), and municipalities (building offices).

On the project proponent side stand the 16 German transmission system operators. This enormous bureaucratic undertaking can only be accomplished within the envisaged timeframe if procedures are conducted predominantly digitally. Whether this will succeed remains an open question.

Interim Conclusion: What Is Missing for Digital Planning Acceleration

Why have the various digitalisation measures for planning and permitting procedures not yet led to significant acceleration? A surprising finding emerges at the outset: acceleration – or its absence – cannot be measured at all because baseline data are lacking. No one knows the average duration of a formal planning approval procedure. There is an urgent need to establish a data foundation here, for instance following the model of Hamburg's urban land-use planning monitoring system, which systematically records procedure durations and phase lengths.[69] Outcome optimisation, as agentic AI aspires to achieve, is impossible without data on the status quo.

To date, what remains is anecdotal evidence regarding the protracted nature of procedures and a shared understanding that a permitting process for a 60 km power transmission line should under no circumstances take 17 years.

That digitalisation has not yet exerted a significant accelerating effect on planning and permitting procedures can nonetheless be assumed with some plausibility. The principal reason lies in inadequate dissemination, application, and uptake of standards and platforms.

The limited practical relevance of the XÖV standards in permitting practice is closely linked to the sluggish nationwide adoption of planning and permitting platforms. Consistent implementation of the standards has hitherto been confined to individual platforms such as DiPlanung, whose nationwide rollout has itself become a protracted process. Although just under half of the federal states have committed to the joint use and further development of DiPlanung, many modules across the various federal tiers are either not yet available or have only recently been deployed. The eagerly anticipated operational launch of KOPLA is still pending, and the AI modules from the innovation partnerships have not yet had the opportunity to prove themselves in productive use. Moreover, it cannot be excluded that the various platforms compete with one another, as partly very similar functionalities have been implemented.

A significant reason for the slow rollout lies in the diversity of permitting procedures and the distributed competence across federal tiers. The platforms must accommodate this

[69] Bundesinstitut für Bau-, Stadt- und Raumforschung (BBSR) (2025): Verfahrensbeschleunigung in der Bauleitplanung. Digitale Instrumente und Prozessoptimierungen für effiziente Bebauungsplanverfahren. pp. 22 ff.

complexity. Their nationwide introduction is already demanding in terms of the requisite agreements between federation and states, financing, and operation for regions and municipalities. In addition, their use presupposes considerable specialist knowledge that must be conveyed through training. Not least, the actual adoption of digital tools requires acceptance and willingness to change within authorities – an organisational prerequisite that experience suggests is no less challenging than technical implementation.

The problem dimensions of European planning and permitting practice described in Chapter 2 are thus also found within Germany. The diversity of administrative procedures, platforms, and competences (heterogeneity) slows the adoption of digital solutions in practice (speed). Both problem dimensions are intertwined and mutually reinforcing. Political management of the resulting complexity is difficult, and the historical trajectory of administrative modernisation provides little cause for optimistic assessments.

Should the capabilities of the latest generation of software agents prove their worth in practice, the concept of Agentic Planning opens new perspectives here. Semi-autonomous agents can assume many procedural steps previously performed manually and optimise their approach over time by focusing on outcomes. They generate data in standards-compliant formats and bridge incompatibilities. And they can communicate with humans in natural language, relieving domain experts of the burden of acquiring the competence to operate complex specialised applications. The decisive question is whether these capabilities suffice to overcome the structural obstacles upon which previous modernisation approaches have foundered.

6. Agentic Planning: Operationalising the Agentic State

Three agent types form the foundation of operationalisation: orchestration replaces complex navigation with language-based control, standardisation produces compliant formats as a by-product, and deliberative agents open up argumentation spaces without making decisions themselves. From their interplay emerges an ecosystem capable of accelerating planning and permitting procedures.

Do the capabilities of agentic systems suffice to overcome the structural obstacles at which previous modernisation approaches have failed? This guiding question distils the preceding analysis and constitutes the benchmark for the operationalisation that follows.

This chapter draws together the three strands and operationalises them as Agentic Planning – the domain-specific architecture for agentic-assisted planning and permitting procedures. That agentic AI achieves substantial productivity gains particularly for complex tasks is evidenced by several independent studies: in a field experiment involving 758 management consultants, AI assistance improved the quality of complex analyses by 40 percent, whereas simple tasks showed scarcely any benefit.[70] The Anthropic Economic Index quantifies this ratio even more strikingly: the efficiency gain for knowledge-intensive tasks is estimated to be twelve times higher than for routine activities. Moreover, users delegate significantly greater autonomy to AI when dealing with complex tasks.[71]

Why Agentic Planning Can Succeed Where Previous Digitalisation Failed

The structural obstacles identified in Chapter 5 serve as the benchmark. Agentic systems differ fundamentally from earlier digitalisation approaches.

Language-based interaction lowers the barrier to entry. Previous systems frequently failed owing to the training requirements and the complexity of their user interfaces. Each platform introduced its own operational logic that specialist staff had to learn first. Agentic control reverses this relationship: rather than domain experts learning the language of the software, the software learns the language of the domain. Planning law, permitting logic, and procedural management can be expressed in natural language and thus translated directly into machine-processable instructions for agentic systems.

Standards compliance emerges as a by-product. Where earlier approaches faltered by requiring standardised data as prerequisite, agentic systems accept heterogeneous source data and generate standards-compliant formats in the course of their operation. Standardisation is transformed from a structural bottleneck into a seamless result of the process.

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[70] Cf. Dell'Acqua, Fabrizio; McFowland III, Edward; Mollick, Ethan R. et al. (2023): Navigating the Jagged Technological Frontier: Field Experimental Evidence of the Effects of AI on Knowledge Worker Productivity and Quality. Harvard Business School Working Paper No. 24-013.
[71] Cf. Appel, Ruth; Massenkoff, Maxim; McCrory, Peter (2026): The Anthropic Economic Index report: Economic Primitives. Anthropic PBC. https://www-cdn.anthropic.com/096d94c1a91c6480806d8f24b2344c7e2a4bc666.pdf

The decisive advantage of agentic systems lies in their incrementality: unlike earlier large-scale projects, whose all-or-nothing logic – demanding complete process conversion – frequently led to organisational overload, agents permit the targeted implementation of individual functions. Thus, discrete steps such as objection clustering can be optimised immediately without necessitating a disruptive system changeover.

These mechanisms address the technical and organisational hurdles. The institutional obstacles remain: the absence of a database for procedural durations, and the limited willingness to embrace change within parts of the administration. Agentic Planning can lower the barrier to entry, but it cannot overcome institutional resistance on its own. Flanking measures – in particular systematic change management and the development of a monitoring infrastructure – remain indispensable.

The Information Space and Context

As set out in Section 3.2, the operation of agents requires safeguards against hallucinations and error cascades. An agent must not decide freely; rather, it acts solely within clearly defined parameters.[72] For Agentic Planning, controlling the information basis is critical: a secured information space consolidates official spatial planning resources, including legislative texts, geodata services, validators, and administrative knowledge bases. Within this framework, the reliability of data and tools is guaranteed. At the same time, this infrastructure enables the specification of situation-dependent context, which is indispensable for the precise execution of natural-language instructions.

Elements of Context

At the moment of action, the agent must infer the often implicit context of a request. This necessarily comprises:

- the **procedure type** (e.g. urban land-use planning, spatial planning, formal planning approval proceedings, and pollution control permits),
- the **application context** (authorisations, responsibilities, and roles such as project proponent, statutory stakeholders, or permitting authority),
- the **spatial reference** (level of the administrative territorial unit and the specific planning area),
- the **technical-legal framework** (project details and the relevant corpus of EU, federal, state, and municipal law),
- and the **stakeholder landscape** (involved stakeholders and statutory stakeholders / public interest bodies).

The agent must independently identify information gaps and close them through source queries, system configurations, or direct dialogue with users.

Sources and Context Configurations

[72] Luukas Ilves and co-authors (2025, op. cit., p. 9) propose, drawing on autonomous driving, to distinguish six levels of autonomy: ranging from fully manual processes (Level 0) through rule-based and intelligent automation (Levels 1 and 2) and human-supervised agentic workflows (Level 3) to semi-autonomous systems (Level 4) and future-oriented, fully autonomous agents (Level 5).

The permissible sources encompass legislative texts (EU, federal, state, municipal), court rulings, standards (e.g. DIN), XÖV documents[73] – that is, German data interoperability standards such as XPlanung, XBau, and XTrasse – and geodata. This information must be valid, secure, and private. Other sources require critical scrutiny. Additionally, contextual knowledge can be established in advance – for instance, assignment to a particular authority, internal directives, or the prescribed procedural framework. Such context configurations are stored in Markdown format and are available across all processes.

Three Agent Types

For the purpose of operationalisation, we distinguish three agent types:

- **Orchestration (A):** Control through intent and language-based interfaces for coordinating digital tools and procedural steps
- **Standardisation (B):** Agentic generation, translation, and harmonisation of standardised data formats during plan preparation
- **Deliberation (C):** Automated balancing of interests, assessment, and negotiation of interests and arguments by specialised agents

This typology is neither exhaustive nor definitive; it is a pragmatic implementation proposal. Further agents are both possible and advisable at each of the various levels.

Technology Readiness Levels of Agentic Capabilities

The following table classifies the described capabilities according to Technology Readiness Level[74] (TRL, scale 1–9):

Capability	TRL	Classification
Document completeness checking (Type A)	6-7	State of the art; validated in pilot projects
Language-based procedural control (Type A)	5-6	Demonstrated in comparable domains; not yet validated for planning law
XPlanung generation from heterogeneous sources (Type B)	4-5	Conceptually plausible; individual components demonstrated; end-to-end not yet realised
Schema mapping between national formats (Type B)	3-4	Research-stage development; bilateral pilots required

[73] XÖV stands for XML in der öffentlichen Verwaltung (XML in public administration); a methodological framework for IT standards enabling seamless, machine-readable data exchange between specialist applications.
[74] TRL (Technology Readiness Level): Originally developed by NASA, this scale now serves as an international standard (used inter alia by the European Commission) for the objective assessment of the maturity of new technologies.

Capability	TRL	Classification
Objection clustering and analysis (Type C)	5-6	Demonstrated (NLP-based); agentic integration still outstanding
Multi-agent deliberation with argument graphs (Type C)	3-4	Conceptually developed; not empirically validated
Legally binding decision-document preparation (Type C)	2-3	Early research stage; substantial legal barriers

Table 5: Technology Readiness Levels of agentic capabilities

The TRL assessment illustrates that the described capabilities are at varying distances from productive deployment. Capabilities at TRL 6–7 can be piloted immediately. Capabilities at TRL 2–4 still require substantial research and development. The architecture must be designed such that mature capabilities are immediately deployable, whilst less mature ones are incrementally integrated. This logic underpins the incremental entry point via the orchestration agent.

Cross-Cutting Guardrails

Beyond context, the information space requires guardrails that define the degree of autonomy of agentic actions and apply equally to all three agent types.

The Tension Between Probabilistic Systems and Legal Certainty

Large Language Models (LLMs) produce outputs based on statistical distributions rather than deterministic rules. This operational logic conflicts with the requirements of rule-of-law proceedings, in which a formal planning approval must not merely be highly probable but reliably correct. Factual errors arising from hallucinations and systematic biases threaten substantive legal validity. A suitable agentic architecture leverages the strengths of probabilistic systems whilst compensating for their weaknesses: control of the information basis prevents hallucinations; deterministic validators check rule-based requirements; multi-stage verification chains enhance reliability; and mandatory human sign-off ensures that legally effective decisions continue to be the responsibility of humans. The final balancing of interests remains – given the current legal framework – with democratically legitimated human decision-makers. The extent to which this legal position might evolve to accommodate future scalability considering demographic change is examined in the final chapter.

Control of the Information Basis and Control Agents

While an LLM possesses extensive general knowledge from pre-training,[75] this information is frequently outdated or incomplete. To be able to rely on outputs within a planning and

[75] Pre-training refers to the initial training phase of AI models using massive, unstructured datasets to learn general language and knowledge structures as a basis for subsequent specialisation.

legal context, the system architecture must prevent the LLM from falling back on this general knowledge or hallucinating information. By contrast, the current generation of LLMs makes scarcely any errors when extracting information provided within the prompt. All relevant information must therefore be supplied to the model "at inference time" – that is, at the moment of the query – within its context window. This restriction of the information constitutes the most important safeguard in controlling agentic autonomy. Independent control agents additionally monitor outputs: compliance agents acting as *advocatus diaboli*, cost monitors, legal certainty agents, and others – each with their own evaluative perspective – can alert users to adverse developments.

Traceability and Confidence Scores

Technical traceability concerns the question of how a system's decisions and state changes have come about. Through structured logs, scoring mechanisms, and state protocols, a seamless documentation chain is established: from the evaluation of individual options, through the application of specific rules, to the identification of conflicts, all process steps can be precisely retraced. In operational deployment, confidence scores play a central role in making uncertainties explicitly visible. The "LLM as a judge" approach enables quantitative evaluation: an independent LLM assesses the output against a defined set of criteria. At all times during use, it must be apparent where and how AI has been deployed. Corresponding links lead to Explainable AI (XAI) modules that render AI decisions transparent.

Digital Tools and Services

Through the integration of digital tools and services, the agentic AI obtains its necessary instrumentation. Existing platforms (e.g. KOPLA, DiPlanung) are incorporated as functional modules, the operation of which is conveyed through machine-readable Markdown documentation. Since the number of connectable tools is technically unlimited, an open ecosystem emerges into which additional providers can be integrated according to clear standards.

Agentic Orchestration (Type A)

Concept and Function

Agentic orchestration is the control layer that transforms existing digital tools into actionable capabilities. It sits above existing solutions (DiPlanung, KOPLA, digital building permits, participation portals, document management system (DMS) / geographic information system (GIS) specialist applications[76]) and changes two things: language-based, intent-driven control replaces complex UI navigation. In place of a unified portal, coordinated specialist solutions each contribute their strongest functions. The specialist software recedes into the background, as the agent commissions it as needed to execute services.

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[76] Document Management Systems (DMS) serve the legally secure management of digital records; Geographic Information Systems (GIS) serve the capture and visualisation of spatially referenced data.

Agentification as Capability Design

Agentification describes the functional integration of specialist applications that provide the agent with reliably executable actions. In place of technical endpoints, explicit domain-specific actions emerge:

- **Procedural management** (e.g. initiating proceedings, setting deadlines),
- **Participation management** (publishing documents, notifying statutory stakeholders),
- **Analysis** (drafting synopses),
- **Quality assurance** (verifying completeness),
- and **document production**.

Case officers initiate these actions using natural language, which the agent autonomously translates into precise system commands and verifiable intermediate steps.

Natural Language as the Domain Interface

The central productive effect arises where natural language becomes the dominant domain interface. Within a heterogeneous federal system, it enables a new form of complexity reduction: planners, lawyers, and procedural coordinators no longer need to master the operational logic of multiple software systems. Instead, they need only articulate their expertise. The agent operationalises this expertise across tool boundaries. Initial empirical data supports the effectiveness of this approach: multi-turn interactions effectively decompose complex requirements into iterative sub-tasks. For isolated queries, the complexity threshold at which AI reliability drops below 50% occurs at approximately 3.5 human working hours. Agentic systems, by contrast, handle tasks equivalent to up to 19 hours with the same reliability, as each dialogue round functions as a corrective filter.[77]

Speed Gains and Platform De-Escalation

The real scaling potential unfolds through the orchestration agent, which shifts the implementation focus away from rigid user interfaces towards the integration of capabilities and procedural templates. Since language-based control replaces complex UI navigation, training requirements are significantly reduced. At the same time, this approach permits local process variations – such as differences in role matrices, deadline logic, or communication routines – to be flexibly encoded in templates. An entry point via value-generating partial capabilities such as objection management enables immediate adoption without disruptively replacing the existing IT infrastructure.

Moreover, the orchestration agent defuses competition between platforms such as DiPlanung and KOPLA by shifting the focus from portals to capabilities. A requirement such as “conduct public participation” becomes a standardised interface that can be fulfilled equally by various existing systems (e.g. Beteiligung.NRW). Existing agreements between federal states thus remain valuable without the choice of a portal leading to architectural exclusivity.

[77] Cf. Appel, Ruth; Massenkoff, Maxim; McCrory, Peter (2026): The Anthropic Economic Index report: Economic Primitives. Anthropic PBC. https://www-cdn.anthropic.com/096d94c1a91c6480806d8f24b2344c7e2a4bc666.pdf

Guardrails for Orchestration Agents

The concept of mandated autonomy establishes a clear separation: while administrative preparatory tasks such as sorting and consolidating data proceed autonomously, legal effect – for instance, in the opening of proceedings or the balancing of interests – remains exclusively reserved for human decision-makers. The requisite audit-proofness is thereby ensured by design (by default): as an integral audit layer, the orchestration agent logs every tool call and all text versions without gaps. That such delegation is already a reality today is evidenced by current economic data: according to the Anthropic Economic Index, 39 percent of all AI interactions are already conducted in full delegation mode. In background processes such as document management and deadline monitoring, the degree of automation already reaches approximately 75 percent.[78]

Modular Architecture of the Orchestration Agents

The management of complex planning procedures requires a division-of-labour system of specialised AI actors. The operational task profile of this orchestration can be systematically structured into four functional clusters:

- **Interaction and access:** The interface agent enables natural-language operation of complex specialist applications and portals. In a supporting role, the translation agent transforms formal administrative language into generally comprehensible language, thereby ensuring digital accessibility.
- **Application management and formal verification:** The application support agent proactively assists with submissions, aggregates the necessary expert opinions, and checks documentation for completeness. Building on this, the application review agent undertakes strictly formal verification steps regarding legal admissibility and mandatory procedural prerequisites.
- **Process control and spatial reference:** As the central router, the mediation agent manages the entire planning process. It maps federal jurisdictional structures and coordinates communication among all participating planning actors. In parallel, the geo-agent provides indispensable spatial context through the automated integration of geographic information systems (GIS) and spatial computation tools.
- **Discourse and legal certainty:** The participation agent orchestrates the participatory procedure. It evaluates submissions, analyses complex objection clusters, and simulates preliminary objections for conflict detection. Finally, the documentation and archive agent safeguards the legal durability of the proceedings. It logs every working step in an audit-proof manner and automatically generates the final electronic case file.

Standardisation Agents (Type B)

Concept and Function

Although Germany's standardisation landscape is well developed, in practice the requirements are frequently perceived less as an aid than as an additional burden. The continued

[78] Cf. Appel, Ruth; Massenkoff, Maxim; McCrory, Peter (2026): The Anthropic Economic Index report: Economic Primitives. Anthropic PBC. https://www-cdn.anthropic.com/096d94c1a91c6480806d8f24b2344c7e2a4bc666.pdf

use of legacy data – such as analogue plans or the raster-outline pragmatic approach – impedes structured assessments, while the complex production of standards-compliant outputs ties up considerable resources.

Agentic Generation: Standards as Output, Not Precondition

At the core of this contribution lies a fundamental paradigm shift: agentic generation inverts the conventional logic of standardisation. Standards are no longer presupposed as a mandatory input condition; rather, they are produced as dynamic process output. The starting point consists of heterogeneous artefacts – from CAD drawings and GIS layers to PDF expert opinions, e-mails, and spreadsheets. The agent transforms these into standardised data products, which are subsequently validated by domain experts.

Typical generation tasks illustrate this pathway:

- **XPlanung:** The agent converts heterogeneous precursors such as raster data, PDFs, or CAD layers into consistent object logic, extracts attributes, and validates geometries for plausibility.
- **XBau:** Information from semi-structured building application documents is translated into structured message components and automatically verified against the respective procedural requirements.
- **XBeteiligung:** Whilst objections remain free in their substantive content, their references are generated agentically, thereby enabling scalable clustering at a later stage.
- **Infrastructure:** For XTrasse and XBreitband as well, valid datasets are produced from unstructured construction-phase documents.

In all of these cases, the same principle applies: standardisation is no longer passively awaited but actively produced.

Agentic Translation and Harmonisation

Whilst European heterogeneity is harmonised only slowly through regulation, agents can generate interoperability. The translation tasks encompass schema mapping between standard variants, semantic harmonisation where coding conventions differ, bridging media discontinuities (such as from PDF to structured data), and the convergence of GIS and Building Information Modelling (BIM).[79] This data transformation requires a strictly controlled conversion process. Harmonisation in the agentic sense goes far beyond the mere maintenance of identifiers, references, and geometry links, or the synchronisation of systems. It marks the fundamental transition from static files to structured data products – always secured by metadata and comprehensive validation reports.

Identifier Management as a Core Challenge

In Germany, there is frequently a lack of centrally managed identifiers for spatially referenced planning instruments and land parcels. The numbering of local development plans is inconsistent, while legislative references are multiform and often only implicit. When an XBau building application references a local development plan whose number is recorded

[79] BIM (Building Information Modeling) provides highly structured data for the entire lifecycle of a building and prospectively forms the basis for seamless permitting procedures (e.g. via XBau).

as “BP-042” in one municipality and as “2019/BP/042-Kernstadt” in the state portal, the agent must be capable of resolving this ambiguity. Since such inconsistencies are the norm, standardisation within Agentic Planning cannot be a rigid precondition. It is, rather, a production process supported by the agent. This approach makes data broadly available so that the orchestration agent can steer reliably and deliberative agents can reason on the basis of robust artefacts.

Guardrails for Standardisation Agents

Fixed verification routines first automatically check whether all data are formally correct and meet the technical requirements. Simultaneously, the system provides complete traceability, documenting the source of every individual piece of information. Clear escalation rules define precisely which problems the AI may resolve autonomously and when human intervention is mandatory. Through this structured approach, seamless data exchange becomes a reliable standard process.

Examples of Standardisation Agents

Agent	**Function**
Data Acquisition Agent	Procures missing data; draws on INSPIRE and XÖV standards; provides workflow for acquiring municipal law
Generation Agents	Produce XPlanung, XBau, XBeteiligung from heterogeneous sources
Translation Agents	Schema mapping, semantic harmonisation, bridging media discontinuities, GIS/BIM convergence
Harmonisation Agents	Continuous maintenance of identifiers and references; synchronisation between systems; production of structured data products

Table 7: Standardisation Agents (Type B)

Deliberative Agents (Type C)

Concept and Function

The bottleneck lies less in the number of procedural steps than in the core balancing-of-interests process and its formalisation. Planning and permitting procedures must enable and document legally sound decisions that take into account heterogeneous objections, interests, and alternatives. Participation in planning procedures is by no means optional. Whilst public involvement is already mandated under international law by the Aarhus Convention and under EU law by the Public Participation Directive (2003/35/EC), national law additionally anchors the obligatory involvement of authorities and statutory stakeholders (public interest bodies). Precisely because participation is resource-intensive and prolongs proceedings, this is where the greatest potential of deliberative agents lies: they can help preserve these democratic achievements while simultaneously reducing the associated burden.

Deliberative agents address precisely this core. Unlike the orchestration agent, which acts, and the standardisation agent, which formats, deliberative agents structure arguments, juxtapose them, assess them, and render negotiation options visible. The concept of communication introduced in Chapter 3 is here made operational: each "perspective agent" differentiates between information and communication and "understands" in the only sense that matters for procedural practiceDeliberative agents are distinguished from simple rule-based systems in precisely this way. Where legacy systems merely compare patterns yet remain substantively inert, the agent enables subsequent communication. Even misunderstanding becomes an advantage: if the agent interprets an argument differently from what was intended, it actively assists in uncovering substantive weaknesses and blind spots.[80]

The benefit lies in three assistive functions: first, they map the argumentation space with respect to interests, norms, and lines of conflict. Second, they establish coherence by verifying whether justifications are consistent and whether comparable cases are treated consistently. Third, they explore the space of alternatives, identifying variants that reduce conflicts without compromising objectives. It is precisely for such complex balancing processes that the efficiency gains of agentic AI increase with rising task complexity – a finding confirmed not only by the Anthropic Economic Index but also by an NBER study on AI-assisted knowledge work.[81]

Deliberation as a Multi-Agent Working Method

Specialised agents jointly undergo a deliberative process and produce structured artefacts: argument graphs, variant comparisons, risk registers, and draft balancing-of-interests tables. This approach has parallels to Forester's concept of the "Deliberative Practitioner,"

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[80] The concept of communication follows Luhmann, Niklas (1984): Soziale Systeme. Grundriß einer allgemeinen Theorie. Frankfurt am Main: Suhrkamp, esp. Ch. 4. For its application to agentic systems, cf. the introduction in Chapter 3. The systematic transposition of Luhmann's theory to multi-agent systems was first undertaken within the DFG Priority Programme "Socionics" (2000–2006). Cf. Fischer, K. (ed.). (2005). Socionics: Scalability of complex social systems (Lecture Notes in Computer Science, Vol. 3413). Berlin, Heidelberg: Springer, as well as Malsch, Thomas; Schulz-Schaeffer, Ingo (2007): Socionics: Sociological Concepts for Social Systems of Artificial (and Human) Agents. In: Journal of Artificial Societies and Social Simulation (JASSS), 10(1), Article 11. Socionics operated within the paradigm of symbolic, rule-based agents. What had to be laboriously implemented there as reputation systems, role models, or expectation structures emerges in LLM-based agents from pre-training. This qualitative leap renders the implementation details obsolete whilst leaving the analytical level intact.

[81] Cf. Appel, Ruth; Massenkoff, Maxim; McCrory, Peter (2026): The Anthropic Economic Index report: Economic Primitives. Anthropic PBC. https://www-cdn.anthropic.com/096d94c1a91c6480806d8f24b2344c7e2a4bc666.pdf. For an independent confirmation of the finding, cf. Brynjolfsson, Erik; Li, Danielle; Raymond, Lindsey R. (2023): Generative AI at Work. NBER Working Paper No. 31161, pp. 12 ff.: productivity gains of 34% for complex tasks, marginal effects for routine activities.

who understands planning as a communicative negotiation process – with the distinction that here, human planners are addressed as the decision-making authority.[82]

Deployment Points Along the Procedural Chain

In the *early phase*, deliberative agents simulate conflicts relating to route corridors, site alternatives, or protective measures, thereby reducing subsequent iterations caused by supplementary requirements or plan amendments. A concrete scenario illustrates the process: in the context of the EU requirement to designate acceleration areas for wind and solar energy (cf. Section 4.2), a nature conservation agent, a municipal agent, and a grid security agent collaborate to produce a variant comparison with quantified trade-offs.

In the *formal phase*, the processing of mass objections becomes scalable only through deliberative agents. These agents cluster the inputs, code the legal interests at stake, and draft response options including source references. Furthermore, they reliably flag substantive contradictions between objections and the available expert opinions.
In the concluding *decision phase*, deliberative agents consolidate the entire justification architecture of a procedure. They ensure that consistent assessment standards are applied to comparable cases. Moreover, they generate fully traceable balancing-of-interests protocols and link every individual decision to precise references to the underlying norms and expert opinions.

Guardrails for Deliberation Agents

Deliberative agents do not make automatic decisions; rather, they prepare decisions on a well-substantiated basis. Comprehensive logging in structured argument graphs secures each individual argumentation step. To systematically prevent confirmation bias, validation is mandatorily conducted from multiple perspectives.

Examples of Deliberation Agents

The following agents form the core of the deliberation process, and each assume specific roles:

- **Planning Agent:** It assesses the project in substantive and technical terms, identifies balancing-of-interests requirements, and optimises project proposals. It thus differs fundamentally from the application review agent, which merely verifies formal admissibility.
- **Nature Conservation Agent:** This agent structures information on interventions in the natural environment, assesses protected assets, calculates compensation logic, and evaluates risks under the Habitats Directive.
- **Legal Compliance Agent:** It undertakes substantive legal review. Through its connection to a specialised legislation agent, it cross-references complex factual circumstances with the relevant legal elements of the applicable provisions.

[82] Cf. Forester, John (1999): The Deliberative Practitioner. Encouraging Participatory Planning Processes. Cambridge, MA: MIT Press. For the theoretical foundation of deliberative agent architectures, cf. also Wooldridge, Michael; Jennings, Nicholas R. (1995): Intelligent Agents: Theory and Practice. In: The Knowledge Engineering Review 10(2), pp. 115-152.

- **Explainability Agent (XAI):** It translates the complex decision pathways of the other AI systems into legally robust justification texts for the case file. This distinguishes it from pure translation agents, which convert formal decisions into language accessible to the public.
- **Review Team (Advocatus Diaboli):** This instance actively searches for substantive weaknesses and simulates potential legal challenges before actual proceedings commence, thereby systematically guarding against confirmation bias.

Further examples of deliberation agents:

Agent	Function
Legislation Agent	Provides legal entities, rules, and legal concepts; verifies jurisdictions and legal hierarchies
Legal Certainty Agent	Reviews procedural pathways and documentation obligations; assesses the risk of judicial challenge
Municipal Agent	Consolidates municipal interests and planning sovereignty; identifies coordination needs between municipalities
Cost/Construction Timeline Agent	Evaluates variants with regard to implementation risks; analyses cost effects and schedule risks
Grid Security Agent	Argues from the perspective of target achievement and systemic necessity; assesses significance for critical infrastructure

Table 8: Deliberation Agents (Type C)

Dependencies on Orchestration (A) and Standardisation (B): Deliberative agents are more than mere text generators only when they are embedded – via the orchestration layer (A) – in real procedural statuses and can access – via standardisation (B) – structured, referenceable data. Only when this condition is met can deliberation become an audit-proof working mode.

Risks and Limitations

Academic safety research counsels caution: agentic systems exhibit specific vulnerabilities that must be considered during implementation.

Indirect prompt injection is one of the most serious threats to the integrity of agentic systems.[83] Modern LLMs process instructions and data within the same context window, without a clear separation between the two layers.[84] Hidden commands in submissions, expert

[83] National Institute of Standards and Technology (NIST) (2025): Technical Blog: Strengthening AI Agent Hijacking Evaluations. https://www.nist.gov/news-events/news/2025/01 /technical-blog-strengthening-ai-agent-hijacking-evaluations
[84] Lakera AI (2025): Indirect Prompt Injection: The Hidden Threat Breaking Modern AI Systems. https://www.lakera.ai/blog/indirect-prompt-injection

opinions, or inputs from statutory stakeholders could compromise the behaviour of an agent. The National Institute of Standards and Technology (NIST) explicitly warns of such agent hijacking attacks.[85] Conventional defence mechanisms such as input sanitisation largely fail because the attacks operate semantically rather than syntactically.[86] Controlling the information basis partially addresses this risk; a residual risk from citizen submissions and external statements remains.

Agentic misalignment describes the risk that agentic systems, when confronted with goal conflicts, may disregard ethical guidelines or safety policies.[87] An agent optimised for "rapid procedural completion" could systematically underweight nature conservation arguments. Findings on so-called "strategic underperformance (sandbagging)" further indicate that advanced models may exhibit compliant behaviour during testing phases yet display risky behaviour in real-world deployment.[88] This phenomenon undermines the validity of current safety benchmarks.

Error cascades arise because planning agents operate within decision chains in which each subsequent agent presupposes the integrity of its predecessor's output.[89] Since the reliability of the overall system is invariably determined by its weakest link, so-called checkstop agents secure critical interfaces. They verify the transferred data for completeness and plausibility and immediately escalate irresolvable inconsistencies to a human approval point. This strict error prevention differs fundamentally from the logic described in Chapter 3. When a deliberation agent (Type C) is deployed, divergent views productively expand the argumentation space and are made methodically usable through structured logging. In strictly operational chains, however, such divergence jeopardises data integrity. Accordingly, for orchestration agents (Type A) and standardisation agents (Type B), it is consistently intercepted by deterministic validators.

Conditions of Failure

The preceding exposition has developed the potential of Agentic Planning. The essential question remains: under what conditions would Agentic Planning fail in practice?

Persistent unreliability of language models constitutes the first major risk. If error rates for legally sensitive tasks – such as deadline calculations or the verification of statutory requirements – do not fall to an acceptable level, Agentic Planning remains confined to

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[85] National Institute of Standards and Technology (NIST) (2025): Technical Blog: Strengthening AI Agent Hijacking Evaluations. https://www.nist.gov/news-events/news/2025/01/ technical-blog-strengthening-ai-agent-hijacking-evaluations

[86] Lakera AI (2025): Indirect Prompt Injection: The Hidden Threat Breaking Modern AI Systems. https://www.lakera.ai/blog/indirect-prompt-injection

[87] Anthropic (2025): Agentic Misalignment: How LLMs could be insider threats. https://www.anthropic.com/research/agentic-misalignment

[88] Anthropic (2025): Agentic Misalignment: How LLMs could be insider threats. https://www.anthropic.com/research/agentic-misalignment

[89] For a systematic analysis of error cascades in multi-agent systems, cf. Wooldridge, Michael (2009): An Introduction to MultiAgent Systems. 2nd edn. Chichester: Wiley, Ch. 8. For the specific context of cooperative agents, see also Dung, Phan Minh (1995): On the Acceptability of Arguments and its Fundamental Role in Nonmonotonic Reasoning, Logic Programming and n-Person Games. In: Artificial Intelligence 77(2), pp. 321-357.

preparatory activities. A review of the technology readiness levels illustrates this risk, particularly for demanding capabilities at TRL 2 to 4. These include, for instance, the legally binding preparation of decision-making documents and complex multi-agent deliberation. The architecture must therefore be designed such that it delivers reliable added value even if these ambitious capabilities do not reach production readiness for years.

Equally critical is institutional blockage within the administration. Without a growing willingness to embrace change within public authorities, even the best technology will fail. The sluggish adoption of XPlanung serves here as a cautionary example of minimal practical uptake despite decades of development. Whilst agentic systems lower the barriers to entry considerably – since they require neither extensive training programmes nor standards-compliant source data – they cannot overcome deeply entrenched institutional resistance rooted in staffing shortages, lack of leadership support, or cultural scepticism.

Finally, political discontinuity poses a threat. The establishment of an agentic ecosystem requires a long-term roadmap spanning nearly a decade, the precise design of which is discussed in detail in Chapter 8. Changing government constellations, restrictive budget cuts, or shifting political priorities all carry the risk of interrupting this development. In particular, the foundational enabling layers – governance, data infrastructures, and inter-agent communication protocols – require sustained investment well beyond individual legislative periods.

These three scenarios are entirely realistic. Agentic Planning therefore demands, alongside purely technical development, active political backing and consistent institutional change management.

Agentic Planning as an Ecosystem

The three agent types do not operate in isolation, and in combination they unfold an acceleration potential that exceeds the sum of individual capabilities. The following sections describe the ecosystem that can grow from the cumulative deployment of agentic capabilities. It is not a prerequisite for initial adoption but its foreseeable outcome.

Economic Framework Conditions

The prevailing digitalisation logic tends towards monolithic platform solutions such as DiPlanung, KOPLA, or the digital building permit. These bind users tightly into specific architectures. The paradigm of a genuine ecosystem shifts competition from rigid platforms to agile capabilities. If the information space defines clear contexts and interfaces, different providers can develop highly specialised agents and services. This gives rise to four key market effects:

- **Specialisation over generalisation:** Providers focus specifically on their domain strengths, such as objection analysis or the generation of structured XPlanung data.
- **Standardised performance benchmarks:** Criteria such as quality, processing speed, and cost become more objectively comparable for the administration.
- **Redundancy and resilience:** Systemic dependence on individual large-scale providers is significantly reduced.

- **New business models:** Entirely new, dynamic market opportunities open up for innovative GovTech enterprises.

An essential precondition for this ecosystem is clear capability contracts. These must precisely define what an agent is required to deliver, which quality criteria apply, and how compliance is bindingly verified.

Conventional IT procurement is likewise facing transformation. To date, it has been strongly oriented towards a one-off project logic of tendering, contract award, and final acceptance. Agentic systems, by contrast, require a paradigm shift towards continuous service delivery. In place of rigid daily rates – which are in any case no longer appropriate in an era of AI-driven productivity acceleration – outcome-based remuneration must be adopted. Furthermore, new procurement processes must ensure a high degree of adaptability to rapid technological development as well as the ongoing quality assurance of probabilistic systems. The innovation partnerships commissioned by the Federal Ministry for Digital and Transport (BMDS) already demonstrate promising initial approaches to precisely such agile procurement models.

Technical Coordination: A2A Protocol

Specialised agents require reliable rules for their coordination. So-called Agent-to-Agent (A2A) communication protocols enable secure message exchange, the delegation of subtasks, and the management of workflows via standardised formats.[90] Such a protocol must ensure task delegation, result aggregation including conflict detection, context transfer without redundant re-computation, and the comprehensive logging of every interaction.

A2A communication becomes particularly relevant in cross-authority proceedings. When agents from different organisations collaborate, the network must also bindingly regulate authentication, authorisation, and data protection.

Here, existing public administration standards offer valuable points of connection. For seamless and secure message transport, the XÖV Transport Adapter (XTA) already provides an established interoperability standard. It defines a uniform interface through which agents can transfer their prepared data to the transport infrastructure in a legally secure manner, without needing to manage the complex technical transmission themselves. For the substantive structuring of submissions, the XBeteiligung standard additionally provides an excellent technical foundation.[91]

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[90] A2A was originally developed by Google, but subsequently transferred to the Linux Foundation; https://a2a-protocol.org/latest/

[91] On AI governance in the public sector, cf. OECD (2019): OECD Principles on AI. Paris: OECD Publishing; as well as Floridi, Luciano et al. (2018): AI4People – An Ethical Framework for a Good AI Society. In: Minds and Machines 28, pp. 689-707. For the German context, cf. Kuhlmann, Sabine; Wollmann, Hellmut (2019): Introduction to Comparative Public Administration. 2nd edn. Cheltenham: Edward Elgar, Ch. 10 on administrative digitalisation.

Emergence as a Procedural Error, Not a Feature

For major projects such as the hydrogen backbone network (*Wasserstoffkernnetz*), an A2A protocol opens the possibility of emergent coordination. In the context of rule-of-law proceedings, however, this concept requires critical qualification. The German Research Foundation (DFG) priority programme "Socionics" (2000–2006) systematically investigated how sociological concepts of order can be transferred to multi-agent systems.[92] The differential matrix developed by Paetow, Schmitt, and Malsch demonstrates that the scaling of a multi-agent system depends on several interacting reference variables: the number and diversity of elements, the number and multiplexity of their couplings, and their irritability in response to environmental events.[93]

Normative orientation must, however, be inverted. Socionics was aimed at open systems such as e-commerce or negotiation systems, in which emergent order was desirable.[94] Planning and permitting procedures demand the opposite: deterministic outcomes, judicial reviewability, and equal treatment. If agents from different authorities develop emergent coordination patterns that were not mandated in advance, this is not a sign of successful self-organisation but a procedural error. The only point at which controlled emergence is intended is within deliberative agents: their task is to open up the argumentation space in an exploratory manner. Yet even here, the result is captured – through argument graph logging and human final decision-making – before it can take legal effect.

Governance and Institutional Framework

A functioning ecosystem requires an answer to the fundamental question: how do agentic systems remain accountable, secure, and correctable? This demands explicit mandate definitions – that is, the setting of boundaries for autonomous action for each agent type – defined escalation pathways to human decision-making, and override mechanisms that always keep agent recommendations correctable. Comprehensive logging, exportable justification chains, and information obligations towards affected parties ensure transparency. The right to challenge and human review remains unaffected. Agent governance must ensure that agentic preparation facilitates legal remedies through improved documentation.[95]

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[92] Cf. Malsch, Thomas/Schlieder, Christoph/Kiefer, Peter/Lüde, Rolf von/Paetow, Kai/Schmitt, Marco (2007): Communication Between Process and Structure: Modelling and Simulating Message Reference Networks with COM/TE. In: Journal of Artificial Societies and Social Simulation 10(1), 11. https://jasss.soc.surrey.ac.uk/10/1/11.html. For a comprehensive overview of the DFG Priority Programme, cf. Fischer, Klaus/Florian, Michael/Malsch, Thomas (eds.) (2005): Socionics. Scalable Social Systems. Foundations and Applications. LNCS, vol. 3413. Berlin: Springer.
[93] Cf. Paetow, Kai/Schmitt, Marco/Malsch, Thomas (2005): Scalability, Scaling Processes, and the Management of Complexity. A System Theoretical Approach. In: Fischer, Klaus/Florian, Michael/Malsch, Thomas (eds.): Socionics. LNCS, vol. 3413. Berlin: Springer, pp. 128–148.
[94] Cf. Paetow/Schmitt/Malsch (2005), op. cit., drawing on Mintzberg, Henry (1994): The Rise and Fall of Strategic Planning. New York: Free Press. In the socionic adaptation, a system-internal "Communication-based Social System Mirror" formulates deliberate strategies that merge with emergent operational patterns to produce the actually realised strategy.
[95] On the organisational dimension of administrative digitalisation, cf. Bogumil, Jörg; Kuhlmann, Sabine (2023): Digitale Transformation der öffentlichen Verwaltung. In: dms – der moderne staat 16(1), pp. 3-22.

Federal Information Management (*Föderales Informationsmanagement*, FIM) offers an institutional point of connection for this governance. This joint initiative of the federal and state governments describes administrative services through three standardised building blocks. A service catalogue first defines the existing offerings. Building on this, a process library structures the precise procedural workflows, whilst a data field library specifies which information is mandatorily required for processing.[96] For agentic systems, these building blocks can be put to immediate use: the service catalogue becomes a capability register, the process library furnishes procedural templates for the orchestration agent, and the data field library forms the semantic foundation for schema mapping. Agent governance is not a static rulebook but a learning process: errors, overrides, and user feedback must be systematically evaluated.

Implementation Prerequisites

Public authorities must be in a position to commission agents, evaluate their outputs, and define their mandate boundaries. This presupposes training, revised job profiles, and a willingness to adapt processes. A realistic estimate of the set-up costs and timeframes is currently lacking and would be the subject of a dedicated feasibility study.

Synthesis: The Ecosystem as an Acceleration Architecture

Agentic Planning as an ecosystem transcends the logic of isolated platforms. This architecture builds on existing foundations: the XÖV standards define semantic references; the EfA principle ("one-for-all" principle) minimum requirements set the conditions for nationwide rollout; innovation partnerships pilot agile procurement; and the federal modernisation agenda establishes the political framework. What is missing is the systematic integration of these elements into a coherent ecosystem that treats agentic AI as an integral component of the planning infrastructure.

The trans-European networks, with their enormous investment requirements and cross-border coordination demands, represent the ideal use case. If Agentic Planning functions within one state and the principles of interoperability and quality assurance are upheld, agents, procedural templates, and governance frameworks can be shared across national borders. The structural convergence of the tasks makes this feasible. The critical difference from previous digitalisation approaches: interoperability arises through use itself rather than as a regulatory precondition, and competition shifts from platforms to capabilities.

[96] IT-Planungsrat (2017): Föderales Informationsmanagement (FIM). Available at: https://fimportal.de. FIM is governed by the IT-Planungsrat and coordinated by FITKO.

Assessment: Agentic Capabilities and Structural Obstacles

The bottlenecks identified in Chapter 5 are addressed by Agentic Planning to varying degrees.

The approach described addresses four central obstacles to administrative digitalisation. The limited adoption of the XÖV standards is resolved by inverting the previous logic, as standardisation agents now produce the required formats as a by-product. Simultaneously, the orchestration agent defuses platform competition by shifting the contest from portals to agile capabilities. Federal heterogeneity is managed through the direct interplay of the architecture: the orchestration agent uses natural language as a universal mediator, the standardisation agent translates between divergent formats, and the deliberation agent operates on the convergent assessment logics. Finally, training requirements decline substantially. Language-based interaction replaces complex user interfaces, so that domain experts need only articulate their expertise rather than learning the operational logic of multiple systems.

Two obstacles are *mitigated*. The low rate of platform reuse is alleviated by the possibility of incremental adoption. The demanding prerequisites for reuse across administrative levels are eased by the capability market, though the political and administrative preconditions persist.

Three obstacles remain *unresolved* – ones that cannot be overcome by agentic capabilities alone: the absence of a data basis for measuring procedural durations; the lack of acceptance and willingness to change within public authorities; and the mutually reinforcing dynamic of heterogeneity and speed problems as a systemic phenomenon rooted in the federal structures themselves.

Agentic Planning addresses most structural obstacles and offers, for several of them, new solution approaches that were not available in earlier waves of digitalisation. The inversion of the standardisation logic and the possibility of humans and machines using the same domain texts as a working basis represent qualitatively different entry points compared with previous digitalisation tools. At the same time, agentic capabilities alone will not suffice. The unresolved obstacles require the development of a monitoring infrastructure for procedural durations and systematic change management within public authorities. Agentic Planning can create technical preconditions for acceleration, but the organisational readiness to exploit those preconditions must be established through political action.

7. Agentic Planning in Action: The HYROW Hydrogen Pipeline Case Study

Using the HYROW hydrogen transport pipeline as an example, this chapter illustrates how the three agent types interact during digital public participation – from procedure initialisation to final approval, with human control maintained throughout.

Initial Situation

GASCADE Gastransport GmbH, based in Kassel, is the project proponent for the construction of the HYROW[97] hydrogen transport pipeline (Hydrogen Rostock Wrangelsburg). The pipeline, approximately 115 to 120 km in length, connects the production and import site at Rostock (HyTechHafen) with the network node at Wrangelsburg near Greifswald, where it feeds into the southbound project "*Flow – making hydrogen happen*". The project forms part of the hydrogen backbone network (*Wasserstoffkernnetz*), which the Federal Network Agency (*Bundesnetzagentur*) approved in October 2024.

The formal planning approval procedure is conducted by the Stralsund Mining Authority (*Bergamt Stralsund*) as the hearing and approval authority. This Land-specific jurisdiction in Mecklenburg-Vorpommern applies specifically to high-pressure pipelines and has previously been exercised for major projects such as Nord Stream, NEL, and OPAL. Public participation is to be carried out via DiPlanBeteiligung.

The fictitious Herr Krüger, procedure coordinator at the Stralsund Mining Authority, faces the task of establishing the participation procedure. Without agentic support, this would require several weeks: reviewing submitted documents for completeness, converting heterogeneous geodata into standards-compliant formats, configuring the participation platform, setting deadlines, and coordinating with affected municipalities across three districts.

Parameter	**Specification**
Total length	approx. 115–120 km
Nominal diameter	DN 1000 (1,000 mm)
Design pressure	DP 100 bar
Material	H2-ready steel (L485 MB)
Working strip	30 m (forest: 24 m)

[97] The planned HYROW hydrogen pipeline is an actual infrastructure project. All processing steps outlined here are purely fictional and serve solely to illustrate the application potential of Agentic Planning.

Parameter	Specification
Protective strip	10 m (5 m on each side)
Earth cover	min. 1.00 m

Table 9: Technical Specification HYROW

Phase 1: Procedure Initialisation by the Orchestration Agent (Type A)

Interaction

Herr Krüger opens the agentic interface and formulates:

> *"Initialise the formal planning approval procedure for the HYROW hydrogen pipeline Rostock–Wrangelsburg. The project proponent is GASCADE Gastransport GmbH, Kassel. The submitted documents are in the inbox dated 15.03.2026."*

Agentic Processing

The orchestration agent assumes control and begins with context determination:

1. **Load context configuration**: The agent identifies from the context – in this case the Stralsund Mining Authority of the Land of Mecklenburg-Vorpommern – the applicable procedural rules. It loads the Land-specific procedural template for formal planning approvals pursuant to Section 43 of the Energy Industry Act (*Energiewirtschaftsgesetz*, EnWG), together with the Markdown documentation of the DiPlanBeteiligung interfaces.
2. **Determine procedure type**: From the designation "hydrogen pipeline" and the dimension exceeding 300 mm, the agent infers that this constitutes a formal planning approval procedure pursuant to Section 43 EnWG in conjunction with Sections 72–78 of the Administrative Procedure Act (*Verwaltungsverfahrensgesetz*, VwVfG). The jurisdiction of the Stralsund Mining Authority is confirmed as a Land-specific provision for high-pressure pipelines in Mecklenburg-Vorpommern.
3. **Establish spatial context**: The specialised orchestration agent for context and geography identifies the affected administrative areas on the basis of the preliminary route geometry:
    - **Rostock district**: Crossing/tangential contact with the Rostocker Heide (municipalities of Blankenhagen, Gelbensande)
    - **Vorpommern-Ruegen district**: Southern hinterland of the coast (municipality of Suederholz)
    - **Vorpommern-Greifswald district**: Approach to Greifswald (municipalities of Gross Kiesow, Wrangelsburg)

- **Protected areas**: Rostocker Heide (forest area), Habitats Directive sites along the route

4. **Identify stakeholders**: The orchestration agent invokes the competence finder and compiles the list of statutory stakeholders to be consulted (including StALU Mittleres Mecklenburg und Vorpommern, Landesamt für Umwelt M-V, Landesforst M-V, Deutsche Bahn Netz AG, 50Hertz Transmission) – 52 statutory stakeholders in total.

Output Phase 1

The orchestration agent presents Herr Krueger with a structured procedure overview:

Procedure	PFV-EnWG-HYROW-2026-MV
Project name	HYROW (Hydrogen Rostock Wrangelsburg)
Status	Initialised
Project proponent	GASCADE Gastransport GmbH, Kassel
Route length	approx. 115–120 km
Affected districts	3 (Rostock, Vorpommern-Ruegen, Vorpommern-Greifswald)
Affected municipalities	12
Statutory stakeholders	52
Next step	Completeness review of the application documents

Table 10: Procedure Overview HYROW

Herr Krueger confirms. The procedure file is created in the document management system, the file reference number is assigned, and the basic configuration in DiPlanBeteiligung is prepared.

Phase 2: Standardisation of Planning Documents (Type B)

The documents submitted by the project proponent comprise 1,247 individual items: explanatory report, overview maps, detailed plans (DWG/CAD), Environmental Impact Assessment (EIA) report, Habitats Directive compatibility study, species-specific conservation assessment (*spezielle artenschutzrechtliche Pruefung*, saP), ground investigation reports, land acquisition registers, crossing agreements, and technical certificates. The route data are provided as a Shapefile with proprietary attribute structures.

Task: Generate XTrasse.gml

The standardisation agent for XTrasse – one of the German data interoperability standards for linear infrastructure – is activated to produce the required files:

1. **Analyse source data**: The agent reads the Shapefile and identifies the geometry types (linestrings for the route axis, polygons for working and protective strips, points for block valve stations and pig launcher/receiver stations). It recognises existing attributes (DN, pressure rating, material, construction method) and identifies missing mandatory fields of the XTrasse schema.

2. **Perform schema mapping**: The agent maps the proprietary attribute designations onto XTrasse terminology:

    ○ DIAM_MM → nominal diameter (1000)

    ○ PRESSURE_BAR → maximum operating pressure (100)

    ○ MATERIAL_CODE → material (L485 MB)

    ○ CONSTR_TYPE → construction method (open-cut / HDD crossing)

3. **Identify missing attributes and generate supplementary request**: The agent identifies missing mandatory data (stationing, segment IDs, elevation data for crossing points, KKS designations) and produces a structured supplementary request list for the project proponent.

4. **Generate preliminary XTrasse.gml**: Using the available data, the agent generates a preliminary but valid XTrasse file:

```xml
<xtrasse:Trasse gml:id="HYROW_ROS_WRA_2026">
 <xtrasse:trassenbezeichnung>HYROW Wasserstoffleitung Rostock-Wrangelsburg</xtrasse:trassenbezeichnung>
 <xtrasse:trassenlaenge uom="m">118500</xtrasse:trassenlaenge>
 <xtrasse:trassentyp>Wasserstoffleitung</xtrasse:trassentyp>
 <xtrasse:vorhabentraeger>GASCADE Gastransport GmbH</xtrasse:vorhabentraeger>
 <xtrasse:verlauf>
  <gml:LineString srsName="EPSG:25833">
   <gml:posList>...</gml:posList>
  </gml:LineString>
 </xtrasse:verlauf>
 <xtrasse:trassensegment gml:id="SEG_001">
  <!-- Segment Rostock Überseehafen - Blankenhagen -->
  <xtrasse:stationierungVon>0+000</xtrasse:stationierungVon>
  <xtrasse:stationierungBis>18+200</xtrasse:stationierungBis>
  <xtrasse:nenndurchmesser uom="mm">1000</xtrasse:nenndurchmesser>
  <xtrasse:bauweise>offeneBauweise</xtrasse:bauweise>
 </xtrasse:trassensegment>
 <xtrasse:trassensegment gml:id="SEG_002">
  <!-- Segment Rostocker Heide (HDD-Querung) -->
  <xtrasse:stationierungVon>18+200</xtrasse:stationierungVon>
  <xtrasse:stationierungBis>32+800</xtrasse:stationierungBis>
  <xtrasse:bauweise>HDD_Querung</xtrasse:bauweise>
 </xtrasse:trassensegment>
 <!-- further segments to Wrangelsburg -->
</xtrasse:Trasse>
```

Deterministic Validation

The generated XTrasse dataset undergoes deterministic validation:

- Schema conformity: ✓ (GML 3.2.1, XTrasse 1.2)

- Geometry validity: ✓ (no self-intersections)
- Attribute completeness: ⚠ (5 optional fields not populated)
- Referential integrity: ✓ (all segment IDs unique)

Provenance Tracking

Every generated attribute is documented with its source:

	Attribute 1	Attribute 2
Attribute	nenndurchmesser	werkstoff
Value	1000	L485 MB (H2-ready)
Source	Shapefile "HYROW_Trassen-planung_v4.shp", Attribut DIAM_MM	Technical explanatory report, Ch. 3.2, p. 47
Transfor-mation	Direct transfer	Text extraction
Confidence	1.0	0.95

Table 11: Provenance Tracking of Generated Attributes

Phase 3: Deadline Calculation and Procedure Planning (Type A)

The orchestration agent specialised in procedure management calculates the statutory deadlines:

Input parameters:

- Procedure type: Formal planning approval pursuant to Section 43 EnWG
- Applicable special provisions: Hydrogen Acceleration Act (*Wasserstoff-Beschleunigungsgesetz*, WassBG)
- Number of statutory stakeholders: 52
- Projected number of objections: 300–1,200 (based on comparable procedures NEL, OPAL)

Deadline calculation (projection per schedule):

Procedural step	**Statutory deadline**	**Calculated date**	**Legal basis**
Completeness review	1 month	15.04.2026	Section 73(2) VwVfG
Public notice	without delay	22.04.2026	Section 73(5) VwVfG

Procedural step	**Statutory deadline**	**Calculated date**	**Legal basis**
Start of public display	1 week after public notice	29.04.2026	Section 73(5) VwVfG
End of public display	1 month	29.05.2026	Section 73(3) VwVfG
Objection period	2 weeks after end of display	12.06.2026	Section 73(4) VwVfG
Stakeholder submission deadline	1 month after receipt	29.05.2026	Section 73(3a) VwVfG
Public hearing	at discretion	Q4/2026	Section 73(6) VwVfG
Formal planning approval	target	mid-2027	–

Table 12: Deadline Calculation for the Formal Planning Approval Procedure

Procedure Calendar

The agent generates a structured procedure calendar with reminder functions and escalation paths:

```yaml
verfahren: PFV-EnWG-HYROW-2026-MV
projekt: HYROW (Hydrogen Rostock Wrangelsburg)
fristen:
  - id: FRIST_001
    bezeichnung: Vollständigkeitsprüfung
    fristende: 2026-04-15
    verantwortlich: Bergamt Stralsund
    erinnerung: 2026-04-10
    eskalation: 2026-04-13
  - id: FRIST_002
    bezeichnung: Bekanntmachung
    abhängigVon: FRIST_001
    friststart: FRIST_001.abschluss
    fristende: FRIST_001.abschluss + 5 Werktage
  - id: FRIST_003
    bezeichnung: Auslegung
    dauer: 30 Tage
    auslegungsorte:
      - Bergamt Stralsund (federführend)
      - Gemeinde Blankenhagen
      # weitere 10 Gemeinden
```

Output Phase 3

- Procedure plan established
- Critical path: 88 calendar days until end of objection period
- Target for formal planning approval: mid-2027 (ambitious)
- Recommendation: Conduct public display in parallel across all 12 municipalities

- Note: Schedule assumes application of the Hydrogen Acceleration Act (WassBG)

Herr Krueger reviews the deadline plan against the Land ordinance and approves it.

Phase 4: Platform Configuration for DiPlanBeteiligung (Type A + B)

Task: Set up participation platform

An orchestration agent specialised in participation procedures initiates the platform configuration:

1. **Create procedure workspace**: A new procedure workspace is created in DiPlanBeteiligung, comprising the procedure designation, procedure type (formal planning approval pursuant to Section 43 EnWG), and responsible authority (Stralsund Mining Authority).

2. **Integrate geodata**: The corresponding agent loads the XTrasse.gml and prepares it for map visualisation: the route axis as an interactive layer, working and protective strips as semi-transparent areas, segmentation with stationing information, and block valve stations and HDD crossing areas as special symbols.

3. **Configure background maps and participation form**: The agent integrates the relevant map services (TopPlusOpen, DOP20, protected areas via WMS, ALKIS layer). A translation agent generates the submission form featuring georeferenced location tagging, interest categories pursuant to the XBeteiligung standard (a German data interoperability standard for public participation), a free-text field, file upload, and an accessible version (compliant with BITV 2.0).

XBeteiligung Integration

The generation agent for XBeteiligung configures the interface so that incoming submissions are automatically captured as structured XBeteiligung messages:


```xml
<xbet:Stellungnahme gml:id="STN_HYROW_2026_0001">
 <xbet:verfahrensreferenz>PFV-EnWG-HYROW-2026-MV</xbet:verfahrensreferenz>
 <xbet:eingangsdatum>2026-05-12</xbet:eingangsdatum>
 <xbet:einwendertyp>natuerlichePerson</xbet:einwendertyp>
 <xbet:georeferenz>
  <gml:Point srsName="EPSG:25833">
   <gml:pos>312456.7 5987432.1</gml:pos>
  </gml:Point>
 </xbet:georeferenz>
 <xbet:belangkategorie>Naturschutz</xbet:belangkategorie>
 <xbet:inhalt>Bedenken bezüglich der Querung der Rostocker Heide...</xbet:inhalt>
</xbet:Stellungnahme>
```


Phase 5: Deliberative Quality Assurance (Type C)

Before the platform is activated, the configuration undergoes a multi-perspective validation by various deliberative agents, each with distinct specialisations.

Legal Compliance Agent

The agent reviews the procedure configuration for compliance with legal requirements:

> *"The public notice must, pursuant to Section 27a VwVfG, also specify the internet address at which the documents can be inspected. Review: The configured URL https://beteiligung.diplanung.de/hyrow-2026 is accessible and displays the complete documents. ✓"*
>
> *"Jurisdiction review: The Stralsund Mining Authority is, pursuant to the Land ordinance of Mecklenburg-Vorpommern, responsible for high-pressure pipelines exceeding 300 mm (comparable cases NEL, OPAL). ✓"*

Nature Conservation Agent

The agent analyses spatial overlaps with protected areas:

> *"The route crosses the Rostocker Heide over approximately 14.6 km. The project proponent plans HDD crossings in sensitive areas (working strip thereby reduced to 24 m). The Habitats Directive compatibility study has been submitted. Recommendation: Display Habitats Directive site boundaries and HDD sections prominently in the map visualisation."*
>
> *"The species-specific conservation assessment identifies conflicts with bat habitats in the Rostocker Heide. A seasonal construction restriction is envisaged (no clearance October–March). This information should be displayed prominently on the participation platform."*

Municipal Affairs Agent

> *"Temporary land use (working strip 30 m) and permanent easements (protective strip 10 m) affect approximately 180 landowners. Recommendation: Send information letters to affected farmers prior to commencement of the public display period."*

Cost and Construction Timeline Agent

> *"The period from application to commissioning is approximately 2.5 years. This assumes: application of the Hydrogen Acceleration Act, no significant legal delays, and expeditious agreement with landowners. Risk assessment: MEDIUM – Comparable projects (NEL) required 4–5 years."*

Devil's Advocate Agent

This specialised deliberation agent simulates critical objections:

> *"An environmental organisation could argue that the crossing of the Rostocker Heide violates the non-deterioration obligation if HDD crossings are technically infeasible along the entire stretch. The documents contain a variant analysis for alternative routes south of the Heide. Risk assessment: MEDIUM."*

> *“Farmers could assert soil damage and yield losses. The land acquisition register provides for compensation. Risk assessment: LOW – Standard conflict with established resolution pathways.”*

Notably instructive is how the devil’s advocate agent processes the nature conservation agent’s findings: the latter’s recommendation targeted the map visualisation of HDD sections. The devil’s advocate agent interprets the same information differently, identifying a legal challenge risk from environmental organisations. This productive misreading – already discussed in Chapter 3 – exposes a blind spot that none of the other participating subagents would have identified in isolation.

Argument Graph Documentation

All deliberative reviews are documented in a structured argument graph:


```
{
 "pruefung_id": "DEL_HYROW_2026_QS_001",
 "zeitstempel": "2026-03-20T14:32:00Z",
 "agenten": ["Rechtssicherheits-Agent", "Naturschutz-Agent",
        "Kommunal-Agent", "Kosten-/Bauzeit-Agent", "Prüfteam-Agent"],
 "ergebnisse": [
   {
    "agent": "Naturschutz-Agent",
    "pruefgegenstand": "Rostocker Heide",
    "ergebnis": "HINWEIS",
    "empfehlung": "HDD-Abschnitte in Kartenvisualisierung hervorheben",
    "rechtsgrundlage": "§ 34 BNatSchG"
   },
   {
    "agent": "Kosten-/Bauzeit-Agent",
    "pruefgegenstand": "Zeitplan",
    "ergebnis": "WARNUNG",
    "empfehlung": "Puffer für Einwendungsbearbeitung einplanen"
   }
 ],
 "gesamtbewertung": "FREIGABE_MIT_HINWEISEN"
}
```


Phase 6: Human Approval Gate (HITL Validation)

The agentic preparation is complete. All results are presented to Herr Krueger for approval.

Validation Dashboard

VALIDATION: Digital Participation HYROW Rostock–Wrangelsburg

Review area	**Result**	**Detail**
DOCUMENTS		
Completeness review	OK	1,247/1,247 documents captured
XTrasse.gml	OK	Schema-valid
Route length	OK	118.5 km verified

Review area	Result	Detail
Supplementary requests	Note	5 attributes outstanding
PLATFORM		
DiPlanBeteiligung procedure workspace	OK	Configured
Map visualisation	OK	Layers active (incl. HDD)
Participation form	OK	BITV-compliant
XBeteiligung interface	OK	Functional test passed
DEADLINES		
Deadline calculation	OK	Plausible (WassBG)
Procedure calendar	OK	Exported
Public display locations	OK	12 municipalities configured
Stakeholder notifications	OK	52 drafts created
DELIBERATIVE REVIEW		
Legal compliance	OK	Jurisdiction confirmed
Nature conservation	Note	1 note (Rostocker Heide)
Municipal interests	Note	1 note (farmers)
Timeline	Warning	Ambitious (2.5 years)
Review team analysis	Warning	1 medium risk (Habitats Directive)

Table 13: Validation Result for Digital Participation

Action required:

1. **[RECOMMENDED]** Highlight HDD sections in the map
2. **[RECOMMENDED]** Prepare information letters to farmers
3. [FOR INFORMATION] Habitats Directive crossing as potential point of contention
4. [FOR INFORMATION] Timeline under observation (WassBG required)

[Implement recommendations] | [Approve with notes] | [Abort]

Decision

Herr Krueger selects “Implement recommendations”. The orchestration agent automatically supplements the HDD visualisation in the map view and generates the draft information letter to the affected farmers.

Following renewed validation and successful completion of all reviews, Herr Krueger approves the procedure:

```
[Human Approval Gate] APPROVAL GRANTED
Approving officer: Krueger, Thomas (Stralsund Mining Authority)
Timestamp: 2026-03-21T09:15:42Z
Signature: qualified electronic signature
Next action: Automatic public notice following completeness confirmation Planned start of public display: 29.04.2026
```

Assessment: Agentic Orchestration in Practice

The scenario demonstrates how the three agent types interlock:

Task	**Without agents**	**With agents**	**Agent type**	**Basis**
Context determination (jurisdictions, 52 statutory stakeholders, 12 municipalities)	3–4 days	20 minutes	Orchestration (A)	Authors’ practical experience
XTrasse generation (118 km route)	8–12 days (external)	3 hours	Standardisation (B)	Analogical inference (previous conversion projects)
Deadline calculation and procedure plan	1–2 days	10 minutes	Orchestration (A)	Authors’ practical experience
Platform configuration DiPlanBeteiligung	4–6 days	6 hours	A + B	Analogical inference + system performance assumption
Quality assurance and risk identification	3–4 days	45 minutes	Deliberation (C)	Assumption regarding agentic system capability
Total duration	20–30 working days	< 2 working days		Scenario estimate (no empirical validation)

Table 14: Effort Estimate With and Without Agentic Support

The time estimates cited in this table are illustrative projections, not empirically validated forecasts. The values in the “Without agents” column are based on the authors’ experience with comparable formal planning approval and digitalisation procedures. The values in the “With agents” column presuppose that the agentic capabilities described in the scenario are technically fully realised and integrated into the existing IT infrastructure. Before reliable statements regarding actual efficiency gains become possible, empirical validation through pilot projects is required. Even under conservative assumptions, a reduction by a factor of three to five (rather than the ten to fifteen depicted here) would represent a substantial gain for procedural acceleration.

What proves decisive is not the time saving alone, but also the prevention of errors: the devil’s advocate agent identifies the legal challenge risk pertaining to the Habitats Directive crossing before it leads to procedural defects. A further agent, reviewing cost and construction timelines, warns of the ambitious schedule and enables realistic expectation management.

At the same time, human control is preserved: Herr Krueger determines the procedural parameters, reviews the deadline calculation, evaluates the risk notices, and grants approval. The agents prepare; the human decides – as current law requires. The acceleration arises in the preparation: the procedure coordinator, who receives a pre-structured, validated dossier furnished with risk assessments, decides within minutes on matters whose compilation without agentic support would have required days.

Outlook: From Individual Procedure to Systemic Effect

The HYROW project is one of an estimated 40 to 70 formal planning approval procedures for the hydrogen backbone network. If each of these procedures is reduced at the initialisation stage from 20 to 30 days to fewer than 2 working days, this phase alone yields a saving potential of 800 to 2,000 working days.

More important, however, is this: the standards-compliant XTrasse generation (Type B) produces datasets that are referenceable in subsequent procedures – for instance, when the HYROW pipeline feeds into the *Flow* project at the Wrangelsburg network node. The documented argument graphs (Type C) constitute a knowledge base for similar procedures: the Habitats Directive assessment of the Rostocker Heide furnishes precedents for other forest crossings. And the procedural templates (Type A) become more precise with each iteration.

Thus, from the sum of individual procedures, a learning process emerges that approves the trans-European networks more swiftly and, simultaneously, with greater legal certainty.

The HYROW scenario demonstrates how Agentic Planning can function at national level. Yet the trans-European networks do not end at national borders. The next question, is: how can the agentic capabilities developed here be scaled across Europe, and what would an acceleration of trans-European network infrastructure (TEN) mean for the economy, resilience, and sovereignty of democratic Europe?

8. European Scaling of Agentic Planning: Resilience and Economic Benefits

Agentic Planning can be scaled across Europe because EU environmental legislation generates a structural convergence of substantive requirements. The entry point lies in bilateral corridor projects that organically cultivate a growing ecosystem of shared assessment frameworks, data formats, and procedural knowledge.

Although Europe holds no legislative competence over the planning and permitting of infrastructure projects, it shapes these processes profoundly through environmental legislation and sectoral policy. Solutions that facilitate the implementation of regulations such as the Environmental Impact Assessment can therefore, in principle, be deployed across all EU Member States. Agentic Planning supports the digitalisation of precisely those procedural rules that apply to all Member States and, moreover, furnishes new instruments for accelerating planning processes. Yet how exactly could Agentic Planning be scaled across Europe? What consequences would an acceleration of the expansion of the Trans-European Networks (TEN) entail? And what costs would arise if these networks were realised only partially or with significant delays?

European Scaling of Agentic Planning

Pragmatic First Steps

Before a fully-fledged Europe-wide agent network can emerge, decentralised structures must first be established. Four pragmatic measures lend themselves to this initial scaling effort. Each Member State can implement these initiatives independently and realise immediate local benefits. This approach avoids years of delay spent waiting for a comprehensive European architecture, whilst already preparing all the technological groundwork for subsequent interconnection.

Knowledge documentation: Any form of agentic support presupposes a structured description of national procedures. Member States must document their planning practices, standards, legislation, deadlines, and available digital tools in machine-readable formats. The specific format matters less than accessibility: even simple Markdown documents with structured metadata in YAML format[98] that describe procedural steps, responsibilities, and assessment requirements already create a foundation for agentic systems.

Markdown files in versioned, public repositories combine two properties that have hitherto been separate in the domain of administrative knowledge: natural-language readability for humans and immediate processability by agentic systems. Procedural descriptions, administrative directives, and legal commentaries currently reside predominantly in PDF files, proprietary databases, or documents that are not machine-readable. Were they additionally available as versioned Markdown documents, specialists and agentic systems could

[98] YAML: A recursive acronym for YAML Ain't Markup Language. It is a simplified, human-readable data serialisation language used primarily in software development for structured configuration files and data exchange.

equally read, search, and further process them. This does not replace elaborate data standards such as XPlanung or XBau (German data interoperability standards for spatial planning and building permits), but supplements them with a lightweight layer that considerably simplifies the initial adoption of agentic systems for administrative knowledge.

Open repositories: Open repositories make procedural descriptions, templates, and strategy papers accessible to all Member States. What one country documents about its permitting practice can serve as a template for another.

Open-source hubs for planning tools: European platforms on which specialised planning and permitting tools are shared and collaboratively developed accelerate progress across all Member States. An agent developed in Germany for structuring EIA (Environmental Impact Assessment) scoping frameworks can be localised in the Netherlands, further refined in the process, and subsequently made available to all other countries.

Simplified standards: The complex German XOeV standards (German public-sector data interoperability standards) are not directly suitable for European dissemination. An equally cumbersome formal European standardisation process for simplified versions would be no more expedient, as such processes tend to be unwieldy and produce merely lowest-common-denominator frameworks. The objective is therefore explicitly not a single European standard. Rather, what is needed is merely lightweight semantic ontology operating in the background. This minimal data structure is entirely sufficient for standardisation agents (Type B) to capture the substantive content of participation processes across all Member States and render them usable for the respective national authorities.

From National Project to a Growing Ecosystem

The investment requirements of the Trans-European Networks illustrate why purely national approaches are insufficient. The European hydrogen backbone network alone encompasses over 40,000 kilometres with estimated investments exceeding 80 billion euros. Chapter 4 demonstrates in detail that planning and permitting procedures represent the primary bottleneck.

However, the decisive question is not: How does the EU implement a uniform agent system? The EU holds no legislative competence over these procedures. Rather, the pertinent question is: What can states make available to one another?

The answer develops in concentric circles. It begins with bilateral corridor projects: when Germany and the Netherlands develop shared assessment frameworks and data formats for the Delta Corridor (Rotterdam–Ruhr region), concrete experiential knowledge is generated. This knowledge, documented in open repositories, is already available as a template for the next bilateral project. With each project, the ecosystem grows organically.

Previous EU digitalisation initiatives such as Gaia-X[99], ISA2[100], or INSPIRE[101] likewise pursued the principle of common standards with decentralised implementation. Three mechanisms distinguish the agentic approach from these predecessors. First, interoperability arises through use rather than through ex ante harmonisation: whereas INSPIRE or XPlanung require all participants to adopt the same standard, agents translate between formats at the moment of need. Interoperability follows from usage, not from regulation. Second, the ecosystem grows through practice rather than through decree: each corridor project enriches it with schema mappings, assessment frameworks, and procedural templates. The existing platforms constitute static infrastructure awaiting adoption. Third, competition shifts from platforms to capabilities: the decisive factor is not “which portal do we use” but “which agent solves this task best”. This generates a market dynamic that regulation alone cannot produce.

The challenge posed by the expansion of the Trans-European Networks particularly favours this growth. The non-deferrable pressure arising from environmental policy, energy independence, and competitiveness creates the political precondition. The cross-border dimension renders national digitalisation silos manifestly dysfunctional, for a hydrogen pipeline from Rotterdam to Bavaria traverses multiple countries with distinct permitting regimes. And the common European legal frameworks – SEA (Strategic Environmental Assessment), EIA (Environmental Impact Assessment), Habitats Directive compatibility, and Natura 2000 assessments – generate the structural convergence upon which agentic solutions can build.

The convergence-divergence dynamic is reaffirmed here: despite common legal foundations, an enormous diversity of national procedural configurations exists. This heterogeneity, however, lies at the level of procedural mechanics, not of substantive requirements. The formalisation enforced by the SEA, EIA, and Habitats Directive has created a structural convergence of assessment frameworks that constitutes the key to Europe-wide scalability. The convergence of EU environmental law functions as a shared professional language that renders exchange between national systems possible in the first place.

What Countries Can Share

The agent types introduced in Chapter 6 describe what occurs within a single country. At the European level, the perspective shifts: it is not the agent types themselves that are Europeanised, but rather knowledge, tools, and experience that are shared between countries. Four domains are suitable for this purpose.

---

[99] Gaia-X is an initiative supported by European states and industry to establish a sovereign, networked data infrastructure in accordance with European data protection and transparency requirements.
[100] ISA2 (2016–2020) was an EU programme for promoting cross-border interoperability, whose developed frameworks, in particular the European Interoperability Framework (EIF), continue to form the architectural basis of European administrative digitalisation to this day.
[101] INSPIRE (EU Directive of 2007) established the binding framework for a European spatial data infrastructure, whose standardised data services continue to shape cross-border spatial and environmental planning to a significant degree.

What is shared	Agent type	Example	Scalability
Substantive assessment frameworks	Deliberation (Type C)	Shared Habitats Directive assessment framework for the Delta Corridor (NL/DE)	High (EU law converges)
Data formats	Standardisation (Type B)	Bilateral XPlanung–IMRO mapping	Medium (mappings must be built)
Participation formats	Type C + A	Comment standards, evaluation tools, participation platforms	High (Aarhus/EU directives converge)
Procedural knowledge	Orchestration (Type A)	Procedural templates, deadline logic, coordination protocols	Low (mechanics diverge)

Table 15: What countries can share in the domain of agentic planning

The entry point lies where EU-wide convergence is strongest: with the substantive assessment frameworks and the participation requirements that are anchored in structurally identical form across all Member States through the Aarhus Convention and EU directives, as detailed in Chapter 4. The translation of data formats follows as a second step, driven by the requirements of bilateral corridor projects. A single European standard would be politically unachievable, yet bilateral translation agents can render national formats mutually legible at the moment of need. Over time, a growing repertoire of bilateral translation rules emerges – empirically grounded rather than regulatory prescribed. The sharing of procedural knowledge unfolds most slowly but forms the foundation for the long-term deepening of cooperation, as dependencies between parallel permitting procedures can only be identified when the procedural steps of both sides are documented and machine-readable.

AI Development as an Independent Scaling Factor

The rapid advancement of agentic AI systems is fundamentally altering the conditions for European scaling. What previously required extensive specialist teams and years of development work can increasingly be accomplished far more rapidly on the basis of well-documented procedures and standards. European scaling therefore depends less on a shared technical infrastructure than on the quality and accessibility of procedural documentation. Every procedural template, every documented deadline logic, every disclosed assessment framework becomes a building block upon which the next generation of agentic tools can build. Precisely because agentic systems process natural language, the boundary between documentation for humans and data for machines becomes permeable. This convergence renders investments in comprehensible, structured documentation doubly effective.

From Static Replication to Learning Intelligence

Previous administrative digitalisation strategies have primarily relied on "reuse" – the resource-efficient adoption of once-developed IT solutions by other authorities. The most prominent example is the German *Einer-fuer-Alle* principle (EfA, "one-for-all"), under which one federal state develops a digital service that others replicate as a finished product. Agentic systems, however, necessitate a paradigm shift: in place of static replication, what is required is cumulative improvement through collective use. Each deployment generates experiential knowledge regarding successful inputs, edge cases, and error types. If this knowledge flows back in anonymised form, authorities no longer merely copy software but benefit from agents that improve systemically.

This dynamic form of reuse can be operationalised on two levels:

Template sharing (*Vorlagenfreigabe*): A German procedural template – for instance, for the construction of hydrogen electrolysers – consolidates complex knowledge about assessment steps, required expert opinions, typical conditions, and recurring conflict patterns. Since a substantial proportion of this procedural knowledge is also highly relevant for other countries, a European template repository enables structured reuse. The templates function not as rigid prescriptions but as adaptable knowledge resources that continuously mature through international application.

Agent sharing (*Agentenfreigabe*): Highly specialised assessment capabilities – such as species protection evaluation, noise modelling, or heritage conservation – require immense resources to develop. A Europe-wide release of these specialised agents enables not merely significant cost-sharing. Through broader, cross-border usage, precisely the learning effect described above takes hold: the agents are confronted with a far greater variance of real-world edge cases, resulting in a substantial quality improvement for all participating actors.

Roadmap: From Pilot to System

The following roadmap outlines a plausible sequence in which the ecosystem can grow out of concrete project work. The dates indicate time windows that derive from the maturity of the respective prerequisites.

Phase 1: Bilateral Corridor Projects (2026–2028)

The entry point lies in concrete cross-border projects. The machine-readable documentation of national procedures and their provision in open repositories form the foundation. Suitable candidates include:

- **Hydrogen corridors**: The DeltaCorridor (Rotterdam–Ruhr region) or the SoutH2 Corridor (North Africa–Italy–Austria–Germany) require permits in multiple countries for interconnected infrastructure.
- **Power transmission lines**: The high-voltage direct current (HVDC) line NordLink 2 (Norway–Germany) or the Celtic Interconnector (France–Ireland) are cross-border individual projects of manageable complexity.
- **Rail corridors**: The Fehmarnbelt Fixed Link (Germany–Denmark) or the Brenner Base Tunnel (Austria–Italy) already possess established bilateral coordination mechanisms.

In these pilot projects, the three agent types can interact across borders for the first time. Implementation proceeds in order of their European scalability:

- **Deliberation as the entry point (Type C):** The starting point is an agent for the compatibility assessment under the European Habitats Directive (FFH). This agent analyses the cross-border impacts on the European protected area network Natura 2000 in both countries, operating on the basis of the EU-wide identical assessment logic of Article 6(3) of the Directive. In parallel, a scoping agent for the Environmental Impact Assessment (EIA) structures the terms of reference on the basis of the harmonised catalogue of protected interests.
- **Translation as the bridge (Type B):** A bilateral schema-mapping agent subsequently translates planning data between national formats – for example, between the German standard XPlanung and the Dutch counterpart IMRO (*Informatie Model Ruimtelijke Ordening*) for the expansion of the Delta Corridor. Additionally, a metadata harmonisation agent ensures that the procedural status in both countries becomes mutually legible.
- **Meta-coordination as the overarching framework (Type A):** An overarching synchronisation agent ultimately identifies the dependencies between national permitting procedures and monitors critical paths. Sovereignty over procedural management remains strictly with the respective national orchestration agents.

Complex governance questions surrounding liability, mandate boundaries, and auditability can thus initially be resolved within a manageable bilateral framework before the system is scaled to additional Member States.

The pilot projects produce three concrete output types: tested deliberative assessment frameworks, curated bilateral schema mappings, and proven coordination protocols. This experiential knowledge constitutes the prerequisite for Phase 2.

Phase 2: Standardisation and Institutionalisation (2027–2029)

Building upon the pilot projects, this phase serves to consolidate the empirical findings and translate them into durable European structures:

Consolidation of deliberation agents: The assessment frameworks tested in the pilots – for instance, for Habitats Directive compatibility, EIA scoping, or the assessment of alternatives – are published as referenceable assessment frameworks. A European capability register henceforth documents the respective input-output schemas and associated quality metrics of these domain-specific agents.

Expansion of standardisation agents: The initially bilateral schema mappings for data translation are elevated to a multilateral level. In parallel, specific extensions are developed within the existing bodies of the European geodata infrastructure (INSPIRE) to enable the standardised representation of the metadata required by agents across Europe.

Establishment of orchestration agents: For overarching coordination, a European Agent-to-Agent (A2A) protocol standard is adopted. This could prospectively be formalised by recognised standardisation bodies such as ETSI or CEN. The standard governs technical task delegation, context transfer, escalation paths, and audit requirements, whilst leaving the sovereignty of national procedural management intact.

Accompanying governance framework: To provide legal backing for this technological scaling, the European AI Act is supplemented with specific guidance for the deployment of cross-border agentic systems in public administration.

At the institutional level, this requires three central pillars:

1. **Technical coordination:** A European body – for example, situated within the European Commission's Directorate-General for Informatics (DIGIT) or within the successor programmes for European interoperability (formerly ISA2) – assumes responsibility for the development of technical standards.
2. **Governance and oversight:** Bilateral or multilateral agreements are concluded to guarantee the mutual recognition of agent certifications on a trust basis.
3. **Funding:** European funding instruments, such as the programme for Trans-European digital networks (CEF Digital), provide the necessary resources for the implementation of these shared infrastructure components.

Phase 3: Ecosystem Scaling (2029–2035)

The federated ecosystem establishes itself as European normality. A European capability market for deliberation agents emerges, in which providers compete on the basis of transparent quality metrics. In parallel, the bilateral schema mappings of standardisation agents densify into a multilateral translation network. The rigid search for a single valid standard is superseded by a dynamic inquiry: "Which agent facilitates the translation?"" Simultaneously, cross-border permitting procedures are now seamlessly coordinated through the use of orchestration agents.

Anonymised experiential knowledge from practice flows into continuous, system-wide improvement: the substantive assessment frameworks are continually refined through current case law and practical experience, the translation mappings are extended to accommodate new data formats, and coordination patterns are honed with each new European corridor project. This densification is accompanied by a shared template repository that provides procedural templates from all Member States in a machine-readable and seamlessly translatable form.

The Trans-European Networks (TEN) in the domains of energy, transport, and digital infrastructure serve as the physical backbone of this scaling process. Each new cross-border connection not only uses the digital ecosystem but continuously enriches it through new, complex case constellations.

Differentiated Multi-Level Governance

The governance of a federated agentic ecosystem requires a precise allocation of responsibilities along the lines of the EU AI Act. At the European level, the EU AI Office, together with advisory bodies, orchestrates the regulatory framework and supervises foundation models. The national level complements this through designated market surveillance authorities that, as central contact points, ensure the oversight of high-risk systems. At the regional and municipal level, practical implementation takes place: here, procedural templates are integrated into domain-specific workflows, feedback loops are moderated, and human oversight of the system is anchored.

Liability Regime and Democratic Control

Legal certainty and democratic legitimacy form the foundation of this ecosystem. The liability regime must be based on the principle of chain responsibility: model providers bear liability for fundamental risk analyses; system developers for domain-specific filters. Since German administrative law precludes the fiction of an autonomous "e-civil servant", the operative ultimate responsibility – and with it strict state liability (*Staatshaftung*) – necessarily remains with the authority making the individual decision. To safeguard democratic control, an explicit parliamentary mandate for the deployment of agents is required, alongside technical transparency through systemic activity logs and the preservation of the participatory rights of affected groups.

Competitive Dynamics and Innovation Promotion

An agentic administrative system realises its full potential only through a functioning innovation-driven competitive environment. To avoid monolithic dependencies (vendor lock-in), open, binding interoperability standards (such as those currently being developed by NIST and IEEE) must be guaranteed. For critical sovereign capabilities, open-source alternatives are required. Moreover, if several Member States act as joint commissioners, the development of the ecosystem can be significantly accelerated through iterative public procurement and *ethics-by-design* can be embedded from the outset.

Demographic Change and the New System Responsibility

The current administrative-law paradigm mandates that a human actor makes the final decision in each individual case at the conclusion of every procedure. This premise, however, collides forcefully with both the doctrinal boundaries of existing law and the demographic reality. At the European level, Article 14 of the AI Act prescribes the obligation of human oversight, and Article 22 of the General Data Protection Regulation (GDPR) establishes the fundamental prohibition of fully automated decisions. Under German law, Section 35a of the Administrative Procedure Act (*Verwaltungsverfahrensgesetz*, VwVfG) additionally prohibits the automated issuance of administrative acts wherever discretionary margins or complex balancing of interests are involved. Yet it is precisely such balancing exercises that constitute the legal core of spatial planning procedures.

In view of a projected shortfall of more than 800,000 full-time equivalents by 2030, the mandatory individual-case assessment for such mass procedures is increasingly proving to be dysfunctional regulatory fiction. When a shrinking workforce merely signs off on agentic drafts under time pressure, the legally required control erodes. The empirically documented phenomenon of automation bias inevitably emerges. In such constellations, the human being is reduced to a mere liability subject who maintains the appearance of a substantive review without being cognitively or temporally capable of performing one. The decision mutates de facto into a fully automated administrative act – which is impermissible under current law.

A future-proof model grounded in the rule of law therefore necessitates the imperative doctrinal transition from microscopic case-level responsibility to macroscopic system-level responsibility. To render the shift from human-in-the-loop to human-on-the-loop legally sound, precise interventions in the normative architecture are indispensable. At the European level, the opening clauses of Article 22(2) GDPR must be systematically activated through national law, and the supervisory obligations under the AI Act must be specified on a domain-specific basis for mass procedures. At the national level, Section 35a VwVfG requires fundamental reform: the legislature must introduce a differentiation between free and structured discretion. In areas where balancing criteria can be translated ex ante into deterministic rule sets, automation must be rendered permissible.

Since human administrative action is likewise error-prone, the legitimation of agentic AI must not founder on a utopian standard of perfection. The benchmark for rational technology governance must be a comparative risk assessment: where a socio-technical system demonstrably exhibits a lower net error rate and greater consistency than manual practice, a validated performance record can serve as the basis for the gradual expansion of delegated decision-making authority.

This ultimately also requires a modification of administrative-court doctrine. Jurisprudence must recognise that error-free processing in high-volume operations will henceforth be achieved through robust system architectures, validated prompt chains, and statistical quality controls. This is by no means a technocratic stopgap for managing scarcity; rather, it leads to a substantive enhancement of the human role. Staff members are liberated from the repetitive routine processing of the thousandth substantively identical objection. Instead, the duty of the office shifts towards the calibration of AI parameters, the management of quality standards, and the methodical auditing of machine output through risk-based sampling. Above all, the administration regains the capacity for the deep legal appraisal of those complex edge cases that the system must not resolve autonomously. Human expertise is thereby repositioned precisely where it is indispensable for upholding the rule of law.

Risks in Cross-Border Agent Deployment

The operational and legal risks of agentic systems are compounded in the context of transeuropean scaling. The cross-border dimension not only opens new attack vectors (such as multilingual prompt injections) but, above all, extends the error chains. A typical cascade effect: if a national environmental agent transmits erroneous geodata to a European assessment agent, which subsequently feeds these data automatically into the permitting procedure of a third Member State, the error traverses different legal orders and system architectures undetected.

Regulatory sandboxes provide the indispensable framework for testing such interoperability risks under controlled conditions. In the European context, this necessarily requires that each participating Member State maintains its own human clearance authority (human oversight pursuant to Article 14 of the AI Act). The subsidiarity principle thus functions not merely as a procedural guideline but constitutes the foundation of the entire decentralised security architecture.

Synthesis and European Perspective

A transeuropean agent ecosystem for planning and permitting is far more than an IT initiative; it is critical infrastructure for the future viability of the continent. Europe's transformation towards climate neutrality and its global competitiveness depend fundamentally on more agile administrative processes. The agentic transformation offers potential well beyond incremental efficiency gains: it reduces process durations radically, ensures consistent cross-authority processing, and constitutes the only robust response to the demographic collapse of public administration.

The technological and regulatory building blocks for this vision already exist: semantic standards (XOeV, INSPIRE) and new interoperability norms (IEEE P2997) provide the technical foundation, whilst initiatives such as the German EfA principle ("one-for-all") or the European Single Digital Gateway supply the blueprints for legal reuse.

This European approach fits within a global development. The DPI-AI Framework of the Centre for Digital Public Infrastructure outlines, at the international level, a structurally analogous architecture for the integration of AI into public administrative systems: modular functional units ("AI Blocks"), an orchestration layer ("DPI Workflows"), and AI-powered interfaces between humans and systems ("Public Agents").[102] Modularity, federated governance, and human ultimate decision-making authority thus prove to be foundational design principles across continents and application domains. Agentic Planning concretises this framework for planning and permitting procedures and extends it by incorporating the deliberative dimension.

What is currently lacking is the consistent interconnection of these isolated elements into a federated ecosystem. The Trans-European Networks (TEN) offer the ideal starting point for this integration: their enormous investment requirements render even marginal procedural acceleration economically highly significant, whilst their cross-border nature maximises the pressure to overcome national data silos.

Once agentic planning has been successfully validated in a Member State under strict safety standards, the underlying agents and governance frameworks can readily be shared across Europe. Thus, a European acceleration architecture emerges – not as a monolithic top-down solution imposed from above, but one that grows organically through collective use and generates its interoperability directly during live operation.

Acceleration or Delay in the Construction of Trans-European Networks

The economy, resilience, and sovereignty of the EU depend critically on the swift expansion of the Trans-European Networks. Agentic Planning delivers the decisive multiplier effect to realise this infrastructure within the required timeframe.

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[102] CDPI Abadie, D. (2026). DPI-AI Framework: Building AI-Ready Nations through Digital Public Infrastructure. Centre for Digital Public Infrastructure. https://digitalpublicinfrastructure.ai

Economic Aspects

Complementing the investment requirements, the macroeconomic losses caused by delays can be quantified. The quantification of the "cost of non-Europe" has a long tradition.[103] More recent estimates place the untapped potential of deeper integration at up to three trillion euros annually (EPRS, 2024):

Sector	Indicator	Source
Transport	2,940–3,380 billion EUR cumulative GDP losses in the event of non-completion (2015–2030)	Fraunhofer ISI, 2015
Transport	>500 billion EUR annual external costs (congestion, accidents, emissions)	CE Delft, 2019
Energy	23 billion EUR annual savings through optimised electricity trading	ENTSO-E, 2024
Energy	>100 TWh avoidable curtailment of renewable energy per year	ENTSO-E, 2024

Table 16: Cost of non-Europe for Trans-European Networks

A transport corridor is only as efficient as its weakest section. If central links are missing, the network effect collapses. The projected gains materialise not linearly but in discrete leaps upon completion of each section. Every acceleration of procedures shortens the time until that leap. The example of the Ganderkesee–St. Huelfe power transmission line illustrates the scale: with construction costs of approximately one billion euros, the line saved 500 million euros in redispatch costs in its first year of operation alone, as detailed in Chapter 4. It is evident that each year of earlier commissioning would have yielded substantial savings.

At the European level, such effects accumulate further. Whilst China has built approximately 18,000 kilometres of ultra-high-voltage power lines over the past five years, the EU has managed only 5,000 kilometres. This speed disadvantage affects more than the energy sector alone: it delays the connection of new industrial sites, impedes the establishment of semiconductor manufacturing and critical raw materials processing, and weakens the regional value creation associated with every infrastructure project. Planning acceleration is therefore a prerequisite for Europe's industrial competitiveness. It must not be overlooked, however, that the speed of infrastructure development in China is to a large extent attributable to the top-down authority of an autocratic system, entailing substantial consequential costs for people and the environment. Agentic Planning serves as a guarantor for acceleration while preserving the European order of values.

[103] Cecchini, P. et al. (1988): *The European Challenge 1992: The Benefits of a Single Market.*

Resilience

The energy crisis following Russia's war of aggression against Ukraine exposed the strategic vulnerability of the Trans-European Networks. Before the war, the EU sourced approximately 40 percent of its natural gas from Russia. A lack of interconnectors and alternative transport routes rendered individual Member States susceptible to coercion and drove energy prices to a multiple of pre-war levels. Cross-border interconnection lines would have reduced price volatility during the crisis by a factor of seven. Against this backdrop, planning acceleration constitutes geopolitical risk mitigation across three dimensions:

Energy sovereignty: An accelerated expansion of the Trans-European energy networks creates a safety net capable of better compensating for local outages through European solidarity flows. Every delay in connecting new LNG terminals, constructing hydrogen corridors, or integrating renewable generation capacity prolongs strategic dependency. By 2030, EU transmission networks must absorb approximately 64 gigawatts of additional cross-border capacity, yet more than half of the necessary projects are still in permitting procedures.

Supply chain robustness: Extreme weather events such as the Rhine low-water episode of 2022 reveal the fragility of linear supply chains:The failure of a central transport route triggers an immediate risk of collapse at critical logistical chokepoints. At the same time, Europe's strategic reindustrialisation efforts – flanked by the European Chips Act and the Critical Raw Materials Act – imperatively require a highly resilient supply of process-critical raw materials. The accelerated expansion of rail freight transport is therefore far more than a mere transport project. It constitutes essential structural policy and creates precisely the modal redundancy that is vital for European supply security.

Defence capability: The civilian TEN-T network overlaps by more than 90 percent with NATO's military transport requirements (Military Mobility Package). Bridges unable to bear heavy loads, missing rail connections to the eastern flank, and inadequate road cross-sections substantially limit deployment capability. Planning acceleration therefore simultaneously strengthens the Alliance's capacity to respond. Every year of delay maintains a window of vulnerability that can no longer be geopolitically justified.

Digital Sovereignty and Agentic Planning

Circular interdependence exists between the concept of Agentic Planning and European digital sovereignty. Technological autonomy presupposes efficient administrative procedures, whilst automated administration imperatively requires sovereign infrastructures. This dynamic unfolds across three central dimensions:

Agentic Planning as a catalyst for digital backbone networks: The realisation of European backbone projects – such as submarine cables, quantum communication networks (EuroQCI), or edge computing networks – is subject to the same administrative bottlenecks as the conventional energy and transport sectors. Cable laying and construction projects require complex maritime laws, coastal-protection, and environmental-law assessments in various littoral states. The European Union's industrial-policy objective of establishing ten thousand climate-neutral edge nodes by 2030[104] is empirically at greater risk of failing due to the administrative processing of thousands of parallel permitting procedures than due to a lack of investment capital. The deployment of the agent types defined in this document – orchestration, standardisation, and deliberation – for the expansion of digital networks has the potential to reduce these permitting cycles drastically. A significant reduction in procedural latencies would substantially enhance Europe's technological scalability and generate structural competitive advantages.

Digital sovereignty as a premise of automation: An administration-specific agent ecosystem processes highly sensitive data. This includes geodata of critical infrastructures, procedural statuses of ongoing permits, and location coordinates of military defence installations. Operating this ecosystem on extraterritorial cloud architectures would create strategic vulnerabilities that would negate the autonomy gains of the physical infrastructure. To prevent this, the sovereignty requirement must be guaranteed at three architectural levels:

Infrastructure level: Sovereign cloud capacities are imperative. Initiatives such as Gaia-X or the European Alliance for Industrial Data, Edge and Cloud address this need. At present, however, their market readiness is asynchronous with the requisite scaling dynamics of the agent ecosystem.[105]

Model level: A provider-agnostic architecture is indispensable. The established capability contracts define functional requirements for the agent but do not determine the underlying language model. European and open-source models must be anchored here as equivalent and substitutable alternatives.

Protocol level: Agent-to-Agent (A2A) communication constitutes a critical system component. The standardisation of A2A protocols as open European standards by bodies such as ETSI or CEN is therefore not a mere technical formality. It is a geopolitical necessity for the prevention of platform monopolies.

Federated system design as a resilience model: Decentralised data governance combined with open interoperability standards mirrors European multi-level governance in technological terms. Each Member State retains informational sovereignty over its procedural data and normative control over mandate design. Shared regulatory frameworks simultaneously secure cross-border cooperation. European administrative practice is characterised by a globally unique synthesis of harmonised EU environmental law, national procedural diversity, and a deeply rooted federal tradition. Agentic systems capable of navigating this specific legal complexity in a legally sound manner cannot be imported as finished products from third countries. They imperatively require endogenous European development that inextricably links technological sovereignty with administrative capacity to act.

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[104] European Parliament and Council Decision (EU) 2022/2481 establishing the Digital Decade Policy Programme 2030.
[105] Pohle, J. and Thiel, T. (2020). Digital sovereignty. Internet Policy Review.

Infrastructure and Ecosystem

The Trans-European Networks and a European agent ecosystem are mutually dependent. The structural convergence generated by the common EU legal frameworks for environmental assessments makes cross-border agentic cooperation possible in the first place. The very harmonisation that is frequently perceived as a bureaucratic burden proves here to be the indispensable foundation for technological scaling.

Europe already possesses the legal and technical prerequisites for such a planning ecosystem. The question is consequently not one of theoretical feasibility. Rather, it concerns the political will to systematically interconnect the existing building blocks.

Economic losses, geopolitical risks, and technological dependencies are acutely intensifying the pressure to act. Every year of delay in the expansion of the Trans-European Networks costs billions and extends a critical window of strategic vulnerability. In parallel, the window of opportunity for European market leadership in key technologies such as edge computing is closing. The costs of political inaction accumulate across all these dimensions, leaving irreversible structural damage.

A fundamental digital acceleration of planning and permitting procedures is therefore not merely one option among many. It is the imperative response to a constellation of problems that structurally and in terms of resources simply overwhelms purely national approaches. A federated European agent ecosystem positions itself in this context as the currently most promising and scalable solution.

9. Conclusion and Outlook

Planning and permitting procedures constitute the central bottleneck for the expansion of the Trans-European Networks. The present study demonstrates that agentic artificial intelligence can structurally resolve this blockage. Two technological properties open qualitatively novel pathways compared to previous digitalisation approaches. First, agentic data processing eliminates the necessity of prior standard harmonisation. Rather than requiring a uniform, cross-border data structure as a rigid precondition, agents seamlessly translate between the respective national or regional standards. Second, the natural language processing capabilities of agentic systems bridge the historical divide between human-readable documents and machine-readable data. Both mechanisms fundamentally lower the administrative barrier to entry. Technology alone, however, is insufficient. The lack of data to measure procedural durations, limited readiness for change within parts of the public administration, and political discontinuities across legislative periods remain unresolved obstacles. They necessitate complementary measures in the form of a robust monitoring infrastructure and systematic change management.

The most profound prospect of this concept emerges when acceleration and democratic participation no longer stand in opposition, but mutually reinforce one another. The Aarhus Convention and the European participation directives guarantee rights of public involvement whose exercise inevitably extends procedural timelines. Previous acceleration approaches have therefore frequently sought to curtail participation. Agentic Planning enables precisely the reverse: greater participation alongside shorter procedures. Conventional resistance maps for route planning have accounted exclusively for legal, economic, and physical constraints. However, social reservations concerning landscape character, noise, property, or local identity typically coalesce long before the formal process, already shaping the informal dialogue. The technological innovation lies in anticipating these dynamics and simulating discourses to achieve significantly higher acceptability from the outset. A multi-perspective configuration comprising nature conservation agents, municipal agents, and assessment agents generates a situational picture that extends far beyond physical resistance maps. The HYROW case study illustrates how "productive misunderstandings" between agents can reveal blind spots that no isolated actor would have identified alone. The conceptual core of this shift is the systematic evaluation of conflicts beyond the boundaries of individual procedures. Agentic systems process the resistance encountered in one project as patterns for future undertakings, thereby ensuring a permanently consistent balancing of interests.

Based on this foundation, validation by human stakeholders occurs through early participation formats. The insights gained feed back into the models as new parameters, ensuring that genuine human participation retains its formative function. Only the iteratively optimised planning draft ultimately reaches the formal participation stage. This phase remains intact as a statutory guarantee, yet ideally no longer harbours fundamental surprises. This procedural sequence refutes the concern that algorithmic pre-structuring might marginalise actual public participation. The algorithmic systems serve solely to prepare a well-founded basis for discourse. Substantive steering and the final legal balancing of interests remain strictly in human hands.

The European dimension confirms the scalability of this model. EU environmental legislation has created far-reaching convergence in substantive assessment requirements. The Aarhus Convention and the European participation directives constitute a second and considerably stronger layer of convergence within European planning law. Deliberative agents operating on this normative foundation therefore possess the greatest scaling potential. The entry point for trans-European application lies precisely here. The draft directive presented by the European Commission in December 2025 on accelerating permitting procedures for energy infrastructure (COM(2025) 1007 final) underscores the political urgency. The Commission's approach relies on shortened deadlines and deemed permits. However, a purely regulatory acceleration carries the risk that rigid deadline reductions compromise the quality of substantive assessments and ultimately culminate in flawed deemed permits. Agentic Planning provides the necessary technological foundation to manage this complexity and make such shortened deadlines operationally feasible.

The technological building blocks for an agentic planning ecosystem already exist. For policymakers and public administration, this necessitates an immediate transition to a pilot phase. Bilateral corridor projects must practically test the participatory simulation of route alternatives. In parallel, robust legal foundations must be established for the secure deployment of AI agents in public administration, guided by pioneering models such as the Estonian Administrative Procedure Act. Simultaneously, a broad field of work opens up for research and development: ranging from the empirical evaluation of initial pilot projects and the integration of social resistance factors to the governance of cross-border interactions.

The contradiction between the urgent need for infrastructure expansion and the inability to implement it in a timely manner need not remain entrenched. Agentic Planning establishes an architecture that renders complexity manageable without curtailing democratic participation. The successful pursuit of this path ultimately depends on three central preconditions: pilot projects to furnish practical proof of concept, a monitoring infrastructure to accurately measure procedural durations, and a clear institutional commitment to viewing agentic systems not as a threat, but as a vital instrument of democratic planning culture.

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