Institutional Drift in Power System Planning

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Abstract

Long-term network development plans play a key role in ensuring system adequacy. However, planned infrastructure investments are frequently subject to delays, rescheduling, or cancellation during their lifetime. This paper presents an empirical analysis of 15 consecutive annual Hungarian high-voltage network development plans published between 2010 and 2024, covering 748 transmission and sub-transmission projects. A harmonised project-level dataset was constructed to track the evolution of planned commercial operation dates, initial lead times, revision frequency, cancellation rates, and realised implementation timelines. Results show that project schedules are inherently volatile. Projects with longer initial lead times exhibit significantly higher cancellation risk, with more than 50% of projects planned four years ahead ultimately not being realised. Transmission-level investments display both higher planning look-ahead time and longer realised lead times compared to distribution-level developments. These findings highlight the importance of empirically tracking the temporal evolution of development plans to improve the realism of expansion modelling and support adaptive planning practices under changing technical and policy conditions.

1 Introduction

Institutional drift refers to slow, formally unnoticeable change in the way an institution works, even though its official rules stay the same. The formal rules and procedures of power system expansion planning have stayed remarkably stable, while the technological, climatic, and policy environment around them has changed at break-neck speed. Expansion rules optimised for yesterday's incremental reliability fixes now gate the energy-transition build-out. Regulators are racing to retrofit, but those reforms themselves testify that institutional drift let the gap grow for a decade first.

The term 'institutional drift' was coined in the works of Kathleen Thelen, Wolfgang Streeck and James Mahoney [1], [2], [3] as a situation of changed impact on existing institutions because of shifts in the institution's environment and a lack of adjustment to them. Institutions are based on formal or informal rule systems that define how processes should operate. However, these rules can never be fully precise or complete. The people who design them, such as regulators or planners, have limited information and cannot fully predict future system conditions. As a result, rules are often created based on simplified assumptions that may later prove to be inaccurate. In addition, rules are typically built on implicit assumptions about how the system will function in practice. These assumptions can be interpreted differently by actors involved in planning, permitting, or implementation. Enforcement can also be challenging, especially when the organisations applying the rules are not the same as those that designed them. Due to limited foresight, differing interpretations, and enforcement challenges, rule-based systems tend to evolve over time in response to changing technical, economic, or social conditions. The typology of gradual institutional change consists of four processes; layering, conversion, drift and displacement. Of these, drift is unique because nothing new is formally added or deleted – the meaning and impact of the existing rules just migrate as circumstances change. In this paper, we show that power system planning shows systematic patterns of date slippages and demonstrate that in many cases the root cause is the mismatch between stable planning rules and a shifting external environment.

Examples of such systematic project delays have been reported by multiple sources recently. The 2022 Ten-Year Network Development Plan of ENTSO-E reported an approx. 14% of planned transmission investments experiencing delays, with a similar share being rescheduled in a two-year period [4]. Significant number of projects remained in a prolonged permitting phase as well, illustrating that long-term plans are frequently delayed or deferred between successive planning cycles. ACER's 2023 monitoring of Projects of Common Interest (PCI) also found that approx. 30% of transmission system projects experienced delays, with slow permitting being the most frequently identified cause [5]. A study by the Niskanen Center examined transmission projects between 2010 and 2020, identifying 37 U.S. projects, which required and environmental impact statement, 11% of which were eventually cancelled [6]. They also found that permitting for these projects took on average 4.3 years. Finally, a survey performed by Pall et al. presented a wide spectrum of delay factors affecting transmission projects, organized in 10 groups, of which 'Administrative Factors' and 'External/Unavoidable Factors' are closely related to the concept of institutional drift [7].

Literature of the field also provides examples for researchers analysing the root cause of these delays. An empirical analysis by Cohen et al. found that local social opposition to new transmission projects has delayed and in some cases led to cancellations [8]. Their survey-based work showed that while public resistance is an important factor, providing information on the long-term benefits of a project can reduce such opposing sounds. The cost-benefit analysis framework of ENTSO-E was criticised by Schmidt and Lilliestam, arguing that it may overlook local factors, potentially increasing public conflicts [9]. This finding shows that purely technical planning criteria can miss institutional and social dimensions. Süsser et al. propose the integration of social and environmental factors into grid planning models, noting that transmission system operator (TSO) models typically assume that all planned projects are implemented on schedule, which is empirically not true [10]. Such false assumptions were also revealed by a recent report on European transmission planning projects [11]. The analysis of 32 European TSOs showed that many rely on scenarios aligned with outdated targets, not reflecting the rapid growth of renewables. The report calls for action in updating TSO mandates and planning rules, to avoid further delays.

The motivation of present paper is to coherently analyse power system expansion and development plans on the long run. Our aim is twofold; first, to present a statistical analysis of a 15-year period, covering hundreds of projects. Second, to test the hypothesis that signs of institutional drift can be captured in long-term development plans.

The remainder of the paper is structured as follows. Section 2. presents the legal background of the Hungarian network development planning process, and introduces the dataset, assembled by the authors. Section 3. provides a brief overview of three aspects of the data analysis results, namely statistics, temporal trends and the effect of carried over projects. Finally, conclusions are drawn in Section 4.

2 Methodology

In this section the relevant legal background of the Hungarian transmission planning process and the analysed dataset are presented.

2.1 Legal background

In Hungary, the preparation of the Transmission Network Development Plan (NDP) is a statutory obligation of MAVIR, the transmission system operator, under Act LXXXI of 2007 on Electrical Energy [12], which incorporates and transposes key European Union directives such as Directive 2019/944/EU [13], the RED II Directive [14], and the Electricity Market Directive. These instruments jointly require transparent, regularly updated planning to ensure compliance with EU market integration, renewable energy, and transparency objectives, specifically for networks operating at 132 kV and above. National legislation is continually amended to reflect evolving EU policy, with government decrees providing detailed implementation rules that directly affect investment decisions and grid connection conditions. The Hungarian Energy and Public Utility Regulatory Authority (MEKH) reviews and formally approves the NDP through binding resolutions, which may also prescribe additional development tasks. This multi-layered governance structure – anchored in national law, shaped by EU mandates, and operationalized through government decrees and regulatory approvals – ensures that Hungarian transmission planning remains aligned with both domestic energy strategy and the integrated European electricity market.

2.2 Dataset

For this study, we collected data from 15 consecutive annual network development plans published by the Hungarian TSO MAVIR between 2010-2024. These plans include all planned investments of DSOs and the TSO on high-voltage level (sub-transmission and transmission). As many of the individual developments have modified or become obsolete during the 15-year period, the data was pre-processed manually to ensure continuity of the physical needs driving the NDP. (E.g. certain developments were renamed, when the site of the planned substation was slightly modified, however this is still a single project from the TSO's perspective.) As the result of this data cleaning process, the final dataset includes 748 entries.

Entries of the dataset received flags based on the following decisive points:

- The investment is planned by the TSO or a DSO
- The investment is a new element or an upgrade of an existing one
- The investment is a node (substation), an edge (power line) or an auxiliary element

Detailed statistical analysis of the dataset was carried out with two approaches: from the perspective of the dataset entries (project-focused) and from the perspective of the temporality of the entries (plan year-focused).

Project focused metrics include the following:

- First appearance in the NDP
- First announced commercial operation date (COD)
- Initial lead-time (years planned before COD)
- Changes in COD during project lifetime (number of revisions)
- Standard deviation of CODs during project lifetime
- Sunken effort of cancelled projects
- COD trajectory (advanced, planned, delayed)

Plan year-focused metrics include the following:

- Initial lead-time
- Mean delay of COD
- Cancellation rate
- Completion rate

To avoid distortion of the statistics by project delays happening before or after the evaluated 15-year period, we applied left and/or right truncation when calculating certain metrics.

Table 1. Selected statistics of the analysed projects.

	All	New	Upgrade	Substation	Line	Finished	Cancelled
Mean initial lead time [year]							
Total	4.606	4.357	4.822	4.352	4.869	3.458	5.149
TSO	5.955	6.269	5.756	5.485	6.360	4.581	7.882
DSO	4.295	4.003	4.568	4.134	4.543	2.564	4.679
Mean standard deviation of CODs [year]							
Total	1.147	1.070	1.230	1.157	1.105	1.022	1.280
TSO	1.401	1.303	1.488	1.361	1.368	0.843	1.764
DSO	1.074	1.010	1.146	1.113	1.000	1.166	1.146
Relative changes in COD during project lifetime							
Total	0.463	0.482	0.443	0.479	0.435	0.406	0.512
TSO	0.366	0.338	0.390	0.353	0.364	0.276	0.419
DSO	0.492	0.520	0.461	0.506	0.465	0.487	0.540

Table 2. Statistics related to finished and cancelled projects.

	All	New	Upgrade	Substation	Line
Sunken effort [year]					
Total	2.148	2.456	1.806	2.200	2.128
TSO	4.039	5.200	2.923	4.950	4.227
DSO	1.825	2.025	1.597	1.893	1.709
Actual lead time [year]					
Total	4.268	4.491	3.888	4.271	4.666
TSO	5.255	6.823	4.230	5.400	6.111
DSO	3.481	3.590	3.000	3.692	2.933

3 Results

3.1 Statistical analysis

Across the complete portfolio (Table 1.), projects enter the plan with a mean initial lead time of 4.61 years, with TSO projects planned further ahead (5.96 years) than DSO projects (4.30 years). This difference is also visible by asset type, as lines have longer initial lead times than substations (4.87 vs 4.35 years). Project that are ultimately finished, have shorter initial lead times (3.46 years), while cancelled projects have the longest (5.15 years), indicating that long-term planned investments are more exposed to changing conditions. The mean standard deviation of CODs is 1.15 years overall, but higher for TSO projects (1.40 years) than for DSO projects (1.07 years). However, relative COD changes during the project lifetime are larger for DSO projects (0.492) than for TSO projects (0.366). This indicates that although TSOs plan further ahead, DSOs revise project timelines more strongly relative to their initial schedules, especially for new and cancelled investments.

Table 2. highlights differences in both sunken effort (time spent in the plan cancellation) and actual lead time across operators and asset types. On average, projects accumulate 2.15 years of sunken effort, but TSO projects require significantly more time (4.04 years) than DSO projects (1.83 years). This gap is most pronounced for new projects, where TSOs show 5.20 years compared to 2.03 years for DSOs, indicating that large transmission-level investments tend to remain longer in the planning pipeline before being cancelled.

A similar pattern appears in actual lead time. The overall mean is 4.27 years, but TSO projects average 5.26 years, compared to 3.48 years for DSOs. New TSO projects have the longest timelines at 6.82 years, while new DSO projects average 3.59 years. By asset type, lines take longer than substations, especially at transmission level (6.11 vs 5.40 years), reflecting higher permitting complexity.

3.2 Temporal analysis

Fig. 1. shows the difference of actual and planned CODs for projects across the portfolio. Numbers are positive if projects started in the given year were delayed during their lifetime, while negative numbers show advanced projects. An important change in the trends is seen after 2020, when the new (current) NDP methodology was introduced; Projects launched after this date show almost no delay. It has to be noted though that the data of the figure only reflects finished projects. Given the mean initial lead times shown previously in Table 1., we can assume that statistics of the 2020-2024 period will show more delay in some years' time.

Fig. 2. shows how many years the cancelled projects spend in the development pipeline compared to their initial planned CODs. Numbers of the figure are positive, if the decision for cancellation was made past the initial COD. On the contrary, negative numbers suggest that plans were modified on time. In this case, the methodological change of 2020 only affects DSO plans. Before this year, projects showed an average sunken effort of 1-3 years, while after 2020, cancellations are decided more rapidly. However, if we compare this to the initial CODs of the DSO projects for the 2014-2020 and the 2021-2025

period, we see an increase from 3.47 years to 4.58 years, indicating a longer look-ahead time in planning. Smaller changes are seen in case of TSO projects, and it has to be noted once again, that the fate of most of the projects launched after 2020 are yet unknown.

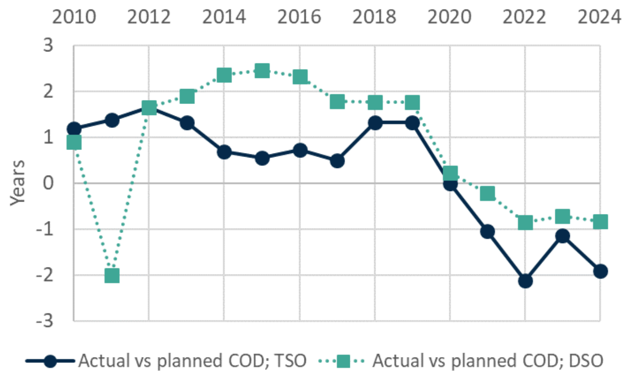

Fig. 1. Difference of actual and planned CODs for finished TSO and DSO projects. Positive numbers indicate lagging projects, negative numbers indicate projects being finished in advance.

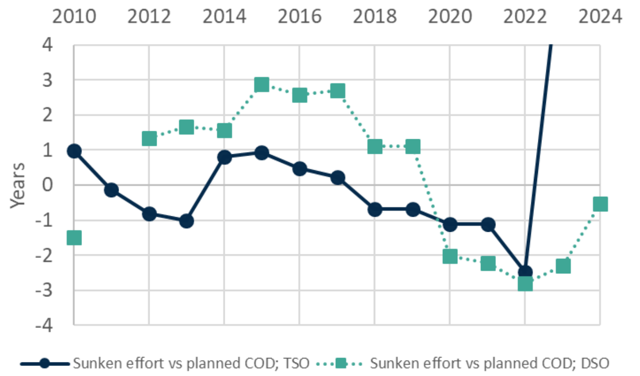

Fig. 2. Difference of years cancelled projects spend in the development pipeline and their planned CODs. Positive numbers indicate projects where the decision for cancellation was made past the initial COD.

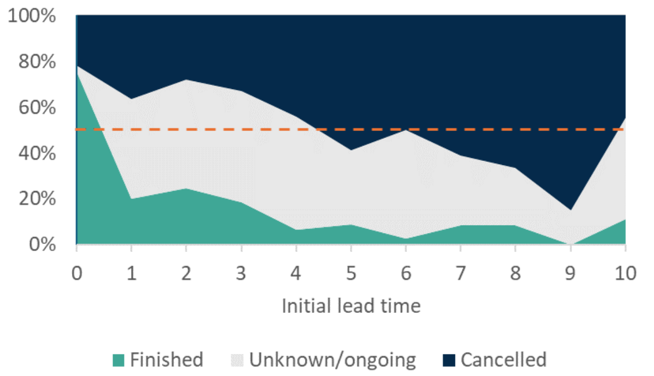

Fig. 3. Probability of projects being finished of cancelled, depending on their initial lead time.

As the results shown on Figs. 1 and 2. indicate that projects with a longer initial lead time carry more risk of being cancelled, we show the cumulative probabilities of projects being finished or cancelled, depending on their lead time. It is shocking to see that across the 748 elements of the analysed long-term planning portfolios, the only look-ahead time, where a project has more chance of being finished than being cancelled is 0-years. (This practically means that the NDP includes projects, which first appear in the year of the planned COD.) More than 50% of the plans with initial lead times of 4 years are newer finished, which also questions the relevance of the 5-year planning horizon of the TSO.

3.3 Discussion

To better understand the underlying phenomena that causes such high risks to long-term plans, we will now recap the most important external changes of the Hungarian power sector. Between 2010 and 2025, the external political, economic, and social environment of power system expansion in Hungary underwent substantial changes that directly affected transmission and distribution planning processes. In the period between 2010 and late 2015, grid development activity remained relatively low. This was associated with sluggish economic growth, a transforming peak demand profile, and a persistently high electricity import share of approximately 25-30%. At the same time, the share of industrial electricity demand increased gradually, altering load distribution and planning priorities. From 2016 to 2021, renewable energy support schemes such as KÁT and later METÁR stimulated significant growth in distributed generation, particularly household-sized photovoltaic systems. This period was characterised by increasing grid connection requests and steadily narrowing network uptake capacity. Grid access processes became more complex due to the presence of seven different connection entry points across six DSOs, operating within five distinct ownership groups. Notably, four of the six DSOs underwent ownership transitions during this period, contributing to institutional and operational uncertainty.

The COVID-19 pandemic introduced additional volatility, with the most significant impacts occurring between the first and third quarters of 2020. From late 2021, peaking in the third quarter of 2022, Hungary experienced a sharp increase in energy prices alongside a high share of natural gas in the primary energy mix, initially sourced almost entirely from Russia via Ukraine and Austria. Concurrently, government investment subsidy programmes aimed at economic recovery stimulated large-scale industrial developments and associated network expansion projects. These developments, particularly in regions such as Debrecen, Nyíregyháza, and Göd, concentrated new industrial loads equivalent to up to 5% of national peak demand, significantly increasing pressure on grid infrastructure planning and expansion.

As a lasting aftereffect, the country faces regulatory challenges in skyrocketing network operation costs. The tariff calculation scheme of the regulator typically has a 1-2-year delay in reflecting costs and deviations from previous OPEX plans, which does not leave room for a fast correction. These findings carry important policy implications. Empirical tracking of how plans evolve over time is essential for developing realistic transmission expansion models that account for implementation uncertainty. In addition, planning approaches should become more adaptive and anticipate future policy targets, rather than relying solely on current assumptions, in order to better align infrastructure development with evolving system needs.

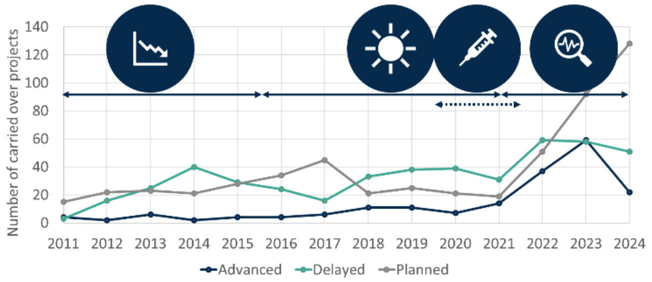

Fig. 4. Shifts of the external environment, and the number of projects carried over multiple years

4 Conclusions

Analysis of 15 years of network development plans indicates that project schedules are inherently volatile, with widespread delays and a non-negligible share of planned investments ultimately being cancelled. This suggests that expansion timelines are subject to continuous revision as technical, economic, and policy conditions evolve. From the perspective of institutional drift, this pattern reflects a mismatch between relatively stable planning rules and a rapidly changing external environment. As a result, formally defined development processes may produce outcomes that diverge over time from initial expectations, even without explicit changes in regulatory frameworks.

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