Power system planning in the energy transition era: the case of Vietnam's Power Development Plan 8

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Abstract

This review examines Vietnam's eighth Power Development Plan (PDP8), analyzing how it reveals tensions between traditional energy planning concepts and emerging realities. PDP8 aimed to balance renewable energy and natural gas priorities amidst Vietnam's rapidly changing energy landscape. The planning process struggled to incorporate uncertainties like technology cost declines and global energy crises. Although following a conventional optimization approach, PDP8 underwent repeated delays and pivots, pointing to misalignment between rational planning ideals and implementation constraints. The case study highlights the limitations of 'plan to build' methods focused on rigid engineering blueprints. Instead, Vietnam's energy transition requires strategic approaches that embrace flexibility and scenario analysis. Based on years of participative observation, two interview surveys, and extensive corpus analysis, the review traces PDP8's evolution towards more open-ended strategies. While still detailing infrastructure projects, PDP8 defines adaptive implementation mechanisms and conditional goals dependent on external finance. This shift from project lists to navigational thinking illustrates the need for energy planning to incorporate uncertainty and maintain the capacity to adjust. PDP8 represents a transitional compromise between traditional ten-year planning and emerging 'plan to drive' concepts focused on navigating change with annual updates to the Plan.

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Key policy insights

1. Power development planning agencies must expect moving goalposts as high-level policymakers periodically adopt more ambitious greenhouse gas emission goals.
2. The relevance of traditional 'plan to build' energy planning approaches, which focus on finding cost-minimizing blueprints for long-term power system expansion, is limited by policy shifts, rapid technological change, and market volatility.
3. Adaptive 'plan to drive' approaches focus on achieving long-term goals while maintaining the ability to adjust course as circumstances change. These approaches use conditional objectives and annual plan updates.
4. International partnerships could facilitate ambitious energy transitions in emerging economies but complicate it by involving a broader range of stakeholders, including foreign affairs, finance, and economic development administrations.

Keywords

Power System Planning; Energy transition; Vietnam; Case study; Adaptative strategies

JEL codes: L52, O21, Q48

1. Introduction

The urgency of the clean energy transition necessitates rethinking traditional energy policy and planning to tackle questions like: How can a country increase reliable, affordable electricity supply while decarbonizing? How do we balance renewable energy and gas-fired power? How can developed countries support a developing country in limiting greenhouse gas emissions? Vietnam, a fast-growing middle-income country, offers an insightful case study.

This study analyzes Vietnam's *National Power Development Plan for 2021-2030, with a vision to 2050* (PDP8), and its pivot in the context of new climate commitments and the signature of a Just Energy Transition Partnership during the Plan's preparation. It explores the complex shift from traditional 'plan to build' methods to a more flexible 'plan to drive' approach.

Vietnam's experience with PDP8 demonstrates the global relevance of adaptive energy transition planning. Rapid technological progress, ambitious policy goals, and volatile markets complicate traditional policy-making. Effective energy governance now requires flexibility and strategic foresight.

The case study is structured as follows: Section 2 outlines the method, Section 3 provides the context, and Section 4 describes the case chronologically. Section 5 analyzes the Plan's effectiveness, highlighting the tension between the 'plan to build' and 'plan to drive' approaches. Section 6 discusses increased uncertainty and the need for adaptive planning methods, and Section 7 presents policy implications for improving energy transition planning in developing countries. The study concludes with a summary; technical appendices provide detailed statistical and legal data.

2. Methods

This study utilized a mixed-methods approach, primarily through participative observation and corpus analysis.

Participative observation is a qualitative method in the social sciences. It allows researchers to gain a holistic overview of the studied context through engagement and observation of the setting to describe its population, social environments, processes, and relationships (Mucchielli, 1991). This method is particularly relevant for studying multi-stakeholder climate policy processes. It enables an understanding of the practical challenges, constraints, and opportunities faced by policymakers in real-world settings and the social, cultural, and political contexts that shape climate policy decisions. This is not the place to review the complex and contentious discussion about participant observation as a research method over 200 years old (Gérando, 1800); refer to Atkinson et Hammersley (1994) as a classical entry point.

My extensive field presence allowed me to engage actively in PDP8 planning discussions and related events in Vietnam. From January 2018 to August 2023, I conducted ten research visits to Hanoi, totaling 886 days. During that period, I directed the research of a think tank in Hanoi: the Vietnam Initiative for Energy Transition Social Enterprise (VIETSE) (Nguyễn et al., 2020). That position as a foreign visiting scientist allowed a relatively neutral and objective posture, and the think tank was independent of the government and the industry. I conducted two interview surveys: one about energy data and statistics(29/9/2017 - 17/11/2017, 29 interviews in Hanoi and online, Brizard et al., 2018), and the other about the Just Energy Transition Partnership (10/2/3 to 20/3/2023, 19 interviews in Hanoi, Ha-Duong, 2023a). I interacted with both local and international stakeholders involved in energy policy, notably at the Vietnam Energy Partnership Group events (VEPG Secretariat, 2019), at PDP8 consultation workshops (MOIT, 2020, 2021a), and national energy modeling conferences (EREA and DEA, 2019).

One limitation of participative observation was the external perspective it provided, without access to governmental meetings or internal exchanges. This issue was compounded when PDP8 became politically sensitive in late 2021, reducing opportunities for engagement. Corpus analysis was employed to address this.

A bibliography of over 213 references related to PDP8 preparation was compiled from public sources. The collection started mid-2019, with about half of the texts acquired between January 2021 and September 2022. Approximately 60% were governmental documents from the Government Offices, MOIT, ERAV, and EVN. The corpus also included about 20% newspaper articles and presentations and 20% analytical texts from sources like Vietnam Energy Online and LinkedIn posts by experts. This corpus was analyzed to establish the chronology of discussions and changes to PDP8 drafts.

Several methodological limitations warrant reflection:

As a researcher and practitioner, I participated in energy policy discussions, using my expertise to promote the transition towards carbon neutrality within existing policy processes. However, my presence had minimal influence on the planning method being studied.

My subjectivity likely influenced my observations and analysis of the PDP8 process. My economics training shaped my focus on efficiency and decision-support systems, whereas a political science perspective would highlight the interplay between administration and political powers. This study, however, focuses on the international climate policy aspects, particularly the interaction with the Just Energy Transition Partnership (JETP) and the National Climate Change Strategy.

My comparative perspective mainly drew from European cases, whereas Vietnamese policymakers often reference China, South Korea, Japan, Singapore, and ASEAN countries. My attention to transitioning away from fossil fuels did not match the Vietnamese government's priorities for fighting corruption and economic development. Cultural and linguistic barriers also affected my understanding of local dynamics, which I mitigated by engaging with diverse stakeholders and analysts from the VIETSE think tank.

Participant observation research has limited generalizability, a point addressed in the Discussion section by showing this case's relevance to other jurisdictions.

Qualitative research often maintains confidentiality and anonymity, which is particularly stringent in this study due to research ethics, political sensitivity, and legal prudence, as some stakeholders have faced legal issues. I take full responsibility for the research and results presented.

3. Context

Vietnam has experienced significant economic growth, transitioning from a poor economy to a lower middle-income country, aiming for high-income status by 2045. However, this growth has increased greenhouse gas emissions, stagnant energy efficiency, and a heavy reliance on coal. Despite a three-fold increase in electricity production capacity from 2011-2020, domestic coal and gas extraction have struggled to keep pace with surging demand (see Appendix 1 for national statistics and energy data).

The preparation of PDP8 occurred when anti-corruption was a primary internal policy driver. Under PDP7, only 60% of planned thermal sources were constructed by 2020, while solar and wind targets were exceeded. An ongoing inspection of compliance with PDP7 policies and laws (Lê, 2023; VSE Lawyers, 2023) created uncertainty about the legal operation of many power plants, stalling solar power planning. This environment discouraged initiative-taking among private investors and the administration. As one stakeholder told me: *"Nobody goes to jail for doing nothing, you go to jail for making errors."*

Vietnam's active participation in climate diplomacy influenced the PDP8 planning. By 2018, international financing for new coal power plants in Vietnam seemed unlikely, raising concerns that PDP8 would rely heavily on gas. At that time, Vietnam had minimal experience with solar and wind power and no offshore wind power, with costs still high compared to coal or gas.

During PDP7, feed-in tariffs for renewable projects led to an overwhelming response, causing grid management issues and regional capacity imbalances. The COVID-19 crisis resulted in 85 projects missing operational deadlines, leaving over 4.5 GW of "transitional" solar and wind projects stranded without market access (Ha, 2020; Vietnamnews, 2023).

The Ministry of Industry and Trade (MOIT), responsible for the energy sector, reports to a Deputy Prime Minister, supported by a planning follow-up committee and an appraisal council. MOIT, assisted by the Institute of Energy, began preparing PDP8 in 2018 (Nguyễn, 2018) and finalized its outline and terms of reference in October 2019 (Trịnh, 2019). (see Appendix 2 for the legal framework).

4. Case description

4.1. Initial preparation and technical consultations

In line with the Communist Party of Vietnam (CPV) 's leading role as defined in the Constitution's Article 4, the contents of PDP8 were guided by the CPV Politburo's Resolution 55-NQ/TW (2020). This resolution targets increasing the share of renewable energy in Vietnam's total primary energy supply to 15-20% by 2030 and 25-30% by 2045 and reducing energy consumption per unit of GDP by 1.0-1.5% annually from 2020 to 2030.

Following Article 14 of the 2017 Planning Law, the planning agency conducted multiple stakeholder consultations on PDP8 scenarios between July 2020 and February 2021. Experts suggested several improvements, including Incorporating system flexibility, source diversity, capital availability, and system reserve capacity in the analysis; Extending sensitivity analysis to cover a broader range of uncertainties in fossil fuel prices and future costs of wind, solar, and storage technologies; Maintaining regional supply-demand balance while considering realistic financial implications of long-distance transmission; Comprehensive calculation of external costs, including land use impacts; Ensuring coherence between power development and seaport development plans, particularly for coal, LNG trade, and offshore wind infrastructure (Ha-Duong, 2021; Nguyễn et al., 2020).

These recommendations could alter the role of gas, highlighting its suitability for peak generation over baseload due to its flexibility and quick ramp-up potential. By 2020, Western financial institutions had ceased to fund new coal projects, and with China also withdrawing support from 2021, new coal plants in Vietnam became financially unviable. Experts also noted the exclusion of critical factors in risk analysis, such as the impact of large-scale LNG imports on energy security and macroeconomic outcomes, balanced by geopolitical advantages. Lastly, the regional energy imbalance was attributed to bottom-up planning from renewable energy developers, leading to grid congestion and curtailment in optimal regions.

4.2. March 2021 initial draft and request to downsize and lower cost

MOIT submitted the initial PDP8 draft in March 2021. For 2030, the draft proposed doubling Vietnam's power generation capacity, doubling carbon dioxide emissions, and shifting from

coal to gas as the system backbone. It suggested adding 20 GW of new coal power plants, 17 GW of new gas power plants (using imported fossil fuels), and 5.4 GW of new solar PV.

The formal stakeholders' meeting in April 2021 asked to update the planning basis to account for project delays and the 2020 surge in solar and wind, to reduce the goal of having 167 GW of installed power generation capacity in 2030, and to control the cost. The total proposed investment for power development for 2021-2030 averaged 3% of Vietnam's GDP or 9.2% of total State investment. The meeting also asked to ensure alignment with Resolution 55 goals on renewable energy and LNG, to optimize the proposed LNG infrastructure, and to work further on regulation and implementation strategies (Nguyễn, 2021).

4.3. The pivot at the end of 2021

The first revised PDP8 draft, submitted in October 2021, adjusted the total capacity goal to align with Resolution 55, excluded new long-distance transmission line projects before 2030, increased electricity imports from Laos, and excluded certain coal-fired power plants due to objections from Northern provinces. It also considered the fossil fuel prices crisis.

The early version, circulated in September, sparked debate by increasing the coal-fired power capacity target by 3 GW to 40 GW by 2030, reducing wind power capacity by 6 GW, and removing offshore wind from the base scenario. The October 2021 draft planned for 50.9 GW of coal by 2045. The public debate closed as PDP8 became politically sensitive. As stated by MOIT (2021b Claude translation):

> *In a democratic and civilized society, consensus or dissenting opinions are necessary but must be constructive and based on reality. Energy is a matter of national security, so the development of power sources and the entire power system in general needs to be considered objectively, comprehensively, scientifically, and from various macro and micro factors. More importantly, it must be suitable to the actual situation, putting the interests of the nation and people first and foremost, ensuring compatibility between regions, and avoiding the waste of social resources.*

The context changed after COP26 in Glasgow. On November 1, 2021, Prime Minister Phạm Minh Chính declared that Vietnam would achieve net-zero greenhouse gas emissions by 2050. Vietnam signed the Global Coal to Clean Power Transition Statement, committing to

transition away from unabated coal power in the 2040s and cease new permits for such projects. Vietnam also joined the Global Methane Pledge to cut emissions by 30% by 2030. Over 30 countries and financial institutions committed to halting overseas fossil fuel development funding, impacting Vietnam's LNG and offshore fossil fuel strategy.

A post-COP26 draft plan reduced the 2030 power generation capacity target to 155 GW, lowered thermal power, increased renewable capacity, and reduced the need for 500 kV transmission lines. Meeting conclusions requested revisions aligned with COP26 pledges, avoiding new coal plants post-2030, increasing offshore wind, exploring electricity storage, reorienting energy-intensive industries to regions with abundant solar and wind, and preparing a 'low demand' scenario. Provinces have proposed 80 GW of wind and 50 GW of solar power, far exceeding the needs (Xuan Tung, 2021).

4.4. April 2022 draft: integrating the energy transition vision in 2045 goals

The Institute of Energy refined the Plan to align with Resolution 55 and new climate commitments, incorporating a draft Climate Change Strategy. The revisions included phasing out fossil fuels, updating energy price forecasts, and revising the solar PV projects pipeline. The fundamental changes were the cessation of new coal power sources post-2030, the co-firing of biomass, ammonia, or hydrogen in remaining fossil fuel plants by 2045, and limiting LNG developments after 2035 to reduce fossil fuel imports.

At the April 15, 2022, online meeting with localities (Nguyễn, 2022), participants endorsed a total capacity of 146 GW by 2030, noting it required less investment than the first draft. The Appraisal Council approved the draft on April 26, highlighting its remediation of earlier shortcomings and the opportunities it provided for wind power (Đức Tuân, 2022).

4.5. Finalization

The draft was updated and harmonized with other plans, such as the national land use plan, during the spring and summer of 2022. However, the finalization was delayed due to ongoing international energy policy discussions. On December 14, 2022, Vietnam and G7 countries, along with Denmark and Norway, established a Just Energy Transition Partnership (JETP), raising the standards for PDP8.

The Plan was finalized in May 2023, integrating JETP objectives and updates on PDP7 legacy projects, market developments, and technology trends (Trần, 2023a). A final stakeholders' workshop on April 21, 2023, called for a more adaptive and flexible approach to energy planning, recognizing the rapid advancements in the global energy industry. The workshop concluded (Nguyễn, 2023 para 2.3, Google translated):

> *The global energy industry is developing rapidly due to scientific and technological advances and the transition process. Power Plan VIII requires a new approach, including dynamic and open elements.*

The key flexibility mechanism in PDP8 is the National Steering Committee for Electricity Development, tasked with inter-ministerial coordination, adaptive planning, organizing bidding, choosing investors, and terminating non-performing projects (Phạm, 2021). The Committee will use a new sectoral database to track progress and ensure timely detection of project delays.

5. Findings

5.1. A late arrival compromises the effectiveness.

The Power Development Plan 8 (PDP8) was released in May 2023, two years into the 2021-2030 period, primarily due to new procedures from the revised Planning Law published in November 2017. This delay is problematic for rational decision-making, as PDP8 only became operational after its Implementation Plan was published in April 2024 (H. H. Trần, 2024).

With only 6.5 years left until 2030, some PDP8 goals are challenging. For instance, 6 GW of offshore wind power by 2030 is implausible without a legal framework for site surveying. A second pumped storage project by 2030 seems unlikely without an identified investor today.

After PDP8's promulgation, the Energy Masterplan was released in July (Trần, 2023b), the JETP Resource Mobilisation Plan in December (JETP Vietnam Secretariat, 2023), the Energy Development Strategy in March 2024 (Trần H. H., 2024), and the PDP8 Implementation Plan in April 2024. These planning documents give their marching orders to the State-owned companies, which control the lion's share of today's energy sector. However, they do not allow private-led projects to be invested in. The Ministry of Industry and Trade (MOIT) works on

regulations to attract private investment, such as tariff frameworks, rooftop solar incentives, and carbon credit mechanisms. Starting these regulations after the Plan has caused delays. A non-blocking planning process would have avoided "paralysis by analysis."

Even having a legal framework may not be enough because what counts for investors is the expected profit: at which price will they sell electricity, how much, and taking which risks. The current numbers offered by EVN are not attractive to many investors.

In line with the PDP8 aim to "*Strive to have 50% of office buildings and 50% of residential houses by 2030 using self-produced and self-dissipating rooftop solar power (for on-site consumption, not selling electricity into the national electricity system)*", the current draft of the revised Electricity law proposes that EVN can buy back excess electricity from rooftop solar systems, but at the null price of zero VND/kWh. Understandably, the system operators are wary of the "duck curve" effect, that is, the drop in daytime electricity demand caused by decentralized solar power. However, it is optimistic that the cost of PV + storage will drop fast enough to reach the 2030 goals with these commercial conditions.

Another PDP8 goal is "*By 2030, the maximum total capacity of LNG power sources will reach 22,400 MW*." Vietnam only started importing LNG in 2024; it has only one regasification port, and no long-term LNG supply contract exists. Moving from that to having three to five operational gas-to-power centers in six years is ambitious. It will require more than setting a ceiling price on electricity from LNG at 10.56 US cents/kWh (Nguyễn, 2024).

Many countries use capacity payments to support the thermal power sector in the face of increasing penetration of intermittent renewable electricity sources. China, for example, recently installed a 100-165 yuan/kW/year capacity payment for all coal plants. The idea recently re-emerged in the Vietnam power development policy debate, although its absence from the PDP8 will make it delicate to use in the short term (Ha-Duong M., 2024).

In summary, delays in PDP8 planning have delayed private investments, necessitating costly emergency measures to meet electricity demands and increasing consumer tariffs. The success of PDP8 will be judged by the stability of the electricity supply, especially in Hanoi: Will the 2023 blackouts repeat? Due to rapid demand increases and the planning delay, the years ahead remain electrically challenging for Vietnam.

5.2. A limited alignment with the JETP

The Just Energy Transition Partnership (JETP) delayed Vietnam's Power Development Plan 8 (PDP8). Did it influence its contents? JETP aims to peak electricity sector emissions at 170 MtCO2e, cap coal-fired power generation capacity at 30.2 GW, and achieve 47% renewable electricity by 2030, with international partners mobilizing $15.5 billion over 3-5 years (Ha-Duong, 2023b).

Vietnam's planned coal power generation for 2030 is 30.1 GW, reflecting a decision to abandon 7.4 GW of coal projects influenced by international financial and diplomatic pressures. This aligns PDP8 with JETP goals. Prime Minister Pham Minh Chinh initially committed to stop new coal power projects at the Glasgow December 2021 conference.

It is harder to assess alignment for the other two goals. The share of electricity from renewable sources in 2030 is not formally part of the power development plan: the Plan prescribes what to build, not how to dispatch and prioritize the various power sources in a given year. According to the PDP8, the share of renewable electricity in 2030 would be in the 30.9–39.2% range, towards the JETP goal of 47%, provided that commitments are made (M. Ha-Duong, 2024 drawing 3).

The PDP8 is prepared by MOIT, the ministry responsible for securing energy supply, while the Ministries responsible for the JETP are those in charge of the environment and foreign affairs. Contrary to Resolution 55, the JETP declaration is not legally binding, and its goals depend on hypothetical contributions from international partners. For these reasons, the PDP8 draft was not unconditionally revised towards the JETP goal for the share of renewable electricity in 2030. It does not mean incompatibility. It acknowledges that Vietnam can not raise enough capital on its domestic financial markets for that much new solar and wind power capacity.

The situation of carbon dioxide emissions is similar, as the two goals are physically linked. The PDP8 aims to *control greenhouse gas emissions from electricity production to reach about 204-254 million tons in 2030 and around 27-31 million tons in 2050. It aims to reach peak emissions of no more than 170 million tons by 2030, with the condition that international partners fully and substantively implement commitments under JETP.*

Vietnam's JETP, like those in South Africa and Indonesia, aims to diversify the energy mix with a focus on renewable sources, leveraging international financing. However, the financial terms may not always be attractive. For stakeholders in South Africa, "*the cost and type of finance in the JET-IP [Just Energy Transition Implementation Plan] needs to be reconsidered*" (PCC, 2023). In Vietnam, the deal agreed upon was "*$7.75 billion of public sector finance which should be on more attractive terms than Viet Nam could secure in the capital markets*", but $4.2 billion of the funding pledges in the Resource Mobilisation Plan came from development finance commercial loans, that is non-concessional terms (JETP Vietnam Secretariat, 2023, p. 97 table 12). According to Indonesia's Comprehensive Investment and Policy Plan 2023 drawn up for its JETP, 60% of the first US$11 billion funding tranche will be in the form of a concessional loan, with grants and technical assistance making up only 3% of the total funding package (JETP Indonesia Secretariat, 2023).

Despite international interest in JETPs, their influence on national electricity plans is proportional to their expected financial contributions to electricity sector needs: modest. Vietnam's PDP8 requires $12 billion annually until 2030, while JETP partners pledged $15.5 billion over 3-5 years. Thus, JETPs serve more as diplomatic signals of willingness to accept G7 capital rather than primary drivers of power development planning.

5.3. The PDP8 pivots towards more flexible planning.

The Power Development Plan 8 (PDP8) exemplifies the challenges of strategic energy planning in a rapidly changing environment. The Institute of Energy employed state-of-the-art analytic methods, pushing the boundaries of power development planning compared to PDP7 by incorporating external environmental costs, publishing modeling assumptions, and engaging with experts and stakeholders to enhance transparency and quality.

However, the delays and revisions during the PDP8 process highlighted a misalignment between rational planning approaches and the realities of energy policy-making. Traditional energy planning aimed to build a least-cost centralized system in a stable environment, resulting in an engineering blueprint listing new generation projects and transmission lines. Its essence was the list of all the latest generation projects over 30 MW and the new 500kV/220kV transmission lines to be built, with a schedule. The Plan was also an administrative gatekeeper

since no project outside the Plan would be allowed to be built. This "Plan to Build" method was systematic and evidence-based but is now becoming obsolete due to rapid technological advancements and cost reductions in the energy sector. As (Brown, 2021) argues:

> *Traditional power sector planning disciplines were developed when technology was relatively static and generation-led planning was the norm. That is not the right approach for the unprecedented innovation and cost reduction we are witnessing now. This calls for a fundamental shift from the traditional planning approach of assessing technology choices on an "as is" basis to a pathway development process that sees each generation of technology more holistically. [...]*

By 2021, Vietnam's energy landscape had shifted significantly compared to 2018, with 20 GW of small-scale projects emerging alongside large-scale coal power plants. Fossil fuel markets faced crises, and international commitments to net-zero emissions by 2050 and stopping new coal plants post-2030 redefined planning constraints. The rapid installation of solar and wind farms in 2021 further complicated PDP8's development, demonstrating the need for a more flexible approach.

The "Plan to Drive" metaphor represents this flexible and adaptive planning approach. Unlike the rigid "Plan to Build," it focuses on long-term goals and continuous adjustments in response to changing conditions. It emphasizes strategic foresight, ongoing decision-making, and adaptability, akin to driving towards a destination while constantly adjusting to road conditions and traffic.

PDP8's numerous revisions illustrate that planning is a complex, multi-stakeholder process. It must balance the historical "Plan to Build" perspective with the need for a "Plan to Drive" approach. While still based on a list of projects, PDP8 partially shifted towards a more flexible and dynamic planning method. This adaptive planning is crucial for effectively navigating the rapidly changing energy landscape and achieving a sustainable, secure, and prosperous future. The PDP8 case underscores the need to move beyond rigid planning and embrace a more responsive, adaptive approach to strategic energy planning.

6. Discussion

6.1. All countries are using energy transition strategies

The urgency of steering away from catastrophic climate change renews the classical economic question: "How to best allocate the means of production towards a socially desirable future?". Nobody questions the necessity of governmental actions to meet sustainable development goals.

Regarding climate action, the Paris Agreement requires all parties to periodically submit two kinds of documents: Nationally Determined Contributions (NDCs) and Long-Term Low-Emission Development Strategies (LT-LEDS) (UNFCCC/CMA, 2023). The NDCs operate on a five-year cycle and present the countries' actions to reduce emissions and increase resilience, typically at the 2030 horizon. The LT-LEDS is also about transitioning to a low-carbon climate-resilient future, but typically at the 2050 time horizon. The LTS are voluntary under the Paris Agreement; there is no specific frequency.

Most governments also use some form of national planning or at least prepare long-term strategic visions to guide public policy in the energy sector. This is a sector where incomplete markets, externalities, increasing returns to scale, and network effects abound (Helm et al., 1988). Many policymakers, economists, and environmental experts emphasize the necessity of planning the energy transition (Bardi and Sgouridis, 2017; IRENA, 2021; Schubert, 2022).

The European Union, for example, is using the REPowerEU plan, launched in May 2022, to reduce its dependence on Russian fossil fuels and accelerate the green transition. It aims to increase the share of renewable energy in the EU by 2030 to 42.5%, with the ambition to reach 45%. It may interest Vietnam planners that the REPowerEU plan is an adjustment of the previous European Plan named "Clean Energy for All European," characterized by a reduction of gas-to-power generation.

The transition to a low-carbon energy system involves large-scale changes to infrastructure, technology, and practices, and these changes need to be managed strategically to minimize disruptions and costs. Planning allows the management of many market externalities. Having a strategic plan does not mean that a State-owned enterprise will run—or keep running—the electricity sector as a monopoly.

In France, for example, the Programmation Pluriannuelle de l'Énergie (PPE), or Multiannual Energy Plan, is a strategic framework established by the French government to outline the direction of the country's energy policy over multiple years. The PPE provides the framework for the organization and frequency of auctions for both onshore and offshore wind projects. It outlines the volumes of capacity to be auctioned and the timelines. Renewable energy companies in Vietnam look forward to the day when auctions will be launched. If the country had been able to use auctions for a well-defined volume, it would have avoided the over-investment problems caused by the feed-in tariff policy in 2019-2021.

Strategic planning of the energy transition is essential for all countries. How to do it rationally?

6.2. Advanced decision analysis for the "Plan to drive" approach

The traditional "plan to build" approach to power development planning typically relies on optimal power capacity expansion models like TIMES, PLEXOS, or OSeMOSYS, for example, the Typical Integrated Resource Planning Process Flowchart in ADB (2020, p. 21). These models determine a least-cost trajectory towards a goal given constraints, with uncertain parameters replaced by their expected value. They are commonly used in a discrete choice framework, as illustrated by the PDP8 case: the Institute of Energy explored eleven scenarios and then performed a multicriteria ranking using five dimensions to select the preferred one.

Running a deterministic least-cost capacity expansion planning model a few times to compare and select the best policy option has some advantages. The process is intuitive and does not require much more resources once the model is established. However, advanced decision-making under uncertainty theory tools in energy transition planning could support the shift towards a more flexible "plan to drive" approach (Kunreuther et al., 2014). They include probability and utility theory, ensemble methods, multi-stage programming, and scenario analysis.

Utility theory, for instance, is more appropriate for decisions involving large gains or losses, as cost minimization assumes risk neutrality, which may not be justified for national electricity supply plans (Ha-Duong and Treich, 2004).

Uncertainty analysis through Monte Carlo simulations, which runs a large ensemble of simulations, can provide a more comprehensive view of risks, such as fossil fuel price volatility, which was underestimated in the initial PDP8 draft.

Multi-stage programming, or stochastic programming with recourse (Shiina and Birge, 2003), aligns well with the "plan to drive" approach by modeling adaptation directly. The approach is similar to real options analysis used to value flexibility in energy sector investment decisions. It is particularly relevant for plans with multiple time horizons, like the PDP8's 2030 and 2045 stages, allowing for course corrections as circumstances change. The NDC/LT-NETS are also two-stage planning exercises.

Scenario analysis enables the exploration of qualitative futures when uncertainty is not amenable to parametrization, such as geopolitical issues or global crises. Robust decision-making under deep uncertainty (RDMDU) helps identify strategies that perform well across a wide range of future scenarios. This approach moves beyond optimizing for a single expected future, allowing for more flexible planning in uncertain environments (Lempert et al., 2006).

The first three of those four tools require explicit probability distributions. When empirical frequencies are not available, subjective probabilities can be used. In case of divergence between experts, pooling methods can combine the individual assessments into a single coherent probability distribution, or imprecise probability theory can be used to work with the set of probability distributions.

The IPCC scenario database can support the transition to more advanced planning methodologies. This database provides a comprehensive set of long-term climate and energy systems scenarios that capture various socio-economic pathways, technological developments, and policy interventions (Intergovernmental Panel On Climate Change, 2023). It can support a 'plan to drive' approach by allowing planners to see various possible futures, facilitating more adaptive and flexible planning strategies.

While these advanced methods offer powerful tools for managing uncertainty in energy transition planning, many current practices still rely on simpler approaches. The PDP8 manages risks and uncertainties through a 15% over-provisioning of generation capacity. This falls short of helping the national planners fully manage the risks of the transition to net zero.

More sophisticated methods for evaluating and preparing for risks and uncertainties are available. Analysts working in power development and energy transition planning could look laterally into climate change adaptation and electric system reliability, where these methods are more commonly used.

7. Policy Implications for Energy Transition Planning

Vietnam's experience with PDP8 offers valuable insights for energy transition planning across diverse jurisdictions. This section explores how to reconfigure stakeholder relations to enhance energy planning processes' timeliness, effectiveness, and methodological rigor.

7.1. Enhancing Coordination and Inclusive Engagement

Energy transition planning requires coordination between the ministries responsible for ensuring affordable energy for all, protecting the environment and climate, and managing international relations. To address this, countries establish an interministerial task force under high-level authority to balance diverse priorities. Developing clear communication channels between central and local governments is also crucial.

Comparing the Vietnam case with other countries shows that there is more than one way to promote inclusive engagement. Vietnam follows an Asian tradition where dialogue is primarily internal, and think tanks can only be embedded in established institutions like national academies, universities, or state-owned enterprises. In contrast, South Africa has a Presidential Climate Commission, a multi-stakeholder forum that brings together government agencies, industry representatives, labor unions, and civil society organizations. France has two instances. The High Climate Council, replacing the Energy Transition Experts Committee in 2018, independently evaluates the nation's climate policy. The National Energy Transition Council, comprising all parts of the social body, is the dialogue forum. It has been in charge of discussing France's ecological planning since 2023.

7.2. Integrating International Partnerships and Commitments

The interaction between PDP8 and the Just Energy Transition Partnership (JETP) underscores the importance of aligning domestic planning with international commitments. Countries should create mechanisms for early integration of global climate commitments into national

planning processes. The PDP8's approach of setting conditional goals for renewable energy share in 2030, contingent on JETP implementation, illustrates a practice relevant to many other developing countries.

Having both conditional and unconditional components in Nationally Determined Contributions (NDCs) is a common practice: at least 78% of the 156 Intended NDCs submitted for the COP21 in Paris included conditions (Day et al., 2016; Pauw et al., 2020). Rationally, all countries with conditional NDCs should have conditional goals in power development plans. Flexible planning frameworks that can accommodate conditional targets based on international support are thus essential.

7.3. Enhancing Analytical Capabilities and Transparency

Vietnam's PDP8 case illustrates the limitations of traditional planning methods in a rapidly changing landscape. Developing countries have little capacity for advanced modeling techniques such as stochastic programming and robust decision-making under the abovementioned uncertainty. Enhancing analytical capacity can help countries manage risks. For example, Pakistan should have better included fossil fuel price volatility in its power development plan because its economy suffered from LNG cargo redirection during the energy crisis due to a risky low-penalty clause in its long-term provision contract (Stapczynski and Mangi, 2023).

Given the diversity of methods available, having diverse teams run their models and simulations to examine different pieces of the problem can only enrich the planning debate. In France, the National Debate on the Energy Transition French (Arditi and Durdilly, 2013) relied on scenarios from eleven sources, including government agencies, academic research labs, energy production and transmission companies, and environmental and professional organizations.

In Vietnam, most of the planning is concentrated in one agency: the Institute of Energy. This setup challenges ensuring the agency's objectives align with national priorities. There is little transparency about potential conflicts of interest inside the plan drafting agency, particularly the separation of the consulting work for project developers from the planning work for the public sector.

It is impossible to centrally orchestrate national planning because multiple related plans must be prepared simultaneously. The PDP8 was published after the socio-economic development plan but before the land use, marine spatial, and energy plans. Enhancing national analytical capability and transparency is necessary to solve this concurrency problem.

Vietnam is taking two steps to improve these as a developing country that could inspire other countries. It regularly publishes energy technology catalogues for Vietnam's power system modelling, supported by Danish cooperation (EREA and DEA, 2023). It is also establishing a national energy data center, which will, when operational, alleviate some energy data restrictions hindering activity in the sector.

7.4. Adopting Adaptive Planning Approaches

The PDP8 experience, with its multiple revisions and pivots, highlights the need for more flexible planning approaches. The outdated practice of crafting a ten-year plan with a single mid-course adjustment no longer suffices. According to the LT-LEDS synthesis report (UNFCCC/CMA, 2023, p. 41):

> *Given that many significant changes can occur over a long-term period, including factors beyond the control of one country, Parties highlighted the iterative nature of LT-LEDS, often referred to as living documents.*

The Philippines Energy Plan (PEP) shows how to implement rolling long-term planning processes with frequent updates: The PEP 2023-2050 updates the PEP 2020-2040, the successor to the PRP 2018-2040.

7.5. Aligning Planning with Market Mechanisms

As seen in Vietnam's transition towards market-based approaches, developing smooth interfaces between centralized planning and market mechanisms is crucial. For instance, the PDP8 approach to defining large priority projects and using auctions for smaller renewable energy capacity provides a model for balancing central planning with market-driven development.

Incorporating market feedback loops into planning processes can ensure that plans remain economically viable. This is particularly important in contexts like Vietnam, where attracting

private investment is crucial for achieving ambitious capacity expansion goals, the economy is in transition, and planning is usually designed to regulate the State-owned enterprise, which is responsible for the whole sector. Planning does not block economic activity in France and many other countries with a market economy.

Countries can develop more robust, adaptive, and effective energy transition plans by reconfiguring stakeholder relations along these lines. While the specific implementation will vary based on local contexts, these principles can guide improvements in planning processes across diverse jurisdictions, helping to navigate the complex challenges of the global energy transition. The PDP8 experience demonstrates that while traditional 'plan to build' approaches may falter in rapidly changing environments, a more flexible 'plan to drive' approach, supported by enhanced stakeholder coordination and advanced analytical methods, can provide a pathway to successful energy transition planning.

Two specific guidelines regarding planning can help coordinate the energy transition across all sectors. First, rules can be given for the discount rate parameter. Economic theory reminds us that the discount rate does not have to be uniform for long-term evaluation; it can decrease. Second, providing a notional value of future carbon dioxide emissions to evaluate public choices helps coordinate the markets. Even without integrating a carbon trading system into the energy policy, this can be a guideline.

8. Conclusion

The preparation of Vietnam's *Power Development Plan for 2021-2030, with a vision to 2050* (PDP8), illustrates the limitations of traditional "plan to build" approaches when confronted with uncertainties. The case demonstrates that rigid planning falters when critical parameters like technology costs, fossil fuel prices, and even policy objectives are highly dynamic. Delays and repeated pivots in PDP8 preparation point to a misalignment between rationalist planning ideals and on-the-ground implementation realities. As PDP8 underwent successive revisions, Vietnam confronted the imperative to transition infrastructure and planning mindsets. It accepted the emerging necessity of 'plan to drive' approaches focused on strategic navigation.

Fundamental limitations of the traditional planning approach include over-reliance on fixed blueprints, lack of participatory processes, failure to adapt to changing conditions, and inability

to manage risk and uncertainty properly. However, advanced decision analysis methods like uncertainty analysis, multi-stage programming, and scenario analysis are available to support planning processes seeking to improve flexibility and strategic agility.

The case study suggested several ideas to improve energy transition planning:

1. Enhance flexibility in planning approaches to accommodate rapidly changing technological, economic, and policy landscapes. A planning process that blocks all activities in the sector is problematic, especially when it takes longer than expected.
2. To develop more robust mechanisms for stakeholder engagement, inter-agency coordination with high-level inter-ministerial supervision and central-local communication channels are necessary but insufficient.
3. To improve analytical capabilities and transparency in the planning process, particularly in developing countries: Although national analytical capabilities and transparency may not be as high as in OECD countries, publishing technology catalogs and establishing a national energy statistics administration can help improve them.
4. To integrate international commitments and partnerships more effectively into national planning processes. Conditional goals in JETP and NDC require some form of conditional goals in the power development plan.

As countries worldwide grapple with the complexities of defining long-term, low-emission development strategies, these lessons from Vietnam's PDP8 experience offer valuable insights for creating more adaptive, resilient, and effective planning processes.

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Appendices

Appendix 1: Vietnam key statistics and power generation data

Table 1: Vietnam's key statistics in 2015 and 2021.

Year	2015	2021
Population	92,2 million pers.	98,5 million pers.
Human Development Index	0,688	0,726
GDP per capita (PPP)	7 596 USD	11 676 USD
Index of income inequality (GINI)	0,42	0,37
carbon dioxide emissions per capita	1 960 kgCO_2/person	2 843 kgCO_2/person
Commercial electricity production	158 TWh	245 TWh

Source: Statistical Yearbook of Vietnam 2022 (GSO, 2023).

Table 2: Vietnam power generation mix: 2011, 2020, the 2030 plan and 2050 vision

Capacity (GW)	Past 2011	Recent 2020	Plan for 2030	Vision to 2050
Coal, domestic and imported	3,4	21,6	30,1 [a]	0
Coal plants repowered to use H2/NH3	-	-	-	25,6 – 32,4
Oil and Diesel	1,3	1,4	0	0
Gas domestic, including some using LNG	7,4	7,4	14,9	7,9
Gas domestic repowered to use H2	-	-	-	7,0
LNG new plants	-	-	22,4	0
LNG new plants cofiring or full H2	-	-	-	25,4 [h]
Flexible sources using LNG/H2	-	-	0,3	30,9 – 46,2
Hydroelectricity, including small	10,0	20,8	29,3 [b]	36,0
Wind on/near-shore	-	0,5	21,9	77,0 – 60,0
Wind offshore	-	-	6,0	91,5 - 70
Solar, including rooftop	-	16,6	20,6 [c, d]	189,3 – 168,6
Biomass + other renewable	0,05	0,4	2,3	6,0
Interconnectors	-	0,5	5,0 [e]	11,0
Storage, hydro + battery	-	-	2,7 [f]	30,6 – 45,6
Cogeneration	-	-	2,7 [g]	4,5
Total capacity (GW)	**22,0**	**69,3**	**158**	**573 – 490**
Maximum load (Pmax GW)		38,6	90,5	185 – 209
Commercial electricity	97 TWh	238 TWh	505 TWh	1 114 – 1 255 TWh
Offshore wind to H2/NH3			15 GW by 2035	240 GW
GHG emissions			204 – 254 Mt[j]	27 - 31 Mt

Source: Col. 2011 from EVN Annual Report 2010/2011 p. 12. Col. 2020 from EVN Annual Report 2021. Col 2022 from VEPG 2023/06 meeting. Col. 2030 and 2050 from PDP8 Decision 500.

Notes:

[a] "*coal sources having difficulties in deploying will be replaced by LNG or renewable sources.*"

[b] "*can be developed further if technical-economic conditions allow.*"

[c] Includes rooftop projects under legal review.

[d] Solar auto-production is prioritized for unlimited development.

[e] "*can be up to 8,0 GW*",

[f] includes 2,4 W of hydro storage and 0,3 GW of battery,

[g] can increase according to industry needs,

[h] includes 16,4 GW to 20,9 GW on 100% H2, the other co-firing H2 with LNG.

[j] "*Aim to reach peak emissions of no more than 170 million tons by 2030 with condition that commitments under JETP are fully and substantively implemented by international partners.*"

Appendix 2: Legal texts governing the PDP8

Five-year plans are government tools characteristic of socialist economies, aiming to rationalize high-stakes public decision-making. Rather than relying on markets groping to allocate resources, the State decides what should be produced and how based on scientific and engineering analysis. Soviet Union's first quinquennial Plan was for the 1928–1932 period. Today, many countries still have a comprehensive planning framework, even if they are transitioning to a market-oriented economy. In Vietnam, the 2017 Planning Law states:

> *The national comprehensive planning serves as a basis for formulating national marine spatial planning, national land use planning, national sector planning, regional planning, provincial planning, special administrative-economic unit planning, urban planning, and rural planning nationwide* (Nguyễn, 2017, art. 6.1).

This law organizes planning along two dimensions. One is the socio-economic dimension. Its top document is the national comprehensive planning, under which the various sub-ministerial units prepare thirty-nine sectoral plans. The other is the geographic dimension. It has two top documents: the national land use plan and the national marine Plan. They govern a regional, provincial, and finer administrative unit planning hierarchy. The 2017 Planning Law removed the sectoral–regional cross-planning from the architecture. Consequentially, there is no legal framework to publish provincial-level wind development zones. Local plans for developing the electricity supply network are integrated into the provincial Plan.

The planning under the national planning system covers ten years. The orientations of the national planning cover 30 - 50 years. The orientations of the regional planning and provincial planning cover 20 - 30 years. However, plans are reviewed after five years so that adjustments can be made. Considering that the power demand has been growing at over ten percent per year in the context of rapid technological change and energy market volatility, adjusting the power sector planning after five years is equivalent to conducting a new planning exercise.

The Power Development Plan (PDP) is one of thirty-nine sectoral plans under the three overarching national plans, which address comprehensive planning, land use planning, and marine spatial planning. The PDP sits at the same level as the Comprehensive Energy Plan, the Oil and Gas Storage and Supply Infrastructure Plan, or the Plan for Exploration, extraction,

processing, and Use of Minerals. Preparation for all of these plans started in 2018, after the 2017 planning law (Nguyễn, 2018 Decision 995).

In Vietnam, the Plan is not just indicative; it carries billions of dollars per year implications for the public and the private sector. In the electricity sector, as in others, a project must start by getting approved into the Plan before undertaking its pre-feasibility study. The Electricity Law (Nguyễn, 2012, art. 8a) states that the national electricity development plan includes the following key contents:

> *a) The overview of the socio-economic development situation and the national energy system in the planning periods;*
>
> *b) The forecast of electricity demand;*
>
> *c) Assessment of sources of primary energy, the ability of exploitation, the ability of energy import and export; Assessment of the ability of electricity exchange among regions and areas; forecast of fuel prices for electricity production;*
>
> *d) The programs on the development of national electricity include detailed programs for the development of electricity sources, development of the Power grid, the connection of the Power grid with countries in the region, development of rural electricity, development of sources of new energies, renewable energies, and other relevant contents;*
>
> *đ) Synthesis of construction volume and the investment capital for programs on national electricity development, the economic-financial analysis of the programs on national electricity development;*
>
> *e) Environmental protection and natural disaster fighting and prevention;*
>
> *g) Anticipation of land fund for electricity works;*
>
> *h) The mechanisms, policies, and solutions ensure the implementation of the programs for national electricity development during the planning periods.*

Appendix 3: The Power Development Plan conceptual model

The PDP planning process follows a systematic sequence of demand forecasting, project proposal collection, scenario analysis using optimization models, and defining the approved projects list and investment needs, as follows:

a Economists forecast how much electricity will be needed. PDP8 Article 1 assumes a 7%/year GDP growth and infers that Vietnam needs about 505 billion kWh in 2030 with 90,5 MW of peak generation capacity. Forecasts are detailed; for example, planners know that demand in the northern region will grow faster than in the central or southern parts of the country.

b Public and private investors propose electricity production projects for inclusion in the Master Plan; investors do not propose electricity transmission projects.

c The State chooses projects as needed according to its priorities. The projects' selection is justified scientifically, using a suite of models (BALMOREL, PLEXOS, PDPAT) to compute various scenarios and assess them on multiple criteria: national energy security, financial costs, and other environmental/social goals.

d The Plan lists the infrastructure projects to build: power sources of 30 MW or more and electricity transmission lines of 220 kV or more (Trần, 2023a, app. II).

e The Plan reveals the financial need. Over 2021-2030, the investment needed to develop the power generation sources and the transmission grid is 13.5 billion USD per year, of which 1.5 billion per year for the grid (Trần, 2023a, para. III.6).

f The Plan provides solutions and resources for implementation, particularly for mobilizing capital, and assigns responsibilities to the various branches of the administration and state-owned enterprises.

The Institute of Energy, drafting the PDP8, conducted a very comprehensive technical and economic study (Viện Năng Lượng [Institute of Energy], 2020). It used three state-of-the-art national-scale models to explore the system at different technological, spatial, and temporal resolutions. It explored a set of 11 scenarios. It then performed a multicriteria ranking of these scenarios using five dimensions: Fit with current policy goals, System cost, carbon dioxide emissions, New grid needs, and Diversification. The selected scenario KB1B is defined as:

The social objective includes external costs, constraints include Renewable Energy targets based on REDS and Resolution 55-NQ/TW are 38% in 2020, 32% in 2030, 40,3% in 2045, and 43% in 2050.

Further sensitivity analysis of this scenario examined how it performs when under marginally perturbed conditions: a high/low load forecast, a dry year, different primary fuel prices, different costs of offshore wind technology, and different CO_2 prices. To mitigate these risks, 15% over-provision generation capacity was added to PDP8, which was also justified by the fact that the capacity planned for in PDP7 was only partially built.

The *a to f* six-step planning method is a waterfall process, moving linearly from data collection to an optimal solution. In reality, the process is an iterative search. Policymakers guide the search for a satisfying plan, providing comments on successive drafts to ensure quality, clarify policy goals, and respond to concurrent changes on the national and international scenes.