Impact of Public Policies and International Trends on Residential Electricity Tariffs in the Chilean Power Market

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***Abstract*— This paper introduces a novel framework to quantify the impact of selected public policies and international trends on residential electricity tariffs. The approach links each measure to functional relationships that affect the main tariff components (GX, TX, DX, SC, TAX) and combines historical information with forward-looking scenarios to assess their individual and combined effects. Results show that while renewable cost reductions and competitive auctions lower generation prices, transmission expansion, system-flexibility needs, and legacy contracts introduce upward tariff pressures. The study concludes that Chile's energy transition produces mixed but traceable impacts on final electricity prices, offering a transparent tool to support regulatory evaluation in evolving power systems.**

Keywords—Residential electricity tariffs; energy transition; public policy impact; Chilean power market.

I. Introduction

The global energy transition is reshaping electricity systems around the world, driven by the need to meet climate-change commitments while preserving affordability and reliability for end users. The Paris Agreement has created a cooperative platform that seeks to coordinate countries' efforts to meet the required mitigation and adaptation challenges [1]. In this context, Chile is a particularly illustrative case: it combines world-class solar, hydropower, and wind resources with an ambitious decarbonization agenda and a long tradition of market-oriented regulation [2]. Moreover, Chile has near no domestic fossil-fuel resources, relying entirely on imports and therefore remaining exposed to international price fluctuations. Against this backdrop, Chile has implemented, for more than 20 years, a set of public policies aligned with its energy-transition goals, which have remained largely stable regardless of the political orientation of the administration in power. The ambition of these policies has been to achieve a clean energy mix and deliver low electricity prices to support national development [3][4]. However, the expected decline in electricity prices has not yet materialized, raising questions about the effectiveness of these policies. In practice, the formation of electricity tariffs for final customers is a complex process that, depending on the market structure, combines multiple components and interactions. Global evidence further shows that tariff levels reflect heterogeneous structural factors, such as geography, resource endowment, fuel dependence, and cost-recovery practices, making it difficult to isolate the determinants that shape their evolution [5]. Additionally, international evidence about carbon pricing shows heterogeneous price effects depending on the energy mix: a 40 €/tCO_2 tax in Europe could cut emissions by 40% with moderate increases in coal-dependent countries [6], Australian regions experienced rises between 22–68% depending on their generation base, and U.S. simulations suggest a ~19% increase in residential tariffs under a carbon tax [7]. As a result, it becomes challenging to systematically identify the main drivers that explain the potential evolution of the final price.

This paper addresses the identified gap by proposing an analytical framework that links each policy or trend to explicit functional or methodological relationships that act upon specific tariff components. Using historical data from the Chilean regulator and the Independent System Operator, supplemented with prospective scenarios, we quantify the isolated and combined impacts of the eight selected factors on residential tariffs in the context of Chile's energy transition.

II. Proposed Methodology

As previously discussed, this study aims to understand the effect of selected public policies, regulatory adjustments, and global trends on residential electricity tariffs. To this end, it analyzes the impact on the different tariff components paid by customers, as shown in Fig. 1 for year 2025. The distribution (DX) and transmission (TX) components represent payments for the use of the respective network infrastructure segments, including investment, O&M, and administrative services. The system cost (SC) component reflects payments for ancillary services, system support charges, redispatch and curtailment costs, and the financing of the market and system operator (ISO), among other expenses. The generation component (GX) corresponds to payments associated with long-term electricity supply contracts resulting from competitive auction mechanisms. Finally, the TAX component captures the predefined fiscal obligations established by law, see (1).

$$Bill = Fixed\ Charge + kWh*(Public\ Service + Transmission + Energy + Power + Distribution) + TAX \quad (1)$$

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The main hypothesis is that countries such as Chile, pursuing an energy transition based on investment in renewable energies, the decarbonization of the electricity mix, and the modernization of their grids, can lower future electricity prices—particularly the GX component—without compromising one of the core objectives of electricity supply: providing the service at the lowest possible cost (Fig. 1).

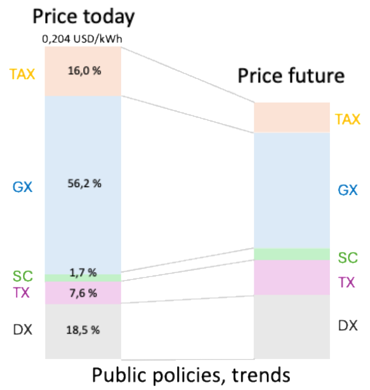

Fig. 1. Electricity tariff components and the ambition.

The proposed methodology is organized into four main stages, as illustrated in Fig. 2. In the first stage, an information system is developed to gather all elements required for the tariff analysis. This includes identifying the different components of the electricity tariff and their specific characteristics, selecting relevant sectoral or environmental public policies, and compiling public available historical and statistical information, both national and international, on associated variables and parameters.

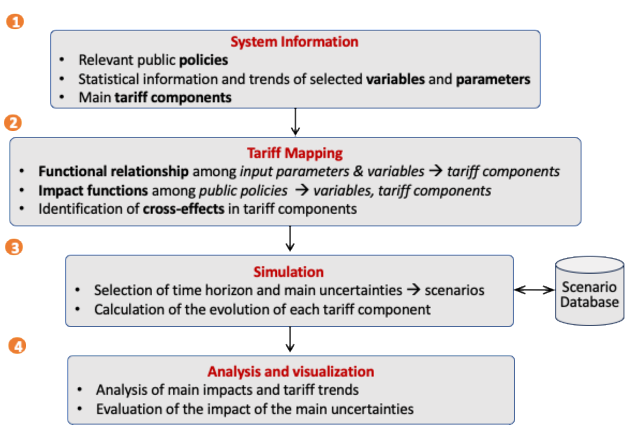

Fig. 2. Proposed mothodology.

In the second stage, a tariff mapping is developed to establish functional relationships between the input parameters/variables and each of the identified tariff components (DX, TX, SC, GX, TAX) (see Fig. 3).

The parameters include international trends such as the USD exchange rate and global fuel prices, while the variables refer to elements such as electricity supply contracts and equipment costs at the transmission and distribution levels, among others. During this phase, impact functions are formulated to capture the direct and indirect effects of the public policies under study on both the tariff components and the relevant intermediate variables. In addition, potential cross-effects among the analyzed elements are identified.

Moreover, the proposed framework relies on a limited set of clearly defined driving parameters rather than on a detailed cost-optimization model. These drivers are context-specific and depend on local market design, regulatory arrangements, and the generation mix. For instance, the estimation and projection of infrastructure investments and flexibility service costs can be based on publicly available planning processes, expansion trajectories, and regulatory information. This structure allows the methodology to be adapted and replicated across different electricity systems while preserving transparency and analytical tractability.

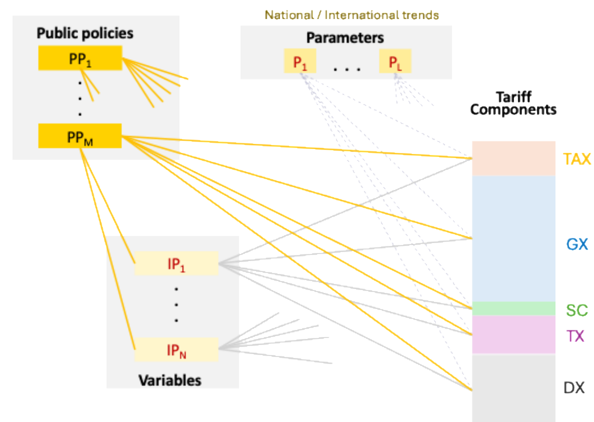

Fig. 3. Overall relationships and impact functions.

Building on this, the third stage involves defining the simulation scenarios by establishing an appropriate time horizon and identifying the key sources of uncertainty. Based on these inputs, the expected evolution of each tariff component is simulated as a nationwide average, incorporating the effects associated with the elements under analysis (Fig. 3).

Finally, in the fourth stage, an integrated assessment of impacts and trends on residential electricity tariffs is conducted. This includes evaluating the influence of the identified uncertainties, enabling a deeper understanding of the system's sensitivity to regulatory, technological, or market changes.

III. Application to the Chilean Context

In the following section, the proposed methodology is applied to the Chilean context. At each step, the main findings are presented with the aim of serving as a reference for applications to other power systems.

A. System Information

After reviewing the main public policies and international trends implemented in Chile over the past 20 years, the following eight actions are selected:

1) Renewable Energy Quota Scheme

Chile's renewable energy quota scheme has been central to its energy transition. Law 20.257 (2008) established mandatory NCRE (Non Conventional RE) quotas, starting at 5% and rising to 10% by 2024; later strengthened by Law 20.698 (2013), which increased the target to 20% by 2025. These obligations, aligned with international Renewable Portfolio Standard (RPS)

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979-8-3315-8138-1

models, mobilized investment, reduced technology costs, and expanded renewable deployment. Evidence from the U.S. and China shows that quota-based schemes effectively increase renewable penetration but have mixed impacts on retail tariffs, depending on market structure, resource availability, and compliance mechanisms [8][9][10]. This suggests that while Chile's quota system successfully accelerated renewable integration, its influence on end-user electricity prices, particularly the GX component, is indirect and context-dependent (see Fig. 4).

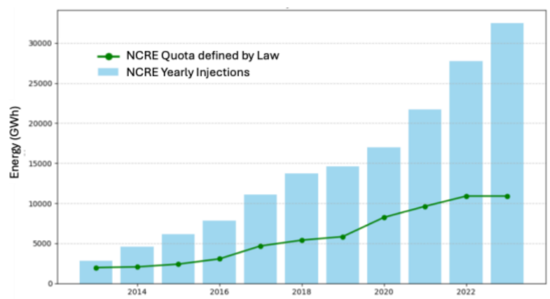

Fig. 4. Evolution of NCRE energy quota scheme.

2) Block Based Auction Scheme

Law 20.805 (2015) restructured Chile's long-term supply auction mechanism, replacing the former nodal price approach, strained after the 2004 natural gas crisis, with fixed supply–demand contracts and an ex-post price adjustment mechanism. The reform also introduced three daily bidding blocks, aligning offers with demand patterns and renewable generation profiles, which enabled NCRE projects to compete more effectively and drove a marked reduction in awarded prices (see Fig. 5 and 6).

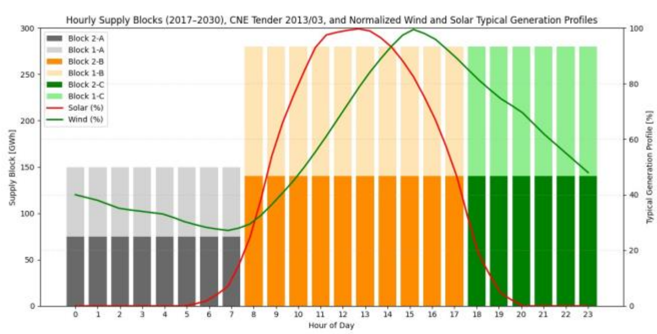

Fig. 5. Block-based auction scheme (based on www.systep.cl).

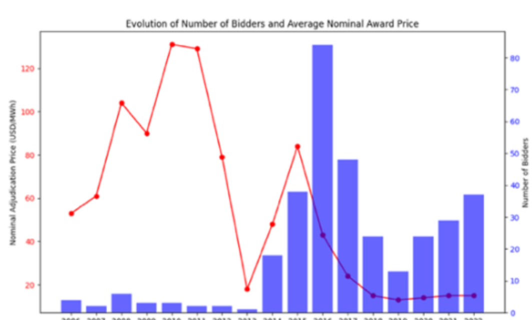

Fig. 6. Evolution energy and prices in supply auctions, 2006 - 2022.

3) Carbon Tax

Chile introduced a carbon tax through Law 20.780 (2014), implemented in 2017, applying a rate of 5 USD/tCO_2e and aligned with the country's commitments under the Paris Agreement [1][11]. While the tax was intended to internalize environmental costs and encourage cleaner generation, the current market design prevents its direct pass-through to regulated customers. Because spot prices and long-term supply contracts exclude these externalities, generators ultimately absorb most of the burden.

4) Point-Purchase Transmission Pricing

Law 20.936 (2017) restructured Chile's transmission pricing system by replacing the point-injection/point-purchase access scheme with a 100% point-purchase model that allocates transmission costs entirely to consumers following a postage-stamp usage principle. A transition period between the two schemes was established for 2019–2034. While the reform aimed to facilitate the rapid integration of renewable generation in resource-rich areas and to strengthen the robustness and flexibility of the grid, it has also increased the transmission component of regulated tariffs (reaching 7.6% in 2025).

5) Voluntary retirement coal-fired power plants

Chile's 2050 carbon-neutrality commitment prompted the adoption of the voluntary 2021 Plan for the Retirement and Conversion of Coal-Fired Units before 2040, which covers 28 plants totaling 5,529 MW—approximately 15% of the country's installed capacity (2025) [12].

6) New Market Design for Ancillary Services

Ancillary services ensure the balance between generation and demand, maintaining system security and efficient operation. Recent regulations introduced competitive auctions for procuring these services, replacing the ISO's previous direct dispatch and instruction mechanisms [13]. This market design enhances transparency and efficiency but also increases the system's flexibility requirements as renewable penetration grows.

The main international trends selected for the analysis are:

7) LCOE Reduction of Renewable Energy

Global efforts to mitigate climate change have accelerated the shift from fossil-based to renewable power generation, driving sharp cost reductions in solar and wind technologies as the electricity sector remains a major source of GHG emissions [2]. Between 2000 and 2024, global renewable capacity increased from 753 GW to 4,443 GW, while the LCOE of solar PV and onshore wind fell by approximately 90% and 70%, respectively, over 2010–2024, mainly due to mass production, efficiency improvements, and supportive policy frameworks [14] (Fig. 7). Chile—endowed with world-class solar and wind resources—has mirrored this global trend, expanding utility-scale solar and wind capacity from near zero in 2010 to approximately 11 GW and 5.5 GW, respectively, by 2025.

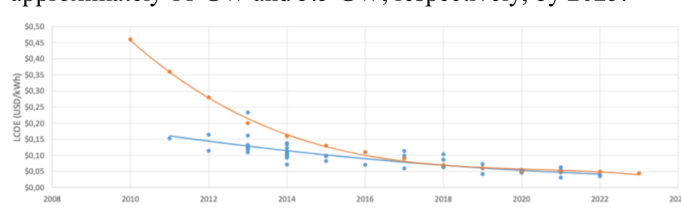

Fig. 7. Evolution of PV LCOE, IRENA database and Chilean projects.

979-8-3315-8138-1

8) USD currency exchange rate

The USD–Chilean peso exchange rate, which exhibits significant volatility, plays a key role in several indexation mechanisms within the tariff formation process for final customers.

It should be noted that the present analysis excludes subsidies, the tariff freeze implemented during the pandemic period, and other indexation mechanisms, such as the CPI.

B. Tariff Mapping

Table 1 summarizes the proposed tariff-mapping approach depicted in Fig. 3.

TABLE 1. RELATIVE IMPACT LEVEL BY TARIFF COMPONENT.

T. component	LCOE trends in RE	RE quota scheme	Block based auction scheme	Carbon tax	Transmission pricing scheme	Coal plant retirement plan	Ancillary Services pricing	Dollar
DX	Indirect - Evolution of distributed generation and DX savings/ reinforcements.	Limited impact	Indirect - Potential development of more distributed generation	Limited impact	Limited impact	Limited impact	Limited impact	Direct - All tariff components depend on this international parameter, either as an indexer in contracts (GX) or as the reference currency for investments (DX, TX & SC).
TX	Indirect - Need of more transmission infraestructure	Limited impact	Indirect - Higher requirements in specific time blocks	Indirect - Need of more transmission for RE integration	Direct - Complete cost allocation to consumers + elimination of locational incentives.	Indirect - Need of more transmission for new RE-project integration	Indirect - Need of more transmission equipments (i.e. storage) for ancillary services	
SC	Indirect - New requirements of ancillary services due to variable resources	Limited impact	Indirect - Additional services to maintain system security	Limited impact	Direct - Removal of locational signals may exacerbate congestions	Indirect - Need for supply security and system flexibility rises	Direct - Resulting costs pass-through to customers from 2027 + partially mitigated by RE integration	
GX	Direct - Lowering bids in auctions	Direct - Minor impact due to consistently surpassed quota	Direct - Improve competitiveness of RE resources	Direct - Reduced competitiveness of non-renewable power plants in Auctions	Direct - Incentivizes generators to bid lower in auctions	Direct - Need of more RE-project integration	Indirect - Improve competitiveness of RE resources	

For example, the indexed auction clearing prices are directly linked to the GX component of regulated tariffs by adding the contribution of energy and price blocks for each period. Thus, with a forecast of auction price evolution and the corresponding energy requirements, an estimation of the GX component becomes feasible. In fact, the coal-fired power plant retirement scenario indicates the need for new energy auctions to supply residential customers.

This study also assesses the short-term tariff impacts of LCOE trends, the renewable quota, and the coal phase-out. While these policies advance decarbonization, they simultaneously increase investment needs and system-flexibility requirements as coal capacity is replaced by renewable generation and supporting resources. From 2027 onward, ancillary service costs will be passed through to regulated customers via the SC of the tariff, while infrastructure-related costs will be reflected in the TX component. Fig. 8 summarizes this cost allocation.

Within this framework, infrastructure investment costs (transmission and distribution) are not endogenously optimized, but are estimated based on regulated expansion plans, observed investment trajectories, and the prevailing cost-allocation rules defined by Chilean regulation. Similarly, flexibility and ancillary service costs are represented through their observed relationship with the increasing penetration of variable renewable energy, the reduced dispatch of conventional units, and the current market and regulatory design for ancillary services. These driving parameters are treated as exogenous and explicitly defined, in order to transparently capture how policy decisions and structural trends propagate into final tariff components.

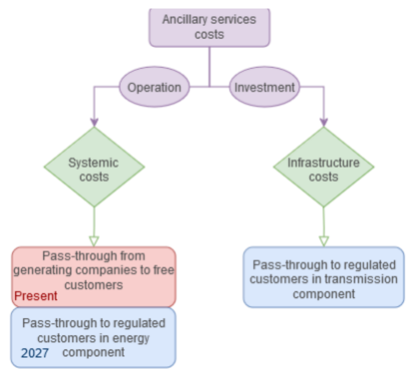

Fig. 8. Impact functions linked to ancillary services.

Moreover, the extent to which declining renewable LCOE trends translate into lower residential tariffs is constrained by grid, storage, and contractual limitations.

C. Simulation

Based on the preceding mapping procedure, simulations are conducted for each tariff component. Fig. 9 presents the expected evolution of ancillary service costs associated with the SC component.

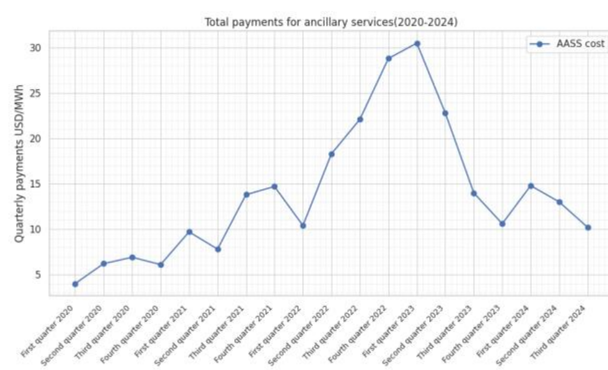

Fig. 9. Evolution in payments for ancillary services.

Fig. 10 describes the evolution of the existing electricity supply contracts until 2030, while Fig. 11 summarizes the respective contribution to the final GX component.

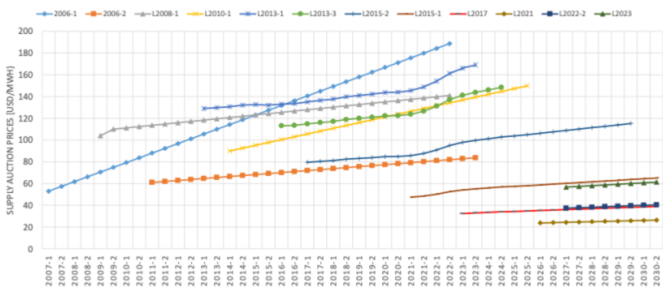

Fig. 10. Evolution of electricity supply contracts and durations.

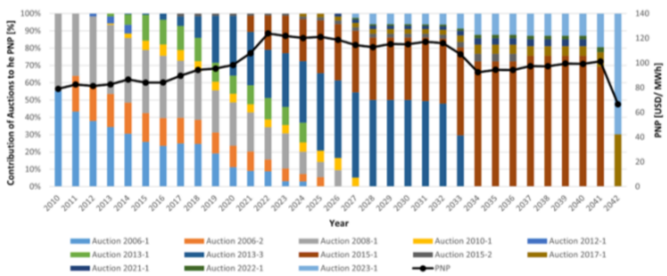

Fig. 11. Evolution GX component and contribution of each supply contract.

Finally, the simulation shows a sustained increase in transmission payments for regulated customers, with a particularly notable rise beginning in 2024 (see Fig. 12). This trend is driven by two main factors: the gradual implementation of the new transmission pricing scheme and the substantial investments required to adapt the transmission system to the challenges of Chile's energy transition.

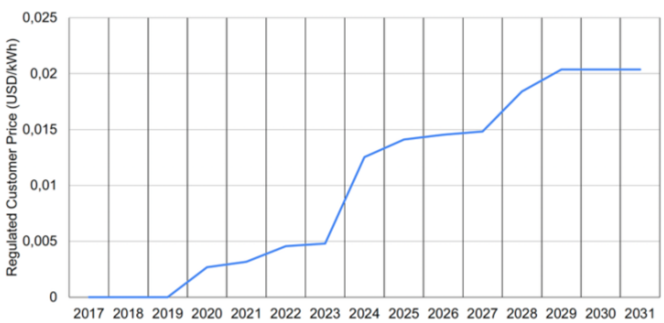

Fig. 12. Trajectory of TX component.

D. Analysis and Visualization

The resulting analysis allows the integration of all estimates into the expected residential tariff and its components for the selected years (see Fig. 13).

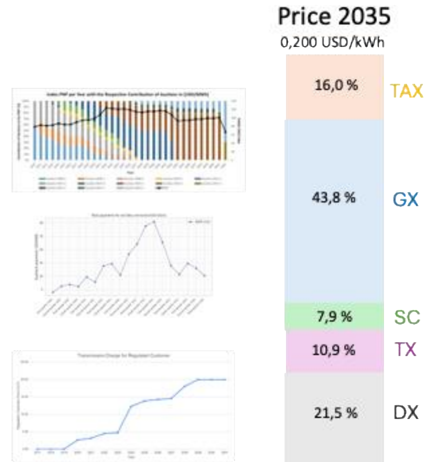

Fig. 13. Synthesis and estimation.

An important change in the percentage allocation among tariff components is identified for the year 2035. Nevertheless, based on the available information and assumptions, only a marginal change in the final electricity price is expected. One possible explanation is the influence of the currently higher prices of electricity supply contracts, which remain in force until 2041, together with a significant increase in expected system costs.

IV. Conclusions

The contribution of the work is summarized in: (1) articulating a coherent framework that links public policies and global trends to final tariff components; (2) deriving and applying simple but robust functional representations for each factor; and (3) identifying which measures tend to reduce or increase residential tariffs, under what conditions, and over what time horizons. Although the analysis is based on the Chilean electricity market, the conclusions can be of interest for other countries that face similar challenges in reconciling decarbonization, integration of local renewable energy, security of supply, and affordability for end users.

Based on the obtained results, the proposed framework can support regulatory evaluation and policy design in concrete ways. By explicitly mapping how public policies, regulatory adjustments, and market trends affect each tariff component, it enhances transparency and traceability in tariff formation, helping to clarify why final electricity bills may not immediately reflect reductions in generation costs. This contributes to improving communication between decision-makers and the public and to aligning expectations, particularly in contexts such as Chile, where the energy transition has been widely associated with anticipated tariff reductions. Moreover, the framework helps identify where regulatory efforts are likely to be most effective. In a context of sustained investment requirements in transmission and distribution, the results point to the need to prioritize regulatory and institutional modernization in these segments. At the same time, given that no significant reductions in residential tariffs are expected in the short to medium term, the analysis supports the relevance of complementary mechanisms—such as distributed generation, demand-side management, or other forms of active consumer participation—to mitigate tariff impacts.

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Moreover, the quality of the available information is critical for the robustness of the obtained results. Thus, future work will incorporate in a systematic way the treatment of uncertainties (climate change, technological developments, and geopolitical aspects).

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