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Sustainable Energy Governance in Developing Countries: A Case Study of Natural Gas Policy in Timor-Leste

Denilson Tilman Da Silva Barreto, Mahmud Sudibandriyo

Department of Chemical Engineering (Gas Management), Universitas Indonesia, Depok, Indonesia.
**Coresponding Author: Denilson Tilman Da Silva Barreto*
Corresponding email: denilsontilman5@gmail.com

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ABSTRACT
The utilization of natural gas as a strategic resource for sustainable development in developing countries still faces multiple challenges, particularly in terms of equitable access and inclusive governance. This study aims to assess the sustainability of natural gas governance in Timor-Leste using the A4 framework (Availability, Accessibility, Affordability, Acceptability). A qualitative case study approach was employed, involving in-depth interviews with ten key stakeholders, including government officials, academics, energy company representatives, and local community members. Primary data were supported by the analysis of national policy documents and official petroleum sector reports, and examined through thematic analysis and source triangulation. The findings reveal a significant gap in perception between government and local communities across all four A4 indicators. While the government shows optimism regarding resource availability and technical feasibility, local communities report poor accessibility and affordability, having experienced little direct benefit. Public acceptability is rated as moderate, with limited participation and top-down communication approaches. The practical implication of this study highlights the need to shift the Petroleum Fund's investment strategy toward domestic energy infrastructure and introduce inclusive subsidy policies. Theoretically, this study reinforces the importance of integrating natural resource theory, development economics, and investment strategy in shaping a fair and sustainable energy governance framework for post-conflict countries like Timor-Leste.

1. Introduction

Managing natural resources sustainably has become an important issue in global development, especially for countries that have large reserves of oil, gas, or minerals. As the world shifts toward cleaner energy, concerns about fairness, good governance, and local benefits are playing a bigger role in how resource-rich countries plan their development strategies. Timor-Leste is at an important turning point in its energy development. Although the country has large natural gas reserves, especially in the Greater Sunrise field, domestic access to and use of this energy remains very limited. Traditionally, gas extraction has been linked to economic growth, but recent studies argue that sustainable development must also include equity and social impact (Haris Annannab et al., 2022; John et al., 2020; Scheiner, 2021; Shin et al., 2024; Yu et al., 2022). In many developing

countries, including Timor-Leste, resource wealth does not always benefit the wider population due to weak governance and policy gaps (Bungwa et al., 2025).

Timor-Leste possesses significant natural gas reserves, positioning the country as a potential energy leader in Southeast Asia. However, this resource wealth has yet to translate into broad-based, inclusive development. Although the economic promise of natural gas development is often highlighted in policy and academic discourse (John et al., 2020), the implementation of major projects such as Greater Sunrise and Tasi Mane remains slow. Weak institutional coordination, inconsistent regulatory frameworks, and limited government capacity hinder the operationalization of these projects (Bishoge et al., 2019). Similar patterns of governance fragmentation have been observed in other resource-rich developing countries, where inter-agency competition and unclear mandates disrupt energy development (Chuwa & Perfect-Mrema, 2024; Dhali et al., 2023; Xiong et al., 2025). Technical barriers further compound the problem, including the challenges of subsea pipeline construction and disputes over the location of gas processing facilities (Becerra-Fernandez et al., 2020). Social resistance adds another layer of complexity, especially from communities concerned about environmental degradation, land dispossession, and lack of consultation (Bungwa et al., 2025). The combination of technical, institutional, and socio-political hurdles makes energy governance in Timor-Leste particularly fragile. The A4 framework—Availability, Accessibility, Affordability, and Acceptability—offers a comprehensive tool for evaluating energy sustainability but has not been systematically applied in this national context (Groh & Möllendorff, 2020). Without an integrated approach, policy efforts are unlikely to achieve their intended outcomes.

The financial aspect of Timor-Leste's energy development presents further challenges. While the country's Petroleum Fund is praised for ensuring fiscal sustainability, its effectiveness in financing transformative infrastructure remains limited (Scheiner, 2021). The fund's allocations have mostly supported short-term consumption rather than long-term investments in domestic energy systems. Globally, there is a growing interest in leveraging sovereign wealth funds to support sustainable and inclusive development (Hidayat et al., 2024; Simangan & Bose, 2021). However, empirical studies on how such financial tools can be aligned with long-term energy goals in post-conflict or fragile states are still scarce (Han et al., 2025). In Timor-Leste, the lack of strategic alignment between financial instruments and national energy planning reflects deeper issues of institutional disconnection. Moreover, current investment strategies rarely prioritize decentralization or off-grid solutions that could benefit rural communities. This is particularly problematic as many areas remain disconnected from gas infrastructure despite their proximity to extraction zones (Chuwa & Perfect-Mrema, 2023; Mills et al., 2017). Centralized planning continues to favor urban and industrial areas, marginalizing rural populations (Sovacool & Dworkin, 2015). As a result, energy inequality persists both spatially and socially. Addressing these financial and planning deficiencies requires more than economic efficiency—it demands inclusive development frameworks that ensure equitable access.

Despite increasing attention to sustainable energy transitions, significant research gaps remain. Most notably, there is limited empirical work that integrates technical, institutional, and financial barriers with the social dimensions of energy justice in Timor-Leste. While the global literature supports the need for multi-dimensional frameworks (Gacitua et al., 2018)(W. Li & Lu, 2019), few studies apply these to Southeast Asian or post-conflict settings. The A4 framework has been largely underused in Timor-Leste, particularly as a stakeholder-based tool for evaluating energy policy effectiveness (Hou et al., 2021). This oversight weakens the ability of policymakers to capture local realities and community perspectives. Furthermore, concerns such as land displacement, environmental risks, and lack of transparency continue to fuel distrust among rural communities (Varkkey et al., 2018). There is also an absence of systematic monitoring mechanisms to track the local impact of energy policies (Graczyk et al., 2023). Without incorporating these feedback loops, national strategies risk overlooking key social and political dynamics. Although some scholarship explores the idea of inclusive energy planning, it often remains abstract and disconnected from policy practice. More research is needed to understand how stakeholder engagement and frameworks like A4 can be applied to support energy legitimacy and fairness (Xia et al., 2023). This study seeks to fill these gaps by providing a comprehensive analysis of stakeholder perceptions and governance barriers in Timor-Leste's gas sector.

This study aims to addressing these questions: (1) assess stakeholder perceptions of natural gas development using the A4 framework; (2) identify key institutional, technical, and socio-political barriers to project implementation; (3) evaluate the role of the Petroleum Fund in supporting

equitable energy investment; and (4) explore how natural gas governance can promote more just and inclusive development outcomes in Timor-Leste. This study contributes to provide understanding of natural gas governance by applying the A4 framework, integrating stakeholder perspectives, and highlighting institutional, financial, and social barriers to inclusive energy development in Timor-Leste.

2. Methods

The study employs a qualitative case study approach to examine the implementation of sustainable gas management policies in Timor-Leste and their implications for national economic development. This methodological design enables a comprehensive contextual understanding of complex and dynamic energy governance phenomena involving multiple stakeholders and political-economic dimensions. The study focuses on key stakeholders in the country's oil and gas sector, including government officials, representatives of oil and gas companies, academics, and local community members directly affected by gas-related development projects. Purposive sampling was employed to select participants based on their direct involvement in the policy formulation and implementation processes, as well as their knowledge of the economic impacts of sustainable gas governance.

Primary data were collected through in-depth interviews, guided by a structured interview protocol that covered core themes including energy policy, sustainability, and economic impact—drawn from the theoretical framework and literature review. Interviews were conducted both face-to-face and online during the research period, and were complemented by documentary analysis of national policies (e.g., Law No. 9/2005, Timor Sea Treaty), official reports, macroeconomic indicators, and petroleum sector data obtained from credible institutions such as Autoridade Nacional do Petróleo, Timor Oil and Gas, Banco Central de Timor-Leste, and Ministério das Finanças.

Table 1. Informant list

Code	Interviewee's Position	Description
Informant A1	Academic, National University	An energy engineering lecturer from a public university in Timor-Leste.
Informant A2	Energy Policy Researcher	An academic and energy policy researcher who emphasizes the importance of a participatory approach in planning oil and gas projects.
Informant M1	Community Leader	A local community leader actively involved in environmental and social issues. He emphasized the importance of direct dialogue between the government and the community regarding relocation, customary land rights, and the impacts of the project.
Informant M2	Local Community Member	A community member from an area affected by the gas project, who highlighted the limited direct access to natural gas resources and expressed concerns about the affordability of energy at the household level.
Informant M3	Village Resident	A resident from a rural area who has not yet experienced any direct impact from the oil and gas project.
Informant P1	Senior Official, Ministry of Petroleum	A senior official responsible for the national energy pricing strategy.
Informant P2	Government Staff – Public Consultation Division	A ministry staff member responsible for public outreach and consultation activities related to the Greater Sunrise project.
Informant P3	Project Manager, Oil and Gas Company	A project manager from one of the oil and gas companies involved in planning gas infrastructure, including pipelines and the LNG terminal in Beaço.
Informant G1	Government Official	A senior official at the Ministry of Petroleum of Timor-Leste involved in the formulation of national energy policy.

Source: Author analysis

To further contextualize the findings, the study identified and analyzed key internal and external factors affecting the success of gas management strategies. These include internal factors such as infrastructure capacity, political and regulatory stability, and institutional readiness; and external factors such as global natural gas prices, foreign investment climate, and comparative experiences of other resource-rich countries. Expert consultations with professionals in energy, economics, and policy further enriched the analytical process.

The data were analyzed using thematic analysis, supported by source triangulation—comparing insights from interviews with documentary evidence and relevant literature to ensure validity and robustness. For policy impact assessment, the study employed a semi-quantitative rating system based on the A4 framework (Availability, Accessibility, Affordability, and Acceptability) proposed by Sovacool & Dworkin (2015). Findings were presented both in matrix form and narrative interpretation. Furthermore, the study conducted a comprehensive evaluation of the Tasi Mane Project and the Greater Sunrise gas field, focusing on strategic infrastructure development, financing schemes, and potential economic returns. This evaluation included:

1. Availability Analysis: Measuring current and projected energy needs versus available and potential supply sources, including gas quality, location, distance to demand centers, and infrastructure readiness.
2. Accessibility Evaluation: Assessing logistical feasibility, geographic challenges, and equitable access to energy resources for the population.
3. Affordability Assessment: Investigating the upfront capital costs, long-term economic viability, and financing capacity of the government.
4. Acceptability Analysis: Exploring social, environmental, and political concerns, as well as public support or resistance to oil and gas expansion.

Table 2. Grading Scale Based on A4 Framework

Grade	Availability	Accessibility	Affordability	Acceptability
5	Highly available, always present and easily accessible	Easily accessed by all groups without barriers	Highly affordable for all economic levels	Widely accepted by society and aligned with cultural values
4	Widely available, though occasionally limited under certain conditions	Accessible by most groups, with minor obstacles	Affordable for most social segments	Accepted by the majority, with minimal resistance
3	Available but often limited by time or region	Accessible, but requires additional geographic effort or overcomes minor obstacles	Affordable for some segments of society	Accepted by some groups, though with noticeable differences in opinion
2	Very limited availability, often difficult to locate	Difficult to access, only available to specific groups	Not affordable for most segments of society	Accepted by a few individuals, but largely rejected by the majority
1	Almost unavailable or extremely rare	Extremely difficult to access, limited to exclusive groups	Not affordable for most people	Not accepted widely, facing high levels of rejection and resistance

Source: Author analysis

3. Results

3.1 The Greater Sunrise Gas Field

The Greater Sunrise gas field, located approximately 150 kilometers southeast of Timor-Leste and 450 kilometers northwest of Darwin, Australia, is a significant offshore reserve comprising the Sunrise and Troubadour fields. Discovered in the 1970s, the field is estimated to hold 226 million

barrels of condensate and 5.1 trillion cubic feet (Tcf) of natural gas. In 2019, Timor-Leste, through its national oil company TIMOR GAP, acquired a combined 56.56% stake in the project from ConocoPhillips (30% for $350 million) and Shell (26.56% for $300 million), totaling $650 million. The remaining shares are held by Woodside Energy (34.44%) and Osaka Gas (10%).

Discussions on the development of Greater Sunrise have been shaped by complex geopolitical and economic negotiations between Australia and Timor-Leste. According to the 2018 Maritime Boundary Treaty, revenue-sharing will depend on the gas processing location: 80:20 in favor of Timor-Leste if processed onshore in Timor-Leste, and 70:30 for Australia if processed in Darwin. Timor-Leste advocates for domestic LNG processing to stimulate local economic growth and job creation. However, the onshore option (via the Tasi Mane project) would require a costly deep-sea pipeline reaching depths of 3,000 meters, posing technical and financial challenges.

Alternative options include utilizing existing LNG facilities in Darwin—favored by Woodside for cost and feasibility—or a floating LNG (FLNG) facility at sea. While FLNG is not yet fully explored, it may serve as a compromise. Despite resistance from investors, Timor-Leste remains committed to the Tasi Mane vision. Given that over 90% of Timor-Leste's state budget is oil-dependent and the Bayu-Undan field is nearing depletion, Greater Sunrise is considered critical for future fiscal stability. The project is currently in the planning and negotiation stage, with final investment decisions pending. Its success will depend on overcoming political, financial, and technical hurdles.

3.2 Tasi Mane Project

To achieve success in ensuring Timor-Leste's energy security through sustainable gas management—so it can deliver a positive impact on the national economy—the government of Timor-Leste is investing in supporting infrastructure, technology, and human resources. This includes the development of pipeline networks, processing facilities, and the technologies used in the oil and gas industry, all of which are part of a large-scale initiative known as the Tasi Mane Project.

Timor-Leste will require nearly $20 billion to implement the Tasi Mane Project, as indicated in Table 3. The financial, economic, social, and environmental costs, along with the benefits, risks, and available alternatives, have been thoroughly, objectively, and comprehensively analyzed. The government is currently seeking funding from various sources, including China, while project proponents continue to look for lenders or investors willing to bear the costs and associated risks. The Tasi Mane Project represents Timor-Leste's ambitious plan to secure energy security and sustainability, aiming to generate long-term positive effects on the country's economy.

Table 3. Money spent, budgeted, and required to build the Tasi Mane project (millions of USD)

Component	Location	Status	Spent through 2019	Budgeted 2020	Budgeted 2021–2024	Estimated total capital cost	Percent budgeted
Airport	Suai	Constructed	75	9	4	100	88%
Supply base	Suai	Tender pending	51	5	705	850	89%
Highway	Suai–Fatukai	Mostly built	305	4	4	340	92%
Highway	Fatukai–Beacu	Not started	3	4	18	1,320	2%
Airport	Viqueque	Not started	-	-	-	75	0%
Oil refinery & pipelines	Betano	Pending design	3	5	6	1,500	1%
Gas pipeline, LNG plant & port	Sunrise–Beacu	Pending design, seeking financing	12	35	19	6,000	1%
57% share of Greater Sunrise Joint Venture	Offshore	Borrowed directly from the	650			650	100%

		Petroleum Fund					
Interest on loan to buy into Sunrise JV	Offshore	Debt accrued in Petroleum Fund	21	30	135	512	36%
57% of Sunrise upstream capital expenditure	Offshore	Pending design, seeking financing	-	25	-	6,840	0%
Administrative and other costs	Dili	Ongoing	64	10	-	500	15%
TOTAL			**1,184**	**126**	**889**	**18,687**	**12%**

Source: Author analysis

Natural Gas Availability and Continuity

Table 4 presents the current state of natural gas production in Timor-Leste. Globally, the country is recognized as a moderate natural gas producer. However, production has dropped significantly—by 63% in 2023 compared to 2022. As a result, Timor-Leste's share of global gas production fell to just 0.02%. Despite being a gas-producing nation, Timor-Leste consumed virtually none of the global natural gas supply (132,290,211 MMcf), placing it 114th worldwide. With a population of 1,340,434 in 2022, the country recorded zero cubic feet of gas consumed per capita annually. This minimal domestic usage, despite notable production, justifies assigning Timor-Leste a score of 2 on the Availability indicator of the A4 energy security framework. It also highlights the need for robust governmental policies and regulations to support sustainable energy implementation. Ensuring every citizen's right to access natural gas on demand requires both availability and continuity of supply. Interruptions in processing facilities, fluctuations in distribution, or limitations in network coverage can disrupt this balance. Therefore, strategic storage facilities are necessary to maintain continuous supply, especially if excess production or imports are available.

Production records show that Timor-Leste began producing gas around 2004, with a steady increase until its peak in 2016, reaching over 350,000 MMcf. Despite moderate annual variations, overall output remained high until the recent decline. In 2019, natural gas production totaled approximately 5.1 billion cubic meters, all of which was exported. This indicates that while the country produces a substantial volume of natural gas, domestic consumption is negligible, underscoring a critical imbalance between production and local energy needs.

Table 4. List of gas-producing countries

No	Country	Gas Production/Year
1	United States of America	32,914,647,000
2	Russia	22,728,734,000
3	Iran	9,097,956,245
4	Canada	6,751,698,275
5	Algeria	6,491,744,560
6	Qatar	6,000,936,690
7	Norway	5,763,408,000
8	China	4,559,625,595
9	Saudi Arabia	4,231,796,450
10	United Arab Emirates	3,178,738,465
46	Timor Leste	347,852,750

Source: Wordometer, 2015

Timor-Leste Petroleum Fund

According to the Banco Central de Timor-Leste (Quarterly Report, 2023), the total assets held in the Petroleum Fund of Timor-Leste amounted to $18.252 billion as of December 31, 2023. This represents an increase of $0.731 billion or approximately 4.17% compared to the previous quarter's balance of $17.521 billion. Of the total fund, $302.064 million was allocated to the state budget (Orçamento Geral do Estado/OJE), with $300 million earmarked for fiscal spending and the remaining $2.064 million used for fund management expenses.

As illustrated in Figure 1, the Petroleum Fund achieved a 10.0% return on investment in 2023. This growth indicates strong performance, particularly in equity markets. Equities delivered

the highest return, reaching 23.7%, suggesting that stock investments significantly outperformed other asset classes during the year. In contrast, fixed income instruments (such as bonds or other interest-bearing assets) yielded a comparatively lower return of 5.0%.

The relatively modest overall return of 10%—despite high equity gains—suggests a conservative asset allocation strategy. It is likely that the Petroleum Fund maintains a limited exposure to equities (estimated between 30–40%), with the majority of the portfolio invested in lower-risk, fixed-income instruments to preserve capital and reduce volatility. This conservative approach reflects prudent fiscal management aimed at ensuring long-term economic stability, especially given the strategic importance of the fund in supporting Timor-Leste's national budget and future development programs.

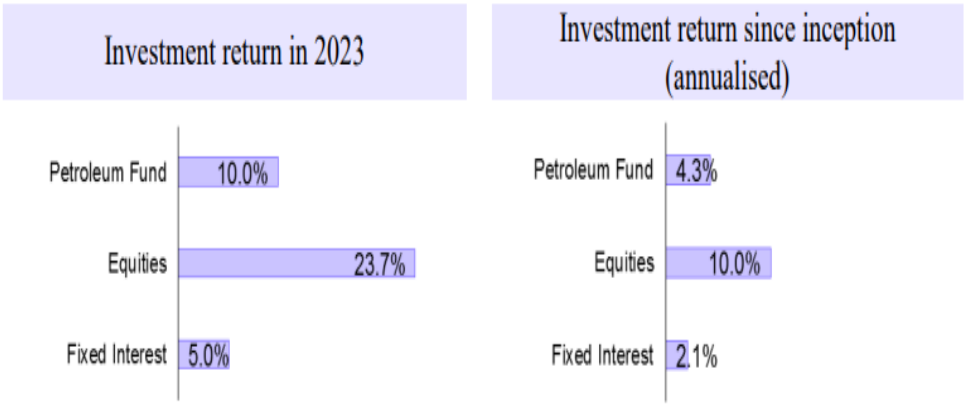

Figure 1. Investment Highlights of the Petroleum Fund (P. P. Li, 2024)

Source: Author analysis

Availability Indicator

The evaluation of the availability indicator reveals a significant discrepancy in perceptions between government officials and local communities. Government representatives assigned a relatively high score of 4, reflecting their confidence in the sufficiency and long-term viability of natural gas resources, particularly those located in the Greater Sunrise field. According to a key informant from the Ministry of Petroleum,

> *"The Greater Sunrise gas reserves are sufficient to meet the country's national energy needs for several decades, and even enable sustainable energy exports"* (Informant G1).

This optimism is rooted in the strategic planning documents that project consistent supply levels to support both domestic energy consumption and international commitments. Conversely, local communities perceive the availability of gas as limited, reflected in their lower score of 2. This perception stems from a lack of direct access and benefits from these energy resources. As one community representative expressed,

> *"We know there is gas in the sea, but we have never seen or felt any direct benefits from it in our daily lives"* (Informant M2).

This disconnect suggests that while the state views availability through a macroeconomic and geopolitical lens, communities evaluate it based on immediate, tangible access. Therefore, despite promising reserves, the distribution and perception of energy availability remain uneven across stakeholder groups.

Accessibility Indicator

The accessibility of natural gas resources in Timor-Leste exhibits a divergence in stakeholder perceptions. Representatives from oil and gas companies assigned the highest score of 4, reflecting strong confidence in future infrastructure development plans that would improve access. One project manager from the energy sector stated,

> *"We have planned to build the initial infrastructure network, including pipelines and an LNG terminal in Beaço, to facilitate gas distribution to areas in need."* (Informant P3).

These plans are part of the broader Tasi Mane project, which aims to build a southern energy corridor as the backbone of national gas distribution. However, this optimism contrasts sharply with the perspective of the local community, who gave a score of 2. Many residents feel left behind due to the lack of visible progress and tangible infrastructure. As one villager expressed,

> *"We are still waiting for the implementation of the project. So far, it's all just talk—there has been no actual development that we've seen on the ground."* (Informant M1).

Furthermore, some locals raised concerns about the geographic and logistical barriers that remain unaddressed, particularly in rural areas. This indicates that although strategic planning is underway, the absence of timely execution continues to hinder local access to energy. Moreover, another respondent emphasized,

> "*If there really is a major project, then why haven't the people been able to experience stable access to electricity or gas?*" (Informant M3).

This reinforces the notion that accessibility is not only about infrastructure plans but also about how swiftly and inclusively those plans translate into real-world improvements. The gap between policy and practice continues to shape public trust and perceived accessibility.

Affordability Indicator

The affordability dimension reveals varied perceptions among stakeholders regarding the economic accessibility of natural gas in Timor-Leste. Government and company representatives rated this indicator at a moderate level (score 3), indicating cautious optimism about affordability in the long term. A senior official at the Ministry of Petroleum stated,

> "*The government is working to ensure that gas prices for industry remain competitive in order to attract investors.*" (Informant P1).

From the perspective of state policy, pricing strategies are oriented toward macroeconomic stability and export competitiveness. However, academic experts and local community members provided a lower score of 2, reflecting concerns over the absence of clear mechanisms to ensure affordability for households and rural users. An academic from the national university specializing in energy systems remarked,

> "*Gas prices may be affordable at the industrial level, but there is still no subsidy mechanism for end consumers in rural areas.*" (Informant A1).

This statement underlines the structural gap between national energy strategies and grassroots affordability. Furthermore, local communities emphasized the financial burden of alternative energy sources due to the unavailability of gas infrastructure. One resident expressed,

> "*We still have to buy kerosene or firewood at increasingly high prices. If gas is truly intended for public use, there must be subsidies or special programs in place.*" (Informant M2).

This highlights that affordability is not only a matter of pricing but also of inclusive energy policy design that ensures equitable access across socioeconomic groups. Without tangible support systems—such as subsidized tariffs, household distribution networks, or rural access programs—the perception of affordability will remain low among the broader population.

Acceptability Indicator

The acceptability indicator, which measures the degree to which oil and gas policies and projects are accepted by the public, received moderate to high scores across all stakeholder groups, ranging between 3 and 4. Government officials rated it highest (score 4), citing that extensive public outreach and socialization had been conducted in relation to the Greater Sunrise project. One official from the Ministry of Petroleum stated,

> "*We have conducted several outreach sessions with municipalities regarding the benefits of the gas project, including job opportunities and improvements to local infrastructure.*" (Informant P2).

This reflects the government's confidence that public dialogue has been sufficiently initiated to build support. However, local communities offered a more cautious evaluation, assigning a score of 3. Their response suggests that although formal consultation activities had occurred, the process did not fully address their deeper concerns. A community leader shared,

> "*We want more direct dialogue with the government, not just through leaflets or ceremonial events. We need clear explanations about relocation and its impact on our customary land.*" (Informant M1).

Academic informants also echoed similar sentiments, noting that participatory engagement needs to be more inclusive and sustained. One university researcher commented,

> "*Sustainable energy policies must be built from the bottom up, not just from the top down.*" (Informant A2).

Highlighting the importance of co-creating legitimacy and trust in national-scale energy projects. This gap between government perception and public acceptance underscores the need for more transparent, inclusive, and responsive consultation mechanisms—especially on sensitive issues such as environmental risks, land rights, and community displacement.

4. Discussion

4.1 A4 Analysis through the Lens of Development, Natural Resources, and Investment

Findings from various informants indicate diverging perspectives among stakeholder groups regarding the four core indicators of natural gas energy sustainability (Availability, Accessibility, Affordability, Acceptability) in Timor-Leste. The A4 rating scale developed in this study captures these variations, with scores ranging from 2 (low) to 4 (moderately high), depending on the stakeholder's role in the policy and project implementation chain. For the Availability indicator, government officials rated it at 4, expressing confidence in Timor-Leste's long-term gas reserves. In contrast, local communities rated it at 2 due to the lack of tangible benefits received. This discrepancy points to an asymmetry in access to information and benefits, a pattern frequently seen in resource-rich developing economies (John et al., 2020). According to the Development Economics Theory, development should not solely focus on macroeconomic outputs but must prioritize equitable distribution of benefits (Bungwa et al., 2025). Without meaningful inclusion of local stakeholders, the developmental impact of resource exploitation becomes skewed and exclusionary.

For the Accessibility dimension, oil and gas companies assigned a high score of 4, reflecting their optimism surrounding infrastructure development through the Tasi Mane project, which includes pipelines, LNG terminals, and road networks. However, this view was not shared by local residents, who gave a much lower score of 2, citing visible delays and limited progress on the ground. Many communities claimed the infrastructure remains conceptual, with little impact at the village level. This disconnect reflects the classic "implementation gap" often found in extractive industry planning (Bishoge et al., 2019). Furthermore, infrastructure inequality in resource-endowed but underdeveloped areas continues to hinder equitable energy access (Xia et al., 2023). According to the Natural Resource Theory, effective resource management must incorporate spatial and social dimensions to avoid geographically concentrated benefits (Ahmad & Aminu Zubairu, 2022; Becerra-Fernandez et al., 2020). Without urgent and inclusive infrastructure roll-out, accessibility will remain a major barrier to energy justice in Timor-Leste.

On the Affordability indicator, the divergence of perceptions was particularly sharp. Government actors and industry players rated affordability at 3, emphasizing macroeconomic considerations such as industrial competitiveness and foreign investment appeal. Meanwhile, academics and community members rated it at 2, citing the absence of subsidized pricing mechanisms that would make natural gas accessible to rural and low-income populations. The continued reliance on expensive and polluting alternatives like kerosene and firewood underscores the inequitable energy pricing structure in place (Han et al., 2025). According to Investment Theory, sustainable energy investments should generate not only economic gains but also long-term social dividends (Dhali et al., 2023). High energy prices at the household level constrain local entrepreneurship and inhibit the broader economic multiplier effects associated with energy access

(Graczyk et al., 2023). Thus, affordability should be redefined within policy frameworks to ensure inclusivity and social utility.

Regarding the Acceptability indicator, the government assigned a relatively high score of 4, highlighting their belief in having conducted adequate community outreach related to the Greater Sunrise and Tasi Mane projects. These efforts, according to officials, involved information dissemination and formal consultations with municipal representatives. However, community members rated acceptability at 3, citing that while outreach occurred, it was largely top-down and lacked genuine participatory dialogue. Concerns over unresolved issues like relocation, land tenure, and environmental risks persisted among affected populations. This gap in perception points to a persistent trust deficit and insufficient participatory governance (Gacitua et al., 2018). Academic informants further noted the absence of transparent, responsive mechanisms to incorporate public feedback into policy decisions. As emphasized by Development Economics Theory, sustainable development necessitates both economic growth and social accountability (Groh & Möllendorff, 2020). Without sincere community inclusion, projects risk social resistance and long-term legitimacy challenges (Liebe & Dobers, 2019).

In summary, the A4 scale assessments underscore a systemic misalignment between macro-level planning and micro-level realities. Despite the governments and industry's positive assessments, community-level perceptions expose ongoing structural gaps in benefit distribution, infrastructure provision, pricing fairness, and participatory governance. To enhance the sustainability of natural gas projects in Timor-Leste, stakeholders must reconceptualize these initiatives as long-term social investments rather than short-term economic undertakings. As suggested by international best practices in energy governance (Akbar, 2025), participatory planning, inclusive pricing, and spatially just infrastructure development is key to transforming gas reserves into catalysts for equitable and competitive national (Scheiner, 2021; Sovacool & Dworkin, 2015; Wan Ahmad et al., 2016).

4.2 Securing Timor-Leste's Energy Future: The Synergy Between Investment, Gas Reserves, and Energy Security

Timor-Leste is home to significant natural gas reserves, particularly in the Greater Sunrise field, which holds an estimated 5.1 trillion cubic feet of gas and 226 million barrels of condensate. Despite this resource abundance, national gas production declined sharply by 63% in 2023, reducing the country's share of global gas output to a mere 0.02%. This paradox is further complicated by the reality that Timor-Leste's per capita gas consumption remains at 0 m^3 annually. Under the A4 energy security framework, this justifies a low score of 2 for the Availability indicator, highlighting the disconnect between national reserves and actual public energy access (John et al., 2020). While the reserves are geologically significant, their contribution to human development remains minimal without direct domestic utilization. According to Bungwa et al. (2025), such a disparity illustrates how natural resource wealth, when poorly integrated with development strategy, can exacerbate inequality and hinder inclusive growth.

On the investment front, Timor-Leste's Petroleum Fund posted a strong 10.0% return in 2023, largely driven by outstanding equity market performance, which contributed a 23.7% gain. Nonetheless, since its inception, the Fund's annualized return stands at a conservative 4.3%, reflecting a strategy centered on capital preservation, with a majority of assets held in low-yield fixed-interest instruments (2.1%). This cautious allocation is understandable given the need to stabilize national budgets amid declining revenues from the Bayu-Undan gas field (Scheiner, 2021). However, such conservatism may inhibit the fund's potential to finance transformative infrastructure. As highlighted by Hidayat et al. (2024), infrastructure investment is a critical pathway through which resource-rich nations can translate fiscal reserves into long-term development outcomes, especially in contexts with underdeveloped domestic energy infrastructure.

The Greater Sunrise project remains central to Timor-Leste's long-term economic strategy. With the national oil company TIMOR GAP holding a 56.56% stake, there is strong national commitment to its success. Nonetheless, several technical and political challenges persist. The proposed subsea pipeline is located at depths of over 3,000 meters, making construction both risky and expensive. Additionally, processing location debates remain unresolved: if processing occurs onshore in Timor-Leste, the country could receive up to 80% of revenue. Conversely, if processing is conducted in Darwin, Australia stands to gain a 70% share (Dhali et al., 2023). These delays not only reflect geopolitical tensions but also reinforce domestic energy inaccessibility and unaffordability. Community-based interviews reveal persistent concerns over energy pricing and

distribution, with local households reporting little change in access. This supports the A4 framework's low scores for Affordability (2) and Accessibility (2), demonstrating a deep structural disconnect between high-level policy and ground realities (Xia et al., 2023).

From a development policy perspective, Timor-Leste must realign its energy strategy to address domestic needs alongside export ambitions. Allocating a portion of Petroleum Fund returns toward national energy infrastructure could generate meaningful socio-economic outcomes. This approach aligns with Development Economics Theory, which emphasizes resource mobilization for inclusive human development rather than focusing solely on GDP growth (Bungwa et al., 2025). In resource-rich countries, overdependence on extractive exports without reinvestment in domestic priorities often results in stagnation and inequality—an issue widely recognized as the "resource curse" (John et al., 2020). According to Natural Resource Theory, sustainable management of natural resources requires a deliberate balance between preserving sovereign wealth and facilitating structural transformation. Lessons from other developing countries, such as Tanzania, reveal the importance of institutional coordination and stakeholder engagement in energy governance (Bishoge et al., 2019). Timor-Leste faces a similar challenge: transforming its substantial natural gas reserves into tangible domestic benefits. To achieve long-term sustainability, Timor-Leste needs a multi-dimensional energy policy that combines investment in infrastructure, inclusive decision-making, and equitable benefit-sharing mechanisms. Han et al. (2025) stress that sustainable natural gas development depends on integrating financial planning, technological capacity, and community participation. Without such an approach, national energy projects risk perpetuating social exclusion and policy inefficiencies. Therefore, aligning macroeconomic strategies with energy justice at the local level is essential to ensuring that Timor-Leste's natural gas potential contributes to inclusive and sustainable national development.

Timor-Leste's heavy dependence on global gas markets poses another risk. Without domestic diversification and resilience strategies, the country remains vulnerable to international price shocks and political uncertainties. A case in point is the 2023 production decline, which, despite significant reserves, failed to generate local economic stimulation. According to Graczyk et al. (2023), sustainable natural gas management must include risk mitigation measures to protect national energy systems from such fluctuations. This includes long-term planning, local processing, and the establishment of regional distribution networks that can cater to both urban and rural needs. Moreover, the underutilization of domestic gas undermines social equity objectives. Despite billions in reserve value, communities continue to rely on expensive and environmentally harmful fuels such as kerosene and firewood. As emphasized by Sovacool and Dworkin (2015), energy justice frameworks demand equitable access and affordability, ensuring that national energy wealth benefits all segments of society. Likewise, Gacitua et al. (2018) stress the importance of participatory governance in energy policy to ensure alignment between national goals and community expectations.

In the broader context of sustainable development, Timor-Leste must treat its gas reserves not merely as an export commodity, but as a foundation for inclusive and green transformation. As shown by Becerra-Fernandez et al. (2020), integrated modeling of gas supply chains that prioritize sustainability and domestic consumption can yield superior long-term outcomes. Planning should consider spatial equity, environmental safeguards, and local capacity building to maximize developmental impact. Furthermore, Bishoge et al. (2019) point to the challenges of weak institutional coordination and policy fragmentation as key obstacles in implementing effective natural gas strategies in developing nations.

5. Conclusion

This study reveals the complex dynamics of natural gas governance in Timor-Leste through the analysis of four A4 indicators: Availability, Accessibility, Affordability, and Acceptability. First, stakeholder perceptions highlight a significant gap between the perspectives of government and oil industry actors versus those of local communities and academics. While the government and industry tend to be optimistic about the availability and technical feasibility of energy projects, local communities rate accessibility and affordability poorly, as they have yet to experience tangible benefits. Acceptability is assessed as moderate—communities acknowledge the government's outreach efforts, but these have not fully addressed concerns regarding relocation and environmental impacts. Second, the Greater Sunrise and Tasi Mane projects face various technical, social, and political challenges. Technically, the construction of a deep-sea pipeline reaching depths

of up to 3,000 meters and the infrastructure investment of approximately USD 20 billion pose major obstacles. Socially, challenges include low community participation in the planning process and uncertainty over customary land rights. Politically, disagreements between Timor-Leste and international investors over the gas processing location contribute to the uncertainty surrounding the project's sustainability. Third, the investment strategy of the Petroleum Fund has so far been conservative, focusing heavily on fixed-income instruments. Although the fund achieved a 10% return in 2023, allocations toward domestic energy development remain limited. To support inclusive and sustainable infrastructure development, the investment strategy must shift toward national energy priorities, such as distribution networks, household access subsidies, and local human resource development. Fourth, current natural gas resource management has yet to generate broad-based social and economic benefits, especially for rural communities. Domestic gas consumption remains minimal, and the country remains heavily dependent on exports. Limited accessibility and affordability highlight that resource utilization is not yet strategically aligned with local empowerment goals.

This study contributes to the development of the A4 analytical framework for assessing energy sustainability in resource-rich but infrastructure-constrained developing countries. Its practical implications urge the Timor-Leste government to strengthen participatory governance, realign the Petroleum Fund's investment strategy toward domestic energy development, and formulate subsidy policies that ensure equitable energy access, especially in rural areas. Theoretical implications emphasize the importance of integrating natural resource theory, development economics, and investment strategies in building a just and sustainable national energy security framework.

6. References

Ahmad, F., & Aminu Zubairu, S. (2022). The Impact of Population, Export, and Capital Formation to The Oil Consumption and Economic Growth in Indonesia. *Economics, Business, Accounting & Society Review*, *1*(1), 9–20. https://doi.org/10.55980/ebasr.v1i1.12

Akbar, F. A. (2025). A Holistic Approach to Sustainable Corporate Governance : Exploring the Role of Business Ethics and Technology – A Bibliometric Study. *Economics, Business, Accounting & Society Review*, *3*(3), 182–196.

Becerra-Fernandez, M., Cosenz, F., & Dyner, I. (2020). Modeling the natural gas supply chain for sustainable growth policy. *Energy*, *205*, 118018. https://doi.org/10.1016/j.energy.2020.118018

Bishoge, O. K., Zhang, L., & Mushi, W. G. (2019). Challenges facing the implementation of the national natural gas policy in Tanzania. *International Journal of Energy Sector Management*, *13*(3), 500–517. https://doi.org/10.1108/IJESM-08-2018-0005

Bungwa, Z. S., Yanda, P. Z., & Lyimo, J. (2025). Stakeholders' analysis for supporting sustainable natural gas development in mainland Tanzania: Implications for coastal forest ecosystem management. *Marine Policy*, *178*, 106703. https://doi.org/10.1016/j.marpol.2025.106703

Chuwa, L., & Perfect-Mrema, J. (2023). Strengths, weaknesses, and opportunities of local content policy, legal, and institutional framework in the upstream natural gas sector in Tanzania. *Resources Policy*, *81*(May 2022), 103304. https://doi.org/10.1016/j.resourpol.2023.103304

Chuwa, L., & Perfect-Mrema, J. (2024). An assessment of local content policy, and the legal and institutional framework in Tanzania's upstream natural gas sector. *Extractive Industries and Society*, *17*(October 2023), 101424. https://doi.org/10.1016/j.exis.2024.101424

Dhali, M., Hassan, S., & Subramaniam, U. (2023). Comparative Analysis of Oil and Gas Legal Frameworks in Bangladesh and Nigeria: A Pathway towards Achieving Sustainable Energy through Policy. *Sustainability (Switzerland)*, *15*(21). https://doi.org/10.3390/su152115228

Gacitua, L., Gallegos, P., Henriquez-Auba, R., Lorca, Á., Negrete-Pincetic, M., Olivares, D., Valenzuela, A., & Wenzel, G. (2018). A comprehensive review on expansion planning: Models and tools for energy policy analysis. *Renewable and Sustainable Energy Reviews*, *98*, 346–360. https://doi.org/10.1016/j.rser.2018.08.043

Graczyk, A., Graczyk, A. M., & Węgrzyn, A. (2023). Change in Natural Gas Utilisation in the

Context of Sustainable Energy Management in Poland. *Economics and Environment*, *84*(1), 51–75. https://doi.org/10.34659/eis.2023.84.1.567

Groh, E. D., & Möllendorff, C. v. (2020). What shapes the support of renewable energy expansion? Public attitudes between policy goals and risk, time, and social preferences. *Energy Policy*, *137*(February 2019). https://doi.org/10.1016/j.enpol.2019.111171

Han, H., Asif, M., Bhatti, U. A., Por, L. Y., Awwad, E. M., & Sarhan, N. (2025). The role of finance, technology, and growth policies in shaping sustainable mineral and natural gas management: Utilizing dynamic auto-regressive distributed lag (ARDL) and frequency domain causality (FDC) models. *Energy & Environment*. https://doi.org/10.1177/0958305X251322896

Haris Annannab, Surajo, A. Z., & Ahmad, F. (2022). Coal consumption and economic growth in Indonesia: An analysis of restricted structural var. *Economics, Business, Accounting & Society Review*, *1*(2), Press. https://doi.org/10.55980/ebasr.v1i2.13

Hidayat, B. A., Supartoyo, Y. H., Setiawan, S., Ragimun, R., & Salim, Z. (2024). Government infrastructure investment stimulation through booming natural resources: Evidence from a lower-middleincome country. *PLoS ONE*, *19*(5 May), 1–20. https://doi.org/10.1371/journal.pone.0301710

Hou, X., Lv, T., Xu, J., Deng, X., Liu, F., & Pi, D. (2021). Energy sustainability evaluation of 30 provinces in China using the improved entropy weight-cloud model. *Ecological Indicators*, *126*, 107657. https://doi.org/10.1016/j.ecolind.2021.107657

John, S., Papyrakis, E., & Tasciotti, L. (2020). Is there a resource curse in Timor-Leste? A critical review of recent evidence. *Development Studies Research*, *7*(1), 141–152. https://doi.org/10.1080/21665095.2020.1816189

Li, P. P. (2024). Annual Report 2023. *AIMS Energy*, *12*(1), 271–276. https://doi.org/10.3934/energy.2024013

Li, W., & Lu, C. (2019). The multiple effectiveness of state natural gas consumption constraint policies for achieving sustainable development targets in China. *Applied Energy*, *235*, 685–698. https://doi.org/10.1016/j.apenergy.2018.11.013

Liebe, U., & Dobers, G. M. (2019). Decomposing public support for energy policy: What drives acceptance of and intentions to protest against renewable energy expansion in Germany? *Energy Research & Social Science*, *47*, 247–260. https://doi.org/10.1016/j.erss.2018.09.004

Mills, D. J., Tilley, A., Pereira, M., Hellebrandt, D., Pereira Fernandes, A., & Cohen, P. J. (2017). Livelihood diversity and dynamism in Timor-Leste; insights for coastal resource governance and livelihood development. *Marine Policy*, *82*(April), 206–215. https://doi.org/10.1016/j.marpol.2017.04.021

Scheiner, C. (2021). Timor-Leste economic survey: The end of petroleum income. *Asia and the Pacific Policy Studies*, *8*(2), 253–279. https://doi.org/10.1002/app5.333

Shin, W.-T., Tania, C., & Susanto, H. A. (2024). Transboundary Environmental Harm and the Increasing Risk of Oil Spills and Marine Debris in the Semi-Enclosed Arafura and Timor Seas Region. *Coastal Management*, *52*(3), 127–146. https://doi.org/10.1080/08920753.2024.2370063

Simangan, D., & Bose, S. (2021). Oiling the rigs of state-building: A political settlements analysis of petroleum revenue management in timor-leste. *Asian Journal of Peacebuilding*, *9*(1), 67–89. https://doi.org/10.18588/202105.00a177

Sovacool, B. K., & Dworkin, M. H. (2015). Energy justice: Conceptual insights and practical applications. *Applied Energy*, *142*, 435–444. https://doi.org/10.1016/j.apenergy.2015.01.002

Varkkey, H., Tyson, A., & Choiruzzad, S. A. B. (2018). Palm oil intensification and expansion in Indonesia and Malaysia: Environmental and socio-political factors influencing policy. *Forest Policy and Economics*, *92*, 148–159. https://doi.org/10.1016/j.forpol.2018.05.002

Wan Ahmad, W. N. K., de Brito, M. P., & Tavasszy, L. A. (2016). Sustainable supply chain management in the oil and gas industry. *Benchmarking: An International Journal*, *23*(6), 1423–1444. https://doi.org/10.1108/BIJ-08-2013-0088

Xia, L., Wan, L., Wang, W., Luo, J., & Yan, J. (2023). Energy accessibility via natural resources: Do natural resources ensure energy accessibility in low income countries? *Resources Policy*, *86*(PB), 104145. https://doi.org/10.1016/j.resourpol.2023.104145

Xiong, J.-J., Zheng, L., & Wang, C. (2025). Natural resources, economic growth, and environmental sustainability in China: the role of technological innovation. *Journal of Environmental Planning and Management*, *68*(6), 1472–1495. https://doi.org/10.1080/09640568.2024.2311814

Yu, H., Hu, C., & Xu, B. (2022). Re-examining the existence of a “resource curse”: A spatial heterogeneity perspective. *Journal of Business Research*, *139*(September 2021), 1004–1011. https://doi.org/10.1016/j.jbusres.2021.10.048