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ORIGINAL RESEARCH ARTICLE

Inclusive energy governance in Morocco: Strategic stakeholder dynamics in the advanced metering infrastructure project

Nissrine Majit[1,*], Naila Amrous[1], Jamal Mabrouki[2]

[1] *Laboratory of Mediation, Information, Knowledge and Society- MIKS: School of Information Sciences, Avenue AllalAl Fassi, Madinat AL Irfane, BP 6204, Rabat Institute, Morocco*

[2] *Laboratory of Spectroscopy, Molecular Modeling, Materials, Nanomaterials, Water and Environment, (CERNE2D), Mohammed V University in Rabat, Faculty of Science, AV Ibn Battouta, BP1014, Agdal, Rabat, Morocco*

***Corresponding author:** Nissrine MAJIT, majit.nissrine1980@gmail.com

ABSTRACT

This study conducts a strategic stakeholder analysis of Morocco's Advanced Metering Infrastructure (AMI) within the country's broader energy-transition reforms. It employs a qualitative triangulation design, combining semi-structured interviews, deep documentary analysis, and relational mapping. Results highlight a centralised governance pattern in which public institutions, international donors, and local authorities play a dominant role, while civil society organisations, innovation clusters, and universities remain weakly integrated. The analysis identifies structural power asymmetries, zones of uncertainty, and dependency relations that affect policy coordination. The resulting stakeholder map provides a decision-support tool for identifying coordination bottlenecks, clarifying institutional dependencies, and designing more inclusive consultation mechanisms between regulators, operators, territorial actors, innovation institutions, and civil-society representatives. The study contributes to the literature on socio-technical transitions in emerging contexts, where institutional design is as critical as technological innovation. As the study adopts a cross-sectional design, it captures stakeholder relations at a specific stage of AMI deployment rather than their longitudinal evolution. Moreover, because several international stakeholders could not be interviewed directly, part of the analysis of the international cluster relies on secondary institutional reports. Future research should therefore examine how governance arrangements, inter-institutional dependencies, and stakeholder influence patterns evolve throughout the later phases of AMI deployment.

Keywords: energy governance; strategic stakeholder analysis; advanced metering; stakeholder mapping; Morocco

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1. Introduction

Today, the global energy transition is seen as a major strategic challenge, particularly for developing countries that need to create a balance between energy security, environmental protection, and economic development[1]. Since 2009, Morocco has undertaken an ambitious restructuring of its energy sector to achieve carbon neutrality by 2050 and increase the proportion of renewable energy to 52% of the electric mix by 2030[2]. A key part of this transformation is the implementation of an Advanced Metering Infrastructure (AMI). These projects aim to improve the grid efficiency, reduce technical and economic losses, and give users tools to manage their electricity use better[3]. In the Moroccan context, AMI should not be understood only as a technical metering system.

It is also a governance instrument expected to support revenue protection, reduction of technical and non-technical losses, remote data collection, billing reliability, demand-side management, and the

progressive digital modernisation of electricity distribution. Its implementation, therefore, depends not only on technological performance, but also on the capacity of institutional, regulatory, territorial, financial, technological, and civic actors to coordinate their roles. These reforms aim to change Morocco's electricity governance to upgrade the power grid. It involved national institutions such as the National Office of Electricity and Drinking Water (ONEE), the Ministry of Energy Transition and Sustainable Development (MTEED), the Ministry of Interior, and international partners[2]. Although the literature on smart grids and AMI has expanded considerably, it remains largely dominated by technical, economic, and user-acceptance approaches[4-6]. Less attention has been paid to the strategic configuration of stakeholders, the distribution of institutional power, and the zones of uncertainty that structure coordination among actors. This gap is particularly important in emerging energy systems such as Morocco, where AMI deployment occurs within a context of centralised public decision-making, donor-supported reforms, territorial restructuring, and rising expectations for participatory governance[4]. This study aims to construct a strategic mapping of the key actors in Morocco's electricity sector within the AMI project, and to analyse their interactions. To address this objective, the research draws on a theoretical framework combining Freeman's stakeholder theory, complemented by Mitchell, Agle, and Wood's stakeholder salience model, and Crozier and Friedberg's strategic analysis of organisations. This framework enables the classification of actors according to power, legitimacy, and degree of involvement, while also examining power relations, interdependencies, and zones of uncertainty structuring organisational behaviour[7-9]. The paper proceeds with a literature review, methods, findings, and a discussion with a conclusion.

2. Literature Review and Theoretical Framework

2.1. Energy Transition and Smart Energy

The energy transition, as defined by the United Nations, refers to the shift from a fossil fuel-based system to a model focused on renewable energy. This transition entails a profound transformation of infrastructures, usage patterns, and governance models. Today, this shift is driven by four structural dynamics: decarbonization, digitalization, decentralization, and democratisation, which form the foundations of a new energy paradigm[1]. The concept of smart energy systems reflects the convergence between physical infrastructures and digital technologies[11]. However, these transformations cannot be understood purely as a technological challenge; they also require reconfiguration of actor relationships, the adoption of a more open governance model, and collective strategic decisions[12].

2.2. Smart Grids and Advanced Metering Infrastructure (AMI)

According to the French Energy Regulatory Commission (CRE), smart grids refer to infrastructures capable of efficiently integrating the actions of various stakeholders, including producers, consumers, and operators, to ensure a more sustainable, flexible, and cost-effective electricity system[3]. Advanced Metering Infrastructure (AMI), or smart metering, constitutes a core component of such systems by enabling bidirectional communication between the grid and its users [3]. However, their deployment extends beyond technical considerations, encompassing institutional, regulatory, and social dimensions[12].

2.3. Participatory Governance in the Energy Transition

The energy transition needs collaborative decision-making around strategy implementation, priority setting, and the compromises to be made[14]. From this perspective, Participatory governance seeks to involve a broad range of actors to enhance the legitimacy and social acceptance of energy policies.

2.4. Theoretical Frameworks

The study relies on Freeman's stakeholder theory, complemented by Mitchell, Agle, and Wood's stakeholder salience model, to identify and classify actors according to power, legitimacy, and degree of

involvement in the AMI project[7,9]. Crozier and Friedberg's strategic analysis is then used to explore power relations, dependencies, and zones of uncertainty[8]. Aligned with our constructivist epistemological position, this approach helps interpret stakeholder interactions through dependency, strategic alliance, conflict, and joint project relations. To operationalise this framework, stakeholder theory and salience analysis were used to classify actors, while strategic analysis was used to interpret relational dynamics through dependencies, strategic alliances, conflicts, joint projects, and zones of uncertainty. In this study, a zone of uncertainty refers to any resource or position controlled by an actor that may influence the behaviour of other actors, such as regulatory authority, financial resources, technical expertise, access to data, territorial legitimacy, or social mediation capacity.

2.5. Previous Research

At the African level, El Hafdaoui et al.'s analysis of Morocco's energy transition highlights significant progress in renewable energy deployment, but also reveals fragmented governance marked by limited institutional coordination[2]. At the European level, the literature highlights the social and institutional determinants of public acceptance for smart grids and associated moral values, especially in the work of Milchram et al.[4].

In the USA, Bugden and Stedman show that institutional trust plays a central role in adoption[5], while Mathisen et al. identify a lack of accessible information as a driver of public mistrust[15]. A transregional meta-analysis by Gumz and Fettermann confirms the significance of perceived motivation, transparency, and user-friendliness in fostering acceptance of energy technologies[6]. On governance, Debusschere and Mallet emphasize the importance of aligning technological innovation with regulatory and social inclusion mechanisms[12]. Despite these studies, two major gaps remain: the lack of strategic analyses capable of mapping stakeholder relationships, and the scarcity of studies focused on emerging economies, where energy transitions are coupled with profound institutional reconfigurations, as is the case in Morocco[2,7,8].

3. Methodology

3.1. Research motivation and rationale

The deployment of smart grid systems does not rely solely on their technical performance. It also depends on stakeholders' capacity to collaborate within an often-fragmented institutional framework. However, existing literature remains largely focused on technological and macroeconomic perspectives, often overlooking stakeholder relationships and coordination challenges. This research seeks to address this gap by offering a strategic reading of multi-actor interactions within the Moroccan context. It adopts a system-oriented approach to analyse governance logics underpinning the implementation of the AMI project.

3.2. Epistemological Positioning and Methodological Design

This research adopts a pragmatic constructivist approach. To capture this complexity, the study employs a methodological triangulation[16], built upon three primary data sources:

- Documentary analysis of 18 documents published between 2009 and 2025, supplemented by foundational texts predating 2009, such as Freeman (1984) and Crozier & Friedberg (1977);
- Semi-structured interviews with public, private, civil society, and academic stakeholders, aimed at exploring their positions, strategies, constraints, and perceptions of energy governance;
- Relational analysis was conducted by combining manual qualitative coding and graphical visualisation using Python to identify four types of relationships: dependency, strategic alliance, conflict, and joint project. Relationship intensity was then assessed using a five-point scale.

The research process unfolded in six stages: formulation of the research problem, definition of objectives, data collection, textual content coding, development of a relational matrix, and stakeholder mapping and visualisation of inter-actor dynamics.

3.3. Data Collection and Processing

3.3.1. Documentary Analysis

Documentary analysis served as an essential preliminary step to identify key stakeholders involved in the modernization of Morocco's electricity sector. Selection was based on inclusion and exclusion criteria presented in **Table 1**.

Table 1. Inclusion and exclusion criteria.

Criteria	Inclusion	Exclusion
Reference period	-Timeline 2009- 2025; foundational scholarly articles on energy transition, stakeholder theory, etc., and official reports dating back to the 1970s	- Before 2009, foundational scholarly articles and official policy reports from as early as the 1970s
Language	-English and French	-Others
Type of publications	-Scientific publications, official and technical reports, and institutional websites	-Non-peer-reviewed papers
Topics	-Topics closely related to our research	-Other topics
Relevance and reliability of sources	-Scientific databases and search engines	-General Research engines
Availability	-Documents available in full text	-Inaccessible documents

3.3.2. Semi-structured Interviews, coding, and ethical considerations

This study conducted 16 semi-structured interviews with key stakeholders identified during the preliminary mapping. The sample was built through purposive sampling. Participants were selected according to their institutional role, their involvement in energy-transition governance, their proximity to AMI-related issues, or their capacity to represent intermediary and peripheral stakeholder perspectives. The sample included institutional actors, private-sector operators, civil-society representatives, academic researchers, and representatives of international cooperation. This selection aimed to capture both central decision-making perspectives and peripheral viewpoints likely to reveal coordination gaps, dependency relations, and acceptability concerns.

Each interview lasted approximately 45 minutes. All interviews were conducted in line with qualitative research ethics principles. Informed consent was obtained from all participants, responses were anonymized, and data were transcribed and manually coded using Excel. This process supported a structured thematic analysis of stakeholder narratives and interrelations.

3.3.3. Relational Analysis and Visualisation

Interview data were combined with documentary analysis to clarify the role of international donors in Morocco's electricity sector. This combination allowed us to build a relational matrix. Each tie between two stakeholders was coded per the theoretical framework, along four dimensions: strategic alliance, dependency, conflict, and joint project. The intensity scale was defined as follows: 1 = very weak relation, corresponding to an occasional or indirect link; 2 = weak relation, indicating limited interaction or low strategic dependence; 3 = moderate relation, indicating regular coordination or an identifiable institutional link; 4 = strong relation, corresponding to formal cooperation, significant dependency, or repeated strategic interaction; and 5 = very strong relation, indicating critical dependency, formal authority, financing control, regulatory power, or a central implementation role. Then, we visualised the results using Python NetworkX. This enabled us to produce a dynamic actor-network map and to analyse centrality patterns, identify clusters of influence, and

pinpoint weak nodes within coordination flows, thereby revealing the structural contours of governance dynamics.

3.3.4. Thematic qualitative analysis of interviews

Since the coding process was conducted manually, coding consistency was strengthened through a three-step procedure: the use of a predefined coding grid, repeated comparison between interview excerpts and documentary evidence, and systematic revision of ambiguous cases. Although no formal inter-coder reliability coefficient was calculated, the explicit coding rules and triangulation between interviews and documents helped reduce interpretive inconsistency. Following Miles, Huberman, and Saldaña, this approach suits moderate-scale qualitative research, privileging interpretive depth rather than automation[17]. This cross-analysis refined the interpretation and deepened our understanding of governance configurations specific to the Moroccan context.

4. Research Findings

Combining documentary analysis and interviews, we identified 21 key stakeholders operating at different levels in the modernisation of Morocco's national grid. This cross-analysis revealed dynamics of uncertainty, institutional tensions, power relations, and strategic dependencies, thereby refining our understanding of governance configurations specific to the Moroccan context.

4.1. Stakeholder Profiling

In line with stakeholder theory and stakeholder salience analysis, the identified stakeholders were grouped into five main categories: (1) national public institutions, approximately 50%, including ministries, regulators, and public agencies; (2) international organisations, donors, and cooperation agencies, 25%; (3) innovation and research actors, 10%, including clusters, universities, and technological centres; (4) private-sector actors, 10%; and (5) civil society, local representatives, and citizens, less than 10% (**Table 2)**. This profiling reveals a governance landscape dominated by centralised public authorities, marked by a high level of dependency on international donors, and by the still peripheral involvement of local and citizen-based stakeholders.

Table 2. Summary Profile of Stakeholders in Morocco's Electricity Sector.

Actor category	Role	Strategic Issues	Main constraints	Resources
Public Institutions (ONEE, MTEED, MEF, Ministry of the Interior, MIC, ANRE, MASEN, AMEE, SIE, ONHYM, CNESTEN)	Electricity supply, regulation, and energy policy coordination	Renewable integration, climate targets, territorial equity, and transparency	Budget dependency, limited autonomy, weak territorial integration	regulatory authority; skilled human resources
International organisations, donors, and cooperation agencies (IRENA, GIZ, IEA, AIEA, CRE,ONU,BM, FMI,AFD)	Promote best practices and standards; provide technical cooperation and funding for development projects	Harmonising domestic policies with international norms; linking finance to governance and sustainability	Geopolitical constraints; diplomatic dependencies;	Technical assistance and financial resources
R&D and Innovation institutions (IRESEN, Universities, Energy Clusters)	Research, foster innovation, and technology transfer	Strengthening competitiveness; ensuring programme continuity	Irregular funding; lack of integration into policy circles	Research laboratories, specialised staff, and collaborative programmes
Private sector (Atos, Siemens, etc.)	Supply advanced technology and support project implementation	Winning public contracts; managing social acceptance and technical reliability	Dependency on tenders; project discontinuities	Global R&D capabilities; technical and support teams
Civil Society and Local Actors	Advocacy, awareness, and local mediation	Transparency, public trust, and acceptability	Limited capacity, weak institutional role	Local legitimacy, communication channels

The following section provides a cross-cutting analysis of these relationships, drawing on triangulated data from both interviews and documentary analysis, to reveal the key actor configurations surrounding the AMI project.

4.2. Analysis of Inter-Stakeholder Relationships

Four types of interactions were coded: dependency, strategic alliance, joint project, and conflict. The coding first used a binary approach to identify the presence or absence of each relationship type, before assessing relational intensity through a five-point scale.

4.2.1. Distribution of Relationship Types

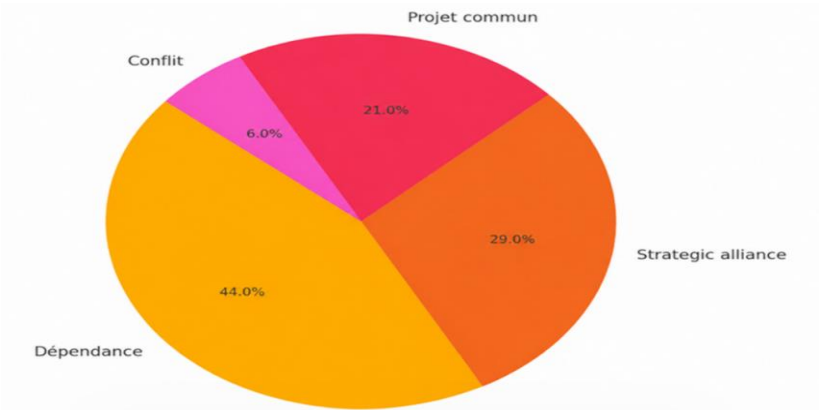

Figure 1. Distribution of coded inter-stakeholder relationship types.

Note. Percentages are calculated from the relational matrix based on four coded relationship types: dependency, strategic alliance, joint project, and conflict.

This distribution highlights a clear predominance of dependency relationships, 44%, largely associated with institutional, financial, or technical linkages. Strategic alliances, 29%, indicate a deliberate intent among certain actors to pursue formal cooperation. Joint projects represent 21% of the coded relationships and refer to formal or semi-formal collaborations such as cooperation programmes, technical-assistance initiatives, public-private contracts, pilot projects, memoranda of understanding, or research and innovation partnerships. They were distinguished from strategic alliances by the presence of an identifiable operational activity, deliverable, or implementation mechanism (**Figure 1**). By contrast, strategic alliances refer more broadly to converging strategic interests or formal institutional alignment without necessarily involving a specific project.

Finally, conflictual relationships represent only 6% of the coded ties. This low proportion should be interpreted cautiously. It may reflect the relatively formal and institutional nature of the relationships analysed, but it may also result from social desirability bias, institutional sensitivity, or reluctance among interviewees to openly report tensions in an ongoing strategic project. Therefore, conflict should not be understood only as explicit opposition, but also as latent tension, mandate overlap, weak coordination, or competition over strategic resources.

4.2.2. Mapping of Actor Clusters

Note. Node size reflects stakeholder centrality; edge thickness reflects relationship intensity; and edge type reflects the dominant relationship category identified through documentary analysis and interview coding (**Figure 2**).

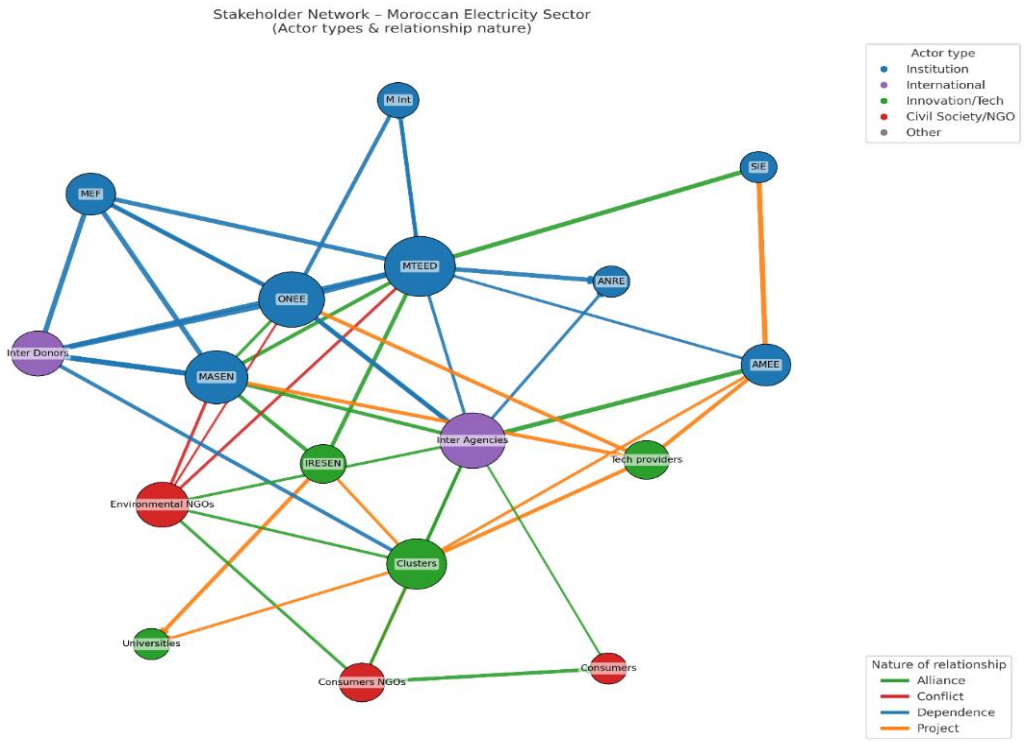

Figure 2. Stakeholder interaction map in Morocco's electricity sector.

Four structuring clusters emerge from the analysis:

1. The Institutional Core: This cluster comprises the MTEED, MEF, Ministry of the Interior, ONEE, AMEE, MASEN, and SIE. These actors concentrate the key functions of regulation, planning, financing, and implementation.
2. The International Cluster: Formed by international organisations, donors, and technical cooperation agencies, this pole is closely linked to the institutional core through dependency relationships and normative influence.
3. The Technological and Innovation Cluster: This group includes IRESEN, universities, industrial clusters, and technology providers. However, its strategic autonomy remains limited in the absence of robust institutional support or policy-integration mechanisms.
4. The Civic Periphery: Encompassing NGOs, consumer associations, local representatives, and end-users, this cluster remains weakly connected to the core decision-making process. Its participation appears sporadic, while tensions are noted around inclusiveness, transparency, tariff justice, and social acceptability.

The institutional centre retains the main levers of decision-making, while civil-society and local actors remain at the margins of the process. The network structure supports the three qualitative dynamics identified in the interviews. First, the concentration of dependency ties around the institutional core confirms the centralisation of decision-making. Second, the position of research, innovation, and private-sector actors as connected but non-dominant nodes reflects their conditional intermediary role: they contribute expertise and implementation capacity but remain dependent on public mandates, funding, or regulatory approval. Third, the weak connectivity of civic and local actors confirms their peripheral position in the governance architecture, which helps explain the limited institutionalisation of consultation and the potential fragility of social acceptability.

4.3. Perceptions and qualitative dynamics of the Actors

Building on this structural interpretation, the thematic examination of the sixteen semi-structured interviews revealed three major qualitative dynamics. These dynamics shed light on the tensions, dependencies, and asymmetries shaping the governance of the AMI project.

4.3.1. Decision-making centralisation and inter-institutional tensions

The interviews highlight a strong concentration of decision-making power within a narrow institutional core, mainly composed of ONEE, MTEED, ANRE, and the Ministry of the Interior. Several respondents referred to overlapping mandates and coordination difficulties, particularly between ONEE and the newly established SRMs, as well as between technical regulators and financial authorities. This siloed mode of governance may hinder coordination and slow down project implementation, especially when institutional responsibilities, regulatory authority, and territorial execution mechanisms are not clearly aligned.

4.3.2. Conditional role of intermediary actors

Intermediary actors, including technological clusters, research centres such as IRESEN and universities, international cooperation actors, and technology providers, occupy a mediating position within the stakeholder network. However, their capacity to influence AMI governance remains conditional upon their alignment with central institutional priorities. While these actors contribute expertise, technical capacity, innovation support, and knowledge transfer, their strategic autonomy remains limited by public mandates, funding mechanisms, and regulatory approval processes.

4.3.3. Marginalisation of civil society and the challenge of social acceptability

Representatives of environmental NGOs, consumer associations, and local authorities reported insufficient involvement in decision-making processes related to the AMI project. The interviews highlight concerns regarding transparency, social consultation, data governance, tariff justice, and public communication. For several interviewees, this limited involvement may weaken institutional trust and affect the social acceptability of AMI, particularly if end-users perceive the project as a top-down technological reform rather than as a participatory energy-transition initiative.

5. Discussion

The findings of this study show that the governance of Morocco's AMI project is structured around a centralised institutional configuration. The relational analysis highlights the predominance of dependency ties, mainly concentrated around the institutional core composed of ONEE, MTEED, ANRE, the Ministry of the Interior, and other public actors involved in energy planning, regulation, financing, and implementation. This configuration suggests that AMI deployment is not only a technological issue, but also a strategic governance process shaped by institutional authority, financial dependencies, regulatory coordination, and uneven stakeholder participation.

From a theoretical perspective, the combination of Freeman's stakeholder theory, Mitchell et al.'s stakeholder salience model, and Crozier and Friedberg's strategic analysis makes it possible to move beyond a descriptive list of actors. Stakeholder theory and stakeholder salience analysis help identify actors according to their power, legitimacy, and degree of involvement, while strategic analysis explains how dependencies, zones of uncertainty, strategic alliances, conflicts, and joint projects structure their interactions. This combined framework, therefore, provides a more dynamic understanding of stakeholder relations in an emerging energy-transition context.

From a practical perspective, these governance levers derive directly from the relational findings. First, because dependency ties are concentrated around the institutional core, multi-level consultation mechanisms involving ANRE, SRMs, local governments, and consumers could reduce coordination bottlenecks and

improve territorial mediation. Second, because innovation and research actors appear connected but weakly integrated into decision-making, open governance platforms involving researchers, regulators, industry players, and civil-society organisations could improve knowledge transfer and policy learning. Third, because civic actors remain peripheral, progressive decentralisation of technical and managerial competencies, combined with training and public information mechanisms, could strengthen trust and social acceptability.

5.1. Limitations

This study has several limitations. First, the sample size remains limited to 16 semi-structured interviews, which is appropriate for an exploratory qualitative design but does not allow statistical generalization. Second, the study focuses on a single national context, which limits direct comparison with other emerging energy systems. Third, several international stakeholders could not be interviewed directly; therefore, part of the analysis of the international cluster relies on secondary institutional reports, which may have affected the depth and balance of the interpretation of international influence and dependency relationships. Fourth, the study does not include a direct survey of end-users or citizens, although their role is central to the social acceptability of AMI. Finally, as the study adopts a cross-sectional design, it captures stakeholder relations at a specific stage of AMI deployment rather than their longitudinal evolution.

5.2. Conclusion

In conclusion, the findings suggest that Morocco's technological modernization of the electricity grid would be strengthened by a parallel institutional and relational transformation. Rather than treating AMI as a purely technical infrastructure, policymakers may benefit from approaching it as a multi-actor governance process involving regulatory coordination, territorial mediation, knowledge transfer, and civic trust-building.

By jointly mobilizing Freeman's stakeholder theory, Mitchell et al.'s stakeholder salience model, and Crozier and Friedberg's strategic analysis, this study links actor salience with power relations, interdependencies, and zones of uncertainty. It contributes to the literature on energy governance by showing how stakeholder mapping can serve as a decision-support tool for identifying coordination bottlenecks, power asymmetries, weakly integrated actors, and potential risks to social acceptability in the deployment of smart energy infrastructures.

Although this study focuses on Morocco, its findings may be relevant to other emerging energy systems where smart-grid deployment is shaped by centralized institutions, donor-supported reforms, regulatory restructuring, and limited citizen participation. Future research should examine how governance arrangements, inter-institutional dependencies, stakeholder influence patterns, and citizen perceptions evolve throughout later phases of AMI deployment.

Conflict of interest

The authors declare no conflict of interest.

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