








Article

Renewable Portfolio Standard Development Assessment in the Kingdom of Saudi Arabia from the Perspective of Policy Networks Theory

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Abstract: Electricity generation from renewable energy (RE) sources has not been well utilized in the Kingdom of Saudi Arabia (KSA). KSA has publicized its Vision 2030 renewable energy target to deploy 58.7 gigawatts of RE, paving the way for a low-carbon economy in the country. Renewable portfolio standard (RPS) may play an influential role as a policy instrument to stimulate the RE development and consumption on a large scale and pursue the Vision 2030 objectives. In this study, the renewable portfolio standards policy assessment was carried out to investigate the issues impelling the employment of or plan to adopt RPS. To elucidate the collaborating interaction amongst the multiple stakeholders at different levels in the formulation of renewable portfolio standard, in this assessment study, we used a multi-theoretical approach for examining the policy networks theory (PNT) to inspect the communication links and strategies of different actors who are responsible and involved in KSA policy formulation and enactment. It will help overcome the interaction limitations amongst the actors, contribute to understanding various actors' behaviors and facilitate RPS development and implementation. In this paper, PNT's four strategy phases (interaction, agenda-setting, action plan and legislative) are used for RPS development assessment. In this paper, we presented KSA's overall systematic picture for RPS formulation to adopt and implement it practically for a collaborative relationship between five actors—policy and regulatory bodies, professional bodies, inter-governmental bodies, power producers and social networks—at different levels by using PNT to analyze the interactive relationship amongst actors. This detailed analysis will help KSA overcome the institutional relationship and interaction limitations of the actors in RPS formulation and thereby offer significant success for RE deployment in KSA, while providing viable ideas, procedures and bases for government departments to formulate applicable policies for the renewable energy system efficiently. The evaluation of the communications among major partakers in the policy network field helps to efficiently explicate the hindrances in policy formulation and enactment to make the RPS more effective.

Keywords: renewable portfolio standard (RPS); policy network theory (PNT); renewable policy; KSA Vision 2030; renewable energy targets

1. Introduction

The energy sector plays a dynamic part in any country's development and, for the most part, in socio-economic activities. With impending oil prices and its major share in the electricity generation sector, countries with higher per capita power consumption are looking forward to opting for alternative energy sources to decrease the high utilization of fossil fuels in their power generation sector and scale up the utilization of renewable energy technologies (RETs), thereby to contribute to sustainable development and climate change objectives [1].

Constantly increasing demand and penetration of RETs in distributed energy generators is shifting the structure of the conventional electric grid to a modern grid [2]. In the first quarter of 2020, renewable energy use increased by 1.5% globally in all sectors, relative to the first quarter of 2019. However, almost a 3% increase in renewable energy electricity generation has been observed because of new solar PV (photovoltaic) and wind projects completed over the past year. Furthermore, in global electricity generation, during the first quarter of 2020, renewables shares jumped to 28% as compared to 26% in the first quarter of 2019. In Figure 1, shares of renewable energy by technology in the first and second quarters of 2019 and 2020 are depicted [3].

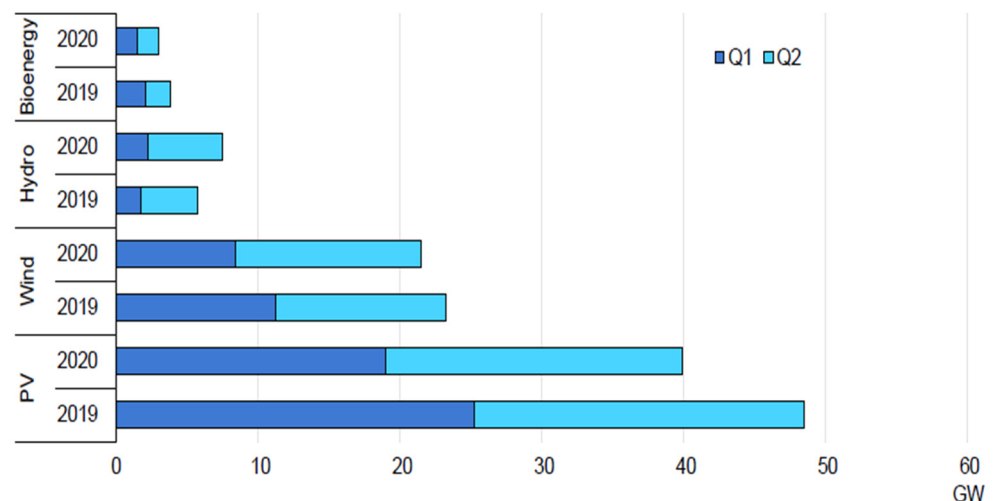


Figure 1. Share of renewable energy by technology (2019–2020) [3].

The Kingdom of Saudi Arabia (KSA) has recognized the importance of a diversified energy mix with the dissemination of renewable energy technologies for its long-term socio-economic success. Therefore, the country's National Renewable Energy Program (NREP) and National Transformation Program (NTP) through the Ministry of Energy, Industry and Mineral Resources have developed a roadmap for the promotion and deployment of RETs to fulfill KSA's electricity demand in the future. On 25 April 2016, KSA for the first time publicized the details of Vision 2030, in which 50% of their electricity from renewable sources was set as an initial target [4].

On 7 June 2016, the Ministry of Energy, Industry and Mineral Resources announced that KSA revised Vision 2030 to cut down the renewable energy deployment target to 10% of power generation from renewables to its energy mix instead of the earlier 50%. The new planned targets were 3.45 GW for 2020 and 9.5 GW in 2023 [5].

For achieving this revised target of 3.45 GW in 2020, in 2018, the Renewable Energy Project Development Office (REPDO) of KSA issued the request for proposal (RFP) for 300 MW grid-connected solar power plant commissioning the city of Sakaka [6] and a 400 MW wind power plant in Dumat Al-Jandal [7]. The request for proposals for 11 pre-developed solar PV projects was underway and scheduled to tender during 2019–2020 with a capacity of 2.225 GW, as depicted in Figure 2.

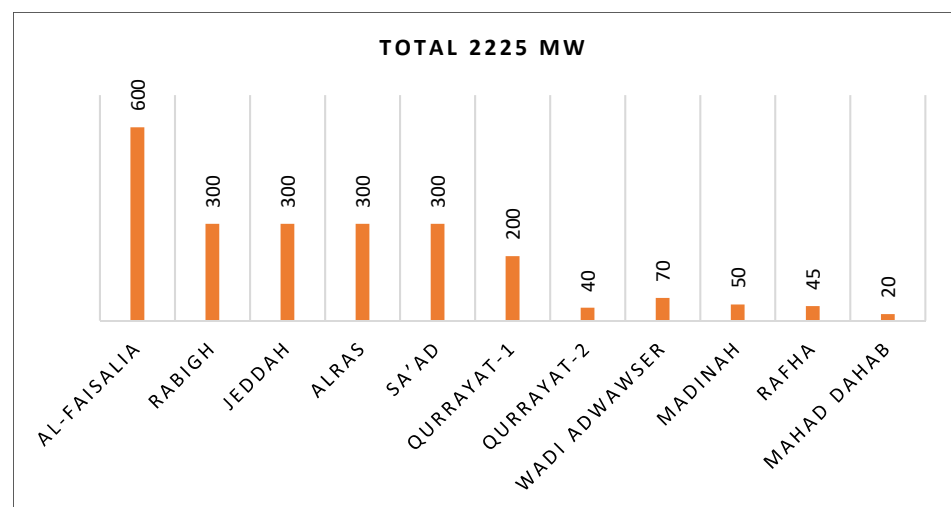


Figure 2. List of 11 solar photovoltaic project tenders in 2019.

On 9 January 2019, the Renewable Energy Project Development Office (REPDO) of Saudi Arabia, for a second time, revised the Vision 2030 targets. In the revised targets, a very high increase was set for RE targets, from 9.5 GW to 27.3 GW in 2023 and an overall target of 58.7 GW in 2030. Of this 58.7 GW, 40 GW are solar PV, 16 GW are wind and 2.7 GW are other RE sources by 2030 [8], as shown in Figure 3.

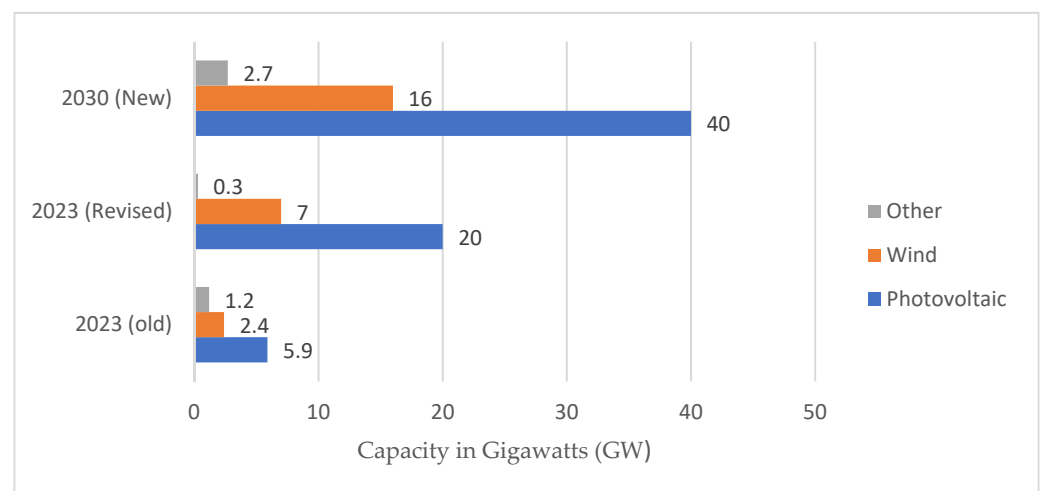


Figure 3. Revised renewable targets of KSA's Vision 2030.

For effective dissemination of RETs, numerous RE policy instruments are formulated and publicized by different countries to accomplish their set targets [9,10]. Renewable portfolio standard is deliberated as an efficacious policy instrument used to nourish the augmented development of RETs in any country [11] as shown in Table 1. The RPS verdicts that not only independent power producers (IPPs) networks but also government-owned electricity generation companies shall generate a specific share or a percentage of their total electricity generation from renewable energies sources such as wind, solar PV, hydropower (mini and micro) and other available alternatives in their system.

Table 1. RE policies in different countries including KSA—comparative analysis.

Country	Regulatory Policies							Fiscal Incentives and Public Financing					
	Renewable Energy Targets	Renewable Energy	Feed-in Tariff/Premium Payment	Electric Utility Quota Obligation/RPS	Net Metering/Billing	Transport Obligation/Mandate	Heat Obligation/Mandate	Tradable REC	Tendering	Investment or Production Tax Credits	Reductions in Sales, Energy, CO ₂ , VAT or Other Taxes	Energy Production Payment	Public Investment, Loans, Grants, Capital Subsidies or Rebates
United States	P ◇		□	□ ◇	□ ◇	•	□	□	○	•	•		• ◇
United Kingdom	E, P, T, HC		• ◇	•		•		•	○	•	•	•	•
Germany	E, P, HC, T		• ◇			•	•	•	○	•	•		• ◇
Canada	P	•	□ ◇	□	□	•			○	•	•		•
China	E, ◇, P, HC	•	• ◇	•		□	•	•	•	•	•	•	•
India	P, HC	•	□ ◇	•	□ ◇	□ ◇	□	•	○	•	•	•	•
Kingdom Saudi Arabia	P	•			•			•					

Abbreviations: E, energy (final or primary); P, power; HC, heating or cooling; T, transport. Symbols: • existing national policy or tender framework (could include sub-national); □ existing sub-national policy or tender framework (but no national); ○ national tender held in 2017; ◇ sub-national tender held in 2017; ◇ new. Source: Renewables Global Status Report 2019.

As the Renewable portfolio standard is considered one of the successful RE policy instruments, it is opted by different states in the USA [12–14], different countries in the EU [15,16], China [17–20] and many other countries for achieving their RE targets. RPS can be regulated with any RE policy according to a country's targets/goals. For maximum effectiveness and impact of RPS, fundamental policy design principles are obligatory to follow.

Presently, the Kingdom of Saudi Arabia has an undeveloped RE market and several RE supporting policies are not yet developed, as shown in Table 1, but KSA is learning from the American, European and Chinese practices. With respect to policy formulation and implementation, there are two approaches: one is decentralized, and the other is centralized. In the second approach, the local community and government bodies, NGOs, power generation companies, research scholars, etc., perform analyses to investigate and discuss basic problems, formulating policies while permitting market sovereignty to play its complete role in the process. However, in comparison to the first decentralized approach, the centralized approach pays more consideration to local sovereignty and lacks a general standpoint, resulting in a deficiency in consistency between policies and governance and indicating noteworthy unfairness. Fundamental for the renewable portfolio standard is the government's realization of the renewable targets for green and sustainable energy development, which is only conceivable with the contribution of multiple partakers. This creates a multifaceted social networking connection, where conventional outdated investigation methods cannot deliver a comprehensive justification of such a dynamic and multifarious policy formulation process for a longer time.

Policy networks theory (PNT) has been used in different public policy development for a long time, and PNT use in renewable energy policy development has also been under greater consideration for the past 2 decades. In [21], renewable energy promotion with consideration and recognition of climate issues is discussed. In the study, an analytical framework proposal was given the local development stakeholders to lead and increase the investment in the renewable energy sector particularly by focusing on the management of the relevant actors' networks. Furthermore, in [22], an idea to scale up the renewable energy development in the perspective of network theory on policy is floated. In their study, the network theory provided the understandings of the complexity of the policy networks for the successful development of renewable energy in the UK. Entrepreneurial innovation behavior enablers or disablers in renewable energy public policy's institutional perspective and its network effects in the industry are investigated in [23]. China's renewable portfolio standards from the perspective of policy networks are proposed in [24]. In their research, a huge increase in solar PV and wind energy installation in China is taken into consideration. In the perspective of PNT, the renewable portfolio is proposed for large-scale renewable energy integration, effectively promoting the targets of renewable energy development in China. Furthermore, the theoretical framework for the renewable energy deployment impact assessment on local sustainability is examined in [25]. This study contributed to the development of an integrated theoretical framework, which allowed a detailed impact analysis of renewable energy on local sustainability.

For multifaceted policy formulation, PNT is used in different countries to develop their road map and to establish fruitful communication between multiple stakeholders involved in RPS policy formulation. In particular, PNT can be defined as a domain where government bodies and other participants are linked by a mutual interest or common means of dependency. The theory of PNT treats the RPS policy as the outcome of the collaboration and involvement of several partakers. RPS–PNT policy development practice is no longer limited to governmental bodies, so the weaknesses of conventional public policy in research could be evaded. The PNT theory highlighted the contribution, involvement and negotiation as well as common trust and teamwork between various partakers while giving acceptable consideration to the efficient policy development process and its characteristics.

Therefore, policy development and enactment following the policy networks theory are more applicable and reliable. Furthermore, PNT advocates for the legalization and democracy of multi-subjective interests in which legalization and democracy cannot be attained by modest guidelines but require common trust and common assistance among the networking partakers. Finally, in terms of a precise investigation process, network execution contains not only structural exploration but also stage investigation to ensure the precise process of policy enactment is appropriate, convincing and more practical. Established on these features, PNT offers an appropriate outline of investigation for research on KSA's renewable portfolio standard development process and widens the research perspective to achieve the Vision 2030 RE targets.

In view of new electricity market reforms and clean energy campaigns in different countries, policy networks are technically established based on different partakers such as the central government and its associated institutions, local governments at all levels, research scholars and experts, electricity generation companies, power grid enterprises, trade associations and the media.

KSA has publicized its Vision 2030 revised targets with very high objectives explicitly for solar PV, aiming for 20 GW and 40 GW of electricity generation from solar PV injected into the national grid by 2023 and 2030, respectively [26]. However, regulatory authorities in KSA are struggling to formulate the national renewable energy policies and other supporting instruments for effective RET deployment and the timely accomplishment of Vision 2030 targets in true spirit. Established on the PNT concept, this study investigates and assesses the institutional structure types and interactions of multiple stakeholders in KSA and presents a detailed discussion of partaker's activities under policy networks theory for the RPS formulation roadmap. This paper could provide considerable support

to KSA in the formulation of RPS policy with the consent of all the partakers in the country to achieve KSA's Vision 2030 renewable energy targets.

1.1. RPS Literature Overview

Many countries such as the UK, USA, Denmark, China, etc., have set the targets to increase the penetration of renewable energy in their total electricity generation system at some percentage. These countries have successfully implemented the renewable portfolio standard for many years to achieve these goals by the target year, as given in Tables 2 and A1 (attached in "Appendix A"). Researchers have been investigating the RPS effectiveness, benefits, challenges and problems that arise during the formulation and implementation of RPS. In 2003, Wisser and Langniss showed an initial assessment of the renewable portfolio standard in Texas to examine its impact on the placement of RETs and observe the competition between power producers from RE resources [24,27]. Employment opportunities after the effective enactment of RPS in the RE sector with its economic benefits were discussed [28]. Additionally, it is proved that after successful implementation of RPS in Texas (USA), CO₂ emission cost per ton was reduced by 11 US dollars [29]. Furthermore, renewable portfolio standard applying cost-benefit analysis in different US states is deliberated in [30–32]. Individual states' renewable portfolio standard implementation years and their targets are given in Table A1 attached in "Appendix A".

Table 2. RPS targets different countries.

Country	RE Target (in %)	Year to Achieve
Netherlands	17	2020
Denmark	50	2020
Japan	21	2030
United Kingdom	20	2020
Australia	20	2020
China	20	2030
Korea	11	2030
USA	State targets are given in Table A1 (attached in "Appendix A").	

Effective enactment of the renewable portfolio standard depends on a country's situation. Many in-depth research investigations have been concentrating on this concern. China's RPS applicability in its power generation system with opportunities and challenges in RE policy implementation are debated in [33]. Furthermore, a study on the RPS impact on Pakistan's energy sector economy and its environmental effect is conducted in [34].

For the effective accomplishment of the Kingdom of Saudi Arabia's Vision 2030 RE targets in true spirit, it is imperative to formulate and disseminate the subsidiary RE policies timely. RPS is weighed as one of the most efficacious policy instruments that is used to foothold the augmented renewable energy technology development in any country. RPS is one of the efficacious policy instruments which is being opted by different states in the US [12], EU countries [15], China [17,18] and many other countries for successful deployment of RE and for achieving their RE targets successfully, as depicted in Table 1.

RPS verdicts that independent power producers (IPPs) networks and national electricity generation companies shall produce a specific share or percentage of their total electricity generation by adding the share of RE in their electricity production using any type of renewable sources such as wind, solar or hydropower (mini and micro) [35].

RPS is an RE policy instrument that can be easily planned and controlled with any RE policy, depending on the targets/goals and policy of countries and regions for maximum impact and effectiveness.

It can be seen in Table 1 that more or less all of the leading countries have picked the RPS for achieving their RE targets. Contrarily, the Kingdom of Saudi Arabia has only RE

policy and tendering in its RE portfolio. Thus, it is vital to investigate and assess the RPS formulation challenges for successful enactment in the world. Based on the assessments, a strawman RPS road map should be proposed to KSA for the efficacious placement of RE technologies and achieving the Vision 2030 targets.

1.2. Data Collection

A wide range of data containing certified documents and archival records were collected to support this study. In addition, KSA laws and regulations, literature and case study reports on the subject of RPS policy have been reviewed to learn about KSA's internal conditions and external constraints that help shape the setting of the RPS policy roadmap. To develop a comprehensive data collection strategy, the 'Good Practice Model' comprising all the relevant policy areas was adopted. This data collection strategy is designed in two phases:

In the first phase of mapping, we planned to analyze the available data within KSA as well as outside it. For this purpose, we opted five steps for data collection and analyses, as depicted in Figure 4.

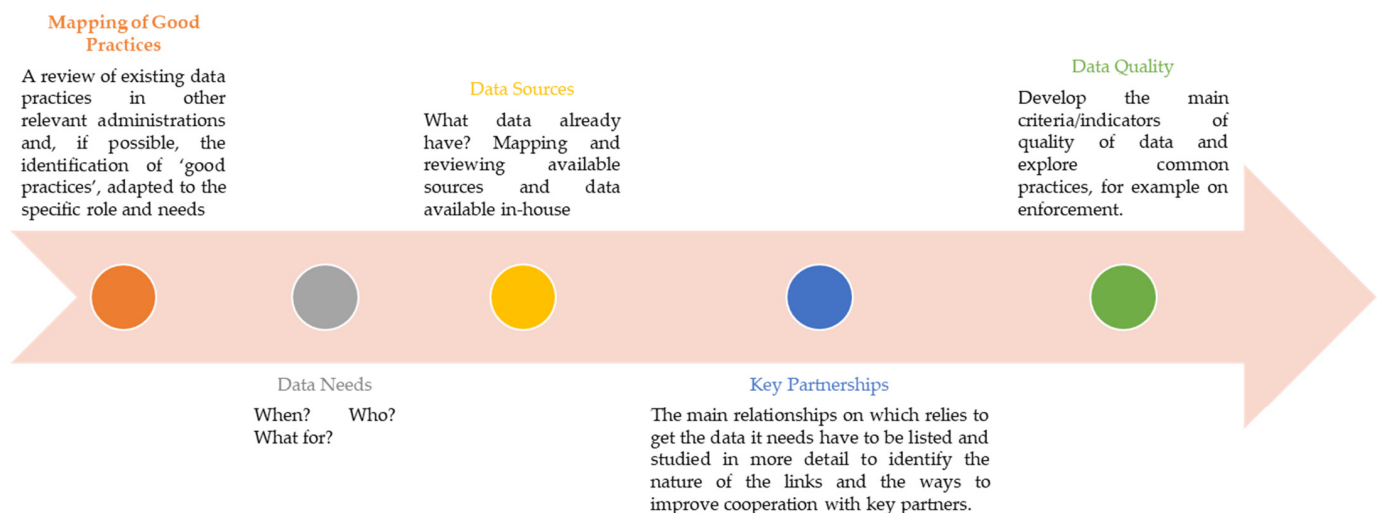


Figure 4. Data collection steps.

In the second strategy phase, the outcomes of Figure 4 are combined and developed into a comprehensive and coherent strategy by following the policy network theory in Section 3 that can then be transferred into an action plan to be implemented accordingly.

In the Kingdom of Saudi Arabia, the former Electricity and Cogeneration Regulatory Authority (ECRA), now changed to the Water and Electricity Regulatory Authority (WERA), is a government body with the mandate to implement the electricity and water desalination rules and regulations in KSA with the support of other state and provincial institutions. In Table 3, a list of current available policies and regulations on electricity generation, transmission and distribution in the Kingdom of Saudi Arabia is given, and in Table 4, reviewed international policies and standards are given.

Table 3. RE supporting policies, standards, regulations and codes in the Kingdom of Saudi Arabia.

Document	Type				Organization	Year	Status		
	Policy	Regulation	Standard	Code			In Force	Proposed	Expired
Small-Scale Solar PV Systems Regulations		✓			Electricity and Co-generation Regulatory Authority	2017	✓		
Technical Standards for the Connection of Small-Scale Solar PV Systems to the LV and MV Distribution Networks of SEC			✓		Saudi Electricity Company	2018	✓		
The Electricity Laws		✓			Electricity and Co-generation Regulatory Authority	2007	✓		
The Saudi Arabian Distribution Code				✓	Saudi Electricity Company	2011	✓		
Saudi Arabian Grid Code				✓	National Grid Saudi Arabia	2017	✓		
The Saudi Building Code Electrical Requirements				✓	Saudi Building Code National Committee	2007	✓		

The list includes the policies, regulations, standards and codes issued by the respective organization at the time of submission of this manuscript. However, the aforementioned documents may be subject to future amendments, revisions or extensions.

Table 4. Worldwide RPS standards and their status.

Policy	Country	Year	Status		Jurisdiction	
			In Force	Ended	State/Provincial	National
Prince Edward Island Renewable Energy Act	Canada	2016	✓		✓	
Renewable portfolio standards: Law on the Sixth Five-Year Economic, Cultural and Social Development Plan for 1396–1400 (2016–2021)	Iran	2016	✓			✓
Vietnam Renewable Energy Development Strategy 2016–2030 with outlook until 2050 (REDS)	Vietnam	2016	✓			✓
Renewable Portfolio Standard (RPS)	Korea	2012	✓			✓
Renewable Portfolio Standards (5000 MW RE Power in 2020)	Iran	2012		✓		✓
Rules and Regulations for Implementing the Renewable Energy Act	Philippines	2009	✓			✓
Nova Scotia Renewable Portfolio Standard	Canada	2007	✓		✓	
Renewable and Energy Efficiency Portfolio Standard—Illinois	United States	2007	✓		✓	
New Brunswick Renewable Portfolio Standard	Canada	2007	✓		✓	
Prince Edward Island Renewable Portfolio Standard	Canada	2006		✓	✓	
Nevada Energy Efficiency Obligation	United States	2005	✓		✓	
Renewable Portfolio Standard—Nevada	United States	2005	✓		✓	
Renewable Portfolio Standard—Colorado	United States	2004	✓		✓	
Strategic Plan for Renewable Energy Development: 8% Target	Thailand	2004		✓		✓
Green Power: Renewable Portfolio Standards (RPS)	Japan	2003		✓		✓
Renewable Portfolio Standard—California	United States	2003	✓		✓	
Renewable Portfolio Standard—Massachusetts	United States	1997	✓		✓	
State-level Renewable Portfolio Standards (RPS)	United States	1983	✓			

The list includes the policies, regulations, standards and codes issued by the respective organization at the time of submission of this manuscript. However, the aforementioned documents may be subject to future amendments, revisions or extensions.

2. Theoretical Framework and Method

Initially, the policy networks theory was introduced in the 1950s in the United States (US). As a result of improved complexities and variation of the contemporary policy environment, PNT attracted the attention of policymakers and become the mainstream model for research in the policy formulation process for many other Western countries such as the UK, Germany and the Netherlands [24]. Due to cultural and political infrastructure differences across the US and Europe and dissimilar viewpoints amongst the different countries' research scholars on policy networks, PNT went through macro-and micro-progressive modifications and ultimately has three well-established dominant areas of policy networks study in the UK, EU and US.

In the United Kingdom, researchers take a meso-level perspective, whereby policy networks are observed as mediators of concern in revealing the association among government bodies and other stakeholders. US researchers, on the other hand, mainly emphasize the micro-level perspective of the association among several stakeholders, with research as the primary source, and government bodies consider it at the secondary level. Scholars in European countries, specifically the Netherlands and Germany, have a macro-level perspective approach for PNT, stressing collaboration amongst the government bodies and civil community. Although different institutes have diverse insights and explanations of policy networks, all are agreed on one point: that the policy formulation procedure is an uninterrupted communication process amongst stakeholders.

Presently, the well-known academic definition of policy networks is given by the British scholar Rhodes. Rhodes portrays the policy networks as "bunches of persons or multifaceted administrations linked with each other by means of dependencies and parted from the other bunches by a structural breakdown in the means of dependencies" [36]. It summarizes all sorts of interactions amongst those involved in policy development. PNT has become an effective model for studying policy formulation practices. This paper shapes PNT as networks formed by government bodies and related independent partakers who are codependent by means of common resources and interests. Their association is diverse and dynamic. In PNT, Rhodes classified five network types built on their different combinations, numbers of partakers and deployment of resources. Ranging from loosely to highly integrated systems, these five classified network types are the policy and regulatory bodies networks, professional bodies networks, intergovernmental bodies networks, power producer networks and social networks, as presented in Table 5.

Table 5. Policy network theory model classification by Rhodes.

Policy Network Body Type	Partakers
Policy and regulatory bodies networks	The central government departments.
Professional bodies networks	Professional regulatory bodies who protect the common interests of professionals.
Intergovernmental bodies networks	The provincial government and its departments.
Power producer networks	Government and independent power generation companies.
Social networks	Social networks, NGOs and INGOs.

The features of policy networks theory that are initially required to conduct the assessment and formulate the renewable portfolio standard are explained in detail below:

First, in PNT, various groups of partakers including utilities providers, government bodies, research scholars, the media and specialists are involved. These actors play different roles according to resources and scopes in networks.

Second, different partakers are contingent on each other. As an example, power producers need to completely understand policies and RPS targets to transform them into a successful investment plan, while regulatory and intergovernmental bodies networks want the feedback of power producer networks and other partakers.

Third, in the networks, there must be constant communication among the different partakers. Under renewable portfolio standard policy, partakers must cooperate continuously to safeguard the appropriate running of the market. These communications are not restricted to once or occasionally in the system.

In the perspective of KSA's Vision 2030, renewable energy deployment and new electricity market reforms to formulate KSA's renewable portfolio standard requires different partakers to coordinate and cooperate based on shared resources and interests. Relationships amongst the network bodies and partakers have an imperative influence on the partakers' participation in the policy formulation process and the enactment of the RPS. To examine the relationships between different partakers under RPS in the Kingdom of Saudi Arabia, by using the PNT approach, this paper develops the framework for an appropriate communication system.

To form policy networks for renewable energy targets, this study first defines the network partakers with their scope, size and limitations. This all helps in the establishment of the foundation for research using the PNT methodology. However, these elements also cause challenges in the solicitation of the network theory method. In terms of renewable portfolio standard, this study examines the development of RPS to categorize the partakers and other basic factors, while taking into consideration KSA's situations. According to Rhodes' PNT classifications, KSA's RPS policy network is divided into five major groups: policy and regulatory bodies networks, professional bodies networks, intergovernmental bodies networks, power producers networks and social networks. Figure 5 shows the complete KSA RPS-PNT network with partakers.

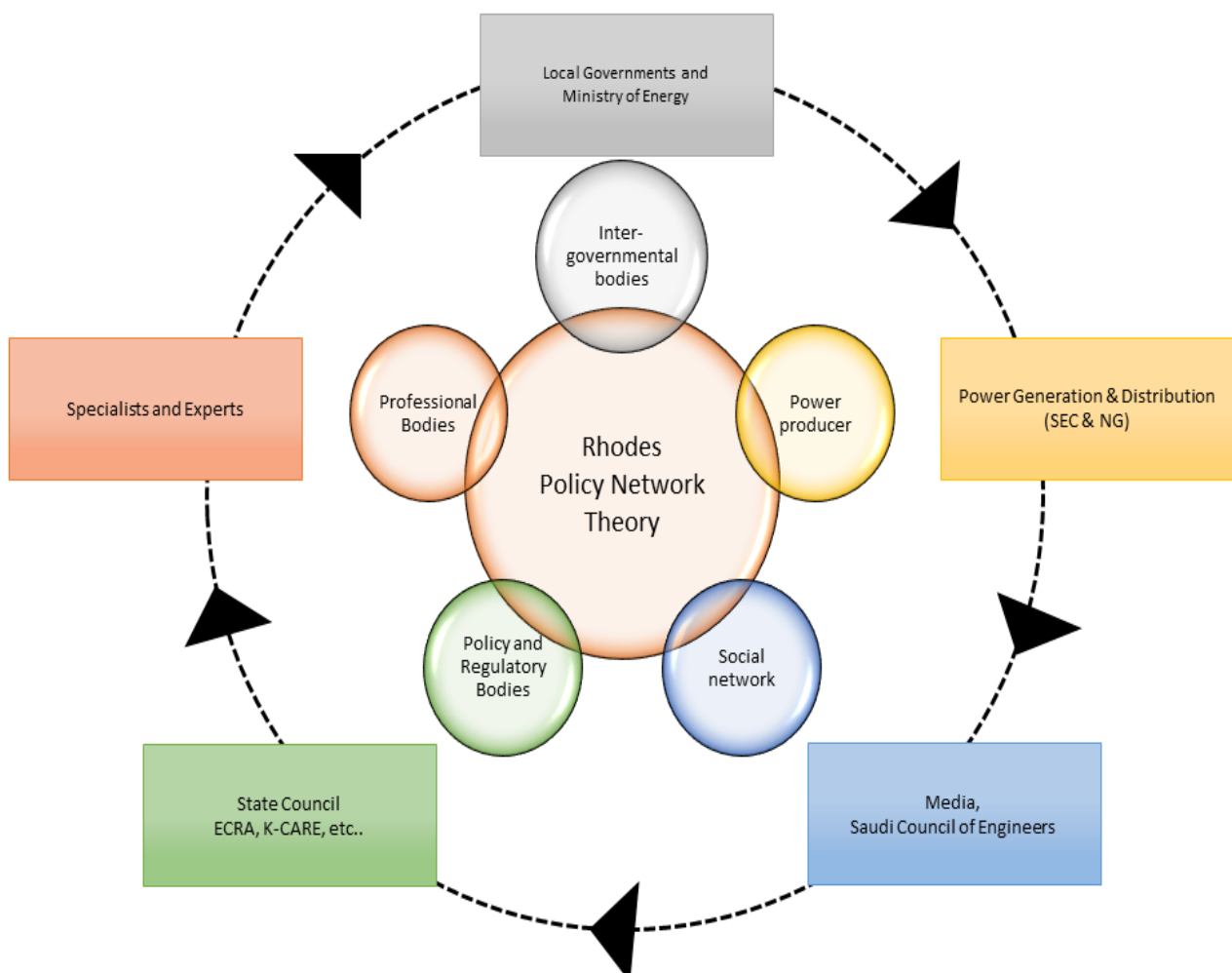


Figure 5. RPS policy network theory model for KSA according to Rhodes' policy network theory model.

RPS policy networks study commences with the classification of different network partakers followed by their position, role and discussions of each. To achieve RPS policy goals, this paper also inspects the particular network's internal structure, which is an essential part of constant and stable communications amongst the different partakers, as well studies the relationship and structure of different networks within the RPS policy networks framework. Partakers' official structures and affiliations can be re-adjusted with the governmental infrastructural changes to accumulate relevant knowledge. To achieve the stipulated policy aims, RPS policy networks require continuous modifications. Such modifications can affect the strategies and action plans of partakers in the networks and, as result, influence the RPS policy outcomes. The outline of communications amongst different networks can change from a decentralized system to a single or multi-center as well as an interdependent and long-term pattern. Different partakers in the networks cooperate and build collaboration with each other for the establishment and implementation of RPS.

3. Findings and Discussion

The renewable portfolio standard includes interacting and exchanging resources between multiple partakers and the demands of other partakers. The analysis of the interactions, structure and type of partakers is usually carried by the application and scope of the policy network theory, which is advantageous to demarcate the decision-making process amongst such partakers in multilevel structures.

3.1. RPS Policy Network Partakers Analysis

RPS policy network includes but is not limited to the following partakers: government, universities and power enterprises, in addition to other numerous entities. The differentiation between the roles of each entity is controlled by the constraints on resources, different target strategies and different interests. This paper divides the policy networks in KSA into five divisions: policy and regulatory bodies networks, professional bodies networks, intergovernmental bodies networks, power producers and social networks.

3.1.1. Policy and Regulatory Bodies Networks

In the case of the current Saudi administrative system, legislature agencies and administrative agencies, who enjoy a high degree of autonomy and a high level of authority, represent the policy and regulatory bodies networks. In terms of the renewable portfolio standard, the Renewable Energy Project Development Office (REPDO) is in charge of the draft and oversight. After revision, REPDO consults other relevant government agencies such as the Ministry of Environment, Water and Agriculture (MOEWA), Ministry of Finance (MOF) and the Electricity & Cogeneration Regulatory Authority (ECRA), with the last entity being responsible for the supervision of power enterprises. During the formation period of the RPS design, tension and disagreement ruled due to the responsibilities being unclear at the time. However, the interests of the partakers started to gradually unify after a certain framework of interaction had been established and the number of partakers decreased. To summarize, governmental agencies represent the major partakers in the policy and regulatory bodies networks in the Kingdom of Saudi Arabia, including REPDO, MOF, ECRA and the Ministry of Energy (MO-ENERGY).

3.1.2. Professional Bodies Network

The role that knowledgeable, multidisciplinary and professional academia can offer is precisely what is required in research on RPS. Despite a scholar being for or against RPS, their knowledge, expertise and skills are considered part of the professional network. This network went through the following phases during the different development stages of RPS:

- During deliberation on RPS, the academic community provided different viewpoints that helped in providing robust and exhaustive theoretical support for the develop-

ment of RPS since no consensus had yet been reached, thus leading to well-balanced, broad-minded and orderly development.

- During the preparation of RPS through policies, scholars switched to speculative research on the intentions of such policies and abandoned independent research. This led to constant decreases in the volume of academia until it lost its voice.
- During the promotion of RPS, the academia regained its influence and vigor by participating in the discussion, thus participating in the decision-making process indirectly.

3.1.3. Intergovernmental Bodies Networks

In KSA, policies are implemented in the intergovernmental networks, which are comprised of the agencies and the bodies of local governments. This network is quite active in interacting with other partakers in the network and can be described as interdependent.

On one side of the argument, the local government is tasked with the implementation of the policies initiated by the central government, thus necessitating the unity of both governments in terms of political stances. For example, when the National Transformation Program (NTP) and the National Renewable Energy Program (NREP) were launched by the central government, the local governments in all of the Saudi provinces adopted similar programs and initiatives to support the central government's initiatives.

On the other hand, local governments are focused on other interests such as the growth of the local economy. Major actors in the power production industry felt that the expansion of local government power in implementing RPS will lead to a decrease in their profits. Such a decrease will lead to an overall reduction in the growth of the local economy, thus increasing the probability of collusion of local governments and the power production industry since they both, in essence, share the same goal. In addition, there will be an increase in the workload of the local government when RPS will be launched in terms of having to be more involved in regulation and oversight, thus leading to a general decrease in enthusiasm for RPS implementation.

3.1.4. Power Producers Networks

This network represents an increasingly crucial element in implementing and designing new policy because it serves as a bridge via which participation of different interest groups in policymaking and should not be used as a tool for conflict and contest. If this network is robust, it will help in the formation of helpful alliances between all partakers which are needed for the smooth implementation of RPS.

This network in KSA is composed of power generation companies that are considered to be the major players in the energy sector, which include but are not limited to Saudi Electric Company, Saline Water Conversion Company, International Company for Water and Power Projects, Rabigh Power Company Ltd., Jubail Water and Power Company, Saudi Aramco, Tihama Power Generation Company Ltd. and King Abdullah City for Atomic and Renewable Energy (K.A.CARE).

3.1.5. Social Networks

This type of network is complex in composition and includes numerous partakers such as trade associations, media groups, coalitions and even individuals. What makes this network special is that it has no certain or definite scope of interests because it is not tightly structured and because of the freedom of participants in accessing or withdrawing such network.

The main role of this network lies in the dissemination of information when and if policies are to be implemented. This network has the ability to choose between integrating with the policy network in the RPS or dissention. Since this network is always changing, conflicts will always exist and the value of any participant in this network is subject to the ebb and flow with time. In addition, the rise of new conflicts and demands leads to the formation of other social networks that seldom correspond with each other and the intensity of such correspondence is not consistent.

3.2. RPS Policy Network Partakers' Interactions Analysis

In this paper, the interactions of the major parties in renewable energy are examined during the four stages of policy formation which are:

1. The construction (definition) stage;
2. The setting of agenda stage;
3. The action planning stage;
4. The legalization stage.

The interactions examined in this study include confrontation, competition, cooperation and alliance formation. The behavioral changes in the process of decision-making among the partakers of KSA's renewable energy system can be effectively highlighted by the use of policy networks as well as revealing changes in the interests of such partakers.

3.2.1. Networks' Interactions during the Definition Stage

Two-way interactions and one-way contact cohabitated among the networks during the definition of the RPS policy question. At that time, the opinion of the latter four divisions (i.e., issue, intergovernmental, producer and professional networks) was sought by the policy community. The professional network provided the policy community with an accurate and balanced description of renewable portfolio standards, which elaborated on the scope of RPS and the entities subject to it, based on the evaluation of initial RPS results. Simultaneously, the policy community (i.e., the government) enhances the definition of the targets of RPS as well as its concept via the social network, which did not have an effective communication channel with the producer network. Since the policy community took the dominant role in defining RPS, the other networks did not have significant input in defining most of the details. This led to strengthening the communication channels and interaction between the latter four networks, thus increasing mutual understanding.

The partakers started interactions with each other during the definition of policy questions stage, and since the policy community had not constructed a methodology for participation, the interactions between the other networks were top-down and one-way. Some two-way interactions did occur but did not produce significant results and were of low frequency. In Figure 6, the phase interaction pattern is described.

3.2.2. Networks' Interactions during the Setting of Agenda Stage

With RPS already having gained a bit of momentum and attention at this stage, members from all levels of society became involved in the setting of the agenda, especially partakers from the power production sector. However, due to the discussion of RPS being in its infant stage and the numerous uncertainties, the interactions between the policy community and the other networks were superficial. This was also reinforced by the fact that RPS had not yet been transformed into an actionable reality. With a monopoly on information and a high degree of autonomy at this stage, the policy community enjoyed most of the power, unlike other networks that lacked the information to take an informative action, thus resulting in the aforementioned superficiality. In Figure 7, the interaction stage pattern is given.

3.2.3. Networks' Interactions during the Action Planning Phase

At this stage, there was slight gaming or divergence between the intergovernmental network and the central government. On one hand, partakers in the policy community took control of dictating the policies of RPS since they held the administrative power wholly and the legislative power partially. At the same time, partakers in the intergovernmental network, represented by the local governments and their agencies, were tasked with the implementation of the central government's RPS policies and regulations. Due to this relationship, the stances of both networks had to be consistent and unified. On the other hand, local governments had to sometimes implement contradicting policies to the central government in order to protect local interests.

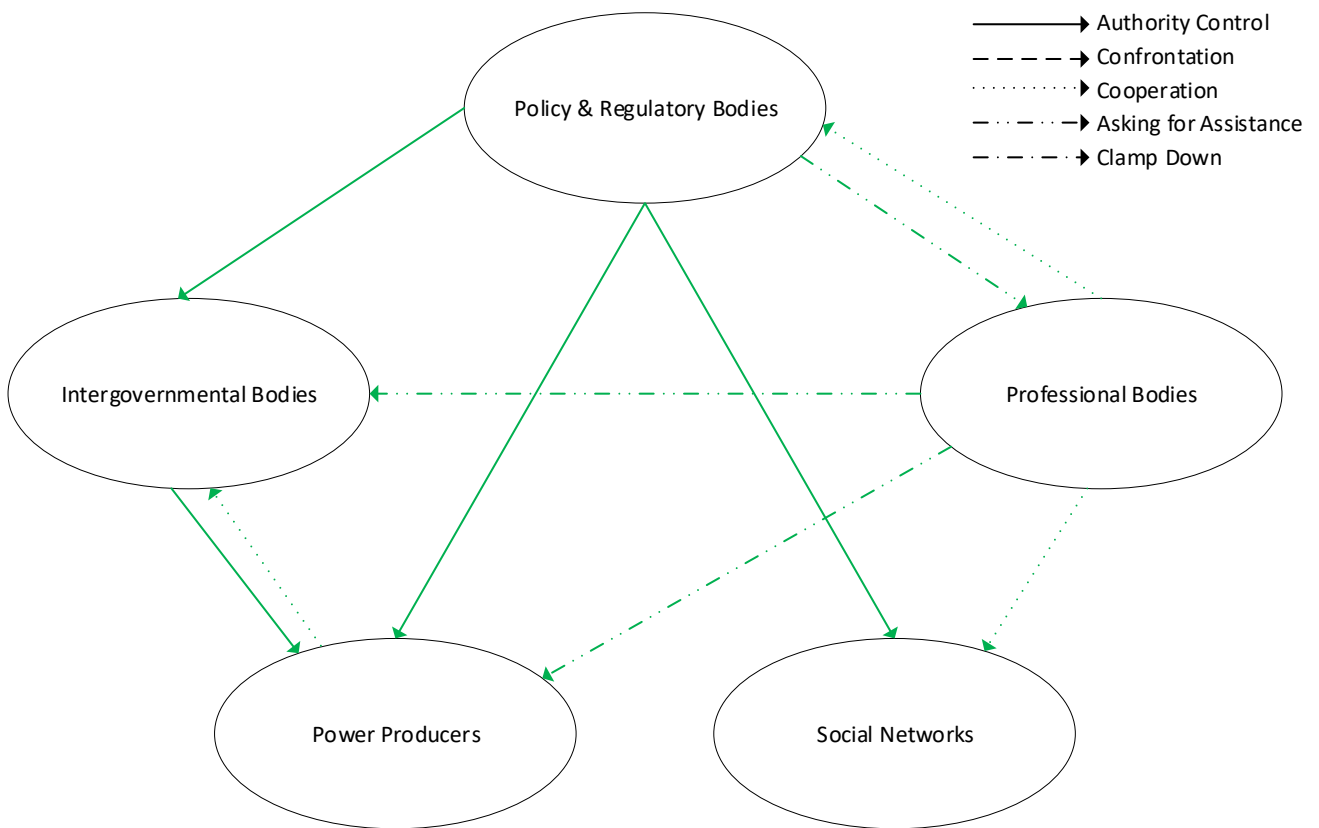


Figure 6. RPS-PNT definition interaction phase diagram.

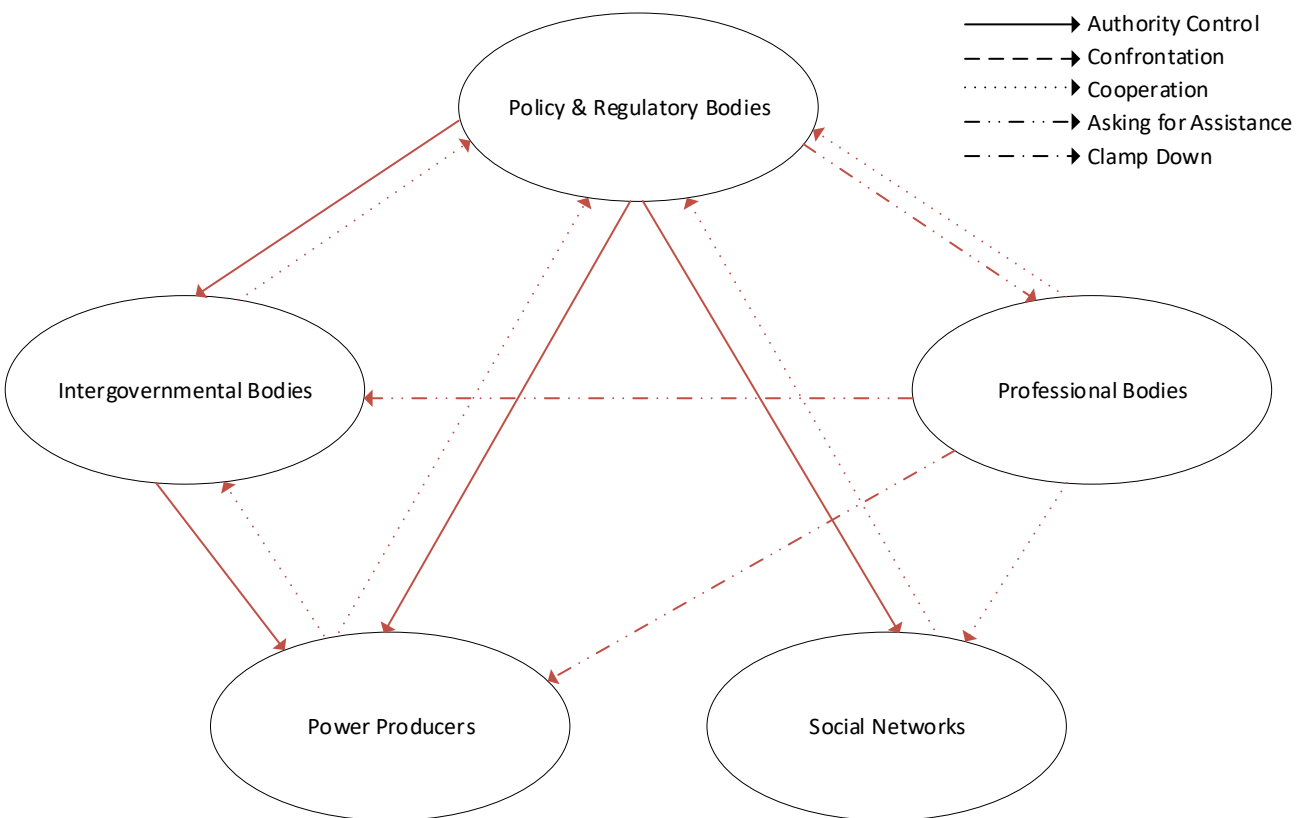


Figure 7. RPS-PNT agenda setting interaction phase diagram.

Despite the producer network being under the absolute authority of the policy community, the former could influence the latter by the utilization of unblocked and effective channels to protect the interests of its members, such as in the case in fighting the implementation of some of the RPS to protect certain power sectors that would have its profits diminished by such implementation.

The social network, despite it being somewhat overwhelmed by the occupation of an important position by the policy community, could still in fact exchange expertise, knowledge and information sources in an attempt to protect its interests or the interests it may represent, which can act as an interest safeguard or a form of checks and balances.

Intergovernmental networks usually own the majority of shares in power companies through enterprise entities that are state-owned in order to facilitate governance and to achieve capital gains, as well. In addition, power production companies greatly contribute to the local economy. This means that the relationship between local government and the producer networks is mutually beneficial. To summarize, local governments would support and pay attention to the development of power companies and the power generation companies would grow their business and financial sources with help from the local governments, forming a symbiotic relationship where the interests of both networks converge and benefit each other during this stage of policy formation.

The relationships between local governments, professional and social networks during this stage of policy formation were complicated. Firstly, the governance of local governments could be improved by the support that would be drawn from trade associations and the media. In addition, the local governments sought cooperation and consultation from specialists, the media and trade associations to ensure a balance between healthy development and optimization of interests. On another note, the partakers in the social network exerted pressures via various legitimate channels, when met with the challenges of RPS, on the local governments, seeing them as an extension of the central government authority. Regarding the producer network, its influencer was able to maintain a positive public image by gaining support and expertise from the issue and professional network, while those two networks pressured the government to protect their interests in the context of worse environmental pollution. All of these interactions between the networks led to turmoil and disunity between the issue and professional networks, thus causing them to be of no match to the strength of the producer network. In summary, the interactions between the networks were numerous and complicated at this stage, as previously stated. In the action plans phase, different networks frequently interacted with each other, as shown in Figure 8.

3.2.4. Networks' Interaction during the Legalization Stage

It is worth noting that during this stage of policy development, networks were more mature and developed than earlier stages. The advancement of RPS's leading role continued to be occupied by the policy community. It communicated with the producer, intergovernmental and social networks through one-way channels and in a top-down fashion while the professional community kept its communication with the central governments, but at this stage, it had nothing of substance to add compared to the action planning stage. Furthermore, the issue and professional networks pivoted towards addressing problems that arose from actually implementing RPS policies. The role played by the social network, especially unofficial media, was extraordinary in providing news coverage of the RPS policies in a fashion that was sensational, vivid, summarized and often critical, which led to wide and heated social discussions. Professional networks provided the governments with knowledge and participation in the decision-making process, often in the form of think-tanks. To summarize, the connections between the networks in this stage existed, but were not of substance. In this phase, contacts amongst the networks occurred but were not practical (please refer to Figure 9 for details).

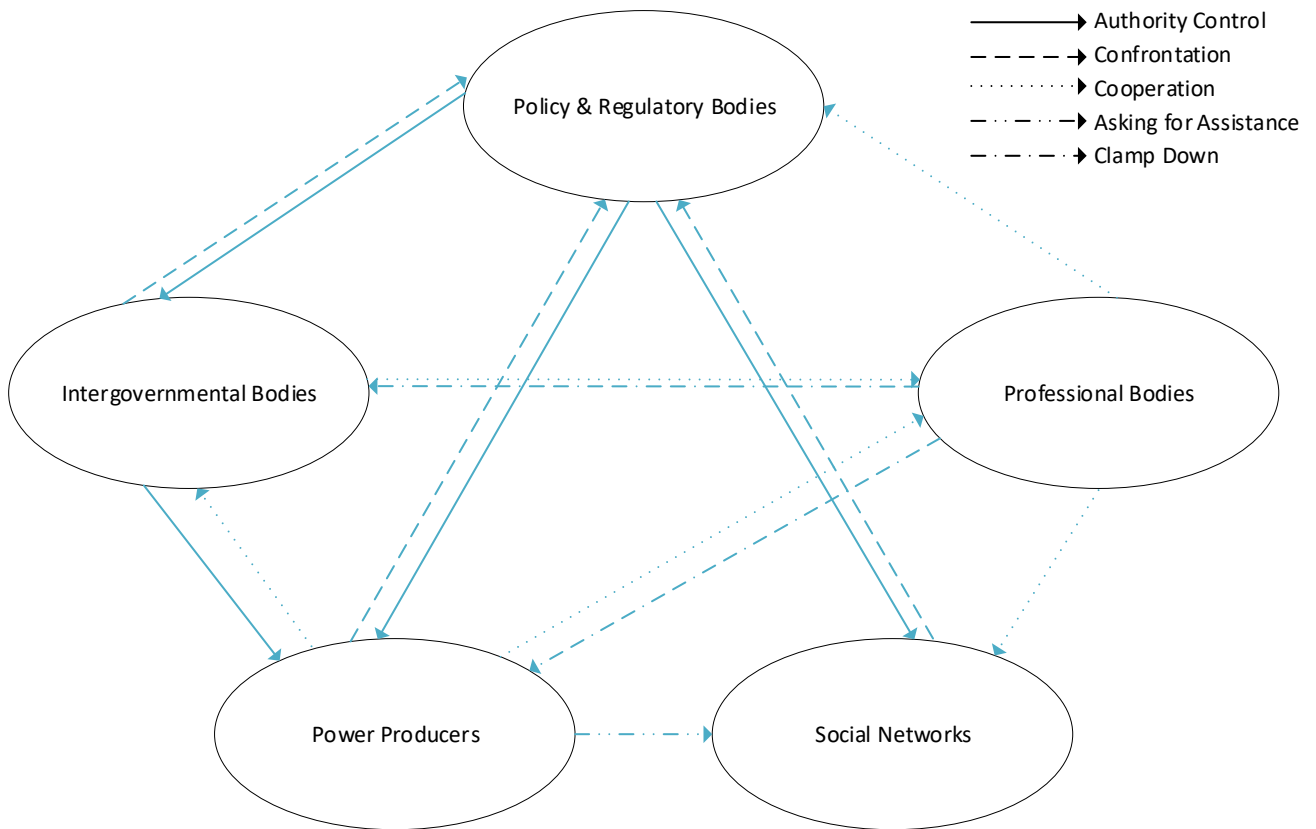


Figure 8. RPS-PNT action plan phase diagram.

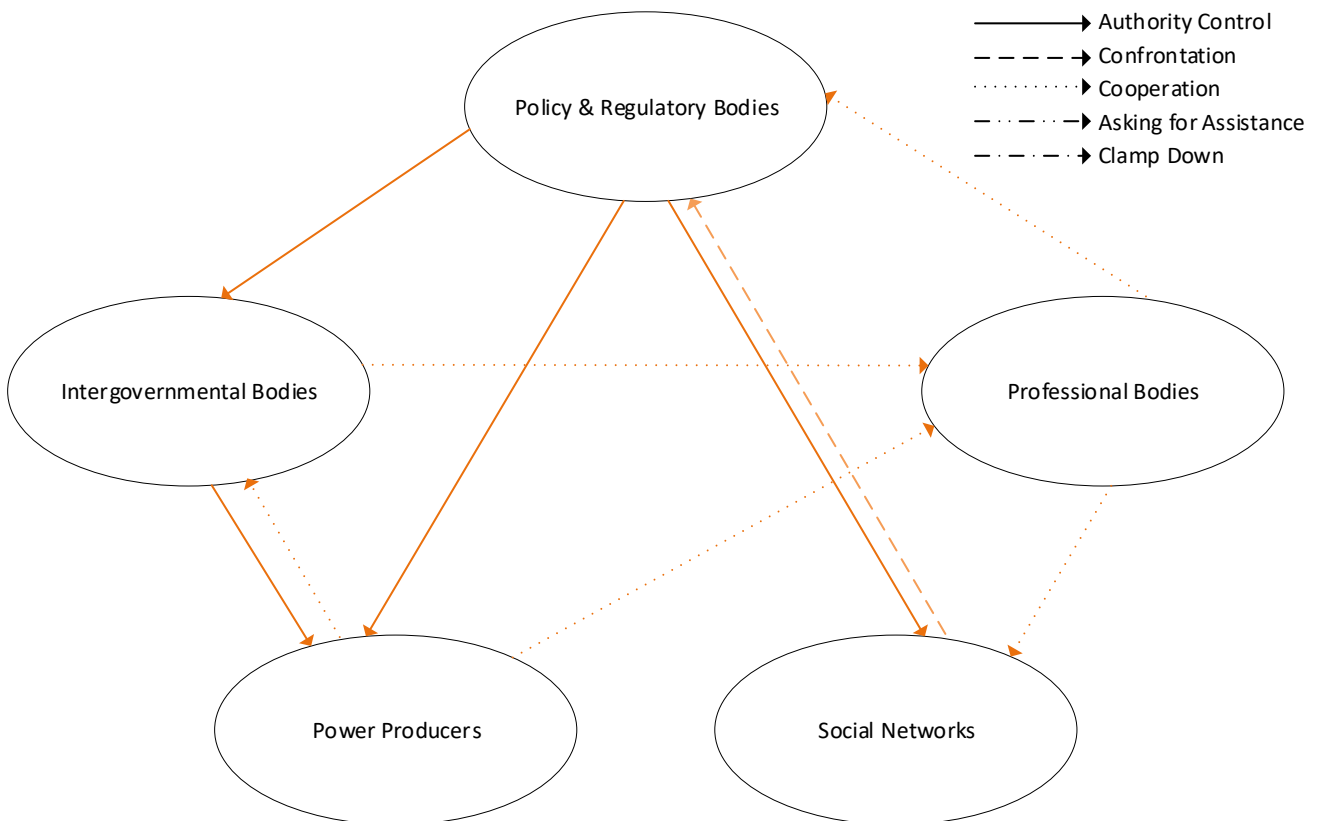


Figure 9. RPS-PNT legislative interaction phase diagram.

3.3. RPS Policy Networks Structure Analysis

The policy network structural features refer to the modes of formed communication articulated by partakers in a network based on requests and interests via repeating interactions. Different policy networks have different structures, forms and codes of conduct since their partakers have different focuses and interaction modes. In order to understand the policy networks' characteristics, network integration and openness represent the key measures to such understanding. This research analyzes renewable portfolio standards of the power production market utilizing those concepts.

3.3.1. Openness

Network openness represents an essential indicator in the assessment of the communication and cooperation intensity levels between the partakers and external entities. In addition, it is used as one of the two significant descriptors of policy networks, as stated earlier.

During the deliberation period of the RPS, the entry barrier was high where few experts and specialists were allowed to enter the policy networks as think-tanks. Other partakers had limited information and request channels and were excluded. The policy network was hierarchal and stable in structure. Such stability was stemmed from the convergence of interests and values between partakers in the network during the initial stage. The RPS development was controlled by the policy community during the initial stage since it had a monopoly over the available resources and a high degree of authority.

During the preparation period, renewable portfolio standards became a professional topic and more important in terms of renewable energy and environmental protection development as well. During the RPS policy decision, the policy community changed its decision-making from a mode that was authority-based to a mode that was more based intellectually. In addition, the central government started lowering the barriers of entry to include experts and specialists and sought their advice based on research. Furthermore, the policy community exchanged information and resources with producer and intergovernmental networks as well as allowed academics to engage in the discussion of RPS since its implementation was forecasted to cause disunity in opinions and interests. During this stage, the structure of the networks started loosening from within since the resources started being shared between them, which increased the flexibility, as well. In addition, as the rate of exchange and interactions increased between the networks, the process pivoted from being controlled by a single network to be more inclusive and based on resource adjustment and integration.

When the time came to the promotion of RPS in the third stage, the structure of the network had become looser and less defined hierarchically compared to the first stage. This led to the formation of alliances between stakeholders of different networks. Furthermore, the network barriers started to overlap, which led to the connection of all partakers in an open structure, which was also helped by the divergence of interests as interactions increased.

3.3.2. Integration

Integration includes the unity of values, the consistency of goals and the level of integration of information within policy networks. It represents the result of cooperation and interaction between the partakers in a network. A network is considered to have a high degree of integration if the partakers within its umbrella can transcend the original network and form a united network that shares the strength, interests and goals in a dynamic fashion, which in turn leads to the RPS undergoing continuous evolution.

During the deliberation of RPS, the central government was quite close to finalizing the structure. However, this changed during the latter two stages due to an increase in interactions, resource sharing and participation among other networks, which resulted in a decrease in the integration level. For example, intergovernmental and producer networks were not able to converge on one point of the RPS policies stated by the central

government during the promotion period. However, after a system of checks and balances was reached during the final stage, the level of openness increased and equilibrium was reached, thus leading to an overall increase in integration.

Finally, the structure changed from closed to open and from loose to integrated as the interaction and exchange of resources increased, which led to the policy community adopting a less assertive attitude that allowed a higher degree of coordination and interaction between the networks with the intention of creating a stronger, more balanced and more integrated structure in order to result in an overall improved RPS policy.

4. Conclusions

Renewable portfolio standard is a policy instrument that has been successfully implemented in several European countries, individual US states, China, etc. Likewise, many other countries are in the process of designing RPS.

For the long-term and rapid development of the photovoltaic industry in KSA, RPS can play an important role. RPS formulation and analysis of the strategic communications amongst partakers could provide a vital reference and it would be valued both theoretically and in practice. There are several stakeholders in every process of RPS formulation and implementation phases. They interact with each other and exchange resources on different issues.

To better analyze the communication and interaction strategies throughout the whole process of RPS, this study developed a policy networks theory model for RPS formulation and split it into five classified network types, which are policy and regulatory bodies networks, professional bodies networks, intergovernmental bodies networks, power producers networks and social networks. By examining the network partakers, institutional structure and interactions, in this paper, we presented KSA's overall systematic picture for RPS formulation. This study also defines major partakers' roles in the RPS–PNT system and discusses their strategies, goals and interests.

RPS enactment will have a significant impact on major partakers' decision-making behavior. In this study, PNT detailed analysis was conducted, which will provide a reference to major partakers in KSA's electricity market and help them in optimal decision-making. The analyses of the communications amongst the major partakers in the RPS–PNT field would help in efficiently explain the hindrances in RPS formulation and enactment and to implement KSA's Vision 2030 RE targets successfully in true spirit.

In this study, the policy networks theory provides information on the serious considerations in designing RPS. Therefore, it is too early to evaluate the successful formulation and implementation of RPS as a mechanism in the Kingdom of Saudi Arabia.

In addition, based on policy networks theory study to formulate the RPS for the Kingdom of Saudi Arabia, we propose some recommendations when implementing the RPS policy:

First, at the commencement of RPS enactment, partakers should continue interacting with each other to better understand the issues and barriers during the implementation of RPS.

Second, to encourage the development of the photovoltaic industry in KSA, partakers should consider increasing the RPS quota proportion appropriately to promote PV grid integration, reduce PV power curtailment and improve PV power utilization.

Third, to improve the efficacy of RPS policy in the Kingdom of Saudi Arabia, partakers should vigorously promote transformation in the existing power system infrastructure of KSA, establish a seamless competitive market and improve relative market mechanisms.

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Appendix A

Table A1. State RPS targets in the US.

States	Year of RPS Implementation	Initial Target (in %)	Year to Achieve
Arizona	2006	15	2025
California	2002	44	2024
Colorado	2004	30	2020
Connecticut	1998	44	2030
Delaware	2005	25	2025–2026
Hawaii	2001	30	2020
Illinois	2001	25	2025–2026
Indiana	2011	10	25
Iowa	1983	105 MW of generating capacity for IOUs.	
Kansas	2009	20	2020
Maine	1999	80	2030
Maryland	2004	30.5	2020
Massachusetts	1997	35	2030
Michigan	2008	15	2021
Minnesota	2007	26.5	2025
Missouri	2007	15	2021
Montana	2005	15	2015
Nevada	1997	50	2030
New Hampshire	2007	25	2025
New Jersey	1991	50	2030
New Mexico	2002	40	2025
New York	2004	70	2030
North Carolina	2007	12.5	2021
North Dakota	2007	10	2015
Ohio	2008	8.5	2026
Oklahoma	2010	15	2015
Oregon	2007	25	2025
Pennsylvania	2004	18	2020–2021
Rhode Island	2004	14.5	2019

Table A1. Cont.

States	Year of RPS Implementation	Initial Target (in %)	Year to Achieve
South Carolina	2014	02	2021
South Dakota	2008	10	2015
Texas	1999	5880 MW by 2015; 10,000 MW by 2025 (goal achieved).	
Utah	2008	20	2025
Vermont	2005	55	2017
Virginia	2020	100	2045
Washington	2006	15	2020
West Virginia	2009	10	2015–2019
Wisconsin	1998	10	2015
Washington, D.C.	2005	20	2020
Guam	2008	25	2035
Northern Mariana Islands	2007	20	2016
Puerto Rico	2010	40	2025
U.S. Virgin Islands	2009	20	2015

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