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Comparing two pathways of strategic niche management in a developing economy; the cases of solar photovoltaic and solar thermal energy market development in Lebanon

Houda Elmustapha [a, *], Thomas Hoppe [b], Hans Bressers [a]

[a] Department of Governance and Technology for Sustainability (CSTM), Institute for Innovation and Governance Studies (IGS), Faculty of Behavioural, Management and Social Sciences (BMS), University of Twente, 7500, AE Enschede, The Netherlands

[b] Organization and Governance (OG), Department of Multi-Actor Systems (MAS), Faculty of Technology, Policy and Management (TPM), Delft University of Technology, Jaffalaan 5, 2628, BX Delft, The Netherlands

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A B S T R A C T

There is abundant solar potential in the Middle East North Africa region. Yet access to sustainable energy is still a fundamental challenge in many countries of this region. In this paper we seek to understand the success and failure of the development and the diffusion of solar energy technologies by analysing using a Strategic Niche Management framework to compare the niche development of solar thermal energy and solar photovoltaics in Lebanon. This paper has two main questions: (1) *How have the solar thermal niche and the solar photovoltaic niche developed in Lebanon, and how do they compare?* (2) In *which ways does the Strategic Niche Management framework help us to understand the development of solar energy niches in a developing country context?* To answer these questions, a cross case analysis of solar thermal and solar photovoltaic systems was conducted. Due to the absence of research using Strategic Niche Management in Middle Eastern developing countries, this study uses an illustrative case from a country in this region to contribute new insights. Moreover, unlike the Strategic Niche Management research that only focuses on single case studies, this paper presents the results of a comparative study of two niches. The main Strategic Niche Management propositions were grouped and compared per item (i.e. on voicing and shaping expectations, social networks, and learning). The results show that the solar thermal niche affected the solar photovoltaic niche to a large extent. This was especially in relation to the learning and coordination processes. This has gradually contributed to establishing a clear vision. However, both niches lacked a niche manager who was able to coordinate, manage and maintain the dynamics of the niche processes. It also lacked horizontal collaboration between key actors involved (i.e. ministries). International donors were found to play a crucial role in initiating and shaping the market with certain constraints of prioritization in the region. The paper ends with conclusions and ideas for future research on solar energy niche development in the context of developing countries.

1. Introduction

Human induced climate change is considered a grand societal challenge (IPCC, 2014). Renewable energy technologies provide a feasible solution to decrease carbon emissions. Yet, to integrate these technologies into viable markets has proven difficult. This requires, for instance, the need to use alternative and novel financing models (Zeng et al., 2017). In this light, integrating renewable energy technologies in developing countries is particularly challenging. These challenges include a range of geo-political, legal, financial, educational and physical factors. However, the presence of international organizations may ease the way forward for renewable energy technologies to expand through the financial stability and support provided by international organizations to the market and to the government (Karp, 2015). One of the challenges that developing countries face in terms of including renewable energy in the energy mix is the infrastructure and technological capabilities (Thornton, 2016). Moreover, third world countries will soon face a lack of energy supply for reasons of (1) population

* Corresponding author.
E-mail addresses: h.elmustapha@utwente.nl (H. Elmustapha), T.Hoppe@tudelft.nl (T. Hoppe), j.t.a.bressers@utwente.nl (H. Bressers).

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growth, (2) load growth, (3) unstable governments and political situation planning, and (4) tangible resources (Kinab and Elkhoury, 2012).

The Middle East and North Africa (MENA) region has abundant solar potential which has enabled countries in this region to adopt solar renewable energy plans and projects (Jablonski et al., 2012; Tsikalakis et al., 2011) with the support of European countries and bilateral agencies (European Investment Bank, 2010). Lebanon is one Middle Eastern country to suffer from a great shortage in energy supply. Although it does have potentially positive climatic and geographical conditions for renewable energy production, it does not benefit from these circumstances yet. This is related to the absence of clear policies to promote the use of renewable energy sources and other challenges, such as the relatively low awareness of the decision makers to the benefits of renewable energy technologies (Kinab and Elkhoury, 2012).

Lebanon has witnessed various national initiatives to develop renewable energy technology markets, in particular solar energy. The first of these technologies was that of Solar Water Heaters (SWHs): a device designed to convert sunlight into heat that is transferred to water by heat transfer phenomena (Sellami et al., 2016). The second technology is Photovoltaics (PVs): a technology which produces electricity from solar energy through the conversion of solar radiation into electricity (CEDRO, 2013).

1.1. Solar water heaters

The Lebanese SWH market has witnessed various efforts supported by non-governmental organizations (NGOs) and international agencies, or supported through grants from foreign governments (such as China, Spain, Turkey, and Greece). The turning point in the history of the market occurred following the launch of a United Nations Development Programme (UNDP). In Lebanon, the Ministry of Energy and Water implemented this programme with funds channelled through the Global Environment Facility (GEF). This aimed at promoting SWH installations in the residential sector to sought to achieve a surface area of 190,000 m^2 of installed solar collectors by 2014 (LCEC, 2016). This initiative was followed by a policy paper which set out to increase SWH penetration and devise a financing mechanism to reach 1 million m^2 of installed capacity by 2020 (Bassil, 2010). As a result of this initiative, the sales of the local SWH dealers increased by 40% (LCEC, 2016). However, currently the industrial sector is still lagging behind (representing only 4% of the installed SWHs). The residential market is the leading sector, containing 74% of the installed SWH systems. The total surface area of installed systems until 2014 is approximately 550,000 m^2 (LCEC, 2016).

1.2. Solar PV

Since 2007, UNDP has managed a project funded by the Spanish government to aid the recovery of Lebanon after the 2006 invasion. This project started demonstrations of both SWH and PV in thirteen public buildings. The key event in shaping the market was the launch of an action plan proposed by the energy conservation centre in the ministry. A financing mechanism was adopted to support new and existing renewable energy projects that allowed different sectors to benefit from subsidized loans with low interest rates (Bassil, 2010). During the startup phase of the programme, the European Union (EU) offered 15 million euros as a grant. This resulted in the funding of 350 projects by the end of 2015. The total installed capacity of PV until 2015 was 9.45 MWp. Most PV systems were installed by the commercial sector (22%). The residential sector and agricultural sector comprised 18%, and the industrial sector was 17% (Amine and Rizk, 2016).

This paper aims to understand the challenges facing the niche market development of two technologies; solar photo-voltaic (PV) and solar water heaters (SWH). In addition, it seeks to further understanding of the differences in niche formation between the two niche markets in a developing country's context. The research questions are: (1) *How have the solar water heater niche and the solar PV niche developed in Lebanon, and how do they compare?* (2) *In which ways does the SNM framework help us to understand the development of solar energy niches in a developing country's context?* To answer these questions, chronological narratives using the sequence of key events implemented at the national level will be presented, followed by a discussion of on-going challenges. Subsequently, a cross case analysis of SWH and PV using internal niche processes will be presented and conclude with insights specific to niche development in a developing economy. The first research question is addressed in section 4 (Results), and, more specifically, in sub sections 4.1 and 4.2. The second research question is addressed in section 4.3, where the internal niche process of SNM framework is discussed in more detail.

2. Strategic Niche Management

A move towards low carbon systems requires a wide range of changes that need to consider, not just consumer practices and behavioural changes, but also changes required of government policies and incentives and technological approaches. The Strategic Niche Management (SNM) approach advocates "the creation, development, and controlled breakdown of test beds (experiments, and demonstration projects) for promising technologies and concepts with the aim of learning about the desirability and enhancing the rate of diffusion of this new technology" (Weber et al., 1999:19). Similarly, Urban et al. (2016) mentioned that for diffusion of clean energy technologies to occur, a process of research and development, demonstration and deployment should take place. Beyond that, a wide environment of aspects evolves in the process, including market creation, presence of adequate incentives, and specialized technicians. Therefore, a wide range of actors play a role in diffusion from public institutions to firms and research organizations. Successful innovations emerge having been initiated from real-world experiments and protected spaces. For this reason, niches should be created to cover these aspects (Markard et al., 2012). SNM sees promising innovations develop in niches that enable experimentation of the technology which, if sustained over time, will pave the way for the creation of viable market niches (Romijn et al., 2010). For the experiments to achieve their desired objectives, three internal processes are critical: (i) voicing and shaping expectations; (ii) building social networks, and (iii) learning processes (Kemp et al., 1998). Many scholars use the three internal niche processes to study social experimentation and niche market development of clean technology. For instance, Xue et al. (2016) found that particular geographic landscape characteristics influence the diffusion of electronic vehicles in China. In another study, van der Laak et al. (2007) applied the SNM approach to study the success and failure of biofuel projects in the Netherlands. They suggested several guidelines to help introduce projects based on the niche internal process of the SNM approach. The results showed that, although some biofuel projects were managed well in terms of voicing expectations, network formation, and fostering learning, other projects were less successful. The main reasons the projects were less successful had to do with the limited degree of cooperation between key actors, and poor resource availability.

However, the SNM framework has also been criticized, for instance, by Lachman (2013) who argues that it is heavily characterized by the context in which it was comprehended and that this is typically done in studies conducted in Western countries (predominantly in Western Europe). These mostly neglected large parts of the World, particularly the global South where certain contextual, institutional, economic, and cultural factors might be of great importance in enabling or disabling niche formation processes. These country-specific factors differ in particular ways from practices more commonly found in Western countries. Moreover, there is a call for SNM to be used to study niche processes in non-OECD and developing countries (e.g. Jain et al., 2016). The gap that the SNM approach is facing here is in shifting to a new (green) growth path in developing countries. Opazo (2014) argues that developing countries have various constraints that limit the development of promising technologies. These constraints include: a lack of technological capacities, appropriate policy frameworks, resource constraints, and limited involvement of actors. Sagar and Majumdar (2014) discussed the important role that the government can play in these countries by financially supporting technological innovations through creating specific policies or institutions, or through initiating research and development. In addition, Opazo (2014) argued that, in developing countries, it is more important to focus on setting the social context of an innovation, rather than focusing on technology development assuming that providing access to the basic daily needs for a living (such as access to utilities like energy) is considered a priority, and is awarded more attention when compared to lowering a country's carbon emissions. For this, international supportive programmes intervene to provide support for the developing countries to get access and allocate resources for market development.

The need for support for developing countries to achieve climate mitigation goals was discussed by Mdivani and Hoppe (2016) and Sagar and Majumdar (2014). They mentioned that most of the collaborative programmes in these countries are top-down in nature. They specifically target market creation and diffusion, while focusing on sharing knowledge, rather than being involved in research and development. Another important aspect influencing niche development in developing countries concerns the support provided by international donors. For instance, Hansen and Nygaard (2013) found that the short duration and unpredictability of donor interventions played a critical role in shaping markets and achieving programmes' objectives. Regardless of their contribution to technology market development, donor interventions have their own complexities. For instance, it can lead fund seekers to shape the market concepts to meet donor concerns in order to receive funding and ending up in a continual search for funding (Nygaard, 2010). At the niche level, donor intervention takes the form of supporting technological experimentation through providing financial support to these experiments, such as demonstrating the technology (Hansen and Nygaard, 2013). Another form of intervention that donors have can be through standing the initial investment risk for private-sector project (Byrne, 2009). As such, donors, directly or indirectly, play an important role in shaping niches through programmes supporting experiments and related niche formation requirements (Jain et al., 2016). This can be regarded as an essential step in developing countries because at the start of any emerging market there is limited or no experience in renewable energy projects. This makes it difficult for investors to finance these projects. Therefore, donors promote renewable energy technologies in developing countries and support institutions in order to prompt change in institutions at the regime[1] level (Hansen and Nygaard, 2013).

2.1. Expectations

In niche internal processes, expectations are described as promises of new technologies and can be “problem oriented and deal with specifications of technology”, “function oriented”, or “scenario oriented with a broad spectrum” (Mourik and Raven, 2006). When radical innovations have uncertain outcomes, expectations can play a crucial role in bringing in new actors (Xue et al., 2016). Expectation can also play a role in strengthening the niche by allowing actors to learn about technology in real life circumstances and develop a community with a shared agenda (Geels, 2010). In a similar vein, Raven (2005) holds that, at the beginning of a technological trajectory, expectations are viewed as broad, general and fragmented. Taking this into account, early expectations need to be at a high level of stability for them to contribute successfully to the niche. Kemp (1994) calls this the “coupling” of expectations. This was then elaborated by Raven (2005) on the concepts of the voicing and shaping of expectations. Therefore, expectations tend to be more powerful when they are; (i) accepted and shared by more actors; (ii) clear and specific; and (iii) supported by experimentation results (Schot and Geels, 2008).

2.2. Actor networks

For a technological innovation to develop, it has to be supported by a social network. In general, different actors have certain perceptions that drive them to be part of a network for various reasons (Xue et al., 2016). Mourik and Raven (2006) viewed that actor networks tend to create coordination and convergence of diverse expectations. Therefore, for a social network to be effective, it has to include diverse actors with higher alignment between them (van der Laak et al., 2007). Moreover, Opazo (2014) discussed the importance of having resources available to support network platforms in which actors exchange their visions and develop new rules to acquire a sustainable role in niche development. Since actors represent institutions of certain practices, cooperation between these institutions (and their network configurations) can provide the network with the required resources to create interaction between those platforms.

2.3. Learning

The co-construction of technologies, markets, and regulations involves, not only experimentation, but also learning (Watanabe et al., 2009). Since experimentation is the core of SNM, learning has a crucial role in leading actors to adjust either the niche's central technology, or the social environment in which the technology is embedded (Raven, 2005). Therefore, learning in SNM is not only about learning from a series of technical experimentations, but also about social experimentation with a novel technology; i.e. in a new social setting. A series of social experimentation learning will not only shed light on opportunities that can develop a niche, but also on barriers that can hinder its development (Mourik and Raven, 2006). The sequence of experiments will contribute to the learning curve and gradually result in new content of knowledge, ideas, and perceptions of a specific novelty in a niche environment (Raven and Geels, 2010).

By learning about the technology by using it, any actors engaged will be able to provide feedback to the wider niche network. Some scholars distinguish between first order learning and second order learning amongst others (Byrne, 2009; Raven, 2005; Schot and Geels, 2008). Schot and Geels (2008) argued that, for a niche to be effective, the learning processes have to be broad and reflexive.

[1] This term is used in this paper to refer to the socio-technical regime as a dominant or pervasive way of ‘doing things’. This concept generally reflects the incumbent ‘socio-technical’ practice or “patterns of artefacts, institutions, rules and norms assembled and maintained to perform economic and social activities” (Berkhout et al., 2004, p. 48).

Aspects of first order learning were defined by Raven and Geels (2010) as a way to gather information on technology, infrastructure, policy, and user's practical accumulation of data within cognitive frames. This type of learning can contribute to improvements in the technical and economic performance of a technology practice. Not only this, but first order learning goes from identifying potential side effects and social desirability to leading on to technological solutions and potential developments. This can result in certain working technological arrangements. However, Opazo (2014) argues that focusing on the first order learning alone is not enough to provide a clear explanation of how the experiences and knowledge can result in new rules that govern a niche. When actors are able to retain cognitive frames and adapt them, then second order learning occurs. Second order learning is more reflexive and will focus on questioning the available norms and rules to reformulate the expectations, redesign the technology, and reconstruct the network (Mourik and Raven, 2006). Byrne (2009) explained this by reflecting that second order learning is about the societal functions and not the technology functionality.

2.4. Interaction between niche processes

To understand the process of niche formation, the niche processes mentioned previously should not be studied in isolation of each other for reason of their dynamic interaction. Kemp and Rip (2001) discussed this aspect by mentioning that the outcomes from an activity at niche level should be viewed as a modulation of on-going dynamics. Actors carry certain visions and expectations, and develop relationships within networks as a result of this alignment within the network. Consequently, expectations influence how experiments are organized. Then, these experiments will offer results to be interpreted by actors and, therefore, influence engagement in additional experiments. The results of the learning process will reshape the expectations and influence the market vision in the long run. However, there are also other external factors that can influence how learning is interpreted (Opazo, 2014). Geels and Raven (2006) differentiated between local experiments from which lessons can be learnt and experiences which lead to learning and coordination at a higher level of aggregation (i.e. the global level). In turn, technological developments are said to occur at the local level. Cognitive rules and practices are shared at higher levels of abstraction though (Raven and Geels, 2010). In sum, the sequence of concrete local projects gradually adds up to a technological path at the global level (Raven and Geels, 2010). This explains how a sequence of local projects might enable socio-cognitive cycles and elaboration of cognitive rules (Fig. 1).

Because SNM research focuses on internal niche processes, it is criticized for not focusing on the roles of actors in local projects. This is seen as a lack of consideration of agency and the role of power reflecting on the important role of decision-making in determining niche construction and niche-regime interaction (Geels, 2010). By stating this, decision making can, in fact, be viewed as a crucial factor in technological change (Opazo, 2014).

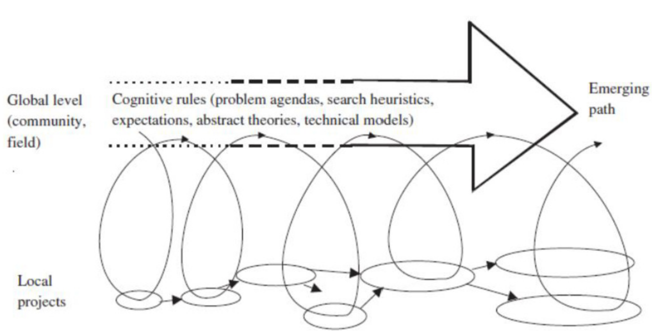

Fig. 1. Emerging technical path carried by sequence of local projects; adapted from Raven and Geels (2010).

3. Research design and methodology

The study presented in this paper uses a case study research design. A case study approach was adopted to allow us to elaborate on existing theory and build complementary new insights with an explanatory aim. Case studies can be viewed as "an empirical inquiry that investigates a contemporary phenomenon within its real life context; especially when the boundaries between the phenomenon and context are not clearly evident" (Yin, 2014:13). Unlike previous SNM research that mostly uses single case study research, this study advances the literature by using a cross case research design of two niches, i.e. a cross case design comparing the historical cases of SWH and PV niche development in Lebanon. The formation of solar energy niches is analysed from a reflective-analytical perspective by understanding niches' formation and the challenges they encountered.

3.1. Case study selection

There is an absence of research using the SNM in Middle Eastern developing countries. Therefore, this study uses Lebanon as an illustrative case to represent developing countries in the MENA region. The study of niche development of solar energy technologies in Lebanon starts to build on the SNM framework to provide insights on diffusion phenomena from a wide perspective. This approach takes into account actors and projects taking place on a national level. Lebanon presents a unique case study due to its geographic location, abundant solar resources and deficiency of conventional energy resources. Despite its positive geographic and climatic conditions, the country still relies on imported fossil fuel for energy production. Lebanon presents a hostile environment to green innovations due to the political and the economic instability (Thornton, 2016). As such, Lebanon illustrates the complexity of market development well. Thus, it can serve as an example for other developing countries of similar geo-political and socio-economic dimensions.

3.2. Data collection and analysis

This section presents information on the data collection and data analysis of the selected case. Various stakeholders were contacted to generate knowledge about the market initiatives and the involvement of the stakeholders in the past and the on-going projects. The principal researcher collected primary information of the projects' implementation details, key actors, institutions, sources of funding, delivery and implemented models to construct a project database.

Projects within each of the two case studies were identified through a detailed review of programme documentation. These documents were accessed via CEDRO, UNDP project newsletters and publications, GEF projects' documents (such as the ones published by the LCEC) and other archival records obtained from project databases and from experts. Additional information about the project details (such as implementation, key actors, institutions, and management models) was also compiled. Using a snowballing method to get access to additional information sources, other key informants were identified and contacted to expand the original list of projects. For the purpose of triangulation, direct observation from the field complemented the evidence obtained from interviews and those sources were compared to seek confirmatory evidence. This field observation enhanced the understanding of technology at work and how projects were implemented and developed. The list of actors was triangulated with those used by UNDP and LCEC to assess the relevance of other actors.

Data collection involved fifteen face-to-face, semi-structured, in-depth interviews with representatives from different stakeholder groups relevant to the solar energy market. Field visits were made during interviews with end users of implemented projects. In Appendix 2, an overview of the interviewees who were contacted for this study is presented (Table 3). The interviews were conducted between February and March 2017, and took between 45 and 60 minutes each. Interviews took place at interviewees' work venues. Field visits were organized with the staff involved in selected projects.

An interview protocol was designed to systematically collect data on the development of the SWH and PV niches. Conceptual elements of SNM were used when formulating the questions. The interview questions were adjusted to the role and area of expertise of each actor, but all encompassed key SNM theoretical concepts. The interview questions were designed to examine the following research areas:

1. The general context of SWH and PV niche formation, challenges encountered during niche formation, and general project development;
2. Internal niche processes and their role in niche formation (i.e. the social network, learning processes and experimentation);
3. Niche dynamics (e.g. actor's roles and rules) influencing the socio-technical regime for each of the two solar energy technologies of interest.

For more details on the interview questionnaire see Appendix 1.

Data collected from interviews and secondary data were coded in a data extraction template (using ATLAS.ti software). This reflected the concepts essential to SNM (i.e. managing visions and expectations, social network formation, and the learning process). By using the theoretical propositions reflected in the framework, the data were analysed relying on how relevant the literature was to the renewable energy projects implemented in Lebanon.

Based on the results of each of the two case studies (SWH and PV) a cross case analysis was conducted. For the single case studies, chronological narratives were constructed by identifying the sequence of key events that influenced niche development processes and their dynamics. Finally, an analysis on similarities and dissimilarities between the SNM determinants across the two cases was conducted to analyse niche development processes and dynamics in key niche development characteristics.

4. Results

The results of this study are presented in three subsections. Section 4.1 and section 4.2 give a general overview of the SWH and solar PV market development respectively. Then, the SNM niche internal processes of the two case studies are compared and presented in section 4.3.

4.1. Overview of SWH market development

The initiatives in the SWH market started in 1999 with early demonstrations funded by a French agency of the technology. The initiative aimed to shed light on the importance of energy efficiency and the role that SWHs could have in reducing energy bills (Houri, 2006). With this effort, the role of the implementing agency was to promote for sustainable methods for energy management and to call for sustainable policies. However, the SWH market was still facing huge obstacles that were preventing its development and increasing the risks to allow any sustained steady growth. Therefore, there was a need for more technical and financial support. Fig. 2 presents a timeline of key implemented projects for SWH in Lebanon.

Following the Kyoto protocol in 2006, the Ministry of the Environment was the first to start supporting a scheme calling for investments in sustainable projects. However, due to the low interest expressed from other ministries, this did not achieve its targets. After the invasion of Lebanon in 2006, UNDP projects under a fund from Spanish Government (CEDRO 1, CEDRO 2, and CEDRO 3) were launched between 2007 and 2013 to aid the recovery of Lebanon after the damage of major infrastructure utilities in 2006. The projects implemented included the installation of SWHs and PVs on public buildings. The main role of the projects was to assist in the market readiness from an economic, social, and environmental perspective. This reflected the UNDP role in supporting the government with attaining environment targets and sustainable development.

After the 2009 Copenhagen Summit, cooperation between the ministries (of the Environment, Energy, and Finance) started to develop, albeit with slow progress. As a consequence, and for the purpose of opening up the market and increasing trust in the technology, an initiative called the GSWH was launched with funds from GEF (an international organization providing funding for developing economies to help in meeting environmental international targets) - see Table 1. The Ministry of Energy assumed a role of planning policies and guidance by drafting an action plan, and allocating funding, either internally, or through international funders, to accomplish targets. To sustain the market growth efforts of stakeholders, the GSWH brought together different actors; the ministry of energy and its energy conservation centre, the ministry of education, the central bank, international agencies, research institutes, NGOs, and private renewable energy technologies dealers. Achievements of the GSWH initiative involved awareness raising, market demand creation, large scale installations from foreign donations, quality control, standardization, and certification (Abou Jaoudeh, 2015).

4.2. Overview of PV market development

Although many initiatives that targeted the adoption of SWHs were also relevant to niche development of solar PV technology, the solar PV market was less mature than that of SWH, and was in need of more support. Some of the initiatives included: the clean development mechanism managed by the Ministry of the Environment in 2006, the CEDRO 1, CEDRO 2, and CEDRO 3 programmes. Fig. 3 presents a timeline of key projects implemented to support solar PV niche development at the national level.

In 2012, a EU co-funded project called Strategic Hubs for the Analysis and Acceleration of the Mediterranean Solar Sector (SHAAMS) started. This targeted policy development, entrepreneurial and research engagement, and social awareness in the solar sector. At the national level, projects with similar targets were implemented. For instance, a project managed by the energy conservation centre and funded by the EU, (MED-DESIRE), aimed to remove barriers related to the legal, regulatory, economic and organizational framework relevant to solar energy technologies. Another EU funded project, CEDRO 4 shifted attention in 2014 to the commercial and industrial sectors. This project delivered support to factories and private companies by bidding for contractors, conducting feasibility studies, and launching the project on the ground. The main objective of this project was to help establish the solar electricity market through facilitating work between donors

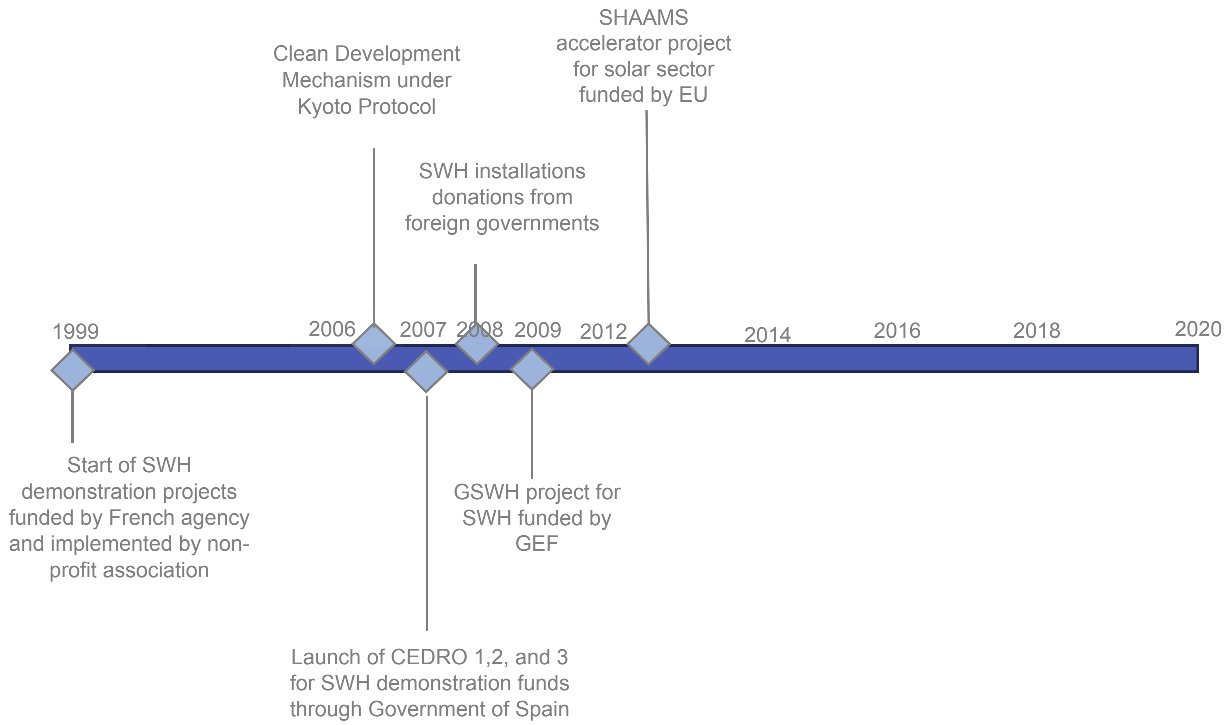

Fig. 2. Historical overview of key events in the SWH niche.

Table 1
Overview of analysed SWH and solar PV projects.

Project Name	Objective	Current Stage (Spring 2017)	Funder
Project 1: GSWH-Global Solar Water Heating Market Transformation and Strengthening Initiative	To accelerate market development of SWHs	Completed	Financed by the Global Environment Facility (GEF) and managed by UNDP
Project 2: CEDRO 1, 2, and 3 country energy efficiency and renewable energy demonstration project for the development of Lebanon	To improve end user energy efficiency and stimulate adoption of renewable energy technologies in public buildings (SWH and small scale PV)	Completed	The Lebanon Recovery Fund through a donation by the government of Spain
Project 3: CEDRO 4 country energy efficiency and renewable energy demonstration project for the development of Lebanon-private sector	To improve the use of renewable energy and energy efficiency systems and measures in economic sectors (commercial, industrial, and utility-scale, and a village scale)-large scale PV	Implementation stage	Financed by the European Union and co-financed by beneficiaries (from industrial and commercial sectors)
Project 4: SHAAMS-Strategic Hub for the Analysis and Acceleration of Mediterranean Solar Plan	The effective deployment of the solar MED plan through policy development, entrepreneurial and research engagement, social awareness	Completed	Financed by the European Union, and implemented under the ENPI-CBCMED (cross border corporation in the Mediterranean)
Project 5: DREG-Small Decentralized Renewable Energy Power Generation	Reducing greenhouse gas emissions through the removal of barriers to widespread application of decentralized renewable energy based power-private owned grids.	Implementation stage	Financed by the Global Environment Facility (GEF). Executed by the Ministry of Energy and Water of the Government of Lebanon and implemented by UNDP

and beneficiaries. In parallel, another UNDP project, entitled DREG (targeting small decentralized renewable energy power generation) started under the fund from the GEF. This focused on pre-feasibility studies and data monitoring with the aim of documenting existing solar electricity performances and carrying out cost benefit analysis of solar electricity generation technologies. Table 1 gives an overview of the key projects with their objectives and relevant funders.

Although the involvement of bilateral agencies (such as UN organizations) ensured the implementation of the projects, the predetermined agenda by the funding agencies end up limiting the flexibility of the project managers to reshape the objectives and relevant activities themselves.

4.3. Challenges of SWH and PV market development

The SWH market is arguably in a mature stage, yet there are efforts that still need to be made. This would include improving lab testing facilities, putting a building code into action, and opening the market for new developments in the technology (in particular to tackle the roof space problem), and to increase promotion of collective systems (large scale) for different sectors. With regard to solar PV, the national electricity operator has a shortage of open-minded qualified staff. This results in it not being supportive of integrating alternative energy sources. Grid connected PV systems face the challenge of connecting to the national grid. This is due to the technical restrictions, such as the inability of the national grid

Table 2
Comparative overview of SWH and solar PV internal niche process.

Niche creation assessment criteria according to SNM		SWH case	Solar PV case
Expectations	a. Shaping expectations b. Shared between actors c. Supported by tangible results	• Unclear expectations at start which were reformulated with time by international actors • Actors shared specific expectations • Approaching specific targets in total installed capacity	• Positive expectations of demonstrated and on-going projects • Specific expectations are shared between actors directly involved via projects • On the project level, technical specifications and guidelines have been developed
Actor network formation	a. Diversity of actors b. Alignment	• Wide and diverse actor network (which grew more rapidly with the start of international funded projects at the national level) • Expectations took more time to align, especially with actors from outside the projects • Formal interaction in workshops and conferences • Involvement of outsiders varied across projects	• Wide and diverse actor network (which grew more rapidly with the start of internationally funded aid projects at the national level) • High level of interaction between actors directly involved in demonstration projects • Formal and informal interaction through projects and national networking event Involvement of outsiders is limited
Learning Process	a. First order learning (on technological performance and data and social alignment) b. Second order-reflexive-learning (reconstruct and reformulate)	• Learning on techno-economic aspects with limited attention to social issues • Resulted in formulating a new financing mechanism and addressing quality control • Limited degree of second order learning	• Learning about techno-economic aspects • To a certain extent involved higher level learning through setting guidelines for electricity grid operators specific to the Lebanese case • Formulating a guideline for connecting to the grid

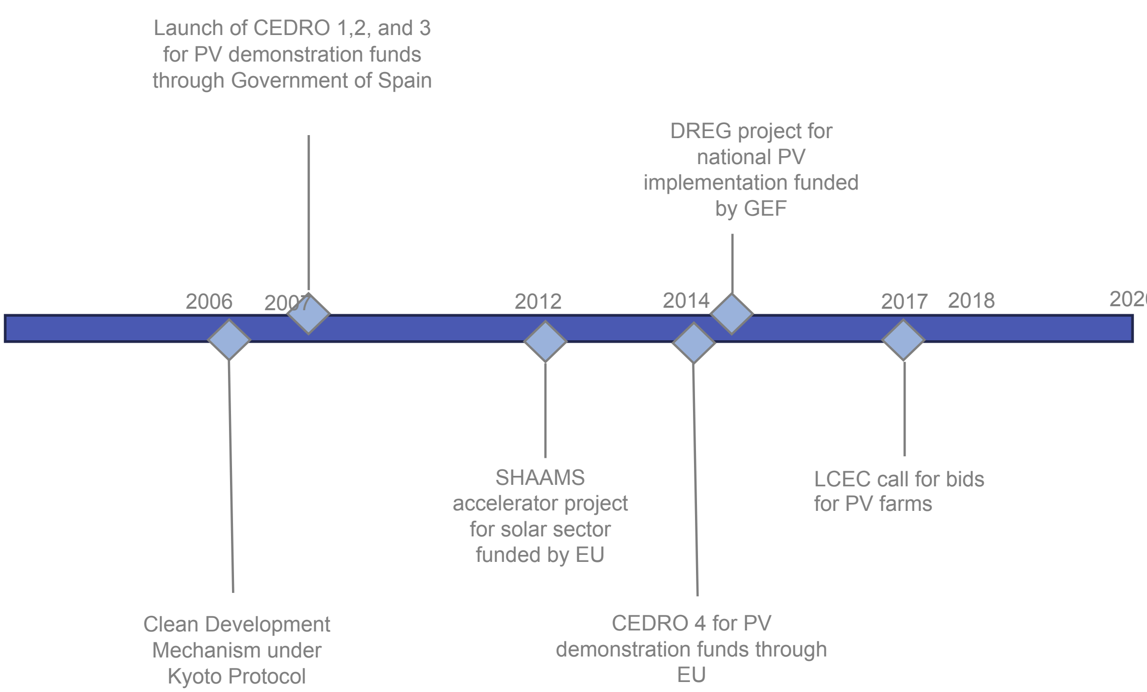

Fig. 3. Historical overview of key events in the PV niche.

to supply electricity 24 hours a day. This necessitates installed small scale PVs to use batteries, thus increasing the price of the system (CEDRO, 2013). Yet, there is still ambiguity on what the best solutions available could be to integrate medium sized installations. One obstacle facing the financing scheme of the systems is the lengthy assessment procedures of capital grants, which are drawing investors away.

To boost decentralized renewable energy markets in Lebanon, the GEF financing as a primary outcome was used as a complementary grant co-financing scheme to leverage financing mechanisms. For instance, the programmes of Med Solar and CEDRO 4 were supposed to facilitate a move from entirely grant-financed projects to a more (financially) sustainable model involving the private sector to finance the investments. This aimed to move operations towards more sustainable business models that will open up new market opportunities. To achieve sustainable market growth needs more measures, such as rigid regulations.

For these reasons the solar sector presents an interesting study of the dynamics of diffusion. The two technologies differ in technological, economic and social characteristics and dynamics. For instance, PVs are still considered to be rather expensive and, unlike SWHs, they require integration with the electricity grid, which is still considered by main stakeholders in market to be a major bottleneck, mainly because of its institutional and political nature.

4.4. Internal niche processes

4.4.1. Voicing and shaping of expectations

Since the early 2000s and the start of the SWH, there has been no government policy to stimulate social experimentation or adoption. Encouraged by the achievements of the GEF funded programme (project 1 in Table 1), PV projects benefitted from the experience actors gained through implementation of SWH. Thus, government institutes received support from an earlier stage due to the role that the international donors (who handled expectations from different perspectives) played in include government institutes at the planning and implementation stage. The expectations shaped in the renewable energy market were triggered by the international bodies and then adopted by central government represented by the Ministry of Energy.

Attaining energy targets and reducing emissions was an important expectation shared by government institutions. A common vision for the implemented demonstration projects entailed creating market readiness and increasing market demand by lowering market prices as set by UNDP projects. Other actors, such as the energy conservation centre and other financing institutes, shared this vision and which was later shared by other actors, Hence, afterwards the expectations shifted to include enhancing potential users' knowledge about available solutions and international demonstration projects.

Actors promoting the first SWH and solar PV projects were first and foremost international agencies, NGOs, and ministries (of the Environment, and Energy). Substantial support was given through the energy conservation centre, followed by emerging strategies of a private electrification programme. This helped overcome the problem of conflicting interests and differences in vision between different public institutes.

Most projects targeted public and community buildings, particularly those done at the beginning of the experimentation phase. However, the solar PV niche projects rather targeted the private and industrial sectors that required high-energy demand, and comprised of certain actors who were willing to invest in this particular technology (such as end users, private sector). The policy rationale behind the financing mechanism resulted in widening and diversifying the domains of application for renewable energy. In the SWH case, norms and guidelines for quality control were developed. However, in the solar PV case project guidelines for grid connections paved the way for future investments. Due to the technical differences between SWH and solar PV, the latter was currently getting more attention with regard to the adjustment of regulations that hinder diffusion.

Higher expectations were set for solar PV based on results from successful projects and mechanisms for SWHs. For example, during the implementation of some of the SWH projects, the Energy Conservation Institution started setting standards in collaboration with other government agencies. However, in the case of solar PV, projects were initiated without any definition of the standards, and the financing applications were granted based on lengthy assessment procedures. The national utility company had an ambiguous plan for technically integrating renewables into the grid. This was because it was interested in maintaining the status quo to protect the interests of the parties who were benefiting most from its current state.

4.4.2. Social network formation

The social network of the SWH niche started out small, with research institutes and only one national government ministry. Gradually the network of actors became wider and more diverse and, thus, allowed for the involvement of new actors (such as actors from the private sector and NGOs). The establishment of project-oriented networks started by the availability of funding (from international funding agencies) shows that niches were not formed spontaneously, but were already largely supported by international aid organizations. Due to the high number of projects implemented in similar time frames, an overlap of niche networking occurred. This overlap resulted in more frequent exchange of knowledge. This fostered learning processes. Yet, to be even more effective, these networks had to be managed and coordinated by a key actor to prevent duplication and loss of resources.

On the national level, the number of SWH suppliers increased from 35 to more than 150 by 2014 after the GSWH initiative, and 124 PV suppliers (by 2017). This was deemed by interviewees to be an acceptable number to fulfil market needs.

The way inter-stakeholder trust was built and maintained, and how resources were distributed and allocated, was fundamentally related to the funding and the managing body, such as GEF and UNDP. For instance, the large amounts of funding of the GSWH programme that tackled the niche formation from different aspects (e.g. on financial and educational aspects, and on knowhow). In this case, companies and clients were encouraged to take part in such projects. Formal commitments, such as providing technical teams or matching clients with companies, are examples of formal structures observed in the solar PV case that provided some stability to niche activities.

For the GEF funds to be granted required the projects to be based and directly linked to government agencies, such as the Ministry of Energy, thereby guaranteeing the funding agency a higher level of coordination. However, other international donors, such as the EU, did not use this criterion. This might explain, to some extent, the level at which government agencies get involved in projects and the role that funding agencies play in niche formation.

Most of the interaction happened in the context of decision-making processes during the development and project design phases. Once projects were granted approval or were executed, interaction between actors reduced and only formal commitments to operation were kept. This only required a national actor to play a vital role of coordinating and maintaining the niche (also after projects ended).

4.4.3. Learning

In the solar PV case, the demonstration projects served to bridge gaps by disseminating the required knowledge and crucial expertise. A mutual learning process (using workshops and roundtables that were visited by representatives of multiple funded projects) was initiated and led by a project manager from two large-scale funded projects. This led to other actors being informed about project achievements and goal attainment. Although this supported mutual learning and collaboration initially, it was limited to a certain delineated circle of actors (i.e. those under or in close contact with the same project management organization).

The analysis of the SWH and the solar PV cases reveals that different types of learning occurred during the process of niche formation. Cross-niche learning occurred that resulted in more efficient learning outcomes of experiments that would benefit the solar PV niche in the long run. For instance, solving technical problems and quality control of solar PV installations had a positive effect on the launch of the solar PV niche.

In the SWH case, a local team of consultants — who were active in one of the projects - was able to develop skills in the application and assessment of design techniques and learned how to implement the system correctly. The same was true for the solar PV projects. Yet, due to the complexity of integrating the system with the high voltage national electricity grid, local consultants had to seek specialized foreign expertise to deal with the case and develop a guideline and project templates. This improved the technical knowledge of actors involved in project implementation and has positively reflected on designing and assessing future projects.

The analysis of SWH and the solar PV projects reveals that techno-economic learning has been linked to knowhow and how knowledge, skills and practices can be transferred from one project to subsequent interventions regarding similar technologies in other projects. The more project outcomes (i.e. new knowledge on how the technology is used when adjusted to country specific circumstances) were coordinated, the more the use of solar energy technology was likely to scale-up to mainstream practice, and from mainstream practice into regime practice. The replication of the PV projects eventually resulted to the emergence of local rules and practices.

In both in the SWH and solar PV projects the installation of solar plants was outsourced to private companies. This type of implementation provided companies with valuable lessons about the technologies and the system of operation that would comply with current regulations.

Based on the need to change on-going practices and cognitive frames, second order learning occurred through experiencing and interpreting signs from the market (financing, and quality controlling) during the late stages of SWH niche formation. The same was the case in the early stages of solar PV niche formation through meeting the customers' needs and developing a financing mechanism to stimulate the market demand. The learning in the PV niche was more reflexive than in the case of the SWH niche. However, currently, the complex issue of connecting to the grid still needs more attention. This could be related to the complex nature of the technology and its dependency on policies from uncooperative public officials.

Table 2 presents an overview of the SWH and solar PV niches vis-à-vis key SNM concepts.

5. Discussion

The results show that the expectations of the SWH and solar PV cases were initially fostered by independent actors (in the case of SWH) and by international funding agencies (for both SWH and solar PV niche formation). Progressively, government agencies promoted the expectations for both technologies by developing an action plan with the policy goal that these expectations were shared by more actors across different sectors (from both the public and private sectors, and with local communities).

An important characteristic of expectations alignment is that higher expectations will be attained when they are backed by continuous experimentation and concrete results (Raven, 2005; Schot and Geels, 2008). In line with this claim, the analysis of the Lebanese cases has made it clear how results of SWH experimentation have affected the extent to which expectations for solar PV increased in credibility and quality, in particular to attract potential actors (such as investors and private sector).

Another important result concerned the poor horizontal collaboration and integration of niche activities. Neglecting horizontal integration - as discussed by Mdivani and Hoppe (2016) – often results from poor prioritization of topics by key actors (i.e. ministries only prioritizing their own issues and interests). This was observed in both cases, where there was only a minimum degree of inter-ministry coordination. This led them to not become directly involved in project implementation. This, in turn, led to problems in the information flow between the relevant public institutions. As a result, it affected decisions made to develop the market and to remove obstacles where these involved policies and support mechanisms that are important to the technological and social embedding of niches.

Regular actor interactions were found to be rather problematic in the two case studies. Due to the nature of solar PV and its complex connection into the national electricity grid, a lot of pressure occurred trying to involve the monopolistic national electricity grid operator. In collaborating with semi-governmental organizations (in particular, the Conservation Centre), project managers played an important role in the network formation. For the emergence of healthy and sustainable niche networks, the role of a network manager, who can coordinate all activities between different projects, cannot be neglected (see, for example, Hoppe et al., 2015; and Mlecnik, 2012). However, networking was linked more to the funded programmes (both by GEF and the EU) and, hence, the previously set action plans and activities that were deemed necessary by the funding agencies. This problem has been also found in other studies, such as net zero energy niche formation in India (Jain et al., 2016).

In the cases of SWH and solar PV, learning took the form of discovering problems and solutions, identifying the use of technology and adjusting the technology to fit into the socio-technical system, while also identifying potential clients and marketing strategies. This corresponds with results by Kemp and Rip (2001). Learning across the two niches occurred benefiting the implementation process and dissemination of knowledge in the PV niche. This resulted in a more efficient use of knowledge in subsequent projects. The business companies involved in the installation of demonstration projects could distinguish themselves from possible future competitors by utilising head start technologies (Mlecnik, 2012). An example of this was found in the two Lebanese case studies in the launch of innovative façade panels (for both solar thermal and solar PV).

For networks to be more effective in supporting niche formation, higher flexibility and capacity is required to take into account particular context specific conditions. It is actors who help technology progress and improve through learning and gradual experimentation in order for it to become viable within an existing system (Smith et al., 2014). However, the creation of networks is often initiated and linked to international funded programmes. This sheds light on a critical fact that the involvement of stakeholders is linked to programme budgets and available funds where (national) financial resources are absent. This could impact policy integration and, as a result, support niche development actions, and reshape the market (a result also found in a study by Mdivani and Hoppe, 2016).

The results of the two case studies confirm that learning was both broad and reflexive. This is in line with Raven, 2005 and Schot and Geels, 2008. Although most of the learning processes can still be considered as first order nature, second order learning was also encountered in both case studies. An important aspect found in the two solar cases in Lebanon was on how to deal with inter-actor technology learning. There appears to be a gap in how to sustain the niche in the long term, especially with the absence of an actor coordinating between other actors (e.g. an intermediary agent such as a 'network manager' or a 'niche manager').

The subsidized fossil fuel sources that are used for generating electricity (leading a to a poor level playing field in terms of price setting) are still considered a major barrier that influences the economic viability of the renewable energy investments. Yet, there is a lack of political will to remove it. This could be related to conflicting interests of politicians. The results show that there is instability in the system design and a lack of clear intentions from public officials, grid connections and state interference. This is in line with Wüstenhagen and Menichetti (2012), who discussed that all these issues and more create too much uncertainty for investors and end-users.

When introducing change to the energy sector, or to address climate change efforts, there are several difficulties tied in with related actions. There are slow and overlapping responsibilities between government institutions, there is a lack of law enforcement, and a lack of monitoring structure. The results of this study explained this through how unstable government and frequent change of ministers significantly affected the implementation of laws. With the start of the functional period of the new ministers, new settlements were made - which is explained by the policy paper for improving renewable energy in 2010 (start of new electoral cycle) - and the removal of taxes on renewable energy technologies in 2017 (which is related to the appointment of new ministers). As for other developing countries, any change of government can cause a serious delay in implementing policies. This is due to absence of experienced civil servant staff in climate change policies (i.e. Mdivani and Hoppe, 2016) or changes in the interests of the new parties at the national level. This shows that the role and the interests that actors have can influence the market.

The on-going discussion revealed that the SNM framework can be applied to developing countries. However, it needs to capture the contextual aspects specifically related to these economies in a better way. Certain differences between applying SNM to developed countries and developing countries were identified in this study. For instance, in most developing countries, the deployment of renewable energy technologies is not a priority that is on the agenda of a national government administration. In the study, this was illustrated in the role international bodies have in setting expectations and vision, while initiating experimentation projects, in addition to the government delay in setting regulations, or introducing change to the on-going system in Lebanon. Furthermore, the country suffers from security problems, as well as political instability. This prioritizes fulfilment of societal needs and the common interests regarding environmental targets (Opazo, 2014). Unlike western countries, developing countries face a lack of funding, capacity and capabilities to create change in the infrastructure and technologies to achieve ambitious renewable energy goals; let alone energy transition. This was reflected in the Lebanese case where the national electricity grid operator lacked the skilled personnel and financial resources to upgrade and adapt the power infrastructure to any type of renewable technology. On the other hand, in developing countries such as Lebanon, technologies advancement rarely occurs due to limited availability of resources and constraints regarding research and development. Innovative technology solutions are often imported from western countries and integrated into the Lebanese market. In this case, the focus is more on the capacity building and knowledge exchange. In a country like Lebanon, as in other developing countries, the government and public authorities can be considered as rather weak institutional players. In this case, development agencies, along with international donors, play a more prominent role in the support of the solar electricity niche.

Finally, the results of this study reveal that niche market development is heavily influenced by the agendas of the donors, the focus they had in these specific markets, and the targets they set for each available fund. For instance, at the niche level, the donor played a role in supporting technological experimentation through providing financial support to demonstrate the technology. This shaped the niche through these various implemented programmes at the local level. This result is in line with Hansen and Nygaard (2013) and Byrne (2009) who discussed the intervention of donors in the niche for the purpose of handling the initial investment risk for potential users. Furthermore, the donors created more trust in the renewable energy market and amongst the actors involved in the funded programmes. This was clearly revealed in supporting government institutes in renewable energy programmes that increasingly triggered their interest in the niche and initiated their learning process.

We argue that this paper adds to the literature on niche development of renewable energy technology in developing countries (Byrne, 2009; Romijn et al., 2010; Xue et al., 2016). We introduced the role played by donor agencies, which, besides their previously set agenda, contributed to the niche development and actively engaged with Lebanese public institutes. Furthermore, we discussed the dynamics of internal niche processes and addressed the critical role played by funding agencies in triggering the formulation and implementation of national policies and financing mechanisms. This paper also contributes to the SNM literature by pointing out the weak alignment between public actors, and ongoing power struggles between institutions in a developing country's context. The actors' networking in this context is often initiated and triggered by international parties, which affects to a large extent the direction in which future markets are to be developed.

6. Conclusion

The aim of this paper was to review and compare niche formation of two solar technologies in Lebanon, SWH and PV, with a focus on internal niche processes. The results are manifold. The case studies revealed that the network supporting niche development was quite diverse and could establish all its activities with limited user involvement. The expectations for the solar PV niche were ambitious from the beginning. Initially, learning processes for both technologies were focused on improving techno-economic performance. Both niches lacked a single manager to take care of all three processes (expectation, social network, learning). Yet, each project did have a leading actor. However, there was poor collaboration between the ministries involved. There were also existing ‘regime’ barriers, such as poor quality of the electricity grid, and subsidized electricity tariffs. For instance, the cheap electricity tariffs were making both solar energy technologies (SWH and PV) uncompetitive, drawing potential investors away from investing in those technologies. In the light of the geopolitical situation and the absence of an active national government, there was poor prioritization of climate change mitigation and renewable energy on the national agenda. The funds provided by international agencies played a significant role in facilitating a breakthrough in the network initiatives and in the innovation plan (national action plan launched by the ministry of energy). The format of the funding scheme pushed the actor network in SWH and PV cases towards collaboration.

The development of the solar PV niche depended on existing players and stimulating synergies that could lead to the development of skills and knowledge. The formation of both the solar PV and the SWH niches in the early phases was taken to a more international context, such as selecting consultants or experts from Western countries where niche maturity of solar energy innovations was more mature. Lebanon, as many other developing countries, has been viewed as a high-risk country for big investments due to its political instability and lack of sound policies. It can be argued that donor agencies were taking a high risk by supporting niche formation to make solar energy technology more attractive for private investors and to prompt a market change (and hence, a change at the regime level); a phenomenon also seen in other cases (i.e. Nygaard, 2010).

Although donors play a key role in the market development, an important issue to be addressed is the unpredictability of such interventions. This shows that donor programmes adjusted to the local circumstances, and that the continuation of donor related programmes, when implemented in certain regions, is highly uncertain. Due to the unstable situation in these regions (related to key geopolitical events), most upcoming funds and projects are not focused any more on the development of the technologies themselves, but rather on other goals, such as supporting communities hosting refugees. This might result in a delay in niche formation processes, especially in the absence of governmental commitments.

Another fact we established was the reluctance between different ministries to cooperate who were not directly involved in funded projects. This could be related to the fact that these ministries had a closed system in which very little information was shared and that they were also not open to share internal details with other ministries or to receive advice from actors having external interests that might lead to changing policy.

7. Limitations

The analysis of the two solar energy cases is constrained to the particular contextual conditions of the country. More countries do exist in the MENA region that have with similar climatic, but different socio-economic conditions. Therefore, more research is needed to understand the determinants of diffusion of renewable energy technologies from that specific region. This paper considers power struggles and protection of political interests. However, more room is still available to develop a more politically-oriented literature to study SNM in areas of the world like the MENA region.

Building on the results, the study discussed the crucial role of donors in niche formation and in pushing for policy interventions. The role played by some local public officials was not always supportive and did not address, to some extent, on-going challenges for development. In this respect, we feel that the influence of the geopolitical situation, and the objectives of funds provided from international funding agencies, needs more research to improve the understanding of the influence of the donor's agenda on the market development in unstable regional circumstances. The comparison of two technologies from an SNM perspective has offered a great potential for future research to improve the understanding of the nature of the technology on international provided funds and, hence, indirectly on their diffusion.

Appendix 1

Case study questionnaire for solar technologies niche actors
Context and Project Development:
Q1. When did you get involved in renewable energy technologies? How and why did you/your organization become involved in solar energy projects?
Q2. What were main drivers/barriers of projects you were involved in? What was the experience of the project with existing/relevant policy?
Q3. Why and how is SWH project implementation different from PV from the perspective of your role in the process? (for actors involved in both projects).
Q4. What sorts of practices have been developed for SWHs and PVs? Do they have a particular role in creating confidence between actors? (divide this question for the three interview templates)
Niche Processes:
Expectations:
Q5. What has motivated you/your organization's participation in solar energy projects? What does your organization seek to gain from being involved in this kind of projects?
Q6. Who are the main actors involved in projects' implementation? Who was most/least influential? With what actors have you interacted most closely?
Q7. What is your personal opinion about the success or failure of the projects in which you have participated? How the project you worked on contributed to increase likelihood of similar projects to develop? What is the main reason behind this success/failure? What new applications could evolve in the field?
Q8. Do the SWH and PV projects fulfil public needs/demands? where their other needs not considered in development of projects?
Social Network:
Q9. What social network formation activities have been used in SWHs and PV projects? How and to what extent were they effective in supporting SWH and PV niche development? Who/which actors have been crucial in supporting this social network formation?
Q10. What type of work have you done? what type of work was most important in bringing actors together? With whom have you linked?
Q11. What type of resources have you contributed to the network of actors?
Learning
Q12. What types of learning (by trying, by interacting, by doing) have been important in the development of SWHs and PVs projects? would you provide examples for each? How have you interacted with other actors? i.e. users /policy makers/technology providers, etc.)? what have you learned in the process?
Q13. What are the main lessons from the implementation of projects concerning:
• Institutional arrangements and institutional roles in the process?
• The role of standards, technical designs, infrastructure/user preferences and practices?
• Incentives and financial mechanisms?
• Training and access to information and knowledge about solar energy technologies? other crucial roles for implementation of project?
Q14. To what extent have previous projects with similar characteristics (technology/social context) influenced the implementation of subsequent projects? What were the key lessons from previous experience?
Closing questions:
Q15. Will there be new funding for new projects of SWH and PV?
Q16. Would you provide contact for other key actors who might provide valuable information about projects?

Appendix 2

Table 3
The interviewees.

No.	Occupation	Organization
1	Project Manager-Energy and Environment Program	International Cooperation Agency
2	Project manager-Small Decentralized Renewable Energy Power Generation Project	International Cooperation Agency
3	Energy consultant	Private
4	Project Manager-SHAAMS	Private
5	Pre-Sales consultant	Private
6	Project manager-Financial support of strategic Projects	Private
7	Project Manager	International NGO
8	Energy Committee Member-Technical institute	Public
9	Energy Consultant	NGO
10	Technology and Development Director	Research institute
11	Energy End user	Local resident
12	Energy End user	Local resident
13	Energy engineer-Technical Support Unit	Public
14	Project Manager-climate change mitigation	Public
15	Solar technologies provider	Private

Abbreviations

MENA	Middle East North Africa
SNM	Strategic Niche Management
SWH	Solar Water Heaters
PV	Photovoltaics
NGO	Non-Governmental Organization
UNDP	United Nations Development Program
GEF	Global Environment Facility
EU	European Union
CEDRO	Country Energy Efficiency and Renewable Energy Demonstration Project
LCEC	Lebanese Centre for Energy Conservation
SHAAMS	Strategic Hubs for the Analysis and Acceleration of the Mediterranean Solar Sector
MED-DESIRE	Mediterranean Development of Support schemes for solar Initiatives and Renewable Energies
DREG	Small Decentralized Renewable Energy Power Generation Project
UN	United Nations
GSWH	Global Solar Water Heating Program

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