On the crossroad – renewable energy sources or oil shale? Understanding patterns of social attitudes in Jordan

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Abstract

Energy policy in Jordan is a contested issue as several options for deployment of technologies exist. Oil shale and renewable energy sources are two energy generation technologies which are currently being intensively considered by the Jordanian energy policy process and there are oil shale and renewable energy projects which are currently in operation, in planning or in construction. Each of these options relates to various perceptions of risks and benefits of a given technology and has its opponents and supporters. Understanding of how inhabitants of communities where infrastructure is planned perceive these energy generation technologies is crucial as infrastructure will impact the life of the community and the feedback from the community can improve the deployment of infrastructure. The major focus of this paper is on attitudes of local communities where oil shale and renewable energies are in operation. To identify of how various environmental, technical, social and environmental factors influence attitudes including awareness and perceptions of these two energy generation technologies we conducted large scale surveys in four different communities of Jordan. Two of these communities (Ma'an and Tafileh) had renewable energy projects and other two communities (Lajoun and Attarat) had projects on oil shale extraction and power generation.

1. Introduction

The new energy strategy 2020–2030 was launched in 2020. According to the strategy, the major aims of Jordan are to achieve energy security, maximise the deployment of local energy resources, and reduce the cost of energy. For example, only in 2019, Jordan imported about (91 per cent) of its energy needs at high costs (Ministry of Energy and

Mineral Resources, 2019). The National Energy Strategy includes targets to increase the contribution of renewable energy and oil shale sources to the national energy supply. The new strategy states that in 2020 Jordan has 11 per cent of its energy mix is from renewable energy, accounting to 21 per cent in the electricity generation mix, and will reach to 31 per cent in 2030. Currently 39 per cent of the primary energy is being used to generate electricity and the 61 per cent of the remaining energy is for transport, heating and industry. The locally produced energy share does not exceed 4.7 per cent of the current total primary energy.

Energy policy in Jordan is a contested issue considering the availability of several electricity generation alternatives, recent increase in energy tariffs and ongoing public protests against various kinds of infrastructure projects. Currently several technological options are in discussion by the government of Jordan, including oil shale and renewable energy sources (RES). Understanding attitudes of inhabitants from communities where such infrastructure is being planned, constructed or under operation might help to implement the projects with less impact for environment and society and greater benefits for the national economy but also for local communities. Without being addressed, concerns from local communities regarding planned infrastructure might turn into public protests and delay and lead to cancelation of the projects. For example, intensive public protests against planned nuclear energy infrastructure in local communities resulted that the location of the proposed nuclear power station had to be changed several times.

Therefore, the main research question of this paper is to understand the attitudes of inhabitants from the regions which will be affected by deployment of RES and oil shale, towards benefits of these technologies, but also towards perceived risks and impacts on environment and on their communities. This paper aims to evaluate intension and acceptance of private households towards oil shale and RES, while evaluating essential for social attitudes factors which are connected to the following questions:

- What is the level of awareness about such technologies as oil shale and RES? And which sources of information do people trust?
- What are the perceptions of risks and benefits of both technologies?

This paper also aims to address correlations between the levels of awareness about both technologies, expectations of socio-economic benefits and perceptions of risks (environmental, technical, social and economic).

2. Background

2.1. Energy policy targets for renewable energy sources and oil shale

The Government of Jordan is considering further deployment of RES and of oil shale technology which creates the drivers for the deployment of these technologies. Such

political will is also reflected in the crucial for energy policy national documents. According to the National Energy Strategy for the period 2015–2025 Jordan aims to achieve energy security through maximisation of the deployment of local energy resources and reduction of energy costs. The National Energy Strategy for the period 2015–2025 also outlines the need to enhance and stimulate further deployment of RES and oil shale. The national targets for RES in final electricity mix should reach 31 per cent and for oil shale 15 per cent by the year 2030.

The new strategy was benefiting from many documents. One of them was a report prepared by the EDAMA association in cooperation with the Friedrich Ebert Stiftung (2019). This report presents recommendations for energy sector strategy that reflects the opinions of the private sector, non-governmental agencies and academic institutions. The report is focusing mainly on 'maximise local resources share in the total energy mix'. The local resources in the report namely represent renewable energy resources from solar, wind and bioenergy, in addition to energy efficiency and energy saving. According to this report, the share of RES is still small. The grid expansion and retrofitting has not yet been accomplished and are the major barrier for further deployment of RES. Currently the RES sector is not growing much due to investment insecurity and the lack of clear policy directions.

However, currently the energy sector in Jordan has to deal with already excessive electricity generation capacity and the bottlenecks in electricity transmission. The generation capacity of the Jordanian electrical system reached 5.728 MW by the end of 2019. The peak load of the electrical system in 2019 made 3.380 MW, which was only a slight increase in comparison to 3.205 MW in the year 2018. The national energy policy planning operates on the assumption that the yearly annual increase in peak load of the electrical system will by 2.8 per cent, according to the results of the Electricity Demand Forecast Study for the period 2019–2040 (NEPCO, 2019). There are however significant uncertainties about such development.

Jordan has abundant renewable energy resources, such as solar and wind. This country has favourable conditions for deploying solar power in terms of sunshine duration and solar radiation. Long hours of sunshine can also guarantee longer hours of electricity generation. The solar irradiance ranges between 5 and 7 KWh/m^2. The majority of the regions in Jordan offer direct normal insolation above 2000 KWh/m^2/year. The best sites, which are in the south, exceed 2300 kWh/m^2/year (Al-Zou'bi, 2010). The areas of Ma'an and Aqaba have the highest levels of solar irradiance in the country and globally, ranging between 6–7 KWh/m^2 and 1.2–1.35 KWh/m^2 for diffuse irradiance (Al-Sayed, 2013).

Different types of solar systems are in use in Jordan. Small stand-alone Photovoltaics (PVs) and large grid connected PV systems are used for heating water in households, for electricity in educational, public buildings and commercial institutions, water pumping

systems, and agricultural applications such as greenhouses. Several further solar projects in Jordan are in planning and under construction.

Jordan has a long history of exploration of oil shale. However, despite several geological missions, this technology still has not reached the market scale. Oil shale was known in Jordan since ancient time. The modern exploration started during the Ottoman Empire. The first geological survey of oil shale reserves was conducted by the German Geological Mission in 1968 with the focus on El Lajiun area. This was followed by several other studies realised by Germans, Russian, Chinese and Americans during the period 1968–1999.

Oil shale is another area intensively supported by the Jordanian government electricity generation technology considering that Jordan has the eighth largest oil shale resource in the world. Various international and national estimates show that the volumes of oil shale resource consist between 40 and 70 billion tons (NEPCO, 2018). Almost 70 per cent of its territory contains oil shale deposits with good quality marinate oil shale and the majority of these sites are located 20–75 km from the east of the Dead Sea. Jordan has the long history of interest to oil shale reserves. The fact that Jordan is rich of oil shales was already known during the ancient times. Following to this several missions, also including mission of various European countries, tried to explore oil shale deposits. This development intensified during the last decades with the signature of various memoranda of understanding by the Jordanian government with international investors and companies for construction of oil shale power plans and exploration of oil shale sites. However, many of these companies withdrew because of various reasons and still existing uncertainty. Therefore, currently there is only one oil shale project to generate electricity by direct burning with a capacity of 470 MW in Attarat areas.

Besides the balancing between electricity supply and demand, energy policy in Jordan also has to deal with a number of issues such as the need for further development of legislation for electrification of various national sectors, further deployment of electricity transmission grids and increase of their transmission capacities (EDAMA and FES, 2019). Most of the increase of energy generation during the last years in Jordan comes from the RES. The generation capacity of renewable energy projects carried out on the transmission and distribution grids reached about 1.470 MW by late 2019, representing about (25.7 per cent) of the total generation capacity. Most of this increase comes from solar energy, followed by wind, hydro and biogas (NEPCO, 2019). However currently the development of renewable energy market slowed down due to existing uncertainties, lack of transmission capacities and overproduction at the market. The development of oil shale mark*et al*so experiences uncertainty considering the slowing down growth of energy demand.

2.2. Case-study areas

In frames of this paper, we consider four case study areas such as Ma' an, where significant renewable energy deployment is achieved and planned, Tafileh, where some renewable energy projects already exist, El Lajoun, where deployment of oil shale reserves is under consideration, and El Attarat where deployment of oil shale power station is taking place.

Ma'an is the city in the Southern part of Jordan, 218 km southwest of the capital of the country Amman. According to the data from 2018, Ma' an had more than 170,000 inhabitants and the poverty rate among its population was one of the highest in the country. It also had the highest unemployment rate. Those who had jobs were mainly active in public administration and defence as well as in compulsory social security, education, wholesale and retail trade as well as the repair of motor vehicles, transportation and storage and mining and quarrying. To stimulate socio-economic development of Ma'an, the Jordanian government gave it the status of the Ma'an Development Area which makes it a special economic zone benefiting from reduction in payment of taxes and social payments. This special economic zone includes residential community, industrial park, Haji oasis and a Skill Development Center. The construction of industrial park started already in 2008 and is still ongoing with expectations that the industrial park will become functional and will bring jobs and prosperity by the year 2030. RES is another driver of hope for socio-economic development of this area as Ma'an enjoys 320 days of sunshine over the year and a high level of solar irradiance (EcoMENA, 2018).

Tafileh is a city which is located 183 km southwest from Amman and has population of 104,000 people. The poverty and unemployment rate are slightly lower than in Ma'an due to manufacturing capacities which exist in this area. Most employed people are working in the sectors of public administration and defence, compulsory social security, and education as well as human health and social work activities, mining and quarrying but also manufacturing. Tafileh is the area which is rich of natural resources. It has 360 natural springs, one million tons of copper and half a million tons of manganese as well as phosphates mining, which is the largest industry in the region. Together with cement factories, phosphate mining is the main source of income in the region. The area is also benefiting from agricultural activities of fruit and olive farms as well as from domestic tourism which several Jordanians spending their holidays at the hot water springs and natural reserves of the region.

El Lajoun is located 100 km south of Amman and 12 km east of the Al-Karak city. This region is mainly inhabited by nomadic Bedouins and is characterised by many small villages around the region. The region is rich of oil shale resources. El-Lajoun oil shale was deposited in a sedimentary basin and comprises massive beds of brown-black, kerogen-rich, bituminous chalky marl. The oil shale was deposited in shallow marine

environment (Gharaibeh, 2017). It is also rich of water resources. The Wadi El-Lajoun catchment area (370 km^2) consists of two main aquifer systems: The intermediate aquifer (Amman Wadi As Sir Aquifer or B2/A7) and the deep sandstone aquifer (Kurnub/Ram Group Aquifer). The B2/A7 aquifer (Upper Cretaceous) is considered as the main source of fresh water in Jordan (Gharaibeh, 2017). El Lajoun oil shale deposit is the best-known oil shale deposit in Jordan, but the environmental concerns are high due to shallow ground water level and high-risk areas. El–Lajoun area is divided into three zones: low (risk index (10–100); intermediate (risk index 101–140) and high groundwater vulnerability (risk index 141–200). The highly risk areas are limited and are mainly located in the north-eastern corner of El-Lajoun graben and around El-Lajoun village, where the water table is relatively shallow (<60 m) (Gharaibeh, 2017).

El Attarat is located 110 km south of Amman. This is a remote and almost inhabited area which can be reached by the main desert highway between Amman and Aqaba. The region is rich of water resources and has the Azraq surface water basin which is one of the major Jordanian water basins. The region has the first oil shale power station in the region. The size of the development area is 70 km^2 and it contains approx. 3.5 billion tonnes of oil shale. The mining area for the 554 MW (gross) power plant is approximately 11 km^2. According to geological estimates, this mining area can supply the power plant with approximately 10 million tonnes per year for a period of 40 years. The power station is located in the vicinity to one of the most important protected bird areas in Jordan. The Environmental Impact Assessment which was conducted by the Attarat Power Company (APCO) for the oil shale project in 2013 finds that the project area has no permanent settlements except for some nomadic groups moving around during the grazing season. These groups are mainly using soil dams of Wadi Al Ghadaf and Attarah to water their animals. The closest to project site human settlement is 53 km away. This is the village of Al-Damkhi which has 995 inhabitants. A larger settlement of Al-Qatranah is 60 km way from the site and has population of 5420 people as well as some commercial activities. The majority of inhabitants of both villages belong to the local Jordanian tribes. Al-Qatranah has also some Egyptians, Yemenis, Turks, Chinese, Syrian and Saudi people. Both villages have high level of poverty with 48 per cent of households in Al-Qatranah and 32 per cent of households in Al-Damkhi living below poverty line. The level of unemployment is also high, with 43 per cent of people in Al-Qatranah and 41 per cent of people in Al-Damkhi are being unemployed. The families of unemployed people are currently living from financial assistance from the government which is below the minimal month wages.

As **Table 1** shows the most intensive development of the wind and solar projects in Ma'an and Tafileh started from the year 2016. There is one large scale project which is the Tafileh Wind Farm (117 MW). Other projects such as Mass Energy are slightly smaller. The Tafileh Wind Farm was the first commercial utility-scale wind power

Table 1 Renewable energy projects in Ma'an and Tafila

	Location	Project name/company	Capacity (MW)	Operation data
Wind energy projects	Tafila	Tafileh Wind Farm	117	SEP/2015
		Mass Energy	100	Dec/2019
		Abour Energy Company OSC (Xenel)	50	2021
		Daehan (KOSPO)	50	2021
	Ma'an	Al-Hussein wind project Elecnor/ Ma'an	80	Sep/2016
		Green Watt	86	Oct/2018
		KEPCO	89	Jul/2019
		Alcazar	45	Oct/2020
Solar energy projects	Ma'an	Saqr Maan Solar Energy Company	20	2016
		Ennera Company	10	2016
		Shams Maan Company	50	2016
		Anwar Company	20	2016
		Alzanbaka Company	10	2016
		Zahret Al-Salam Company	10	2016
		Al-Ward Joury Company	10	2016
		Ard AlAmal Company	10	2016
		Adwaa Maan Company	20	2016
		Scatec Solar Company	10	2016
		Philadelphia Solar	50	2021

project in the Middle East and the largest privately financed wind farm in the Hashemite Kingdom of Jordan. The Tafileh wind farm was developed by Jordan Wind Project Company, a co-development partnership between InfraMed (50 per cent), Masdar (31 per cent) and EP Global Energy (19 per cent). A comprehensive Environmental and Social Impact Assessment (ESIA) was conducted for the project, in accordance with applicable Jordanian Environmental permitting guidelines, and international best practice. The project area is hilly and heavily eroded, and it is located 5.5 km away from Dana Biosphere, which is Jordan's largest nature reserve. The majority of solar projects are small scale projects.

At the same time, as we look to the oil shale project, we see a different picture (**Table 2**). The oil shale power station in Attarat is being characterised as a large-scale project. The oil shale extraction project in Lajoun can be considered also as a large-scale project.

Table 2 Summary of oil shale projects with concession agreements

Company	Project location	Oil shale exploitation method	Capacity	Phase
Jordan Oil Shale Energy -JOSE Company (owned by the Estonian Company Enefit/ Malay/Jordan)	Attarat um Ghudran	Oil shale fired power plant	470MW	Under construction Operational by 2020
	Attarat um Ghudran	Oil shale production plant	40,000 barrels daily = 40% of Jordan's current daily energy	Engineering and testing phase
JOSCO Company owned by Shell Company	NA	In Situ Conversion Process (ICP)″ technology	NA	Engineering and testing phase
Karak International Oil Company 'KIO'	Lajoun	Surface distillation for oil production technology of the Alberta Taciuk process (ATP)	25,000 barrels a day	Engineering and testing phase The agreement was amended in 2018 extending the pre-development phase upon the global oil price drop
SACOS Company (Saudi Arabian Company for oil shale) owned by a Saudi investor	Attarat	Surface distillation for oil production	9000 barrels/day, ramping up to a production capacity of 30,000 oil barrels/day by 2028	Under construction Operational by 2022 Specific articles in the agreement were amended in 2018 according to the project special requirements

The Attarat power station is a first electric power plant in Jordan with direct burning of oil shale and generation capacity of 470 MW. The power station is being constructed and managed by the Attarat Energy Company which is a coalition of

Chinese, Malaysian and Estonian companies. The Jordanian government hopes that the power station will be able to cover up to 15 per cent of the Jordanian energy needs (NEPCO, 2020), will provide more than 1000 jobs for Jordanians during the construction phase and will involve over 30 local companies. There are also expectations about budget savings due to the reduced need to import energy and budget revenues due to the royalty fees which the Attarat Energy company should pay to the government (NEPCO, 2019).

The Attarat power station might become an example and a driver for further development of oil shale in the country. The Jordanian government already signed eight memoranda of understanding with several international and local companies to investigate further possibilities of retorting oil shale (**Table 3**).

Table 3 Summary of oil shale projects with Memorandum of Understanding agreements

Company	Project location	Oil shale exploitation method	Capacity	Phase
Shale Energy (JOSECO)	Sultani area	Russian technology	50,000 barrels per day	NA
Global Oil Shale Holdings Inc. (GOSH)	Attarat Umm Ghudran and Isfir Al Mahatta	Amended Brazilian technology	50,000 barrels per day	NA
Al Qamer for Energy & Infrastructure Ltd. Co.	Attarat	Produce synthetic crude oil using Canadian technology and generate power from oil shale	NA	NA
Questerre Energy Company	Al Jafer and Isfir Al Mahatta	In capsule technology	NA	NA
AL-Lajiun Company	Attarat area and Al Lajoun	Russian technology	30 000 barrels per day	NA
APCO company for oil shale (Aljonoub Company for oil shale)	Na'dyya area	Russian technology	NA	NA
Whitehorn Canadian company	Wadi Abu Hamam area	In capsule technology	50,000 barrels per day	NA
Fushun Mining Group	Na'dyya area	Chinese technology	NA	NA

3. Methodology

The academic literature names several terms to describe social attitudes which are often used inconsistently or interchangeably although they refer to different notions. The vocabulary includes public perception, acceptability, awareness, willingness-to-pay, readiness to use renewable energy appliances and public support. However, the term 'acceptance' can include a range of potential attitudes towards renewable energy technologies that are other than active opposition, including apathy, passive acceptance, approval, and finally active support. Such acceptance can take place in political spheres, in markets, and in communities. Therefore, we prefer to use here the more neutral term such as 'social attitudes'.

The beginning of the usage of the term 'acceptance' can be found in frames of various discussions about Not-in-My-Backyard (NIMBY) syndrome which describes reaction of local communities as egoistic reaction of local communities towards infrastructure which is needed for socio-economic development of the country or its energy or climate change security needs. The essence of NIMBY is that such infrastructure is needed, and everybody understands that it is needed by nobody wants to have it to own community. Such understanding was diminishing concerns of local communities which were frequently connected with impact of such infrastructure on environment or human health.

Fortunately, such understanding of social attitudes towards planned infrastructure changes towards the understanding of legitimacy of concerns of people who want to have a say about infrastructure which will impact their lives and their communities. Understanding is growing that involvement of knowledge, feedback and expertise of people on the ground, of various stakeholders and inhabitants of communities might increase the legitimacy of decision-making processes on infrastructure deployment, the quality of the decision-making process itself as well as of its outcomes (Komendantova, 2016; Komendantova *et al.*, 2018). The discussion also starts to have elements of polycentric governance of energy transition (Komendantova *et al.*, 2021).

The theoretical basis of this research is in the Theory of Planned Behaviour, which also uses comprehensive socio-psychological models to understand factors which influence social attitudes. This theory is an extended version of the Theory of Reasoned Action which postulates that a person's actual behaviour in performing certain action is directly guided by his or her behavioural intensions. The behavioural intension is determined in its turn by attitudes. The focus of the paper is to identify factors which influence social attitudes towards RES and oil shale in Jordan.

The data collection methodology of this paper is based on the large-scale survey with inhabitants of communities nearby existing or planned renewable energy and oil shale infrastructure. The empirical data collection took place in four communities where

infrastructure is under planning, construction or operation. Two of these communities had renewable energy projects such as wind and solar (Ma'an and Tafileh) and other two communities had projects on oil shale extraction and power generation (Lajoun in Karak governate, Attarat and Um Alrasas on the borders of south of Amman).

The main data gathering instrument was a survey which was developed based on the background review of the literature on social attitudes and energy transition and identified drivers of attitudes towards various technologies and infrastructure projects. The survey was based on the interview protocol with open, semi-open and multiple-choice questions. The interview protocol also included ranking questions to identify various preferences. The interview protocol included separate questions for oil shale and RES. However, each protocol had a common part which would allow comparison of results but also specific questions. These questions included perceptions of environmental impacts compared to perceived socio-economic impacts, the level of awareness about technology and trusted sources, in general, and about the planned project, in particular, general attitudes and concerns towards projects, perceived costs and benefits of renewable energy and oil shale, perceived positive and negative impacts etc.

We conducted our survey with inhabitants of communities around planned renewable energy and oil shale infrastructure projects. The respondents were chosen randomly. The sampling included equal groups in terms of age and sex distribution. The sampling size of 200 people allows us making robust conclusions. The interviews were conducted during summer 2020 and each interview lasted for approximately 30 min. The interviews were conducted in Arabic language by the team of interviewers consistent of five people. The interviews were conducted in person when the team of interviewers went personally to all four communities. Further on, the responses from interviews were entered into a unified database. Data were evaluated with the help of existing statistical programmes and methods of analysis.

4. Results

The results of this paper are based on large-scale survey with inhabitants of four communities Ma'an, Tafileh, Lajoun and Attarat. During this survey we collected empirical data on factors which have important influence on social attitudes towards infrastructure projects such as perceptions of safety, socio-economic and environmental impacts, availability of information and the level of awareness as well as perceptions of procedural justice (**Fig. 1**). These factors were identified from previous research and existing literature on social attitudes towards infrastructure projects (Wolsink, 2006, 2012; Wüstenhagen *et al*., 2007; Sovacool and Dworkin, 2015; Sovacool *et al*., 2015; Komendantova and Battaglini, 2016; Komendantova and Neumueller, 2020).

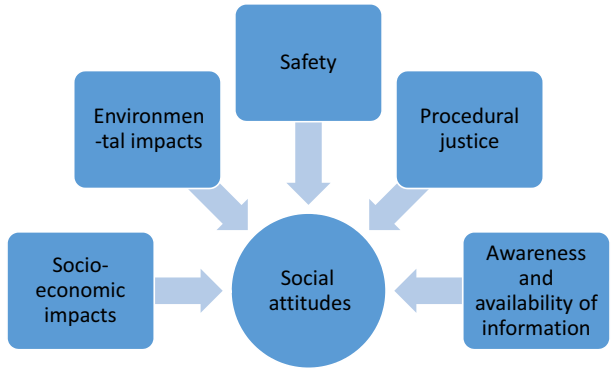

Figure 1 Factors influencing social attitudes. Sources: developed by authors based on works of Komendantova and Battaglini (2016), Komendantova and Neumueller (2020), Wolsink (2006), Wolsink (2012), Wüstenhagen *et al*. (2007), Sovacool *et al*. (2015), Sovacool and Dworkin (2015).

The majority of people in all four communities are completely in favour of such infrastructure projects such as oil shale or RES. It is interesting that the oil shale project in Attarat enjoys the highest level of acceptance, followed by wind and oil shale in Lajiun (**Fig. 2**).

4.1. Awareness, availability of information and procedural justice

Even though social attitudes towards the projects are positive, the level of awareness of people especially about the details of the projects in their communities is low. This level of awareness about projects in their communities is also lower than the level of awareness about the technology, such as oil shale, wind and solar, in general. For example, the majority of people in Lajoun (63 per cent) are aware that the oil shale power station is planned in Jordan. At the same time people feel that they are not well informed about oil shale power station. Many (32 per cent) say that they are not informed at all or badly informed (10 per cent). Another example is the oil shale power station in Attarat (98 per cent) as the majority of interviewed people know about it. At the same time many people in Tafileh and Ma'an feel themselves being somewhat informed (51 per cent) and well informed (22 per cent) about wind projects. This is maybe connected to the fact that solar and wind are small-scale projects and are not so well visible in mass media. For example, only 70 per cent of people are aware that PV projects are planned in their community (**Figs 3** and **4**).

People are also not aware of any public information campaign on oil shale, wind or solar projects providing them with details of oil shale projects planned in their

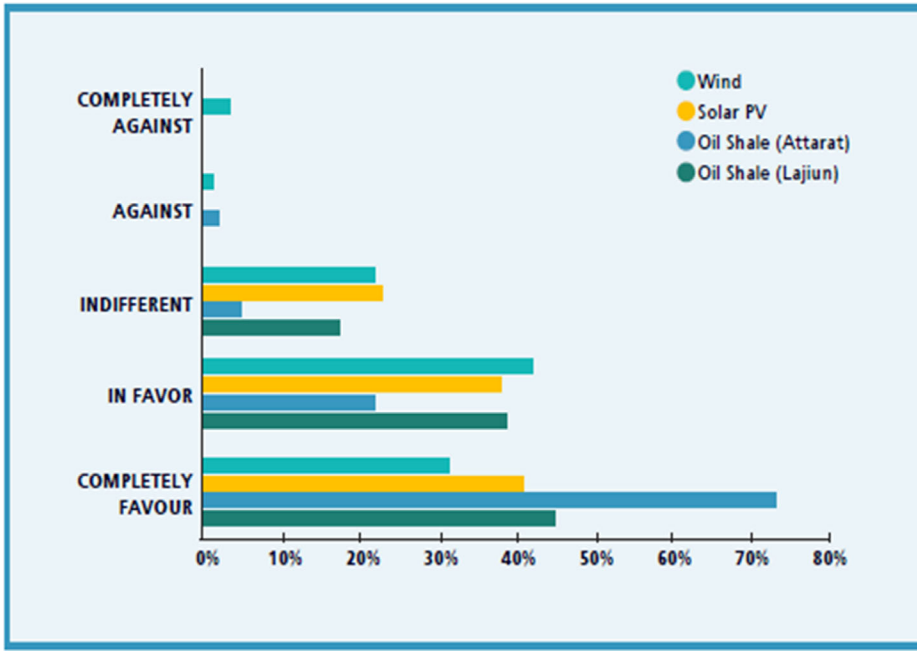

Figure 2 Social acceptance for solar, wind and oil shale.

communities. The majority of people in Lajoun (63 per cent) are aware of the oil shale power station, which is planned in Jordan, but they (78 per cent) are not aware of any public information campaign for the oil shale power station. The majority of people in Attarat (66 per cent) are not aware that any public information campaign about planned oil shale power station exists. The majority of people (61 per cent) is also not aware of any public information campaign for wind projects. People (56 per cent) are also not aware about any public information campaign for solar PV projects.

While speaking about awareness about oil shale, wind and solar projects, it seems that scientists are the most trustful source of information, 65 per cent of people have some trust to scientists and the rate of people who do not have trust to this source of information is the lowest. Also, project developers enjoy some trust (37 per cent). At the same time politicians have the lowest level of trust (49 per cent) as well as foreign investors (29 per cent), NGOs (27 per cent), mass media (25 per cent) and international institutions (24 per cent) (**Fig. 5**).

Social attitudes might be also influenced by the fact that people do not believe that their opinion might change anything. For example, people in Lajoun (66 per cent) don't

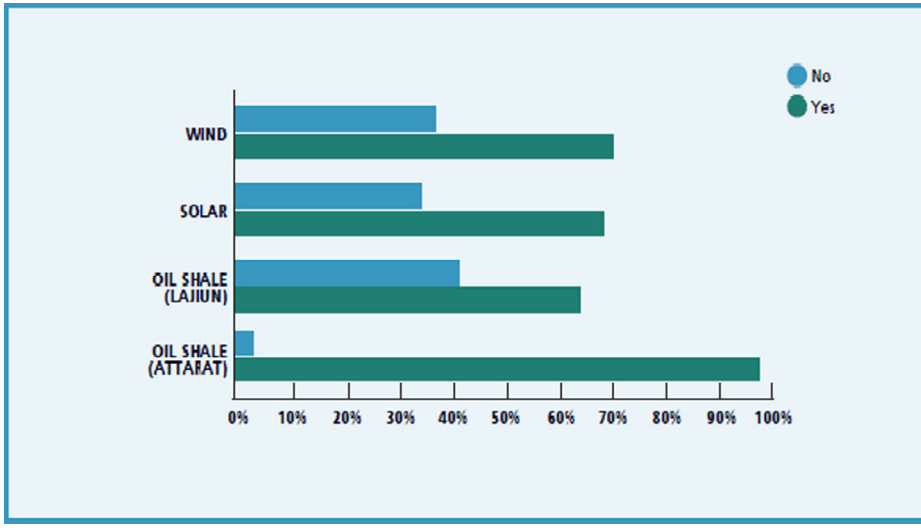

Figure 3 Level of awareness about oil shale, wind and solar.

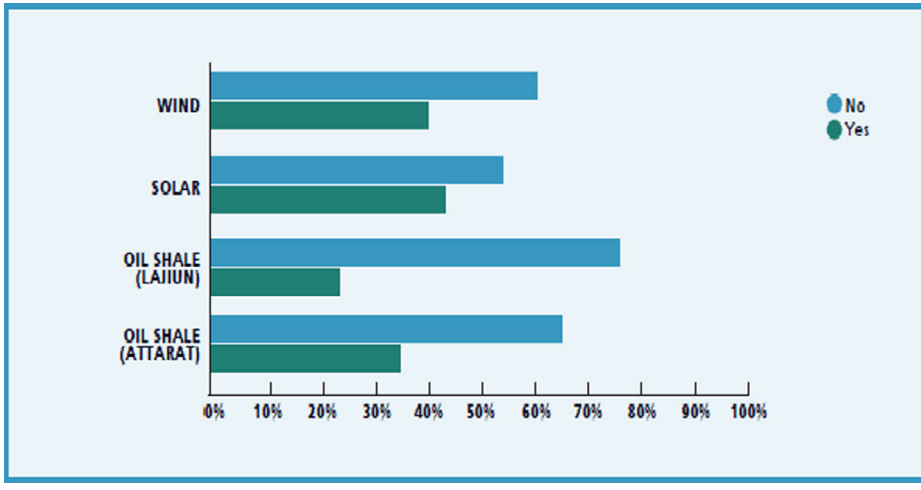

Figure 4 Awareness about public information campaigns about oil shale, wind and solar Photovoltaic (PV) projects.

think that they are encouraged to provide their opinion on oil shale power station. People also don't think that they are encouraged to provide opinion on wind (65 per cent) or solar (59 per cent) projects (**Fig. 6**).

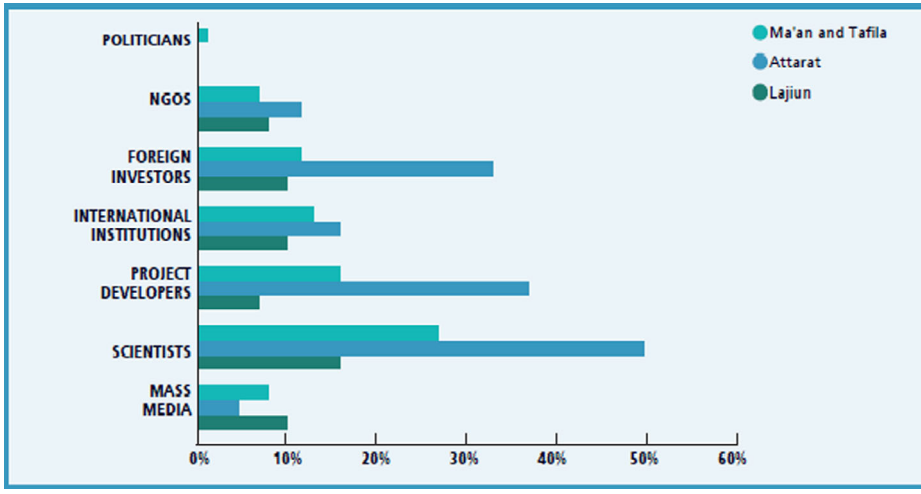

Figure 5 Trust in various information source.

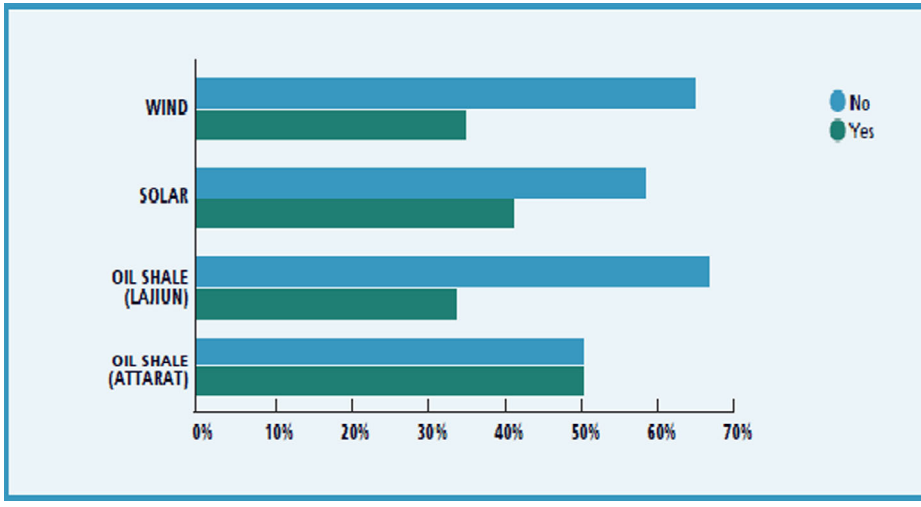

Figure 6 Encouragement to provide opinion about oil shale, wind and solar Photovoltaic (PV) projects.

Our results on communication channels for the case of concerns about the projects show that people would use much more frequently social media for wind or solar projects, but they would prefer more traditional channels of communication of concerns

such as project developers or local government about oil shale projects. In case of concerns about oil shale power station in Attarat, the majority of people (54 per cent) will contact owners of the project or the local government represented mainly by the mayor (18 per cent). Some of them will contact the Ministry of Energy (14 per cent) or go to social media (10 per cent) or private media (4 per cent). Interestingly, nobody will contact the Ministry of Environment. For wind projects, if people have concerns, they will mainly communicate it via social media (26 per cent). They might also go to the local government (20 per cent), owner of the project (17 per cent) or Ministry of Energy (17 per cent). The Ministry of Environment (9 per cent), a parliament representative (7 per cent) or private media (5 per cent) would be the last instances where people would go with concerns. For solar PV, social media are playing much more important role for RES if people want to express their concerns than for oil shale. In case of concern 25 per cent of interviewed people will go to social media. 19 per cent will go to owner of the project or governor of the area. 16 per cent will go to the Ministry of Energy and 12 per cent to a representative of parliament. Only 5 per cent will go to private media or to Ministry of Environment (**Fig. 7**).

4.2. Perceptions of environmental impacts

While speaking about impacts on environment people expect much more positive impacts from solar and wind. The majority of people think that impact of oil shale on

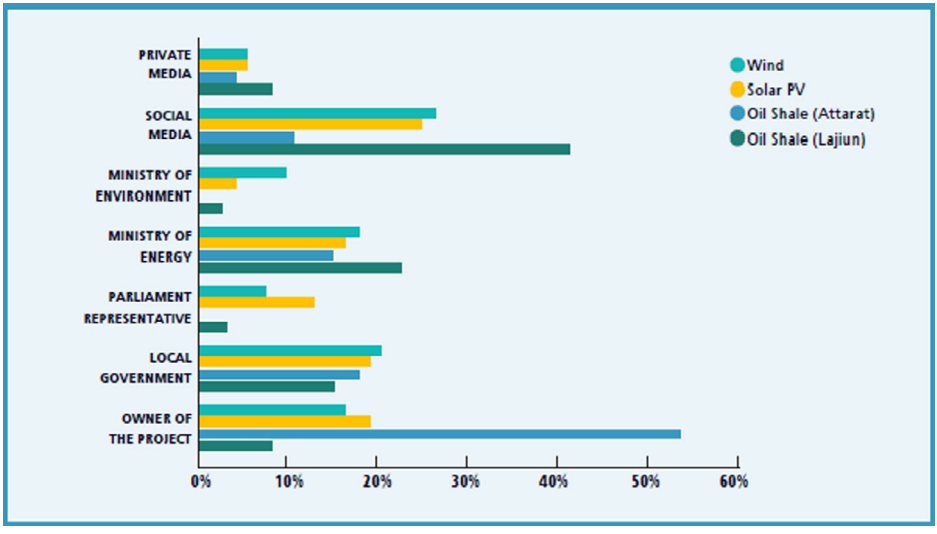

Figure 7 Contacts in case of concern.

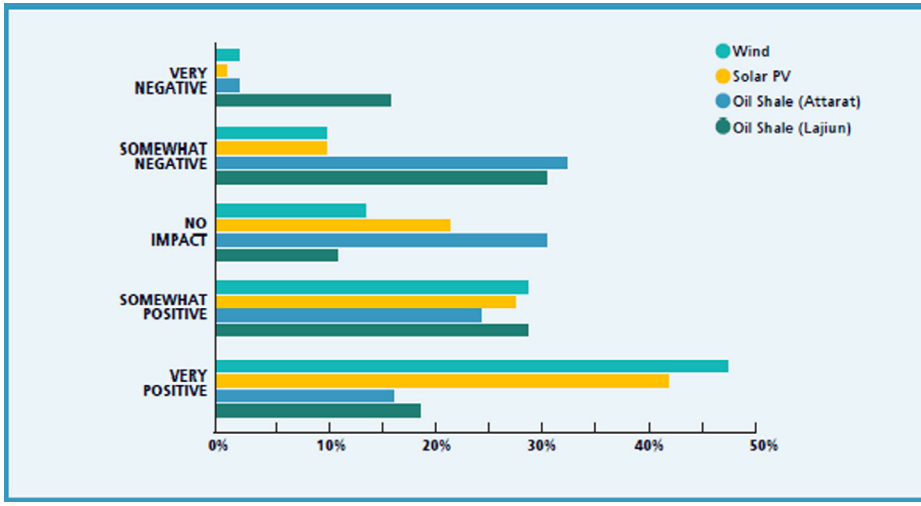

Figure 8 Expectations of impacts on environment.

environment will be somewhat negative. Interestingly that people in Lajoun think that impacts from oil shale on biodiversity will be positive (**Fig. 8**).

While speaking about treats people in all four communities perceive water scarcity and drought as a major threat to their community but they do not connect this threat to the development of infrastructure projects. In contrary, in communities where oil shale projects are planned people think that oil shale projects will have a positive development on the availability and quality of water resources (**Fig. 9**).

Even though people in Attarat think that water scarcity is the biggest threat for their region, they do not think that oil shale power station will have negative impacts on water availability (**Fig. 10**). The share of people who think that it might have negative impacts on water quality is minor (4 per cent). Deployment of wind projects is mainly associated with positive impacts. People think that wind projects will have a positive impact on water availability, human health or quality of air. They are more sceptical about impacts of wind projects on aesthetic of landscape or biodiversity. Deployment of solar projects is associated with highest positive impacts on human health, water availability and quality of air (Fig. 10).

4.3. Perceptions of socio-economic benefits

It is clearly the expectation of socio-economic benefits which has positive impact on attitudes towards infrastructure projects. The majority of people in Lajoun think that the

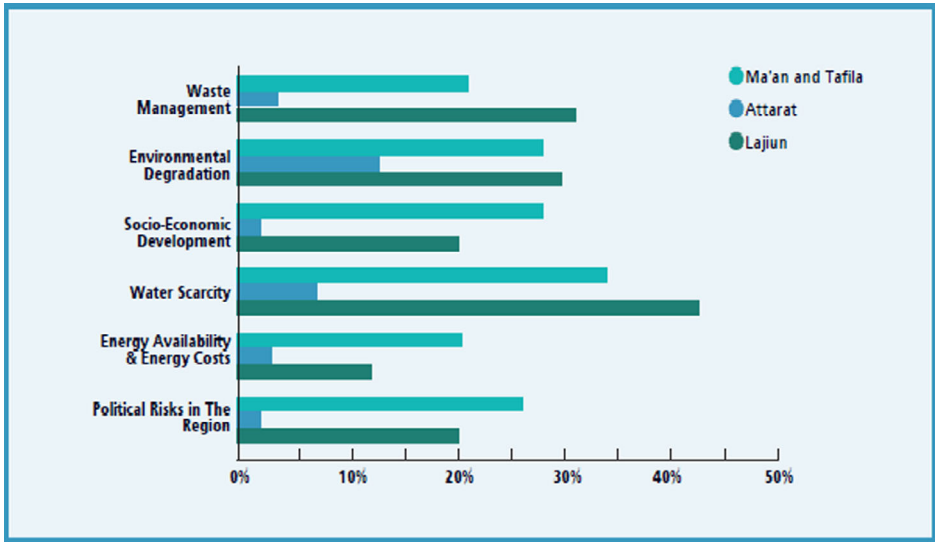

Figure 9 Concerns about various risks in Ma'an, Tafileh, Attarat and Lajiun.

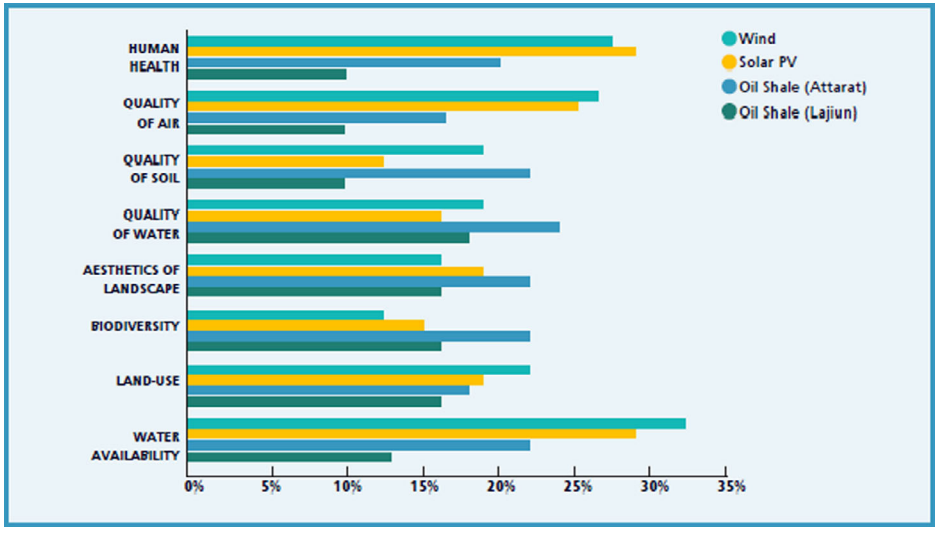

Figure 10 Expectation of very positive impacts on environments from oil shale, wind and solar projects.

Figure 11 Expectations of socio-economic benefits from oil shale, wind and solar Photovoltaic PV.

oil shale project will have positive impacts on their own lives and on their community. People in Attarat are even more positive about socio-economic impacts of oil shale project where 64 per cent expect not only positive but very positive impacts. People in Ma'an and Tafileh are also enthusiastic about socio-economic impacts of solar and wind projects (**Fig.** 11).

These positive expectations are mainly connected with job creation as people think that the projects will provide direct, indirect and induced jobs for their community. 45 per cent of people in Lajoun and 92 per cent of people in Attarat think that oil shale projects will create jobs. People in Ma'an and Tafileh have similar expectations on wind and solar (43 per cent and 46 per cent). People also think that large scale projects such as oil shale will help to improve quality of infrastructure in their communities including roads, water and electricity. 35 per cent of people in Lajoun expect this and in Attarat every 62 per cent. The expectations on impact from solar and wind on the quality of infrastructure are much more modest (24 per cent and 20 per cent). People think that positive impacts from solar and wind will be mainly on electricity prices, cost of land and tourism (**Fig. 12**).

4.4. Perceptions of safety

Our results on perceptions of safety, ability of authorities to control the risk or frequency of possible accidents show that people perceive oil shale projects as safer than renewable

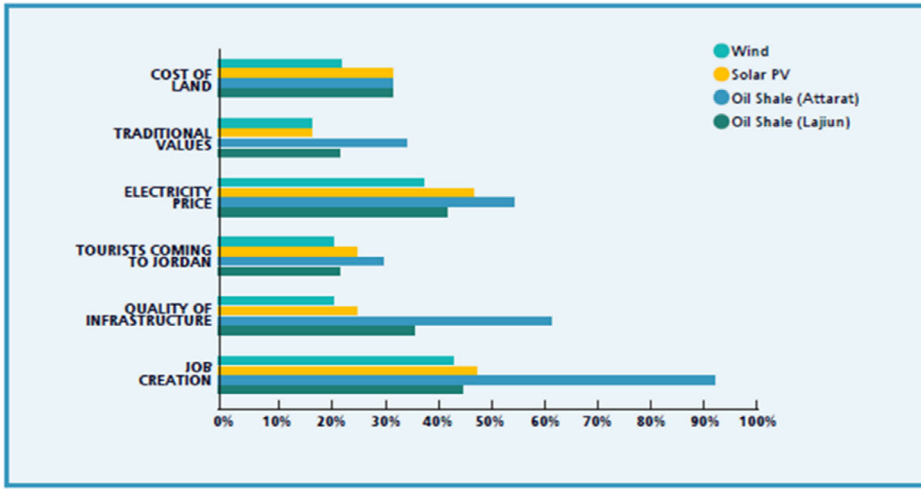

Figure 12 Expectations of impacts on socio-economic development from oil shale, wind and solar PV.

energy projects. Such results might be explained by the fact that people are confusing safety factors which are leading to risks and creating a threat for their community and factors which are connected with successful functioning of technology and require repair and maintenance but do not have impacts on community. Such perceptions of safety will need further research.

People perceive oil shale as being a safe technology and that the government will be able to control the risk. The majority of people in Attarat do not believe that the large accidents are probably during the functioning of the power station, but they think (56 per cent) that a small accident might happen in a 20-year period. However, people think that small accidents every 5 years are more probably during the functioning of solar (38 per cent) and wind projects (44 per cent) (**Fig. 13**).

People at Attarat also have high confidence that if something happens, authorities will be able to control the risk fully (76 per cent) or partially (16 per cent). At the same time people in Ma'an and Tafileh think that the authorities in Jordan will be able only partially to control the risk for wind (49 per cent) and for solar (54 per cent) projects (**Fig. 14**).

People in Attarat (52 per cent) believe that the capacities of disaster risk reduction in Jordan to control accident if something happens at the oil shale power

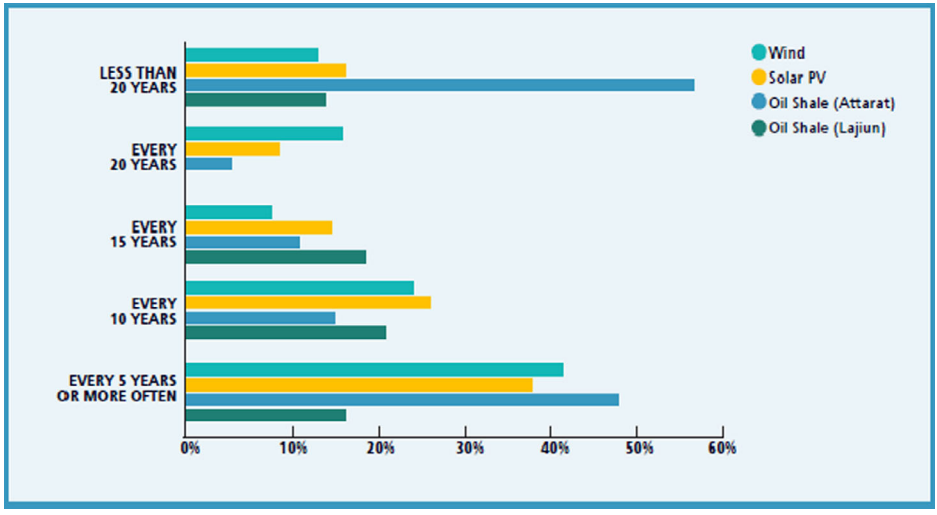

Figure 13 Perceptions of probability for small accidents.

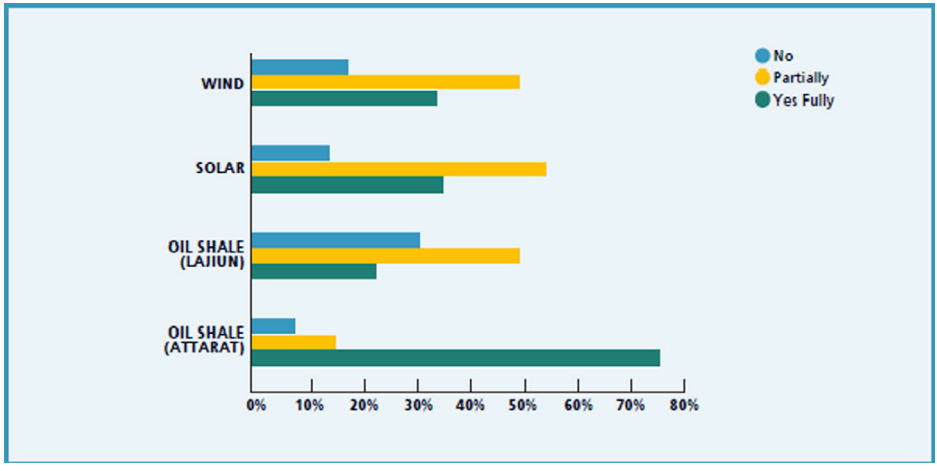

Figure 14 Perception of authorities being able to control the risk.

station are even better than in other countries but they think that these capacities are worse than in other countries for wind (44 per cent) and solar (42 per cent) (**Fig. 15**).

Figure 15 Expectations on how disaster risk reduction can deal with the risk if something happens during operation of power stations in comparison to other countries.

Even if people do not say openly that they perceive oil technology as risky or as having impacts on human health and environment, the majority of people in Attarat prefer to have oil shale power station to be as far as possible from their home and they also do not live in the direct vicinity to the oil shale power station. 68 per cent would like to have it more than 100 km from their home, followed by 24 per cent who would prefer it will be 50–100 km. Only 2 per cent have the power station <20 km to their home and 6 per cent in between 20 and 50 km. But the majority of people would not mind having wind projects close to their homes. 35 per cent would accept it 20 km and less to their homes and 31 per cent would accept the projects at the distance 20–50 km. 19 per cent of people would prefer to have the projects at more than 100 km from their homes. Many people would not also mind having PV close to their homes. For 40 per cent is it convenient to have it with the distance of <20 km, for 22 per cent with distance between 20-50 km. But many (29 per cent) would prefer to have it at the distance of over 100 km (**Fig. 16**).

4.5. SWOT analysis

In **Table 4**, SWOT analysis has been performed to define the Strength, Weaknesses, Opportunities, and Threats of renewables and oil shale from perspective of the Jordanian society and public opinion.

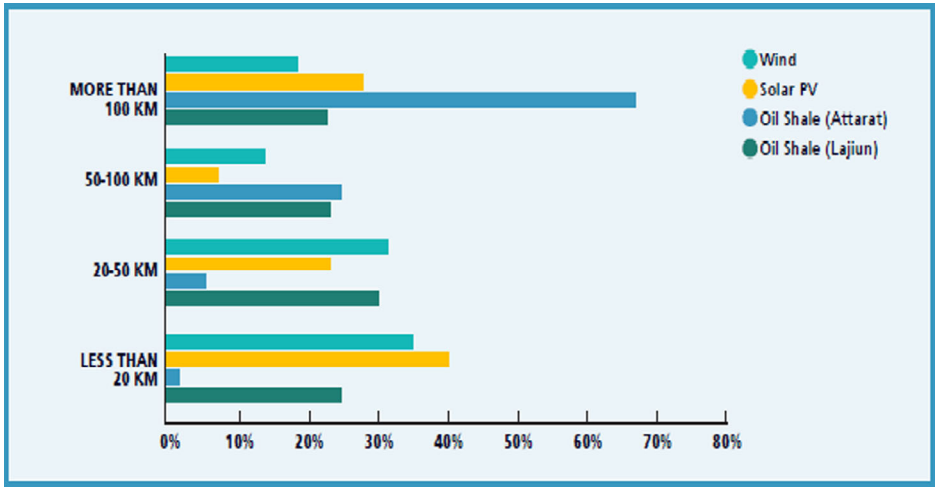

Figure 16 Acceptance distance from private homes to oil shale, wind and solar projects.

5. Conclusions and recommendations

Our results show that people in Jordan have, in general, positive attitudes towards infrastructure projects which are needed for security, in general, or energy security, in particular. Energy security in such contest is mainly understood as the independence from imported energy while generating energy from locally available energy sources.

Other important factors which influence social attitudes are expectations of socio-economic benefits from projects in terms of jobs or infrastructure development for local communities. A significant share of people in communities where we conducted our research live below poverty line and the level of unemployment is high. These makes people to expect that large-scale projects such as oil shale power station in Attarat will bring jobs and create infrastructure for their communities. Without proper regulation there is a danger that such infrastructure projects will rest on the shoulders of communities with less favourable socio-economic development. This might increase the socio-economic divide between such communities and other regions even more. One of the recommendations to proceed is to settle a regulatory and institutional framework to ensure that such infrastructure projects are not only compensating local communities for using resources or being in their vicinity but rather using a part of the earnings from the projects to make these communities a better place to live, while improving the existing infrastructure and creating employment opportunities. However, we did not find an indication if plans from project developers exist to invest into infrastructure of

Table 4 SWOT Analysis of oil shale and renewable energy

Oil shale	
Strength	Weakness
• The oil shale project in Attarat enjoys the highest level of acceptance • Oil shale in Lajiun enjoys the second highest level of acceptance • The majority of people in Lajoun think that the oil shale project will have positive impacts on their own lives and on their community • People in Attarat are even more positive about socio-economic impacts of oil shale project • People perceive oil shale as being a safe technology and that the government will be able to control the risk • People perceive oil shale projects as safer than renewable energy projects • People think that a small accident might happen in a 20-year period • People at Attarat have high confidence that if something happens, authorities will be able to control the risk fully or partially • People in Attarat believe that the capacities of disaster risk reduction in Jordan to control accident if something happens at the oil shale power station are even better than in other countries	• The level of awareness of people especially about the details and technologies of the projects, such as oil shale, wind and solar, in general in their communities is low • People are also not aware of any public information campaign on oil shale, wind or solar projects providing them with details of oil shale projects planned in their communities • The majority of people in Attarat prefer to have oil shale power station to be as far as possible from their home and they also do not live in the direct vicinity to the oil shale power station
Opportunities	Threats
• Encourage people t to provide opinion about oil shale • People would prefer more traditional channels of communication of concerns such as project developers or local government about oil shale projects • In communities where oil shale projects are planned people think that oil shale projects will have a positive development on the availability and quality of water resources • People think that the oil shale projects will provide direct, indirect and induced jobs for their community • People also think that large scale projects such as oil shale will help to improve quality of infrastructure in their communities including roads, water and electricity	• Politicians have the lowest level of trust as a source of informtion, as well as foreign investors, NGOs, mass media and international institutions • The majority of people think that impact of oil shale on environment will be somewhat negative

Renewable energy

Strength	Weakness
• Wind energy in Lajiun enjoys the second highest level of acceptance • People expect much more positive environmental impacts from solar and wind • People in Ma'an and Tafileh are enthusiastic about socio-economic impacts of solar and wind projects • The majority of people would not mind having wind projects or Photovoltaic (PV) close to their homes	• The level of awareness of people especially about the details and technologies of the projects, such as oil shale, wind and solar, in general in their communities is low • People are also not aware of any public information campaign on oil shale, wind or solar projects providing them with details of oil shale projects planned in their communities • People believe that the capacities of disaster risk reduction in Jordan to control accident if something happens are worse than in other countries for wind and solar
Opportunities	**Threats**
• Encourage people to provide opinion about wind and solar PV projects • People would use much more frequently social media as a communication channel in case of concern for wind or solar projects • People think that wind projects will have a positive impact on water availability, human health or quality of air • People believe that deployment of solar projects is associated with highest positive impacts on human health, water availability and quality of air • People think that the wind and solar projects will provide direct, indirect and induced jobs for their community • People think that positive impacts from solar and wind will be mainly on electricity prices, cost of land and tourism	• Politicians have the lowest level of trust as a source of informtion, as well as foreign investors, NGOs, mass media and international institutions • People are more sceptical about impacts of wind projects on aesthetic of landscape or biodiversity • People perceive oil shale projects as safer than renewable energy projects • People think that small accidents every five years are more probably during the functioning of solar and wind projects • People in Ma'an and Tafileh think that the authorities in Jordan will be able only partially to control the risk for wind and for solar projects

communities of Lajoun or Attarat. Also, as Attarat project has started its' trial operation period in 2021, it is recommended to conduct another study after operating with full capacity to see if the social acceptance will change in Attarat. Further development of regulatory framework is also needed to guarantee that commitments towards local communities will be taken in terms of infrastructure creation or quotas for working places at the projects for representatives of local communities. Indicators of monitoring are needed to ensure that commitment are implemented. Finally, policy and institutional

mechanisms are needed and have to be implemented to guarantee fair distribution of risks, benefits and costs from oil shale, wind and solar power projects.

Social attitudes are also influenced by perceptions of how risky infrastructure projects are. The belief that projects are sufficiently safe and that authorities will be able to control the risk in case if an accident happens is a very important driver for positive attitudes towards the project. People in Jordan have high level of trust that authorities in Jordan will be able to control the risk if something happens. They also do not think that accidents during the functioning of the oil shale power station are probably or might be frequent. At the same time people perceive wind and solar projects as being riskier with less frequent small accidents and authorities in Jordan are being less able to control the risk in comparison to other countries. Our assumption is that such results come from the fact that people are confusing risks in operation of the large-scale infrastructure projects which can have significant negative impacts on human health or local communities and problems in management and operation of electricity generation technologies such as wind and solar when the government is less able to ensure their proper maintenance and reparation.

They believe that projects will have no negative impact on human health or environment also has an impact on perceptions of infrastructure projects. People in Attarat and Lajoun don't think that oil shale power station or extraction projects will have a negative impact on the environment. There is also a surprising believe that oil shale projects might help to improve the situation with water security or with its quality. Further research here is needed to understand the reasons of such perceptions. Solar and wind projects are mostly perceived as having positive impacts on environment, with some slight negative impacts on aesthetic of landscape or biodiversity.

The social attitudes towards the projects are also influenced by the so-called procedural justice, namely, of how people perceive the decision-making process and if they have an opportunity to provide feedback or to contribute to decision making. In the case of oil shale projects people don't feel they are encouraged to provide their opinion. In case of concerns, they will go to the project developer or local authorities, but the ministry of environment will be the last one which they will contact. Such results show the need to increase the influence of the ministry of environment in decision making processes. Further channels should be created for people to communicate their concerns regarding the projects. Such channels might help the establishment of early warning mechanisms in case of risks and would help authorities to guarantee the safe functioning of the projects. People do not think that they are encouraged to provide their opinion in the case of oil shale, but they would go more and more frequently to social media in case of concerns about wind or solar. Such results show the need in further research of the role of social media in energy transition.

An indication of how comfortable people are with the planned projects can be found in their responses about how far they would like to have infrastructure projects from their community. For instance, the majority would like to have oil shale power station or extraction projects as far as possible from their own community, but people will not mind to have solar and wind projects in vicinity to their homes.

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