climate

MDPI

Article

Are Energy Security Concerns Dominating Environmental Concerns? Evidence from Stakeholder Participation Processes on Energy Transition in Jordan

Nadejda Komendantova [1,2,*], Love Ekenberg [1,3], Leena Marashdeh [4], Ahmed Al Salaymeh [4], Mats Danielson [3,1] and Joanne Linnerooth-Bayer [1]

1 International Institute for Applied Systems Analysis (IIASA), Schlossplatz 1, A-2361 Laxenburg, Austria; lovek@dsv.su.se (L.E.); mats.danielson@su.se (M.D.); bayer@iiasa.ac.at (J.L.-B.)
2 Climate Policy Group, Institute for Environmental Decisions (ETH), 8092 Zurich, Switzerland
3 Department of Computer and Systems Sciences, Stockholm University, 10691 Kista, Sweden
4 Mechanical Engineering Department, University of Jordan, 11942 Amman, Jordan; leena_marashdeh@yahoo.com (L.M.); salaymeh@ju.edu.jo (A.A.-S.)
* Correspondence: komendan@iiasa.ac.at; Tel.: +43-676-83-807-285

Received: 30 September 2018; Accepted: 31 October 2018; Published: 1 November 2018

check for updates

Abstract: To satisfy Jordan's growing demand for electricity and to diversify its energy mix, the Jordanian government is considering a number of electricity-generation technologies that would allow for locally available resources to be used alongside imported energy. Energy policy in Jordan aims to address both climate change mitigation and energy security by increasing the share of low-carbon technologies and domestically available resources in the Jordanian electricity mix. Existing technological alternatives include the scaling up of renewable energy sources, such as solar and wind; the deployment of nuclear energy; and shale oil exploration. However, the views, perceptions, and opinions regarding these technologies—their benefits, risks, and costs—vary significantly among different social groups both inside and outside the country. Considering the large-scale policy intervention that would be needed to deploy these technologies, a compromise solution must be reached. This paper is based on the results of a four-year research project that included extensive stakeholder processes in Jordan, involving several social groups and the application of various methods of participatory governance research, such as multi-criteria decision-making. The results show the variety of opinions expressed and provide insights into each type of electricity-generation technology and its relevance for each stakeholder group. There is a strong prevalence of economic rationality in the results, given that electricity-system costs are prioritized by almost all stakeholder groups.

Keywords: energy policy in Jordan; participatory governance; conflicting views of different stakeholders groups; perceptions of risks; benefits and costs of electricity-generation technologies; compromise solutions

1. Introduction

Goals of Energy Policy in Jordan

The main goal of Jordan's energy policy is to decrease the country's dependence on imported energy sources from 82% to 40% by 2020. Jordan plans to make up the shortfall with natural gas (29%), shale oil (14%), nuclear energy (6%), and renewable energies (10%). Currently, energy supply in Jordan is driven by the dominance of fossil fuel imports from neighboring countries such as Qatar, Saudi Arabia, and Egypt. Almost all Jordanian energy needs (97%) are covered by imported oil and gas. The cost of energy imports reached its peak in 2011 at 19% of Jordanian GDP.

Ideally, an energy policy should be based on compromise solutions and synergies; it should be able to merge different goals, such as meeting the rising energy demand, mitigating climate change, and fossil fuel depletion, providing stimulus for socioeconomic development, and responding to the reality of political transformation in the Middle East and North African (MENA) region. Meeting these goals will require the deployment of new electricity infrastructure, which will include the scaling up of existing electricity-generation options and the construction of new power plants, including plants not only for renewable energy production, but also for oil shale and nuclear power. The "Arab spring" raised expectations about participatory governance; it is thus essential, in view of the existence of so many alternative forms of energy, for an energy policy to incorporate the voices of multiple stakeholder groups and, in order to avoid possible political destabilization and conflicts in society, to ensure sustainable impacts from investment in electricity infrastructure.

The Jordanian energy field is dominated by large-scale providers, which are often owned by the public sector. Often, these are monopolies which generate, transmit, and distribute electricity to consumers. The energy field in Jordan evolved through strictly favored centralized solutions, and it is the views and interests of these companies that are influencing energy policy. New technologies, as well as new forms of electricity generation, including decentralized electricity generation, are challenging the existing dominant views in this field and the distribution of political power among existing stakeholders. The processes of energy transition could change the existing Jordanian energy mix, with some technologies losing their importance and others gaining a market share. Moreover, the deployment of a new energy-generation and -transmission infrastructure will affect local communities with regard to land and water use, and also with respect to impacts on human health, the environment, and socioeconomic development.

To our knowledge, the discussion both in the scientific literature and in debates about energy transition in Jordan, has mainly focused on technological features, costs, and regulatory issues of energy transition to address the possible risks. Any discussions about social factors that would go beyond social and public acceptance, such as the willingness to engage in decision-making processes on energy transition, have been limited. What is more, despite the value of discourse analyses, assessments of different worldviews, and the development of compromise solutions being recognized in Jordan, this approach has seldom been applied in decision-making processes on energy infrastructure requirements. Compromise solutions are needed not only from a horizontal perspective, to address the views of different stakeholder groups, but also from a vertical perspective, to deal with the need to share the costs, benefits, and risks of energy infrastructure projects between the national and local governance levels.

One of the problems involved in the process of developing compromise solutions for complex policy areas such as energy transition is that numerically precise information is seldom available for stakeholders and that, for the majority of decision-makers, it is difficult to provide realistic information, such as exact weights for different criteria. Frequently, only incomplete information is available, which makes it difficult for stakeholders to rank the technologies according to their preferences.

Therefore, the goal of this research is to address the following questions:

- What criteria for electricity generation are the most and least important to different groups of stakeholders?
- What are the potential conflicts in opinion among different stakeholders?
- What are possible trade-offs among different stakeholder groups in the decision-making processes?

We address these research questions within the framework of different stakeholder interactions in Jordan. To analyze data obtained from stakeholders, we apply methods used for research into participatory governance, such as multi-criteria decision analysis, surveys, focus group discussions, and questionnaires. We collect stakeholder elicitations for technologies such as utility-scale photovoltaic (PV), concentrated solar power (CSP), onshore wind, utility-scale hydro-electric power, bituminous coal, heavy fuel oil, shale oil, natural gas, and nuclear.

2. Background

2.1. Socioeconomic Development in Jordan

Jordan, an upper middle-income country, is currency facing several socioeconomic development issues linked to the political situation in the MENA region, such as instability and migration. The country, which is strongly dependent on energy imports, is affected by the local conflicts in neighboring Iraq and Syria and by former and ongoing political unrest in the entire MENA region. Conflicts with Egypt are also threatening the Jordanian energy supply.

The largest shares of Jordanian GDP are government services; the finance, real estate, and business sectors; and manufacturing. Jordan is experiencing stable economic growth of 3% per annum on average and a considerably low level of income inequality [1], together with a market economy that has functional flaws [2]. Even though the overall socioeconomic development of Jordan is positive, the country is facing a number of challenges, such as high state debts due to energy imports; a low level of foreign direct investment; and a relatively high level of unemployment, especially among women and young people. The country's net savings have been declining since 2009. In 2008, Jordanian government debt constituted 60% of GDP which was the lowest level since 1990. Since 2008, the debt has been increasing continuously, mainly because of changes in commodity prices and increased subsidies to fossil fuels, after interruptions of the gas supply from Egypt when oil was substituted for gas. When subsidies, which constituted 9% of state expenditure, were removed, heating costs increased by 23% and transportation costs by 15% [3]. Although spending on energy is quite high, environmental spending represents only 0.5% of the government budget.

The Jordanian population continues to grow because of demographic dynamics and because of migration into the country. Currently, many Syrian, Iraqi, Yemeni, and Libyan refugees; Egyptian immigrants; and Palestinians are living inside the country without holding Jordanian national passports and are working in the informal sector. The informal sector accounts for 44% of all employed persons in Jordan [4]. The current unemployment rate is 12–14%, and the majority of the unemployed are women [5].

Jordan is a kingdom with a constitution; the monarch has the right to appoint and dismiss the government and the parliament. Jordanian society is strongly based on tribal roots, although nowadays, especially in urban centers, the tribal traditions have weakened; in rural and non-urban areas, however, tribal traditions shape the country's cultural landscape [6].

The recent political reforms aim to improve governance and to increase accountability in the country [7]. The decentralization of decision-making was initiated by the king in 2005 to give more power to local governments and councils. Civil society organizations are playing an increasing role, and transparency has significantly improved in recent years [8].

Water availability is Jordan's greatest environmental challenge. Currently, the country is among the 18 countries of the world with the highest risk of water insecurity and the fourth water-poorest country in the world. Almost 80% of the territory of Jordan is desert and the country is threatened by further desertification. Continuing urbanization puts additional stress on already limited water and land resources. Most of the water is needed for agriculture, which accounts for 64% of Jordan's water usage and contributes only 3% to the GDP. Eighty percent of the country's food security today already relies on water imports. Despite these challenges, Jordan is the world leader in wastewater treatment, and the coverage of water services is universal and indiscriminative. Among other challenges are increasing land and soil degradation, and climate change impacts, such as a decreased level of precipitation and an increasing number of days of extreme heat. The productivity of agricultural land is also reduced due to salinization and waterlogging, resulting in a significant share of land degrading into semi-arid and arid areas. Jordan is also suffering from a significant level of air pollution, the greatest share of which comes from traffic and transportation, with some also resulting from energy generation.

2.2. Energy Background

The energy sector is influenced by a heavy reliance on energy imports. This is a threat to national energy security, as the country is constantly experiencing interruptions in the power supply from neighboring countries. For instance, in 1990, Saudi Arabia stopped supplying oil to Jordan, and this was then replaced by Iraqi oil. Iraq stopped its imports in 2003, and the Iraqi oil was replaced by Egyptian gas. Later, Egyptian supplies became more and more erratic because of the political instability in the country. In addition, the Egyptian Sinai Peninsula pipeline, which provides over 80% of all imports of natural gas to Jordan, has been sabotaged several times. Today, Egyptian gas has been partly replaced by heavy oil and diesel, which are much more polluting.

The consumption of electricity is growing at a rate of 7% per year on average. It is also projected that growth will continue up to 2040. It is further expected that the Jordanian energy demand will triple by the year 2030. Private households and public buildings are the largest consumers of electricity (43%), followed by industry (25%), services (15%), water pumping systems (14%), and street lighting (2%) [9]. Oil and gas remain the main electricity sources. In 2011, more than 82% of all Jordanian electricity was generated from oil and 12% from imported natural gas.

The completion of the Aqaba terminal in 2017 was a milestone in Jordanian energy policy. Its goal was to secure the energy supply of crude oil, oil products, and liquefied petroleum gas. There has also been a significant development in oil shale during recent years; Jordan was discovered to have the fourth-largest oil shale reserves in the world, and the government has granted several concession agreements to local and international companies for oil shale projects. The natural gas sector was driven by the signing of agreements for imports of liquefied natural gas, mainly between NEPCO, the national energy company, and Shell International Limited. Some existing or idle fossil fuel power plants in the country are also currently being rehabilitated.

The debate about the large-scale deployment of renewable energy source (RES) projects in Jordan started in light of the available potential for solar and wind in the country and was also strengthened by large-scale international projects and plans like Desertec and the Mediterranean Solar Plan. These initiatives brought the discussion about RES to a different level, beyond the deployment of single projects. Although the initiatives paved the way for RES technology transfer to the region, they were not entirely successful for several reasons, including social and public acceptance. The achievement of these plans lagged behind the chosen targets mainly because they were developed in a top-down manner and the energy transition roadmaps underestimated the intricacy of managing transformative change toward sustainable energy systems [10].

Considering the potential available for RES, the Ministry of Energy and Mineral Resources increased the target for RES in the total energy mix to reach 10% by 2020 [11]. Electricity interconnections are extremely important to support plans for large-scale energy transition, especially the integration of volatile and intermittent RES. The green corridor project will connect RES projects in the southern area of Jordan and will contribute to a significant upgrade of the Jordanian grid capacity [12].

2.3. Participatory Governance

The interest of the Jordanians with respect to energy infrastructure is different today from half a century ago, when the current infrastructure in Jordan was constructed. Previously, not only in Jordan but also in several other parts of the world, infrastructure projects were perceived as a driver of socioeconomic development. There was evidence that such developments carried benefits and risks. Frequently, the goals for this kind of development, which were set at the national level, were transferred as projects to the local level without a proper consultation with the communities that would be hosting them. Today, several factors—a number of technological accidents, the raised level of awareness about risks and costs of the projects, and the influence of political changes during the Arab spring—have resulted in Jordanians expecting to participate in decision-making processes on infrastructure affecting their daily lives.

Scientists and practitioners have no common opinion as to how participatory governance of energy transition should actually be implemented. Some argue that decisions on the need for infrastructure and what types of technology should be used are best left in the hands of scientists and political decision-makers, such as national ministries, and that public participation should be organized only to evaluate the outcomes of the decision-making processes and details of the individual projects [13]. Others say that participation, especially by the local communities, brings knowledge to stakeholders at the national level and allows the decision-making processes to be improved [14], along with their legitimacy and the creation of trust [15,16].

3. Methodology

3.1. Stakeholder Process in Jordan

The data were collected in the framework of the stakeholder process, which had several steps. The first step was to collect expert views by providing a large-scale online survey to energy experts in Jordan. Altogether, we had three rounds of surveys in the period from April to September 2016. The online surveys contained multiple-choice questions and open questions. For each of the rounds, we received approximately 60 completed questionnaires. After online collection, the responses were analyzed with the help of a statistical program.

The second step was to collect the stakeholders' views in several workshops with homogenous groups of stakeholders. Altogether, six workshops were conducted in November 2016 at the University of Jordan. The workshops provided an opportunity to discuss the visions of environmental, social, and economic aspects of the future of Jordan and the positive and negative aspects of each electricity-generation technology under review. Participants also had a chance to suggest technologies and criteria for evaluation. The third step was to collect stakeholders' views at a workshop in February 2017 with mixed groups of stakeholders.

There were six different groups of stakeholders, representing those most relevant to energy policy in Jordan, such as policymakers, finance and industry, academia, young leaders, national and local NGOs, civil society, and local communities. Altogether, there were 72 stakeholders among the different groups.

The policymaker group included representatives from the Jordanian government and from organizations responsible for developing and implementing energy policies in Jordan, such as the Ministry of Energy and Mineral Resources, the Ministry of Water and Irrigation, the Amman Chamber of Industry, the Ministry of Public Works, the National Electric Power Company, and the Jordan Press Foundation.

The finance and industry group participants included representatives from energy and environment companies, engineering companies, banks, and factories, such as the Al-Masar Engineering Company, Arab Bank, Greenplans Environmental Consult, Petra Elevators Company, and Qatrana Cement company.

The academia group included researchers and academics in the field of energy, such as the University of Jordan, the King Abdullah II Design and Development Bureau, Al-Zaytoona University, Applied Science University, and the German Jordanian University.

The young leaders group included students in the field of energy and young employees at energy companies, power plants, and engineering companies.

The civil society and national non-governmental organizations group included NGOs in the fields of energy, the environment, and engineering, such as the Energy Services Center, the Renewable Energy Establishments Society, the Jordan Engineer Association, the Jordan Environment Society, the Jordan Energy Chapter, and the Sanibel Society for Environment.

Finally, the local communities group included representatives from different cities in the north and south of Jordan where infrastructure projects are planned. These cities included Alsalt, Madaba, Zarka, Amman, and others.

3.2. Multi-Criteria Decision Analysis

Electricity-generation technologies, which have the potential to contribute to the national energy mix and are thus of importance to Jordanian energy policymakers, were evaluated against a set of criteria reflecting the social, environmental, and economic sides of sustainable development. Two types of criterion were considered: (i) those able to make a contribution to national energy policy targets, such as a decreasing dependence on foreign resources, climate change mitigation, domestic industry development, technology and knowledge transfer, and the affordability of electricity-system costs; and (ii) those showing sensitivity to local conditions and impacts on local communities, such as land and water resources, on-site job creation, air pollution and health, hazardous waste, and safety issues. The criteria were identified during a literature analysis of the energy situation in the MENA region. Altogether, 22 were identified and 11 were then selected as being the most relevant. The criteria were later discussed during the stakeholder workshops. Participants had a chance to suggest an alternative formulation of criteria or additional ones. The 11 criteria were defined as follows [17] (note that some criteria sets contain sub-criteria):

- Use of domestic energy sources was defined in terms of dependence on foreign energy imports and how such dependence could be decreased by tapping into domestic resources that were either available today or could be exploited in the mid- to long-term future (criteria set CH1 in Figure 1 below);
- The potential for global warming was identified, as were the ways in which a technology could contribute to the mitigation of climate change (criterion Cr.3 in Figure 1 below);
- The domestic value chain was defined, as was the potential of a technology to use components and services provided by domestic industries throughout the entire value chain (criterion Cr.4 in Figure 1 below);
- Existing technology and knowledge transfer policies were identified based on existing policies: a technology should have a high potential to benefit from technology and knowledge transfer (criteria set CH2 in Figure 1 below);
- Electricity-system costs included electricity-generation costs and additional integration costs at increasing penetration levels and were based on uncertainty and variability, as well as distance and location (criteria set CH3 in Figure 1 below);
- On-site job creation was assessed in terms of the potential of a technology to create direct on-site jobs over the entire lifetime of the power plant (criteria set CH6 in Figure 1 below);
- Pressure on local land resources was defined as how high the additional pressure on valuable land resources would be in terms of the amount and value of land required for technology deployment while avoiding the loss of locally relevant livelihood resources (criteria set CH7 in Figure 1 below);
- Pressure on local water security was defined as the appropriateness of a technology's water consumption to the local water risk context and its pressure on local water security (criteria set CH9 in Figure 1 below);
- Occurrence and manageability of non-emission hazardous waste deals with the disposal of non-emission hazardous waste produced during the operation of a technology and the risk stemming from national waste management capabilities. This risk should be low to minimize adverse consequences for human health and the environment (criteria set CH10 in Figure 1 below);
- Local air pollution and health was defined as the amount of air pollutants (NO_x, SO_2, and PM) emitted by a technology, which should be sufficiently low to minimize the pressure on local air quality and the health risks for people in adjacent communities (criteria set CH12 in Figure 1 below);
- Safety was defined as the absence of severe accidents related to the construction, operation, and maintenance of electricity-generating technologies, including during the transport and storage of resources and equipment. Risk should be minimized to reduce accidents resulting in fatalities within and outside the power plants (criteria set CH13 in Figure 1 below).

The workshop participants, which comprised homogenous and mixed groups of stakeholders, initially ranked the above-mentioned criteria during silent negotiation. Silent negotiation is a process in which ranking is carried out collectively in silence, without discussion and therefore without influencing one another. Participants then discussed their choices and made the final ranking. They were then asked to evaluate the relative importance of each criterion against every other criterion. The "blank cards" method was applied. The greater the perceived difference between two criteria, the more blank cards were positioned between them, turning an originally ordinal ranking into a cardinal one. Participants then also discussed criteria of procedural and output justice and ranked these too.

The final workshop brought together two selected participants from each stakeholder group. The procedure during this workshop was similar to the workshops with homogenous groups of stakeholders, but additionally included two separate rounds of ranking. Further, participants from each stakeholder group had to explain why their group decided in favor of a particular criterion. After the initial ranking, their results were evaluated by DecideIT software to show the outcomes of the rankings in terms of trade-offs for each technology. After the results were presented to the participants, they had a chance to discuss the results and the criteria, and redo the ranking.

Some months later we followed up with an online survey distributed to participants from all workshops. The respondents provided evaluations on their level of satisfaction with the results of the ranking of the criteria and the technologies. They could also provide alternative rankings.

To deal with the impreciseness of information in the process of determining the criteria weights in our analysis, we applied surrogate weights as the most likely interpretation of preferences expressed by the stakeholders. The surrogate weight method allows decision-makers to provide information and to then generate representative weights from underlying distributions. The decision-makers supply ordinal information on the importance of criteria, and this information is subsequently converted into surrogate weights corresponding to, and consistent with, the extracted ordinal information [18,19].

In this research, we use the Simos method, which uses a set of cards to indirectly determine numerical values for criteria weights [20]. This method is widely applied and generally well-perceived by decision-makers. According to some scientists, however, it lacks sophistication and it is not robust when preferences are changed. Thus, we also introduced a session to the workshop during which decision-makers had to state how many times more important the most important criterion or criteria of the group is then other criteria. We therefore used a variant of the Simos method for elicitation purposes and kept the card-ranking part, while significantly changing the evaluation compared to the Simos method and its revisions. The key challenge in our workshops was to elicit a collective ranking. While most methods for ranking and weighting deal with individuals, we had to do this as a group effort. After the first ordinal ranking was finalized, the participants were asked to introduce preference strengths into the ranking by introducing the blank cards.

We introduced surrogate weights to solve the problem of the availability of numerically precise information. Further, we added intervals around both the surrogate weights and the values of the technology options to accommodate the level of imprecision naturally inherent in the workshop statements and rankings. Thereafter, we used multi-criteria decision methods (MCDM) to evaluate the alternatives, such as criteria for electricity-generation technologies, and to identify the weighted average value of the components involved. In particular, we used the CAR method, which converts the cardinal criteria rankings from the workshops (including the blank cards) into numerical weights while limiting the information loss [21]. Included in the method is the concept of cardinal rank sum weights, which is also the evaluation method for the criteria-ranking component used in CAR [22].

The performance of the different electricity-generation technologies was estimated from a large-scale expert survey that, together with the surrogate weights, provided the decision base for the multi-criteria analysis. This methodology allowed us to provide a detailed analysis of each technology's performance compared with other technologies and to conduct sensitivity analyses to test the robustness of the results. We considered the entire range of values of all alternatives presented across all criteria, as well as how plausible it was that an alternative outranked the remaining ones.

Because of the complexity of calculations, we used the state-of-the-art MCDA software DecideIT, which has previously been used in a variety of difference decision situations, such as the storage of nuclear waste, insurance portfolios, demining tasks, and financial risks.

4. Results

Our research allowed the development of two sets of results. The first was that the implementation of MCDA methodology in stakeholder processes on energy transition in Jordan showed that people are not always aware of what their choice of criteria means in terms of trade-offs for technologies. For instance, several rounds of silent negotiations showed that people tend to prioritize financially relevant criteria, such as electricity-system costs. Namely, they prefer to have electricity at the lowest cost possible. They make rankings for the financial criteria, ranking them at the top, while moving the environmental criteria to the bottom of the ranking. However, they are not aware that such criteria rankings push certain electricity technologies up the resulting total ranking of the alternatives. When shown the results (with technologies like coal becoming the most favored one) they were surprised, as originally they would not support coal. Awareness of the relation between the results and the expressed preferences for the criteria made them change their criteria rankings. Thus, in the follow-up rounds of negotiations where they had to rank the criteria again, the stakeholders were making more informed rankings. This showed the value of the computer tool as an awareness-raising instrument to stimulate informed choices.

Second, the results showed a strong dominance of financial rationality, namely, preferences for financial criteria such as electricity-system costs across all groups of stakeholders. This criterion was discussed from the point of view of levelized costs of electricity for consumers and also in light of the existing budget deficit in Jordan and the burden that national expenditure for energy imports places on domestic households.

The following arguments for the high importance of electricity-system costs were put forward:

> Currently the costs of renewable energies are high and there is uncertainty in the cost predictions. At the same time the cost of fossil fuels fluctuates less. Costs are fixed and the technology proved reliable. As the costs of renewable energy sources go down, RE will increasingly become an attractive option for satisfying energy demand. At the same time, significant growth in energy demand, fossil fuel power plants will still have to be maintained to guarantee a base-load capacity and to cover the peaks in case of additional demand.

> The following arguments were provided for a high ranking of financial criteria:

> It is important to use local resources and facilitate technology transfer to create employment opportunities. Further regulatory and institutional frameworks are needed to facilitate technology transfer from other countries to Jordan.

These preferences were supported by a desire for safe electricity generation when the safety criterion was ranked as second-highest. For example, safety was perceived as an absolute top priority by the decision-makers responsible for providing a reliable and safe electricity supply. Safety was perceived by many stakeholders as one of the most important measures, requiring further development of the safety regulations for existing and emerging technologies. To reinforce safety regulations, the empowerment of safety-monitoring authorities will also be required. Concerns were also expressed that the implementation of safety regulations will lead to higher energy costs.

Global warming potential was also frequently a highly ranked concern, especially by local communities which might experience the direct impacts of climate change. At the same time, domestic value chain integration was frequently ranked low because stakeholders perceived this criterion as redundant compared to the job criterion and other financial criteria.

The analysis of stakeholder preferences allowed differences among stakeholder groups to be identified. Civil society and NGOs ranked electricity-system costs as the most important criterion and non-emission hazardous waste and domestic value chain integration as the least important. The electricity-system costs criterion was also the most important criterion for academia, finance, and investment, and future decision-makers. Safety was the most important criterion for future decision-makers, local communities, finance and investment, and policy and decision-makers. Global warming potential was the most important criterion for finance and investment and for local communities. At the same time, global warming potential was the least important criterion for academia. For finance and investment, and for local communities and future decision-makers, the domestic value chain integration was the least important. Non-emission hazardous waste was the least important criterion for academia and decision-makers. Pressure on local land resources was the least important criterion for academia, and pressure on local water resources was the least important criterion for decision-makers.

The results of the analyses of preferences showed that the Utility-scale PV alternative was considered by all stakeholder groups to be the most popular technology. However, opinions varied across different groups as to how much better PV is than other technologies and what the other possible alternatives were.

For instance, the finance and investment group considered PV to be only slightly better than the nuclear alternative. For local communities, it was only slightly better than gas, and for decision-makers, it was only slightly better than oil shale, nuclear, coal, and gas—all technologies providing a stable base-load. There was a strong confidence in almost all groups that oil is the worst technology, which is interesting given the dominant role that oil plays in the Jordanian energy mix today.

During the final workshop, participated in by representatives from all stakeholder groups, conflicting opinions were seen, especially for criteria such as safety, electricity-system costs, and pressure on local water resources. While some stakeholders were constantly moving certain criteria up in the ranking, others were moving them down. For example, academia, together with national NGOs and representatives of local communities, were moving the water criterion up, while at the same time, representatives of industry and finance were moving it down in order to promote other criteria such as safety and electricity-system costs (Figure 1).

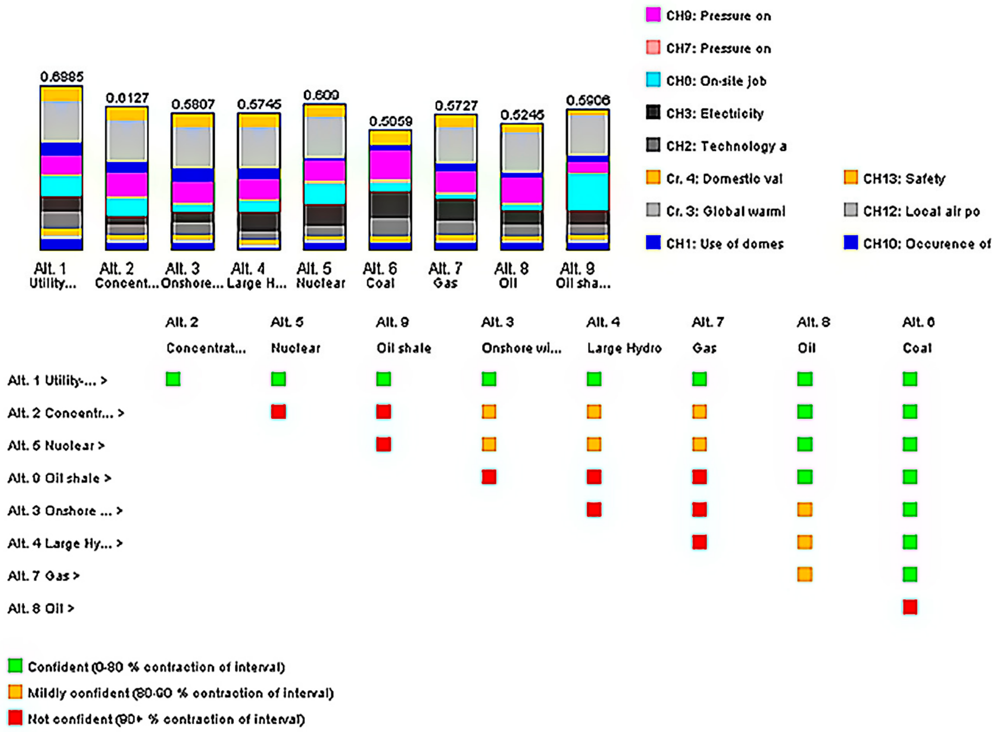

Figure 1. Results for the second round of the final workshop.

Figure 1 displays the overall ranking of all nine alternatives considered. At the top, each alternative's final total score (on a normalized scale [0, 1]) is shown as vertical bars. In addition, the total scores are broken down into the contribution by each criterion or set of criteria from Section 3.2 (defined in [17]), displayed as different colors filling the score bar. The legend to the right of the vertical bars indicates which criterion (or set of criteria) is associated with a particular color. This way, it is easy to gain an overview of how the criteria contribute to the overall result for each alternative. From this part of the display, it can be seen that Alternative 1 (Utility-scale Photovoltaic) ranks the highest. In the lower part of Figure 1, the pairwise rankings of all alternatives are shown. The alternatives are displayed in order of the total score from the top of the display. Thus, Alternative 1 is displayed first, followed by 2, 5, 9, etc. In the matrix, each square represents the outcome of comparing the vertical alternative with the horizontal one. For example, the leftmost square shows the comparison between Alternative 1 (vertical, being the superior) and Alternative 2 (horizontal, being the inferior). The outcome of the comparison is the amount of overlap between all possible beliefs in the two alternatives. A green square indicates that there is little overlap, i.e., that the ranking "Alternative 1 is superior to Alternative 2" can be stated with high confidence. As another example, the lower rightmost square shows the comparison between Alternative 8 (vertical, being the superior) and Alternative 6 (horizontal, being the inferior). The red square indicates that there is much overlap, i.e., that the ranking "Alternative 8 is superior to Alternative 6", while true, can only be stated with low confidence and should not constitute the basis for a decision between those two options.

The interpretation of the results of the final ranking in Figure 1 is that Utility-scale PV is clearly superior to all other options. Its high scoring on criteria such as electricity-system costs played a clear role in the outcome. Criteria such as local air pollution and health, which also included latent fatalities from radiation, pushed back some technologies like coal and nuclear. High ranking of on-site job creation played a positive role for oil shale; however, the pressure on water resources reduced its position and also that of nuclear technology.

The individual preferences, which were collected in the follow-up survey showed an even stronger preference for financial rationality. In this survey, the stakeholders had an opportunity to rank criteria and technologies individually. The results showed that the most and the least important criteria and technologies remained the same; however, in the middle of the ranking, several socioeconomic criteria, such as domestic energy use, job creation, and domestic value chain generation, were moved up. At the same time, environmental criteria such as air quality and health and pressure on water security were moved down. This shows preferences of economic factors over environmental factors and also perceptions that socioeconomic development goals should be addressed first and that environmental sustainability will follow.

5. Discussion

The results collected in the stakeholder processes in Jordan show a strong dominance of energy security concerns, such as, on the one hand, a reliable energy supply, including safety considerations and costs of electricity, versus, on the other hand, climate change and environment protection concerns, such as global warming potential and other impacts on the environment or human health.

It is interesting that during the discussion sessions where we collected perceptions of stakeholders on risks and benefits of technologies, many described renewable energy technologies as "clean" technologies "with little impact on environment". These answers show the existing level of awareness about climate change and about the need for climate change mitigation. However, this awareness did not translate into action. When people had to make trade-offs between environmental criteria, including global warming potential, and economic criteria, they still preferred economic criteria.

Such results also correspond with available evidence in other countries and show the importance of behavioral change at the individual level or policy measures to reduce initial investment costs or costs of electricity being generated by renewable energy sources.

Author Contributions: The authors jointly developed the research protocol as well as organized the stakeholders process in Jordan, analyzed the results and wrote the paper.

Funding: This research was funded by the German Federal Ministry for Economic Cooperation and Development (BMZ) in frames of the project "Middle East North Africa Sustainable Electricity Trajectories".

Acknowledgments: We are very grateful to several experts who participated in the several rounds of the stakeholders' process in Jordan and were very generous with their time and expertise, as well as enthusiastic during the discussions. Any remaining errors of fact or interpretation are those of the authors. Additionally, we also would like to acknowledge Preference AB from Stockholm, Sweden, for their generosity and giving us the opportunity to use the DecideIT. We also would like to thank Antonella Battaglini and Anthony Patt for their innovative ideas and inspiration, which appeared in our discussions.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. United Nations Development Program. *Human Development Report 2015*; United Nations Development Program: Amman, Jordan, 2015.
2. Bertelsmann Transformation Index. Jordan Country Report. Bertelsmann Transformation Index. 2016. Available online: http://www.btiproject.org/fileadmin/files/BTI/Downloads/Reports/2016/pdf/BTI_2016_Jordan.pdf (accessed on 8 July 2017).
3. World Bank. *Jordan Economic Monitor: Maintaining Stability and Fostering Shared Prosperity Amid Regional Turmoil, The World Bank Poverty Reduction and Economic Management Unit Middle East and North Africa*; World Bank: Washington, DC, USA, 2013.
4. Gatti, R.; Angel-Urdinola, F.; Silva, J.; Bodor, A. *Striving for Better Jobs: The Challenge of Informality in the Middle East and North Africa*; World Bank: Washington, DC, USA, 2011.
5. ILO, International Labour Organization. Jordan. Geneva. 2016. Available online: http://www.ilo.org/beirut/countries/jordan/WCMS_474549/lang--en/index.htm (accessed on 5 July 2017).
6. Ecoconsult. *Towards a Green Economy in Jordan—A Scoping Study*; UNEP & The Ministry of Environment Jordan: Amman, Jordan, 2011.
7. USAID, Unites States Agency for International Development. Democracy, Rights & Governance. Unites States Agency for International Development. 2016. Available online: https://www.usaid.gov/jordan/democracy-human-rights-and-governance (accessed on 8 July 2017).
8. Transparency International. The Global Anti-Corruption Coalition. 2016. Available online: http://www.transparency.org/cpi2015 (accessed on 1 July 2017).
9. NEPCO, National Electric Power Company. Annual Report 2013. 2014. Available online: http://www.nepco.com.jo/store/docs/web/2013_en.pdf (accessed on 10 July 2017).
10. Brand, B. *The Integration of Renewable Energies into the Electricity Systems of North Africa (Schriftenreihe technische Forschungsergebnisse, Vol. 20)*; Verlag Dr. Kovac: Hamburg, Germany, 2015.
11. MEMR. *Annual Report 2016*; Ministry of Energy and Mineral Resources: Amman, Jordan, 2016.
12. NEPCO, National Electric Power Company. Annual Report 2014. 2015. Available online: http://www.nepco.com.jo/store/docs/web/2013_en.pdf (accessed on 5 July 2017).
13. Rowe, G.; Frewer, L. Public participation methods: A framework for evaluation. *Sci. Technol. Hum. Values* **2000**, *25*, 3–29. [CrossRef]
14. Hänlein, R. *Public Participation and Transparency in Power Grid Planning. Recommendations from the BESTGRID Project. Handbook—Part 1*; Germanwatch: Bonn, Germany, 2015.
15. Komendantova, N.; Riegler, M.; Neumueller, S. Of transitions and models: Community engagement, democracy, and empowerment in the Austrian energy transition. *Energy Rev. Soc. Sci.* **2018**, *39*, 141–151. [CrossRef]
16. Renn, O. *Risk Governance. Coping with Uncertainty in a Complex World*; Earthscan: London, UK, 2008.
17. Schinke, B.; Klawitter, J.; Döring, M.; Komendantova, N.; Irshaid, J.; Linnerooth-Bayer, J. *Electricity Planning for Sustainable Development in the MENA Region: Criteria and Indicators for Conducting a Sustainable Assessment of Different Electricity-Generation Technologies in Morocco, Jordan and Tunisia (Working Paper)*; BICC: Bonn, Germany, 2017.
18. Barron, F.; Barrett, B. The Efficacy of SMARTER: Simple Multi–Attribute Rating Technique Extended to Ranking. *Acta Psychol.* **1996**, *93*, 23–36. [CrossRef]

19. Katsikopoulos, K.; Fasolo, B. New Tools for Decision Analysis. *IEEE Trans. Syst. Man Cybern. Part A Syst. Hum.* **2006**, *36*, 960–967. [CrossRef]
20. Simos, J. L'evaluation environnementale: Un processus cognitif neegociee. Theese de Doctorat, DGF-EPFL, Lausanne, Switzerland, 1990.
21. Danielson, M.; Ekenberg, L. Computing Upper and Lower Bounds in Interval Decision Trees. *Eur. J. Oper. Res.* **2007**, *181*, 808–816. [CrossRef]
22. Danielson, M.; Ekenberg, L. The Car Method for using Preference Strength in Multi-Criteria Decision Making. *Group Decis. Negot.* **2016**, *25*, 775–797. [CrossRef]