MENA SELECT

Middle **E**ast **N**orth **A**frica **S**ustainable **ELEC**tricity **T**rajectories

Energy Pathways for Sustainable Development in the MENA Region

Energy for the Future

Evaluating different electricity-generation technologies against selected performance characteristics and stakeholder preferences: Insights from the case study Tunisia

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EXECUTIVE SUMMARY

Tunisia is at a crossroads of its energy policy. The growing energy demand and an increasing energy bill has forced the government to set out an ambitious energy strategy which trusts on the expansion of renewable energy (RE) technologies to a share of 30 per cent in 2030. Energy transitions bring about fundamental changes at various levels of society, thus needs broad societal support. To design a conflict-sensitive and socially accepted energy transition that is sustainable and socially compatible, it must aim on the one hand at compromises in balancing differing societal interests through inclusive processes and fairly distributed outcomes. On the other hand, policymakers are well advised to consult a broad mobilized knowledge base drawn from all levels and sectors of society to manage the complexity and contingency of energy transitions. This *Paper* presents the results of a workshop series conducted with selected Tunisian stakeholder groups to elicit their preferences and expectations that determine their willingness to support Tunisia's energy transition.

There is broad consensus among Tunisian stakeholders that Tunisia's future energy system must be built on renewable energies, in particular rooftop and utility PV as well as onshore wind. These technologies are most suitable to meet stakeholders' preferences of tapping into domestic energy resources to decrease fuel import dependency, while ensuring the safety of local communities from physical harm through technology failure. Well aware of Tunisia's economic and sociopolitical challenges, stakeholders seek to balance national interests linked to energy planning on the one hand and concerns over local impacts on local communities on the other. As a result, stakeholders arrived at a robust compromise that keeping electricity costs low to promote economic growth and to protect consumers is just as important as protecting local communities from air pollution and generating benefits for them through maximum direct job creation. Concerns over land use and global climate change were not deemed decisive criteria when it came to Tunisia's electricity sector.

The most critical determinant for societal support, however, is not the technological choice of electricity-generation technologies but rather the opening up of the political and administrative processes of designing and implementing the energy strategy to allow for social interest groups to articulate and advocate for their claims of meaningful participation and expectations of benefits. A conflict-sensitive approach in energy transition, as we argue here, requires all stakeholders to engage with each other in a constructive spirit of mutual acknowledgement of legitimate claims and of working towards a shared and collectively owned goal of a more sustainable future. This requires innovative formats of dialogue and cooperation in a transparent process of mutual learning, anticipating potential lines of conflicts, building a socially

shared vision of a sustainable Tunisia and then constantly evaluate the impacts of the decisions made on that vision. Working towards a conflict-sensitive and socially supported energy transition means cultivating new forms of governance and policy-making to meet Tunisian challenges with Tunisian solutions. An inclusive transition management approach extends the role of the state to a moderator and manager of potential conflicts of interests. Building towards a compromise for harmonizing interests of societal interests ultimately strengthens trust in state-society relations and mitigate potential public opposition to energy plans.

Second, Tunisia's energy transition is deeply intertwined with its political transition. Consequently, stakeholders have high expectations regarding paradigm-shifting structural, regulatory and procedural reforms not only in the electricity sector, but also beyond. Most critical in particular is substantial and effective decentralization which grants local communities more ownership and sovereignty over local energy transitions. The highest risk for losing societal support lies in growing frustration and lack of trust in the state's capacity to follow-through with ambitious plans.

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ABREVIATIONS AND ACRONYMS

A	Stakeholder group “Academia”
ADRI	Association pour le Développement et de la Recherche et de l’Innovation
AES	Alternative energy systems
ANME	Agence Nationale pour la Maîtrise de l'Energie – National Agency for Energy Conservation
ANPE	Agence National de Protection de l’Environment – National Agency for Environmental Protection
APER	Alliance pour la Promotion des Énergies Renouvelables – Alliance for the Promotion of Renewable Energies
ATPG	Association Tunisienne du Pétrole et du Gaz – Tunisien Association for Oil and Gas
CITET	Centre International des Technologies de l'Environnement de Tunis – Tunis International Centre of Environmental Technologies
CNSTN	Centre National des Sciences et Technologies Nucléaires – National Centre for Science and Nuclear Technologies
CRTEn	Centre de Recherches et des Technologies de l’Energie – Research and Technology Centre of Energy
CSP	Concentrated solar power
CSR	Corporate social responsibility
DGE	Direction Général de l’Energie – Directorate-General for Energy
EE	Energy efficiency
ENIB	École nationale d'ingénieurs de Bizerte – National School of Engineers of Bizerte
ENIG	École nationale d'ingénieurs de Gabès – National School of Engineers of Gabès
ENIM	École nationale d'ingénieurs de Monastir – National School of Engineers of Monastir
ENIS	École nationale d'ingénieurs de Sfax – National School of Engineers of Sfax
ESPRIT	École supérieure privée d'ingénierie et de technologies – Private School for Higher Education for Engineering and Technologies

EU	European Union
F&I	Stakeholder group “Finance and Industry”
FTE	Fond de Tranisition Energétique – Energy Transition Fund
GHG	Greenhouse gas
IPP	Independent power producer
IRSET	Institut de Responsabilité Sociétale des Entreprise Tunisiènne – Institut for Social Responsibility of Tunisian Enterprises
ITES	Institut Tunisien des Études Stratégique – Tunisian Institute for Strategic Studies
KfW	Kreditanstalt für Wiederaufbau – German Development Bank
LC	Stakeholder group “Local community representatives”
LNG	Liquefied natural nas
MAUT	Multi-Attribute Utility Theory
MCDA	Multi-Criteria Decision Analysis
MDCI	Ministère du Développement, d’Investissement et de la Coopération internationale – Ministry for Development, Investment and International Cooperation
MEMER	Ministère de l’Energie, des Mines et des Energies renouvelables – Ministry of Energy, Mines and Renewable Energy
MESRS	Ministère de l’Enseignement Supérieur et de la Recherche Scientifique – Ministry for Higher Education and Scientific Research
MINEAT	Ministère des Affaires Locales et de l'Environnement – Ministry for Local Affairs and Environment
NDC	National determined contributions
NGO	Stakeholder group “National NGOs”
ONE	Office National de l´Énergie – National Energy Office
PM	Stakeholder group “Policymakers”
PPP	Public Private Partnership
PROSOL	Programme Solaire – National Solar Programme for Solar Water Heaters
PROSOL ELEC	Programme Solaire Électrique – National Solar Programme for Electricity
PST	Le Plan Solaire Tunisien – Tunisian Solar Plan

PV	Photovoltaic
RE	Renewable energies
SLO	Social licence to operate
STEG	Société Tunisienne de l'Électricité et du Gaz – Tunisian Company of Electricity and Gas
UGTT	Union Générale Tunisienne du Travail – Tunisian General Labour Union
UNDP	United Nations Development Programme
UNOPS	United Nations Office for Project Services
UTICA	Union Tunisienne de l'Industrie, du Commerce et de l'Artisanat – Tunisian Union for Industry, Commerce and Trade
YL	Stakeholder group "Young leaders"

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INTRODUCTION

The Jasmine revolution and its aftermath set Tunisia apart from the rest of the region. The Tunisian constitution of 2014 has been forward-looking about achieving sustainable development, mitigating climate change while highlighting the will of the Tunisian people and pursuing retributive justice. The country's development challenges are marked by high unemployment rates, especially among youth, stark regional disparities, environmental degradation particularly in mining regions and vulnerability to climate change, to name but a few. Similar to its neighbours in the region, Tunisia's urgent developmental pressures are part and parcel of the country's energy challenges. Embedded in this context of a need to find solutions to the pressing challenges for sustainable development, the Tunisian government in 2012 has put in place the revised Solar Energy Plan[1] to initialize a transition from the country's severe dependency on fossil fuels, mainly on gas for its electricity-generation, towards renewable energies.

The research conducted in the framework of the project "Middle East and North Africa – Sustainable Electricity Trajectories" (MENA SELECT) had the objective to a) evaluate the potential of selected electricity-generation technologies to achieve broad societal support and b) to elicit differing and potentially conflicting interests, attitudes, expectations and perceptions of various societal interest groups that determine their support for energy transition policies. To that purpose, the project team conducted focus group workshops with six selected stakeholder groups, namely policymakers, finance and industry, academia, civil society, local communities and young leaders. During these workshops, participants developed a joint vision of sustainability for Tunisia in the year 2050 and ranked a set of sustainability criteria according to their relative importance according to their preferences. In the final seventh workshop, representatives of all stakeholder groups came together with the goal to find a compromise among their interests and preferences. Based on these preferences and a performance evaluation of the selected electricity-generation technologies along national and local criteria, a Multi-Criteria Decision Analysis (MCDA) was conducted to illustrate the potential for societal support.

This *Working Paper* presents the claims and expectations of the different stakeholder groups, lines of conflicts of interests and how they ultimatively succeeded to reach a compromise while balancing their interests in pursuing a sustainable energy transition within a "niche of opportunity" provided by the workshop series. This compromise further suggests which electricity-generation technologies have the highest po-

[1] http://www.anme.nat.tn/fileadmin/user1/doc/DEP/Rapport_final__PST.pdf

tential to achieve broad societal support. First and foremost, the *Paper* addresses policymakers and stakeholders in Tunisia to highlight aspects relevant to the conflict-sensitive management of the energy transition. The generated results, however, are also of interest to international donor agencies as input for suggesting possible areas of cooperation and for formulating priorities. Since this is a social science approach in an academic field dominated primarily by engineers, research design and methodology might inspire future academic research with a stronger focus on the human element in strategic energy planning.

Chapter 1 introduces the current energy situation in Tunisia and briefly relates this to the challenge of conflict-sensitive energy transition management. The second Chapter briefly outlines the research methodology and the participatory workshop methods. A more thorough description is presented in Döring et al., 2018. The results of the workshops are presented in Chapter 3, offering a descriptive analysis of the different stakeholder visions for Tunisia, divergences and commonalities as regards sustainability criteria, including the conflict analysis and the final MCDA-technology ranking for technologies' potential for societal support. The outcomes of more general open focus group discussions on procedural issues and next policy steps are presented in Chapter 4, followed by a concluding synopsis in Chapter 5.

1 ENERGY TRANSITIONS TO SUSTAINABILITY IN THE CONTEXT OF TUNISIA

1.1 Decision-making context

In the last two decades, Tunisia's energy situation has changed drastically, and its energy challenges have progressively increased in magnitude along three factors: 1) dependency on fossil fuels, 2) dependency on fuel imports, 3) fiscal deficit and high subsidies. In 2000, Tunisia turned into a net-importing country after decades of being a net-exporting country in the region. The steadily growing energy consumption rate and the dwindling domestic production lead to an increasing energy deficit (Figure 1).[2] Between 1999 and 2012, primary energy consumption more than doubled (MEMER & ANME, 2014). The Tunisian electricity system remains predominantly fossil-based primarily on natural gas with only a minor share of six per cent renewable energy (RE) (see also Figure 23 in the Annex). 73 per cent of the total consumption of gas is utilized for the production of electricity while 27 per cent is used for industry, residential and service sectors (Harrabi, 2014), constituting almost 40 per cent of the total primary energy. To satisfy this need, Tunisia depends on imports mainly from Algeria, from where it received 43 per cent of its natural gas in 2017 in the form of royalties (ONE, 2017). This makes the country's energy supply highly dependent on regional political conditions and international markets.

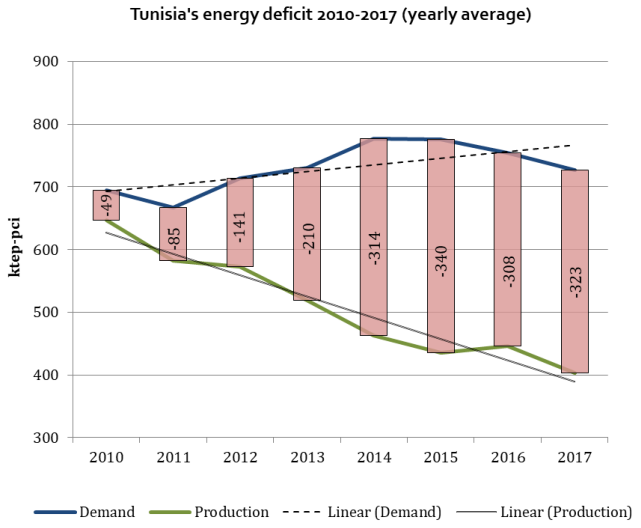

Figure 1: Primary energy deficit 2010-2017 (based on web-data of the Tunisian Ministry of Industry).

Meanwhile, high energy subsidies in combination with increasing gas prices—by factors five between 2004 and 2014 alone according to Harrabi (2014)—are the reason for a growing deficit in the state budget, substantially limiting the government's capabilities for sustainable investment. Subsidies to electricity alone made up 51 per cent of the total state expenditure on energy subsidies in 2013 (World Bank, 2013, see Figure 24 in the Annex).

[2] Retrieved from http://catalog.industrie.gov.tn/dataset/bilan-d-energie-primaire-mensuel/resource/3ae3b192-8539-41f5-b338-3d880488af43

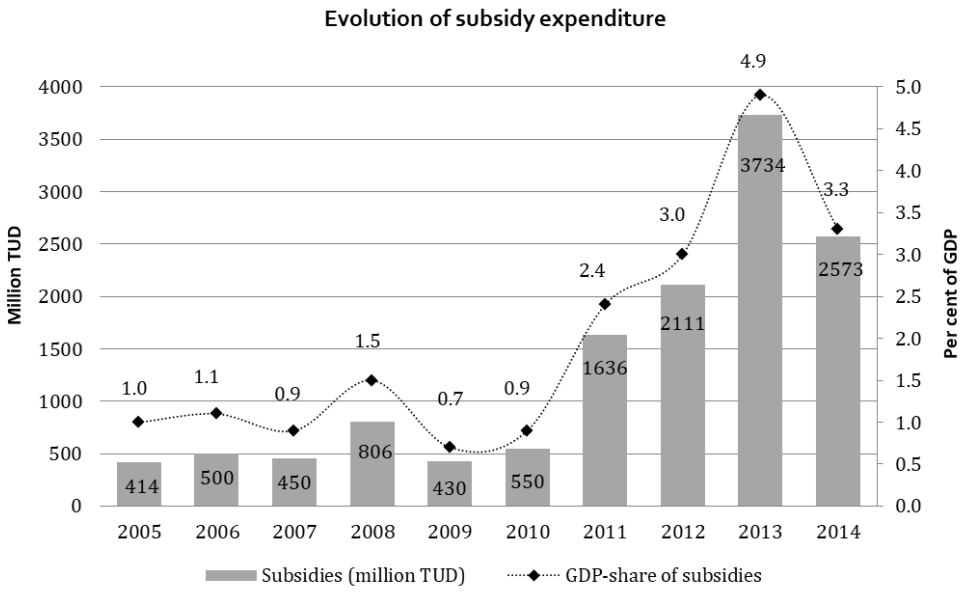

Figure 2: Evolution of state expenditures on subsidies (El-Hanchi, 2016).

As Figure 2 illustrates, the state spent a peak of 19.2 per cent of its budget on subsidies in 2013, which is more than on education and health together (Nahali, 2014). Energy subsidies in Tunisia have increased between 2005 and 2013 four times constituting as much as 4.9 per cent of GDP in 2013 (El-Hanchi, 2016). The removal of subsidies to the cement industry, one of the biggest industrial energy consumers in 2014, contributed to the decrease in expenditures in 2014 (Eibl, 2017). Tunisia is urged to further reduce subsidies to relieve the state budget and liberalize domestic markets. Yet, concerns prevail over the economic and, most importantly, social ramifications of the removal of subsidies. The subsidy systems in place in MENA countries intended as a pro-poor policy and to ensure equity have failed in this regard. Instead, they benefit high-income classes and energy-intensive industries and service business (Eibl, 2017; El-Katiri & Fattouh, 2015). The main profiteers are among those economic elites and business networks associated with the Ben Ali/Trabelsi clan and that remained largely intact after the 2011 Yasmine revolution.

Nonetheless, the removal of subsidies has a much more significant impact on poorer households than on wealthy ones (World Bank, 2014a). An increase in consumer prices during Tunisia's current economic hardship risks aggravating people's distress and frustration. Energy subsidies as such, though representing a critical economic, social and political factor in Tunisia's energy transition, are beyond the topic of this *Paper*. However, taken all the framing conditions of Tunisia's energy situation together, it becomes clear that the electricity sector is an essential and integral part of any national strategy for sustainable development.

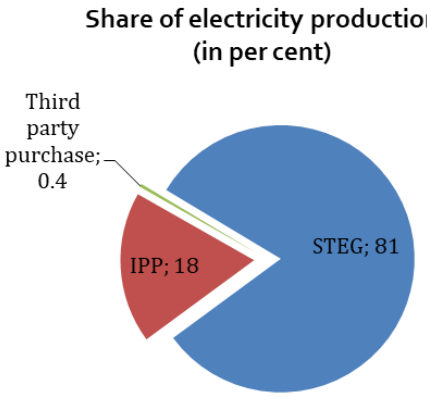

Figure 3: Providers' share in electricity production in 2016.

Regarding the institutional setup, the Ministry of Energy, Mines and Renewable Energy (MEMER) is responsible for the energy sector, natural resources and the energy transition. The design, implementation and coordination of national energy plans is run through the ministry's Directorate-General for Energy (DGE). In 1985, the National Agency for Energy Conservation (ANME) was established under the authority of MEMER to supervise national programmes on energy efficiency and the promotion of renewable energy, propose regulatory frameworks and conduct research. ANME also manages the Fond de Transition Energétique (Energy Transition Fund, FTE), created in 2005, to financially support RE projects. The state-owned Tunisian Company for Electricity and Gas (STEG) is the monopolist in the electricity sector. It is the principal producer (81 per cent of electricity in 2017) as well as the sole buyer and distributor of electricity. Few independent power producers (IPP) that were established and sell electricity to STEG in 1996 (Law N°96-27 and N°2015-12) produce 17 per cent of electricity. The state also permits self-production of electricity for own consumption through RE-installations or cogeneration and for selling the excess to STEG (see Law N° 2004-72 and bylaws). The National Agency for Environmental Protection (ANPE) under the authority of the Ministry for the Environment and Local Affairs is in charge of conducting environmental impact assessments required for the approval of power plant projects with more than 300 MW installed capacity. Relevant research institutions are the International Centre for Environmental Technologies (CITET), also under the Ministry for the Environment and Local Affairs, as well as the Research and Technology Centre of Energy (CRTEn) and the National Centre for Science and Nuclear Technology (CNSTN) under the supervision f the Ministry for Higher Education and Scientific Research (MESRS).

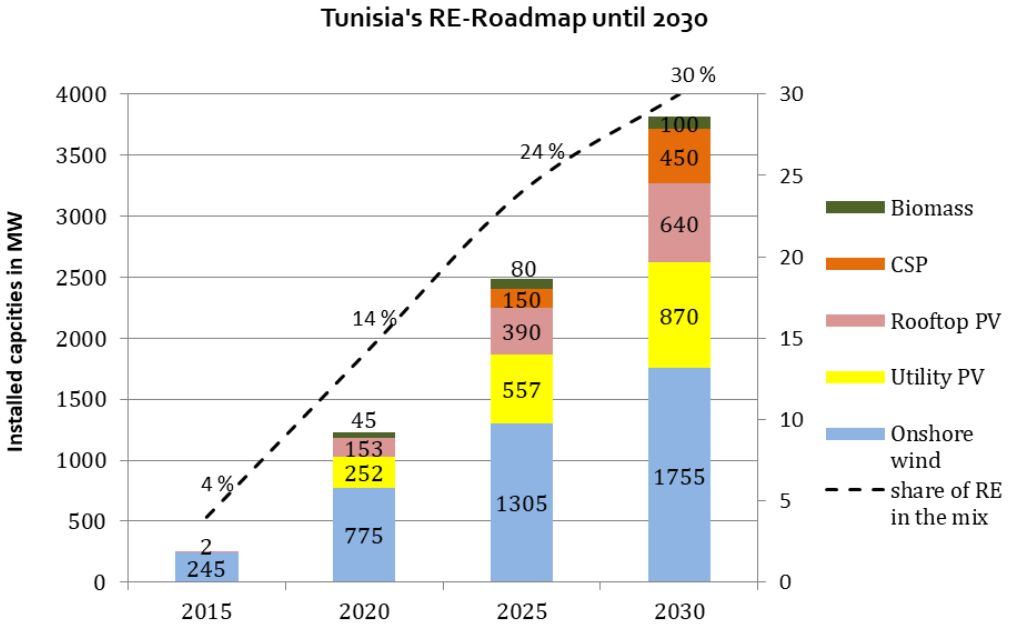

Figure 4: Roadmap for RE-share until 2030.

The Tunisian Solar Plan (Le Plan Solaire Tunisian, PST) of 2009 and its renewal in 2012 have premeditated the expansion of the deployment of RE. In 2016, MEMER launched the Tunisian Renewable Energy Action Plan 2030, setting ambitious transition goals to be achieved by 2030: A 34 per cent reduction of primary energy demand (17 per cent until 2020), a 30 per cent increase of RE in the electricity mix, and 48 per cent reduction in CO_2 emissions. The RE-mix is composed of solar and onshore wind technologies. Tunisia's electricity mix relies primarily on decentralized rooftop PV. CSP only makes up a relatively small part of the mix. The strategy also aims to increase the share of renewable energy (excluding biomass) in the final energy consumption to seven per cent in 2020 and 12 per cent in 2030 while creating 12.000 green jobs (MEMER & ANME, 2014). To enable the implementation of the 2030 plan, Tunisia has passed the Law No. 12 of 11 May 2015[3] with the purpose of initiating renewable energy development in the country by cautiously liberalizing the power sector to attract desperately needed investment. On the climate front, Tunisia has signed and ratified the 2015 Paris agreement. In its National Determined Contribu-

[3] Official Gazette of the Republic of Tunisia, N° 38, Law n° 2015-12 dated 11 May 2015 relating to the electricity-generation from renewable energies, pp. 295-300. Retrieved from http://www.legislation.tn/sites/default/files/fraction-journal-officiel/2015/2015G/038/Tg2015121.pdf

tions (NDC), Tunisia has put forth its ambitious climate objectives.[4] 41 per cent decrease in carbon intensity until 2030 compared to 2010 (13 per cent unconditional contribution and 28 per cent conditional contribution). The energy sector is planned to have the lion share of decarbonization targets with a 46 per cent aimed decrease in carbon intensity.

Tunisia is not starting from scratch. Since the 1990ies, Tunisia has put much effort into tackling its energy issues. Today, electricity access in Tunisia is near universal (99.8 per cent)[5] compared to only 53 per cent in 1992 (Harrabi, 2014). Primary energy intensity has improved by 30 per cent between 1990 and 2011 due to several successive and successful programmes of energy efficiency programmes implemented nationally (ANME, 2012). Due to the successful PROSOL-Programme, during which solar water heaters were installed on residential rooftops and the currently running of PROSOL-ELEC to install grid-connected residential rooftop PV, Tunisia is quite advanced in managing decentralized energy installations. Hence, Tunisia has built up technical and administrative experiences for its energy transition.

However, the current energy strategy suffers from a lack of coordination and clear mandates among state actors. Mandates overlap or are not clearly defined, while actors within the electricity sector guard their respective interests without a procedural framework for cooperation and harmonization of effort and measures. Furthermore, the current energy plans only include the expansion of RE technologies without providing information on the expansion of fossil-fuel power plants or the government's intentions to develop nuclear power. Apart from gas-fired power plants in Marnouguia (600 MW) and Rades C (450 MW), a preparatory report for the latter presents plans for the installation of additional 1,800 MW capacities from gas (JICA & Tokyo Electric Power Services, 2014). In the framework of the ELMED proj-ect, in which Tunisia and Italy intend to establish a grid connection and power export to Italy, project planners have considered building a 1,200 MW coal- or gas-fired power plant.[6] A study from the World Bank (2014b) suggests the introduction of coal power into the Tunisian electricity mix based on techno-economic modelling factors while excluding nuclear and oil as suitable options to meet Tunisia's energy challenges. Yet, there is no official statement of the Tunisian government on fossil fuel plans.

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4 Ministry of Environment and Sustainable Development, Tunisia Intended Nationally Determined Contributions, United Nations Framework. Convention on Climate Change (UNFCCC), 2015. http://www4.unfccc.int/ndcregistry/PublishedDocuments/Tunisia%20First/INDC-Tunisia-English%20Version.pdf

5 World Bank, Sustainable Energy for All (SE4ALL) database from the SE4ALL Global Tracking Framework. Retrieved from https://data.worldbank.org/indicator/EG.ELC.ACCS.ZS

6 Retrieved from http://www.industrie.gov.tn/fr/projetelmed

Due to the path dependency of infrastructural investments, decision made under the current energy planning scheme has determining ramifications for potential decision pathways in the future. The government's current energy plans already set the track for the next strategic planning period beyond 2030, which is why the horizon 2050 already needs to be considered.

1.2 Conflict-sensitive energy transition management

Energy transitions to sustainability are purposeful, goal-seeking reflexive processes that are guided by a vision of where the transition is supposed to lead to (Rotmans et al., 2001). In line with the concept of Transition Management (TM), energy transitions are understood as an evolutionary process from one sociotechnical regime to another (Meadowcroft, 2009). Sociotechnical regimes are shared integrated practices reproduced by engineers, political decision-makers, scientists, consumers and economic interest groups who jointly establish the domination of a certain technological development in societies (Geels & Schot, 2007). This goes beyond the technical or structural dimensions, as sociotechnical regimes frame the cognitive interpretation of the members of society. The sociotechnical regime of fossil fuels in electricity production is reproduced by all of these actors through their routinized and entrenched way of thinking and doing in the respective arenas. These routinized patterns or *social practices* of each of these actors consist of the required competencies, meaning, and technologies (Shove et al., 2012) to maintain the fossil-based social system. Practices, i.e. the way how things are consistently and routinely done in a society, form the *regime* of sociotechnical systems. These systems are not only reproduced by engineers, but by political decision-makers, industries, businesses, researchers and individual consumers alike (Bijker, 1995). It is these practices at the intersection of technology, policy/ power/ politics, economics/ business/ markets, and culture/ discourse/ public opinion (Geels, 2011) that all actors taking part in the reproduction need to change to enable an energy transition.

This gradual transformation of sociotechnical systems is managed by various societal actors within their respective field of activity or sphere of influence, e.g. in companies, private households, communities, etc. Aligning and promoting such efforts in different fields and on different levels into a cohesive societal effort falls upon the state as the overarching political entity of today's societies. Moving towards sustainability is to break through the established technological path dependency of our fossil fuel-based societies by shifting cognitive, evaluative and institutional boundaries to arrive at a new framing of today's challenges. Moving towards sustainability, thus, primarily concerns how social actors frame and address problems in decisions they make today to shape societies' future under conditions of uncertain knowledge and contingency of the transition process (Valkenburg & Cotella, 2016; Voß, Bauknecht &

Kemp, 2006). Hence, energy transitions are not only about changing production and consumption patterns in a technical sense. They are much more a matter of shifting mentalities and breaking social practices of decision-making and social relations among different interest groups.

Such fundamental changes to establish practices inevitably resonate in an alteration of the established social relations between different interest groups (Wittmayer, Avelino, van Steenbergen, & Loorbach, 2017). As a consequence, energy transitions implicate great potential for conflicts of interests and contestation. Involved actors, such as the state, can only manage this conflict potential by promoting an open and transparent dialogue about attitudes, interests and expectations of different social interest groups. Innovative approaches to inclusive governance like this cannot be put in place instantly. Instead, they occur in "niches of opportunity", in which different actors can come together on a platform protected from the pressure of routines they are usually embedded in. Diverging interests and expectations can be elicited through mutual learning among different stakeholders. By an inclusive process of framing the current challenges and collectively reflecting on possible solutions that seek to balance diverging interests, involved stakeholders own the process of change, feel responsible for its success and are more likely to make compromises (Valkenburg & Cotella, 2016).

The workshop series of the MENA Select project provides such a niche of opportunity for different stakeholders to engage with and learn from each other to possibly see the challenges of the energy transition in Tunisia in a new perspective.

1.3 Conceptualization of societal support

Societal support for energy projects, in particular from local communities, is a crucial determinant of a successful implementation of energy plans (Cohen, Reichl & Schmidthaler, 2014; Devine-Wright, 2007). Local resistance increases project costs caused by delays, results in insecurity for investors and compromises trust between the state and citizens. However, a potential local opposition should not be framed as an obstacle created by 'irrational' residents who need to be brought to their senses or appeased (van der Horst, 2007). It is based on legitimate concerns and expectations of local communities as stakeholders (Devine-Wright et al., 2009). Apart from local communities, different social interest groups have a stake in energy planning policies. Engaging them includes but is not limited to procedural mechanisms of participation in planning or implementation processes in a mere technical sense (Aaen, Kerndrup, & Lyhne, 2016). It involves discourses over worldviews, attitudes, perceptions, beliefs and aspirations for the future. Top-down approaches of 'decide, announce, defend' (DAD) or 'decide, educate, announce and defend' (DEAD) do not take seriously into account attitudes, needs and sentiments of these stakeholders,

thus are no longer acceptable to democratic society. According to Boutilier (2014), project developers need a "social licence to operate (SLO)". This notion goes beyond the mere passive connotation of the established term "social acceptance", which is why it is replaced here with the term of "societal support" acknowledging people as active agents (Batel, Devine-Wright & Tangeland, 2013). In line with Cohen et al. (2014), potential for societal support of a electricity-generation technology is understood here as the balance between beneficial and detrimental outcomes of that technology's use. The higher the expected positive outcomes and the smaller the risk of adverse impacts, the more likely it is that this technology receives broad support.

2 METHODOLOGY

2.1 Using MCDA to indicate potential for societal support

In the face of the complexity of a given decision-making problem and the uncertainty of available information and of decision outcomes, a Multi-Criteria Decision Analysis (MCDA) supports the decision-making process by suggesting which alternative suits the objectives of the decision-maker best. In MCDAs, the performance of nine selected alternatives of electricity-generation technologies were compared to each other along a set of eleven sustainability criteria which were ranked according to their importance. The performance was measured along 20 indicators, nine of which are quantitative and eleven quantitative (attribute values). In line with the conceptualization of societal support as a weighing of benefits and adverse impacts of technologies, the set of criteria was divided into two dimensions:

\ National level: The technologies' ability to contribute to national energy planning goals:

1. Use of domestic energy source;
2. Global warming potential;
3. Domestic value chain integration;
4. Technology and knowledge transfer;
5. Electricity system costs;

\ Local level: The technologies' ability to avoid adverse impacts to neighbouring communities on the local level:

6. On-site job creation;
7. Pressure on local land resources;

8. Pressure on local water security;
9. Occurrence of non-emission hazardous waste;
10. Air pollution and health;
11. Safety.

Table 14 in the Annex presents the indicators for each criterion as well as the attribute values used in the MCDA. The entire dataset including the value ranges and the methods of how the values were derived is presented in Schinke et al. (2017). The underlying assumption is that technologies can have benefits for national policy objectives, but present considerable negative impacts to those living near the projects. Similarly, a technology could benefit residents' welfare but also have little gains at the national level. Hence, they can be conflicting priorities on both levels.

The MCDA was conducted using the software DecideIT 2.101[7]. It includes uncertainty and imprecision of data and weights by allowing the computation with ranges of possible outcomes instead of just one assumed value (Borking et al., 2011; Danielson, 2005; Danielson & Ekenberg, 2007; Danielson, Ekenberg, Idefeldt & Larsson, 2007; Danielson, Ekenberg, Johansson & Larsson, 2003). The decision-making problem was defined as: *How can different electricity-generation technologies contribute to sustainable development in Tunisia?*

The selected decision alternatives were

1. Utility-scale photovoltaic (PV);
2. Concentrated solar power (CSP);
3. Onshore wind;
4. Utility-scale hydroelectric power[8];
5. Nuclear power;
6. Bituminous coal;
7. Natural gas;

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7 A license for academic use as well as intensive support in training the project team on the tool and in adjusting the software to project needs were kindly provided free of charge by the company *Preference* through Love Ekenberg, Aron Larsson and Kjell Borking.

8 Hydro-electric power plants are distinguished according to their size (pico-hydro: < 5 kW; micro-hydro: 5 kW to 100 kW; mini-hydro: 100 kW to 1 MW; small-hydro: 1 MW to 20 MW; medium-hydro: 20 MW to 100 MW; large-hydro > 100 MW). In this study, utility-scale hydro-electric power plants are considered to be all stations above the size of small-hydro that feed into the national grid.

8. Heavy fuel oil;
9. Rooftop PV.

Following the concept of "niche of opportunity" and aiming to provide a unique participatory platform for mutual learning and exchange among different actors, six social interest groups were identified and included as stakeholders that would elicit the potential of electricity-generation technologies for achieving societal support.

Participants from each group were selected using purposeful sampling (Palinkas et al., 2015). To ensure a balance between different interest groups and perspectives, participants were invited along specific selection criteria, such as fair representation of key stakeholders, geographic regions, professional backgrounds and gender. The invitation process relied on the available networks of the research team and was opportunity-driven according to actors' availability and willingness to participate. Despite intensive stakeholder networking, the researchers were not able to eliminate the risk of non-attendance. The six stakeholder groups were:

Policymakers: State actors who are involved in policy formation related to energy planning, e.g., Ministry of Energy, Mines and Renewable Energy (MEMER), Tunisian Company of Electricity and Gas (STEG), National Agency for Energy Conservation (ANME), Tunisian Institute for Strategic Studies (ITES), Parliamentary Commission for Energy, Natural Resources, Infrastructure and the Environment, Ministry for Local Affairs and Environment (MINEAT), Ministry for Development, Investment and International Cooperation (MDCI), Tunis International Centre of Environmental Technologies (CITET).

Finance and industry: Representatives from industries characterized by high electricity consumption, the small- and medium-sized enterprises (SMEs) involved in implementing energy project, like EnerCiel Tunisie, Shams Energy Access, Alternative Energy Systems (AES), Clarke Energy, as well as financers of energy projects, like Attijari Bank and KfW.[9]

Academia: Researchers on issues related to energy, the environment and development, such as representative from the faculties of science of the universities Tunis and Gafsa, the National Engineering Schools of Tunis (ENIT), Gabes (ENIG), Sfax (ENIS) and Monastir (ENIM), CNSTN and the Private School for Higher Education for Engineering and Technologies (ESPRIT).

[9] The group of finance and industry unfortunately had the lowest rate of participation. This resulted in a group composition that had strong professional inclinations towards RE technologies. Stakeholders with assumed different backgrounds, e.g. from the phosphate industry, oil companies or service and maintenance industry did not follow the workshop invitation.

National NGOs: Civil society actors working on sustainable development, energy planning, environmental protection or human development, e.g. the Association Tunisienne du Pétrole et du Gaz (ATPG), the Association pour le Développement et de la recherche et de l'innovation (ADRI), the Institut for Social Responsibility of Tunisian Enterprises (IRSET), the Alliance for the Promotion of Renewable Energies (APER), the Tunisian Union for Industry, Commerce and Trade (UTICA), as well as the United Nations Development Programme (UNDP) and the Office for Project Services (UNOPS).[10]

Local community representatives: Actors, who represent interests of local communities located in the vicinity of existing or planned energy projects. These representatives can be local residents or activists, members of local councils or local government/administration. Local networks of the research team were limited, hence, the invitation process relied on the contacts of the national network initiative APER, in which locally active NGOs are organized. Another challenge was that there was no diversity in the infrastructure of electricity-generation in Tunisia at the time of the research, which limited local experiences with different technologies. To ensure local knowledge from different regions, activist where invited from areas in which the government is planning huge energy projects. Representatives who followed the invitation came from Tunis (planned 450 MW gas plant), Tataouine (planned 100 MW onshore wind and 10 MW PV), Gafsa (planned 10 MW PV), Monastir, Gabès (planned 50 MW CSP) and Hammam Sousse (400 MW extension of Sousse gas plant commissioned in 2016.

Young leaders: Young people proactively engaged in civil society, from the private sector or students of topics related to energy planning, environmental protection or sustainable development and who can be considered future decision-makers due to their engagement and position.

2.2 Workshop design

The research was conducted in a series of seven one-day workshops in Tunis. Six stakeholder groups were identified and a workshop was held for each of them. The final workshop included representatives of all the six groups. Table 15 in the Annex illustrates the agenda of the stakeholder workshops. In line with the concept of Transition Management, it was important to have a societally shared vision of where the transition is supposed to lead (Berkhout et al., 2004; Rotmans et al., 2001) as a guide for policies and decisions concerning energy transitions to sustainability. Such visions ideally are the result of an inclusive, participatory discourse among different

[10] The Tunisian General Labour Union (UGTT) did not follow the invitation.

interest groups, in which their respective aspirations, concerns, beliefs, expectations and demands are taken into account. The first objective of the workshops was to elicit the vision of Tunisia in the year 2050 of each stakeholder group as decision goal in the process of the MCDA. The three-dimensional concept of sustainability (society, economy, and environment) was used.[11] Participants were handed cards of different colours and shapes. First, they were asked to write down their vision 2050 in key terms or small sentences, then indicate in a second step their aspirations and concerns regarding the role of the selected electricity-generation technologies that would achieve their vision. Gaps in the criteria set and additional criteria were then collected in a gap analysis. This was necessary because the set of 11 sustainability criteria had to be selected before the workshops to collect the attribute values so that the results could be presented on the spot during the workshops.[12] Picture 1 illustrates the final result of a vision-building exercise.

Picture 1: Final result of the vision 2050 exercise (example).

11 The three-dimensional concept of sustainability has been criticized for its shortcomings (Seghezzo, 2009; Smythe, 2014), but was found practical and suitable for the application in the framework of these workshops.

12 The reasons for the preselection of the set was justified towards the participants and it was explained to them that additionally suggested criteria can only be included in future research. It must be noted that the gap analysis on the individual stakeholder workshops only received little feedback, which is why this exercise was repeated during the final mixed workshop and received more responses.

To elicit criteria weighings, the card ranking of the revised Simos method (Figueira & Roy, 2002) was used. Participants ranked the 11 criteria, which they wrote on cards, according to their relative importance to achieving the vision 2050 from the most important at the top to the least important at the bottom (criteria ranking). Since criteria on the different ranks do not necessarily have the same relative importance, participants were encouraged to suggest the different degrees of importance between two ranks by inserting the maximum of three blank cards between them (criteria weighting). To conduct the ranking and weighting as a participatory group exercise, the Simos method was used in a "silent negotiation". This method developed by Pictet and Bollinger (2005) facilitated a compromise among participants by taking turns in moving the cards up or down the ranking in a total of four rounds. The number of allowed individual moves was reduced step-by-step in each round from eight in the first to two in the last round. Before the final round, participants were given the opportunity to exchange arguments and explanations to convince others of their perspective in a moderated discussion. The form suggested in the Simos method to calculate the surrogate weights was replaced by the more accurate CAR method (Danielson & Ekenberg, 2016). It uses the formula[13]

$$w_i^{CAR} = \frac{\frac{1}{p(i)} + \frac{Q+1-p(i)}{Q}}{\sum_{j=1}^{N}\left(\frac{1}{p(j)} + \frac{Q+1-p(j)}{Q}\right)}$$

In the final mixed workshop, the ranking results of each stakeholder group were pinned to the wall for everyone to look at as a reminder and to help them design their negotiation strategy. Participants of the final workshop were reminded that they negotiate not on their personal behalf but in their capacity as spokespersons of their group. However, some degree of subjectivity cannot be avoided.

The results of the MCDA process were triangulated using a questionnaire during the workshop. In this questionnaire, participants were asked to rank and weight the 11 criteria individually before the collective silent negotiation process. The team made sure that participants were not influenced during this individual exercise to prevent biases from either workshop methods or the influences of groups.

[13] Q is the number of importance scales set by the stakeholders, whereby $p(i) \in \{1, \ldots, Q\}$ is the position on this importance scale. Each criterion i has a position on that importance scale $p(i)$, such that for every two criteria *ci* and *cj,* whenever $c_i > {}_{Si} c_j, s_i = |p(i) - p(j)|$. The position $p(i)$ then denotes the importance of that criterion stated by the stakeholders.

Open discussion

During an open discussion, participants in the respective stakeholder groups had to answer the following questions:

\ How do they envision their role in shaping Tunisia's energy transition?

\ Which are the current obstacles to their participation?

\ Which necessary policy steps have to be undertaken to ensure participation and their contribution?

The objective was to learn about how the different stakeholder groups perceive their current role in Tunisia's strategic energy planning and how they imagine their contribution to the country's energy transition. Stakeholders were given the platform to suggest necessary steps to overcome present challenges and to move towards a more inclusive and sustainable energy transition management.

3 RESULTS

3.1 Visions 2050, aspirations and concerns

The joint vision-building exercise invited stakeholders to develop an image of Tunisia's society, economy and environment in the year 2050. In line with the concept of Transition Management, this vision-building serves to identify present challenges and define the transition goal. The results show strong commonalities as well as stark differences of priorities and notions among the different stakeholder groups, highlighting the diversity of perspectives and visions about the future of Tunisia. Despite the different emphasis within each group, stakeholder visions complemented each other rather than being conflictual. Often, they subsumed the same aspects under different dimensions of sustainability—a result of the conceptual shortcoming of the three-dimensional model of sustainability that neglects the fuzzy boundaries and intertwining of the dimensions. In the process of the analysis, individual deviations were moved to the dimension, where the other stakeholder groups had positioned the issue. Elements that were repeatedly mentioned over more than one dimension were considered to be *cross-cutting* issues, hence, transcending the rigid boundaries between the three dimensions. Commonalities, differences and ambiguities as well as aspirations and concerns regarding the vision 2050 are presented in the next four chapters. In this subsection, abbreviations are used in brackets to indicate which group mentioned the respective aspect. Stakeholder groups are abbreviated as follows: Policymakers (PM), finance and industry (F&I), academia (A), national NGOs (NGOs), local communities (LC), and young leaders (YL).

3.1.1 Cross-cutting aspects

Several elements were mentioned by participants in different dimensions, illustrating their particular importance for a vision of sustainable development (see Figure 5).

\ ***Commonalities***: The vision of an electricity mix based to a significant share on RE technologies by 2050was the greatest commonality among stakeholders. However, ambitions of this objective differed from 50 per cent (F&I) to 100 per cent (YL, LC). All groups addressed transparency either in the social or the economic dimension and primarily in decision-making as well as in fighting rampant corruption and putting an end to illegal wealth-grabbing through elites. Four out of six groups, and most vigorously academia, mentioned a developed culture of sustainability. Tunisia's society in the future is supposed to develop a mentality of sustainability and environmental awareness that is to be integrated into the educational programme (YL). A final commonality among young leaders, local communities, and finance and industry, was the notion of a strong sustainable agricultural sector able to increase food security and self-sufficiency.[14] Young leaders emphasized that Tunisia's oases form a unique sustainable socio-ecological and socioeconomic system, which is part of the country's cultural heritage. The oasis and the associated cultural awareness is currently under threat through pollution and unsustainable agricultural practices. They demand that oases be recovered under strict protection and revived as socioeconomic concept of sustainability.

\ ***Differences***: Finance and industry stressed water security for the environment, while policymakers expressed the objective of achieving food security in the economic dimension. Both aspects are related to human well-being, resource protection and economic exploitation and therefore considered cross-cutting aspects. Though water and food security is no salient theme of the stakeholder visions, water scarcity as a particular challenge for Tunisia became an issue in later discussions.

\ ***Ambiguities***: Policymakers mentioned policy coherence in all three dimensions. Industry and finance refer it to economic policies, while NGOs take the perspective of policy coherency for environmental protection under the framework of a vision for low-carbon development. Policymakers understood quality of life

[14] Agriculture is of major significance socially, culturally and economically. The sector employs 16 per cent of the work force and it contributes 12 per cent to the GDP. The sector grows five per cent annually.[14] Increasing large-scale farming aggravates water scarcity, since irrigation already is responsible for 80 per cent of national water consumption (Horchani, 2007).

more vaguely as an aspect of all three dimensions. For finance and industry as well as local communities, quality of life is primarily linked to proper infrastructural planning of living areas, including public transport, green spaces in cities and villages and family parks. Most aspirations and concerns are related to quality of life under the framing of economic prospects and human safety. Further, stakeholders show a certain degree of scepticism regarding social and political commitment and stability as an imperative factor to their vision 2050 (see Table 1).

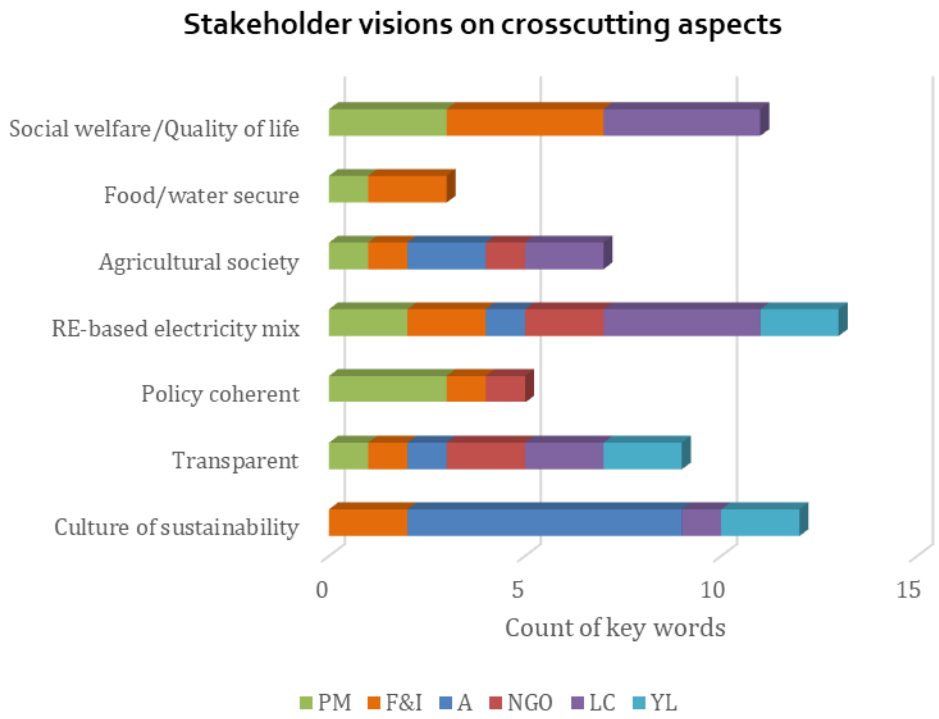

Figure 5: Distribution of key elements cross-cutting the sustainability dimensions of stakeholder visions 2050.

\ ***Aspirations***: Most stakeholder groups share the aspiration that electricity-generation technologies will lead to job creation (PM, F&I, NGOs, LC, YL) resulting in alleviating unemployment and improving people's prospects for a better life through prosperity (F&I, A, YL) and economic growth (PM, YL). Generating local benefit-sharing through energy is seen as an opportunity to improve quality of life in local communities (F&I) as well as to establish positive relationships between project implementers and host communities (LC). For NGOs, the energy transition will prevent Tunisia from resorting to nuclear power to meet its

energy demand. Finance and industry hope to solve the country's water stress through seawater desalination, mainly for securing agricultural production.

\ ***Concerns***: Lack of commitment of relevant societal actors and a missing political will to implement the energy transition is considered a key risk to achieving the vision 2050. Policymakers fear that rapid changes of decision-makers put coherent policy formation at risk. On the technical dimension, stakeholders are concerned about insufficient maturity of technologies and the limited capacity to manage possible technological risks. Here, nuclear was explicitly mentioned by finance and industry and academia. NGOs and local communities both showed concerns about the disturbance of landscapes through expansive RE-deployment and pollution through electricity-generation, while local communities in particular see a risk in managing radioactive waste. Adverse impacts on health stemming from technology operation were also an issue for local communities.

Table 1: Stakeholders' aspirations and concerns associated with cross-cutting aspects of the vision 2050 for Tunisia

	Cluster	Aspirations (green) / Concerns (red)	PM	F&I	A	NGOs	LC	YL
Cross-cutting	Transparent							
	RE-based electricity mix	RE technological innovation (new forms of energy, storage)	X	X				
		Maturity of technologies			X			
		Immaturity of technologies			X	X		X
		Insufficient grid integration/expansion			X		X	
	Agricultural society	Desalination for agricultural development		X				
		Increasing land prices						X
	Culture of sustainability	Societal openness for change						X
		Lack of social awareness						X
	Policy coherent	Lack of commitment from all stakeholders & political will	X		X	X		X
		Rapid changes of governments	X					
	Quality of life	Job creation	X	X		X	X	X
		Economic growth	X					X
		Prosperity		X	X			X
		Prevent nuclear				X		
		Local benefit sharing through energy projects		X			X	
		Inability to manage technology risks (nuclear)		X	X	X	X	
		Pollution				X	X	
		Disturbance of landscapes				X	X	
		Adverse impacts on health					X	

3.1.2 Society

The aggregated image of stakeholders' visions of Tunisia in 2050 can be summarized as a *just, transparent, politically engaged, and participatory society with high rate of employment, in which regional inequalities are alleviated and which is governed according to standards of good governance in a decentralized system* (see Figure 6). Critical stakeholder aspirations among the cross-cutting aspects are linked to build-

ing a knowledge society, achieving social justice, promoting good and participatory governance. Concerns touch upon in particular limits to job creation, good governance and social stability (see Table 2).

Figure 6: Distribution of key elements of stakeholder visions 2050 for "society".

\ ***Aspirations***: To become an educated knowledge society, stakeholders emphasized different aspects to it. Academia and NGOs stressed capacity-building, while the former also mentioned increasing research. Complimentary to that, policymakers named the development of higher education and digitalization. Both NGOs and local communities aspire to a strong civil society involved in taking decisions. Serious concerns were raised in regard to bad management of finances, which puts successful implementation at risk (PM) as well as the fight against corruption (LC), which is a sensitive topic in Tunisia. Diffusion of and public access to technologies is considered a benefit by academia, local communities and young leaders. This highlights aspects of democratizing energy through self-production of consumers.

\ ***Concerns***: Local communities see the risk that expectations regarding job creation might be disappointed as the market is saturated. Job creation through economic growth could further be under threat due to social instability (YL).

Social stability is linked to regional disparities (F&I). Young leaders fear that increasing corruption hinders social and economic development.

Table 2: Stakeholders' aspirations and concerns associated with societal aspects of the vision 2050 for Tunisia

	Cluster	Aspirations (green) / Concerns (red)	PM	F&I	A	NGOs	LC	YL
Society	High employment	Economic growth	X					X
		Market saturation limits job creation					X	
		Social instability						X
	Equal regional development							
	Knowledge society/educated	Capacity-building			X	X		
		Digitalization	X					
		Increased R&D	X		X			
		Development of higher education	X					
	Decentralized							
	Good & participatory governance	Strengthening civil society				X	X	
		Ministry for Solar Energy				X		
		Less corruption					X	
		Bad finance governance	X					
	Political & engaged civil society							
	Social justice	Equal public access to technologies			X		X	X
		Improvement of quality of life					X	X
		Equity	X					
		Increased corruption						X
	Entrepreneurial							
	CSR							
	Democratic							
	Order/stability	Continuing disparities between the regions		X				

3.1.3 Economy

In summary, stakeholders envision a *green, prosper, competitive and productive economy, which is open and attractive for private businesses and international investment, and which is based on RE-technology development and innovation while ensuring fair distribution of benefits and contributing to social solidarity*.

\ ***Commonalities***: Most prominent were aspects related to the development and innovation of RE technologies, which occurred in economic and environmental visions. Participants hope that Tunisia becomes a technological hub, in which economic development in based on RE technologies. As can be seen in Figure 7, all stakeholders share the idea of a Tunisian economy based on RE technologies and domestic innovation to establish Tunisia as an international player in the global energy transition. Academia and young leaders were most ambitious regarding Tunisia's technological future. Young leaders see Tunisia's economic development following the path of technological innovation as industry of the future replacing non-competitive industries and aiming for full societal electrification. This technology-guided vision is linked to contribute to the maturity of

existing RE technologies (A, PM), to promote information and communication technologies (A), increase added-value through developing new technologies (LC) and diffuse and diversify RE technologies in all economic sectors (A). Robustness and competitiveness of the economy is a key vision shared by all stakeholders. Stakeholders see a productive (PM, F&I), modern and innovative (F&I), diversified (A) economy that achieves trade balance (F&I) and decreases fiscal deficits (LC) and a strong service sector (NGOs, F&I).

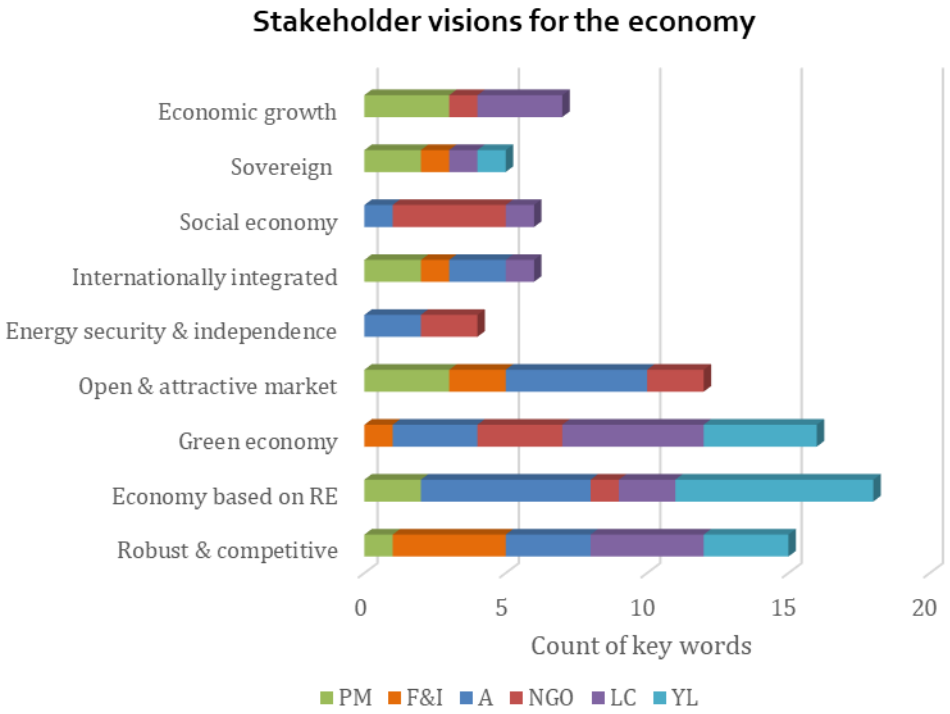

Figure 7: Distribution of key elements of stakeholder visions 2050 for "economy".

\ ***Differences***: Supported by academia and local communities, NGOs imagine a prosperous and equitable social economy based on solidarity and an equal distribution of benefits to achieve social peace and balance. This particular vision of a social economy was not expressed by other groups. Aspects directly related to energy security and energy independence were only mentioned in the vision-building exercise by academia and NGOs respectively. Both issues, however, became more and more prominent during the course of the workshop.

\ ***Ambiguities***: National sovereignty was framed in economic terms by policy-makers, local communities and young leaders. Participants put forth the notion of national economic independence (YL, LC) and autonomy and sovereignty over national decisions (PM), pointing to the vision of self-determination

regarding economic development in the international context. This notion of economic emancipation, however, corresponds to the vision of a regionally and internationally integrated Tunisia with consolidated international cooperation (PM), close relations to the EU (F&I), and a strengthened regional economic integration under Tunisian leadership (PM) based on open borders and a convertible currency (A). Policymakers, local communities and NGOs mentioned increasing productivity and achieving economic growth. Other participants rather saw macro-economic benefits as result of RE-technology development and innovation, economic diversification and profiting from building a green economy. A related critical aspect not reflected in the economic vision, but discussed during the workshop, was the need to find ways of how to integrate the informal market into the formal economy.

The majority of aspirations and concerns expressed by the stakeholders can be attributed to the economic dimension (see Table 3). This reflects the fundamental importance the economy plays in the current public political debates in Tunisia. In this discourse, political and social stability are considered dependant variables of building an inclusive, prosper, divers and robust economy with high employment opportunities.

\ ***Ambiguities***: The general thrust of stakeholders' aspirations is that along with the energy transition, Tunisia's economy will become green thanks to improved cost competitiveness of RE technologies (A, NGOs, LC). Stakeholders aspire to the integration (PM, F&I, NGOs) and diversification of domestic industries (F&I, NGOs, LC). High investments (F&I, A, NGOs, LC) into new technologies are expected to put on track an economic development based on RE technologies with domestic research capable of technological innovation. Stakeholders hope for substantial reforms, in which regulatory frameworks are adapted and improved to create a free and attractive market environment (PM, F&I, NGOs, LC), including a decentralized electricity market (F&I, A, NGOs, LC, YL).

\ ***Concerns***: Academia, NGOs and local communities share worries about the economic costs of the energy transition hindering the development of a green economy. Young leaders doubt whether the current policies will be able to put Tunisia on the right track. In the same vein, other see substantial risks in unfavourable regulatory frameworks for an attractive, open market (PM, NGOs, LC), country risks impeding investments (PM, F&I, YL) and bad governance of the energy sector (PM). Complementary to the shared vision of a decentralized electricity system, the state monopoly and the centralized electricity system is perceived as a critical risk to the vision. Every stakeholder group—except for policymakers—demanded an end to the monopoly.

Table 3: Stakeholders' aspirations and concerns associated with economic aspects of the vision 2050 for Tunisia

	Cluster	Aspirations (green) / Concerns (red)	PM	F&I	A	NGOs	LC	YL
Economy	Robust & competitive	Economic diversification		X		X	X	
		Transfer of technologies			X			
		Energy subsidies		X		X		
		Persistent technology dependence (incl. RE)			X			
	Green economy	Competitive costs of RE			X	X	X	
		Societal support for RE				X		
		Current policies						X
		Dependence on fossil fuels			X		X	
	Economy based on RE	Increased investments in RE		X	X	X	X	
		Economic costs of the energy transition			X	X	X	
		Lack of societal support			X			
		Reversion of transition process				X		
		Lack of research	X					
	Open & attractive market	Improved regulatory framework	X	X		X	X	
		Decentralization of electricity production		X	X	X	X	X
		Monopoly & centralized electricity production & distribution			X		X	X
		Unfavourable regulatory & investment frameworks	X			X	X	
		Bad energy sector governance	X					
		Country risk	X	X				X
	Sovereign	Energy independance	X		X	X	X	X
		Dependance on energy & technology import				X		X
	Internationally integrated	Regional grid integration	X	X	X			
	Social economy							
	Energy security & independence	Diversification of energy sources			X			
		Grid flexibility & stability		X				X
		Discovering new resources	X					
		Reducing national energy bill				X		
		Dependence on global fuel market			X		X	
		Wrong choice of technology		X				
		Increase of energy consumption			X			
		Privatisation (insufficient capacity planning)	X		X			
		Intermittency of RE technologies	X			X		
		Inefficient resource exploitation					X	
		Insufficient regional grid integration						X
	Economic growth	Optimization/reduction of electricity costs	X	X		X		X
		Domestic industry integration in RE	X	X		X		
		High electricity costs	X		X		X	X
		Lack of investments	X			X		
		Investment risks through falling costs and technology innovation						X

\ ***Ambiguities***: Policymakers, academia, local communities and young leaders consider high electricity costs a risk to economic development. Currently, energy prices are regulated by state subsidies ensuring consumption prices well below the world market. Subsidies as a key feature of Arab social contracts are also a critical issue of social stability. F&I as well as NGOs perceive these energy subsidies as a risk to sustainable development as they cover up the true costs of energy. Yet, they did not express concerns over the economic or social impacts of withdrawing the energy subsidies.

Energy independence, which was not very prominent in the vision itself except for NGOs, was aspired to contribute to national economic sovereignty (PM, A, NGOS, LC, YL). However, policymakers, industry and finance as well as academia perceive better regional grid integration as beneficial to their vision, while young leaders see a lack of regional grid integration as a risk to the vision. Energy independence, thus, is rather not associated with energy self-sufficiency, but with the national autonomy over decision-making. Contrary to the majority of stakeholders envisioning a free electricity market, participants from policymakers and academia expressed concerns that market liberalization could subject adequate planning of capacities to private interests, thus putting strategic capacity expansion at risk. Despite the common aspiration for innovation and development of RE technologies in Tunisia, young leaders noted that rapid development could also make investors hesitate because of profit uncertainty.

3.1.4 Environment

The environmental visions show most coherence. It can be described as a *clean and healthy environment that is protected through a decarbonized economy, strict environmental governance as well as efficient and sustainable exploitation of resources and valorization of waste, while at the same time offering quality of life to communities*.

\ ***Commonalities***: Though all stakeholders share the vision of a clean and healthy environment, it was of crucial importance to local communities (see Figure 8), highlighting massive environmental pollution and the vision of green communities with intact local ecosystems. The crucial importance of the fight against pollution illustrates that it is a salient and sensitive issue to the people. Bad waste governance and increased pollution is perceived in public opinion as a symptom of state failure to maintain public order. Linked to waste management is the vision of creating economic benefits and environmental protection through the valorization of waste in all production processes (LC), including waste-to-energy (F&I, A, YL) and an effective national recycling system (NGO, YL). In more general terms, stakeholders see a society that respects its ecological limits (A) and preserves the environment for future generations (NGO) by establishing more efficient and sustainable ways of using natural resources. Key to environmental protection, according to most of the groups, is the decarbonization of the economy. Overall, stakeholders expect improved environmental governance including concretized (PM) and strict laws that are consequently enforced (NGOs) with a clear system of monitoring, incentives and penalties (F&I). Effective resource management (PM) and integrated waste management (LC) are supposed to be accompanied by a committed policy on recycling (YL, A).

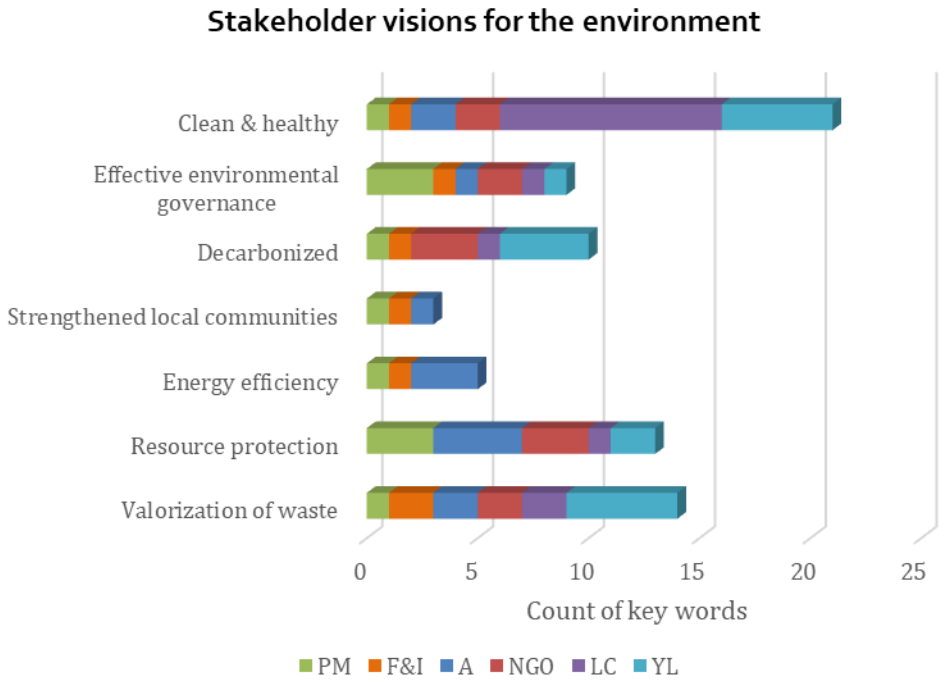

Figure 8: Distribution of key elements of stakeholder visions 2050 for "environment".

\ ***Differences***: Policymakers, finance and industry as well as academia were the only groups that explicitly mentioned energy efficiency. Contrary to NGOs, local communities and young leaders, they also expressed the vision of a strengthened mandate and responsibility of local communities for environmental protection.

Most aspirations and concerns were directed at beneficial and adverse impacts of using RE technologies in terms of protecting the environment (see Table 4).

\ ***Aspirations***: All stakeholders except academia mentioned climate change mitigation as a factor to their vision 2050. The expansion of RE was desired by almost all groups, while academia and local communities emphasized that abandoning fossil fuels would be critical. Efficient waste management (LC) and reducing pollution (A, LC, YL) are aspired to help achieve a clean, unpolluted environment for Tunisians.

\ ***Concerns***: Almost all stakeholders showed concerns about possible adverse impacts of RE technologies on the environment. During discussions, this concern was reflected in the suggestion to consider the contribution of RE technologies to environmental protection from a life-cycle perspective of the technologies. Low fossil fuel prices are regarded as a risk to the environment, as such market conditions could slow down the decarbonization of the economy (F&I, NGOs).

\ ***Ambiguities***: Though clearly in favour of their expansion, local communities expressed at the same time concerns over the extensive land requirements of RE technologies.

Table 4: Stakeholders' aspirations and concerns associated with environmental aspects of the vision 2050 for Tunisia

	Cluster	Aspirations (green) Concerns (red)	PM	F&I	A	NGOs	LC	YL
Environment	Resource protection	Sustainable development				X		
		Adverse environmental impacts of RE		X	X	X	X	X
		Missing strategy for using natural resources (land/water)			X	X		X
		Extensive land use of RE					X	
	Valorization of waste							
	Effective environmental governance							
	Clean & healthy	Waste managament					X	
		Reducing pollution			X		X	X
		Increased waste production				X	X	
	Decarbonized	Climate change mitigation	X	X		X	X	X
		Abandoning fossil fuels			X		X	
		Expansion of RE	X		X	X	X	X
		Reduce energy demand					X	
		Low fossil fuel prices		X		X		

3.2 Technology perceptions

RE technologies

Workshop participants across all stakeholder groups were strongly favoured RE technologies as providers of clean energy at competitive costs and low GHG emissions. According to stakeholders, RE technologies are most adaptable to Tunisia and promise considerable benefits for the future. They are expected to stabilize domestic electricity costs and to decrease Tunisia's fossil fuel dependency while fostering regional integration into a win-win situation with neighbouring countries instead. For most participants PV and onshore wind constitute the most favourable and promising technologies to be dominating the electricity mix. In the eyes of the stakeholders, both technologies have reached a high level of maturity, they are technically easy to deploy and can be quickly integrated into the grid. Some expressed the opinion that the electricity mix should consist of an equal share of different electricity-generation technologies including also fossil fuel technologies.

The critical advantage of PV pointed out by academia and local communities is its suitability for decentralized auto-generation by consumers and for heating. Participants put forth the strong idea for community-based local electricity production instead of an expansion of the national central grid. Participants see Tunisia prepared and well-positioned to introduce a solar-based decentralized electricity-generation system due to its experience with the national solar programmes PROSOL and PROSOL-ELEC. Solar technologies and a sense for auto-generation are well-spread and known among Tunisians due to these previous experiences. Some concerns were voiced over the extensive land use of utility-scale solar plants and the disturbance of landscapes through wind turbines and their adverse impacts on the ecosystem. CSP only placed a little role in the discussions on RE next to onshore wind and PV; it was not even mentioned by NGOs, local communities or young leaders. Academia as well as finance and industry are sceptical that CSP presents an opportune option for Tunisia at the moment as it still needs to become a more mature technology. Policymakers addressed high water consumption of CSP plants, which can be significantly reduced by dry-cooling systems (Schinke et al., 2017, p. 89). Contrary to their vision 2050, in which energy security was not mentioned, policymakers this time raised the concern that a technology mix with a high share of intermittent technologies needs to meet peak load. Though it offers important co-benefits, academia and finance and industry consider Tunisia's water resources for hydroelectric power to be exhausted.

Fossil fuel technologies

Compared to RE technologies, participants in all stakeholder groups have much less debated fossil fuel technologies among each other. Participants across all stakeholder groups felt a higher need to discuss and share their views about new technologies that are about to be introduced to the Tunisian society than about those technologies, which are already established. Well aware of the country's high imports of fossil fuel mainly from Algeria, stakeholders equally associate fossil fuels with the country's subjection to its neighbour, the fuel market and regional as well as international geopolitics. Tunisia's current energy situation with its lack of diversity in energy sources is considered an obstacle for energy security, affordable electricity, sustainable development, and national sovereignty. Notwithstanding this perception, gas still is perceived as a rather positive alternative compared to coal or oil. Stakeholders consider it indispensable for Tunisia to use natural gas for electricity production as it compensates the intermittency of RE technologies and is expected to continue to play an important role in the electricity mix in the foreseeable future. For that reason, finance and industry see the need to diversify gas suppliers. Oil as an energy source for producing electricity did not play any role in any of the stakeholder groups. Coal was only mentioned by policymakers, stating that coal would be a cost

competitive alternative for Tunisia. However, using coal would require additional measures for environmental protection, as one participant argued. Given that Tunisia lacks domestic coal resources, it would have to be imported. Thus, introducing coal would not solve the problem of fuel dependency.

Nuclear

The majority of stakeholders disapproved of nuclear power in the context of Tunisia. While there was a majority of voices in all stakeholder groups that explicitly renounced nuclear power and demanded it to be banned as an option for the future, supporters of nuclear were the strongest in Academia. Nuclear also had advocates among policymakers. Participants in the academia group argued that despite of nuclear being a technology of the past, it could be considered clean and CO_2-free energy that would be able to provide sufficient reliable electricity for Tunisia's industry. However, Tunisia's grid capacities are insufficient at the moment to accommodate nuclear power, one participant argued without abandoning the idea of nuclear power in Tunisia in general. Participants perceived a high risk of accidents with severe consequences (A, NGOs) and lack of societal support as primary obstacle to nuclear power. A counter argument was offered by participants in the local communities, who claimed that the primary reason against nuclear was not concerns over safety, but that it is high investment costs and the long required period of development which makes nuclear and unattractive option for Tunisia. Industry and finance shared concerns over high costs and pointed to the production of dangerous radioactive waste as well. Both NGOs and young leaders consider nuclear power to exceed Tunisia's national capacities and capabilities. Possessing no own resources, Tunisia would be dependent on importing uranium.

3.3 Stakeholder criteria preferences

The following sections present the individual group ranking results to illustrate the different priorities that have to be viewed against the background of the groups' respective visions 2050. These group results present the starting point of negotiation in the final mixed workshop. Table 17 in the Annex offers a qualitative five-step descriptive scale of criteria importance for a quick overview.

3.3.1 Individual groups rankings

Policymakers

"Safety", "Use of domestic energy sources" and "Electricity system costs" are of distinct importance to policymakers compared to all other criteria following (see Table 5). Participants stated that these three criteria are of highest relevance regarding achieving independence of the state and from global fuel markets. Physical safety for the people and low costs for consumers that would facilitate economic growth were seen as critical to easing social tensions and achieving social peace. This reflects policymakers' visions and aspirations concerning social stability and welfare as well as economic growth and sovereignty. "Pressure on local land resources" and "Non-emission hazardous waste" are of least importance. One participant brought forth a strategic argument to place "non-emission hazardous waste" on local importance to avoid creating a barrier for nuclear power. Tunisia's implication in the fight against global warming was another issue of debate among policymakers. It was argued that as the country's GHG-emissions are so negligible compared to the big industrial nations of the world, Tunisia should not assume to play an important role in the fight against climate change. However, it was also pointed out that global climate change has an undeniable effect on Tunisia's scarce water resources and thus does in fact concern Tunisia's policies. Furthermore, placing national importance on the fight against climate change offers great opportunities to attract international funds.

Table 5: Criteria weighting results for policymakers

Rank	Criteria weighting	Surrogate weights
1	Safety, Use of domestic energy sources, Electricity system costs	18.226
3 blank cards		
2	On-site job creation, Technology and knowledge transfer, Local air pollution and health, Pressure on local water security	7.897
2 blank cards		
3	Global warming potential, Domestic value chain integration	4.936
2 blank cards		
4	Pressure on local land resources	2.347
5	Non-emission hazardous waste	1.519

Table 6: Criteria weighting results for finance & industry

Rank	Criteria weighting	Surrogate weights
1	Use of domestic energy sources	22.073
1 blank card		
2	Domestic value chain integration, Global warming potential, On-site job creation	13.137
1 blank card		
3	Technology and knowledge transfer, Safety	10.089
3 blank cards		
4	Local air pollution and health, Electricity system costs	5.956
3 blank cards		
5	Pressure on local land resources, Pressure on local water security	2.425
6	Non-emission hazardous waste	1.576

Finance and industry

As group result (see Table 6), participants ranked "Use of domestic energy sources" as the most important criterion, encouraging Tunisia to economically exploit its natural resources for RE. "Non-emission hazardous waste" was considered least important. One participant argued contrary to the majority that concerns over pollution, safety and health should be of the highest importance. "Global warming potential", ranked second, was exclusively linked to fossil fuels. It is worth pointing out the surprising fact that the cost criterion as the assumed economic key parameter was only ranked fourth behind generating jobs and ensuring physical safety for the population. It is also interesting that the global effort to mitigate climate change is considered more important than local environmental and resource protection. This suggests that their way of thinking is more embedded in the global energy transition framework than within the local context. Seen in this light, participants' claims for ensuring higher local benefit-sharing of energy projects appear to be rooted more in a buy-in-strategy than a genuine concern over local livelihood.

Academia

Table 7 shows the results of the criteria ranking and weighting of Academia. Participants agreed that the independence from fossil fuels, reflected in the criteria "Use of domestic energy sources", and the "Transfer of technology and knowledge" are the two most important strategic objectives. The two least important criteria were "Pressure on local land resources" and "Non-emission hazardous waste". The dominance on economic criteria in general and the first rank for "Technology and knowledge transfer" is well in accordance with the vision of a striving economy based on RE technologies and becoming an educated knowledge society. Participants argued that Tunisia's energy independence is based on transferring technologies and knowledge to the country and integrating it into the domestic industries as a basis for creating benefits in the other criteria. Electricity costs have to be considered with second priority due to their immediate short- and long-term effect on society and economy. Yet, there was also discord. Several participants argued in their concern over increased water scarcity to rank the water criterion at the top. Many stakeholders see Tunisia's water crisis as manageable through desalination, which, however, is cost- and energy intensive. One counterargument to prioritizing water was that, compared to the amount of water consumed in industrial processes, the electricity sector's impact on water resources is negligible. Tunisia's water crisis thus cannot be resolved with the choice of electricity-generation technologies. A minority vote sought to give "Safety" a higher importance.

Table 7: Criteria weighing results for academia

Rank	Criteria weighting	Surrogate weights
1	Use of domestic energy sources, Technology and knowledge transfer	19.397
2	Electricity system costs, Domestic value chain integration	13.336
	1 blank card	
3	Pressure on local water security	8.486
4	Local air pollution and health, Global warming potential	6.789
	1 blank card	
5	On-site job creation, Safety	3.81
6	Pressure and local land resources, Non-emission hazardous waste	2.425

Table 8: Criteria weighting results for NGOs

Rank	Criteria weighting	Surrogate weights
1	Electricity system costs	32.71
	3 blank cards	
2	Technology and knowledge transfer, Domestic value chain integration	11.449
	1 blank card	
3	Non-emission hazardous waste, Local air pollution and health, On-site job creation, Safety, Pressure on local water security	6.425
4	Use of domestic energy sources, Global warming potential, Pressure on land resources	4.089

National NGOs

The result of the final ranking of national NGOs (see Table 8) and the discussions among the group's participants show a high degree of ambivalence and quite significant levels of disagreement among the different NGO representatives. "Electricity system costs" reached highest importance with significant distance to all other criteria, symbolised by the insertion of three blank cards between the first two ranks. Criteria concerning Tunisia's commitment to climate change mitigation, environmental protection and issues related to human well-being —all of which can be assumed to be key to the self-image and mission of NGO's working on sustainability and development—were weighted surprisingly low. Consequently, this spurred intense debate among participants during the exercise. Least importance was given to "Use of domestic energy sources", which was ranked at the top in all other groups. Participants argued that this is not at all a critical criterion for sustainability, as this is primarily a political objective with implications for the economy. Moreover, one participant claimed that the notion of independence is the reason for disturbances in the global geopolitical order and war. Since Tunisia's fuel dependency runs south-to-south and the country is not subjected to the domination of a developed country, the criterion is of minor importance. Instead of placing massive investments guided by the notion of independence, funds would be put to better use in more relevant sectors, like promoting the transfer of technologies and knowledge or protecting scarce water resources. One participant suggested to rank "Safety" first to prevent nuclear, illustrating the predominant perception of nuclear power being an unsafe technology with a high risk of severe accidents. The counter argument was made that it is not

safety concerns that restrict nuclear power in Tunisia, but rather its high investment costs. Costs of the energy transition and achieving low consumer costs for electricity did play a role in the group's aspirations and concerns. Yet, considering the rather strong focus on sociopolitical and environmental aspects in NGOs' vision 2050, environment- and public welfare-related criteria were ranked comparatively low.[15]

Local communities

Table 9 depicts the total ranking of local community representatives. Contrary to the claim one participant made during the discussions that policymakers and civil society had completely different visions, LC's top ranks contain the same criteria as the ranking of policymakers. "Use of domestic energy sources" is considered to be of most importance, followed by "On-site job creation", "Local air pollution and health", "Domestic value chain integration", and "Electricity system costs". The low ranking of the waste and safety criteria seem surprising as their position does not reflect their relevance in the vision 2050 of local communities. The probably convincing argument was that by ensuring the use of domestic energy sources—assuming these will be predominantly through renewable energies—will ensure positive outcomes as regards all of the criteria, including resource protection, job creation and domestic value chain integration as well as solving the problem of pollution. In contrast to the assumption that it would be a key concern to local communities, "Safety" was ranked last.

Young leaders

As Table 10 illustrates, young leaders, like most other groups except NGOs, ranked "Use of domestic energy sources" first, equal to "Safety" and "Pressure on local water security". Least importance was given to "Electricity system costs" and "Pressure on local land resources". The low rank of the land criterion was justified with the argument that Tunisia has plenty of arid land to allocate. While young leaders share the high importance of safety with policymakers, they are the only group that considered the protection of water resources as top priority for Tunisia. Another particularity of young leaders is that the second rank contains only environmental criteria which is in accordance with the group's strong emphasis on pollution and a clean environment in their vision 2050. In the narrative of young leaders, these environmental concerns are closely linked to human welfare and health. A minority vote wanted to rank "Technology and knowledge transfer" first arguing that this is a pre-

[15] It must be noted that when participants were shown the calculated surrogate weights, participants reacted with some surprise. Apparently, they did not expect the weight ratio between the top and the bottom criteria to be that extreme as a result of the three blank cards between the first two ranks.

requisite for energy independence. This suggestion was countered with the assumption that Tunisia, despite its efforts, will not be able to catch up with developed countries in cutting-edge technology innovation in the future. Therefore, not too much emphasis should be put on this aspect. Apart from the disagreement regarding the placement of the criterion, participants were convinced that job creation and domestic value chain integration will follow from the technology and knowledge transfer.

Table 9: Criteria weighting results for local communities

Rank	Criteria weighting	Surrogate weights
1	Use of domestic energy sources	18.968
2	On-site job creation, Local air pollution and health, Domestic value chain integration, Electricity system costs	13.365
2 blank cards		
3	Pressure on local land resources, Pressure and local water resources	7.933
2 blank cards		
4	Technology and knowledge transfer	4.635
1 blank card		
5	Global warming potential, Non-emission hazardous waste	2.673
6	Safety	1.725

Table 10: Criteria weighting results for young leaders

Rank	Criteria weighting	Surrogate weights
1	Use of domestic energy sources, Safety, Pressure on local water security	17.34
1 blank card		
2	Global warming potential, Non-emission hazardous waste, Local air pollution and health	9.393
1 blank card		
3	Technology and knowledge transfer	6.069
4	On-site job creation, Domestic value chain integration	4.697
1 blank card		
5	Electricity system costs, Pressure on local land resources	2.168

3.3.2 Criteria gap analysis

All sustainability criteria presented in Chapter 2.1, which were preselected by the project team, were mentioned by stakeholder groups in one or the other way. Hence, it can be assumed that the preselection matches stakeholders' views as to what aspects of technology performance need to be evaluated. For a summary of comparison see Table 16 in the Annex. Though consistent with stakeholder preferences, the criteria set might not be a complete reflection due to the preselection process. While acknowledging that such criteria sets cannot be exhaustive, but always only represent a number and range of aspects that is manageable in the MCDA process, stakeholders might have additional aspects and criteria that are important to them. These suggestions were revealed in the gap analysis (see Table 11). Participants raised political and social stability as a critical issue for Tunisia. Further criteria deemed important were maturity and intermittency of technologies.[16] It was suggested to consider the life-cycle of technologies to have a more comprehensive performance evaluation of technologies.[17] Sovereignty, which was a prominent concern in the visions 2050 for many stakeholders, was also suggested in the final workshop discussion. "Acceptability of technology to local communities" highlights the critical importance of societal support from neighbouring communities and implies as substantial the inclusion of local communities in the decision-making process and project development. Another interesting aspect that came up in the final workshop was evaluating the impact of expanding RE technologies on land prices for agricultural production as this is directly linked to subsistence and agricultural production of local communities.

16 Technical criteria relevant to the performance of the entire electricity system were deliberately excluded from this criteria set as they were part of the scenario evaluation in another component of MENA SELECT. This was communicated to the participants.

17 Including life-cycle data on environmental impacts is common in MCDA-studies. Since the MCDA conducted in this study focusses only for the impacts of technologies in the immediate national and local contexts of deployment and operation in the three case countries, life-cycle data including up- and downstream impacts was excluded in the performance evaluation.

Table 11: Additional evaluation criteria suggested by stakeholders

Suggested additional criteria		PM	F&I	A	NGOs	LC	YL	Final
Social/political	Political and social stability	✓	✓	✓			✓	
	Reduction of regional disparities				✓			
	Societal engagement		✓					
	Acceptability of technologies to local communities							✓
	National sovereignty							✓
	Affordability of electricity (poverty alleviation)							✓
	Impact on international geopolitical relations							✓
Technical	Maturity of technologies			✓	✓		✓	
	Intermittency of technologies	✓			✓			
	Energy security		✓					✓
Economic	Land prices						✓	
	Costs of CO_2 avoided				✓			
	Regional integration of electricity markets							✓
	Break-even point (including subsidies in the equation)							✓
	Adaptability to the context and problems of the country							✓
	Robustness of the electricity scenarios to varying performance along the evaluation criteria (sensitivity analysis)							✓
Environment	Life-cycle of technologies		✓	✓				
	Biodiversity							✓
	Irreversibility of technologies							✓

3.4 Towards a compromise

3.4.1 Final criteria evaluation

Picture 2 demonstrates the ranking result of the final workshop, while Table 12 presents the surrogate weights calculated from it. During the discussions before the final round, representatives exchanged their arguments regarding their ranking preferences. Interestingly, positions and preferences regarding certain criteria appear to have changed compared to previous group rankings. Finance and industry made the case for their group that competitiveness of technologies is a key priority to them out of economic interests, which makes the criterion "Electricity system costs" the most important. In contrast to that argument, the cost criterion was ranked only fourth in the finance and industry group. Well in line with their group results, representatives of national NGOs supported this statement. While academia put "Safety" only on the fifth out of a total of six ranks, the group's representatives argued for the criterion to be on the first rank in the final workshop. Also similar to

finance and industry, academia framed low costs as a prerequisite for its further development, suggesting to place it on the second rank.

Picture 2: Final compromise criteria ranking

Table 12: Criteria weighting compromise of the final workshop

Rank	Criteria weighting	Surrogate weights
1	Safety, Use of domestic energy sources	15.789
2	Electricity system costs, On-site job creation, Local air pollution and health	10.526
3	Domestic value chain integration, Non-emission hazardous waste, Technology and knowledge transfer, Pressure on local water security	7.895
2 blank cards		
4	Global warming potential, Pressure on local land resources	2.632

Policymakers expressed concerns that regional instability could draw Tunisia into a crisis, which makes energy independence that much more important to the country. In slight deviation from the group's ranking, policymakers agreed to prioritise "Use of domestic energy sources" over "Electricity system costs". This is in so far interesting as the representatives in the policymakers group were senior officials from the two often competing government agencies STEG and ANME. Young leaders brought forth that Tunisia's economic independence must be based on the use of its domestically available resources, protecting scarce water resources and ensuring safety for the people. Therefore, these three criteria should be ranked first. They continued arguing that all criteria related to quality of life and human health should be ranked second. Subjected to these should be all economic criteria on third position. The representative for local communities argued contrary to the group ranking for high priority of the water criterion, safety and waste. Local community representatives countered the cost argument of the other groups and suggested to regulate electricity costs through subsidies.

The boxplot diagram in Figure 9 shows the distribution of the surrogate weights calculated from the respective groups' criteria weightings in comparison to the compromise weights, indicated here by a green line. The smaller the distribution indicated by the line and the smaller the boxes, the more similar the group weights are to each other. This signifies the level of convergence among stakeholder criteria evaluation and also suggests assumptions about the robustness of the compromise weighting. "Use of domestic energy sources", e.g. shows significant agreement

among all groups, except for national NGOs as outliers, who considered this criterion to be of low importance. A similar observation can be made for "Pressure on local land resources" with local communities being an outlier and "Technology and knowledge transfer", on which academia place higher importance than the other groups. In all these three criteria, the compromise weight from the final workshop reflects the preference of the majority. If the distribution is large, a potential conflict can be assumed between those two groups located at the top and the bottom end of the line. Most salient is such a divergence for the criteria "Safety", "Pressure on local water security" and "Electricity system costs". Weights for "Safety" are distributed between 1.73 per cent of local communities and 18.23 per cent of policymakers. In the final workshop, representatives of all groups settled the high importance of the criteria. Contrary to their group rankings, both finance and industry and young leaders had to compromise on the middle position of the water criterion. Significant discordance concerning criterion "Electricity system costs" is marked in particular by the extreme position of national NGOs with the highest importance of 32.71 per cent and young leaders with only 2.17 per cent.

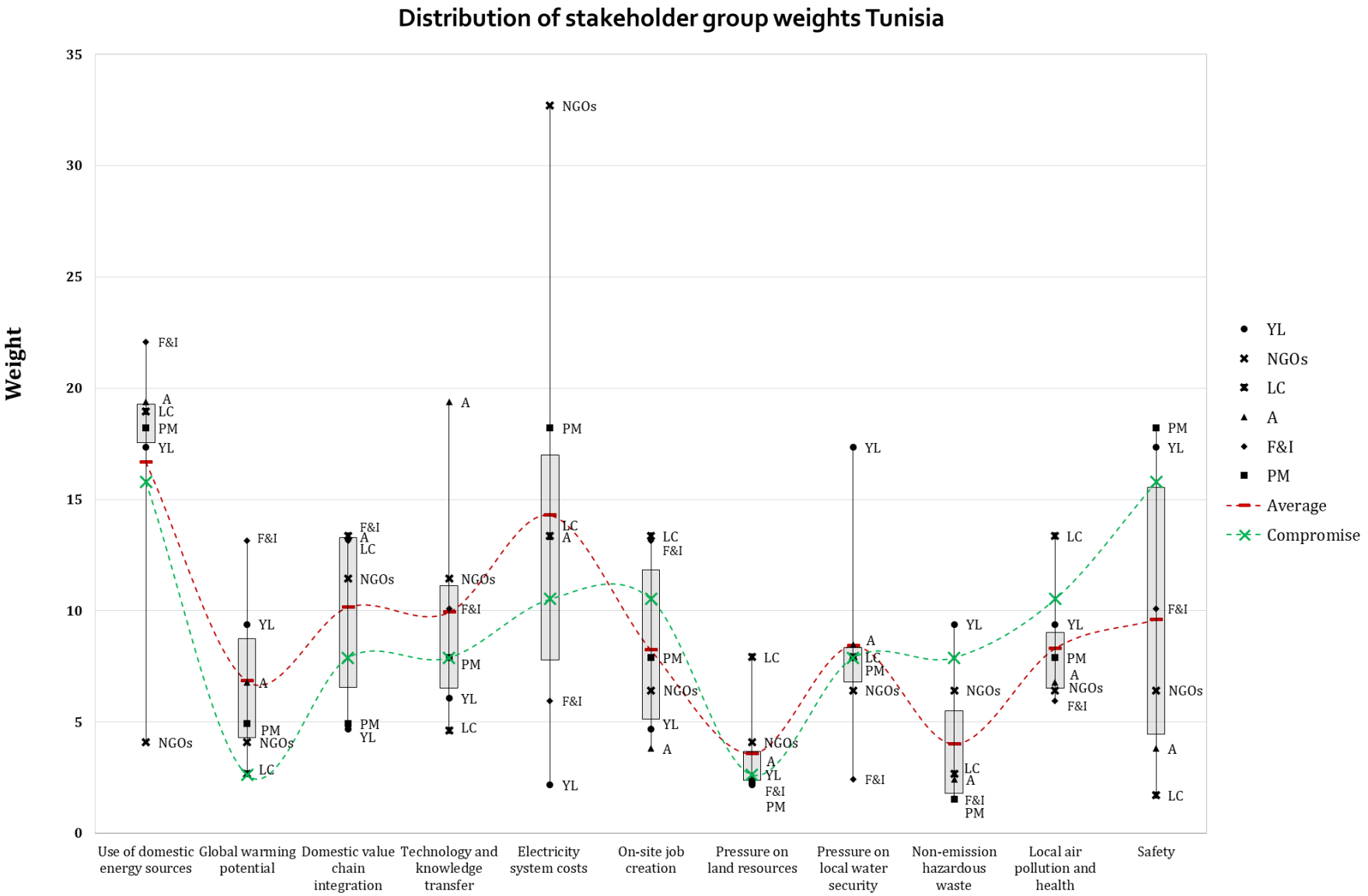

Figure 9: Distribution of surrogate weights across stakeholder groups. The red line indicates the arithmetic mean, the green cross the compromise solution achieved in the final workshop, and the grey shaded box the area between the lower and the upper quartile (i.e. containing 50 per cent of all stakeholder weights around the mean value). Whisker ends represent the maxima and minima.

For most of the criteria, the final compromise appears to be a reliable reflection of average individual preferences, which were collected in the workshop questionnaire. *Figure 26* in the Annex presents the distribution of individual criteria preferences. The compromise solution in most of the criteria lies between the second and third quartile of the observation and within the range of the standard deviation close to the arithmetic mean. It deviates, however, significantly in four criteria, with most significance in "Global warming potential" and "On-site job creation". The former was weighted higher by individuals than in the final workshop. This supports the finding that participants were convinced of its relative little importance in the context of Tunisia. "On-site job creation" gained relative importance compared to the majority preferences of the participants, pushed for primarily by local communities and not opposed by the other groups. The third deviating criterion is "Pressure on local land resources", which received the lowest importance value together with "Global warming potential" based to the argument that desert space is abundantly available in Tunisia. "Safety" moved from rather medium to top importance only. Given the large range of individual preferences on "Safety", it can be assumed to be a robust compromise. None of these deviating criteria were subject to big controversy in the workshops. There was rather overall consent concerning their relative importance. This suggests that participants of the final workshops jointly arrived at an argumentative logic distinct from the majority of participants, further demonstrating the contingent character of such facilitated mutual learning processes.

3.4.2 Importance ratio of national to local criteria

A comparison of the weight sums for the two criteria subgroups shows where the different stakeholder groups put their priorities: On national energy planning objectives or on avoiding local impacts. This is presented in Figure 10. The dashed line indicates the equal importance ratio of 45 (five national criteria) to 55 (six local criteria). The solid red solid line represents the result of the compromise ration, which is almost congruent with the equal ratio (44.7/55.3). The compromise weightings can be seen as a middle ground between young leaders, policymakers and local communities. The other groups made concessions in favour of the locally relevant criteria. This is the result on the higher importance of safety, jobs and air pollution in the compromise ranking.

Young leaders are the only group which clearly prioritized the avoidance of local impacts over benefits on the national level, as they are most concerned about environmental protection and people's well-being. According to them, Tunisia's energy transition should not be subjected to any economic or political considerations, as it is an objective for social change in its own right and not a means to an end. All other groups gave more importance to the national level. Interestingly, policymakers and

local communities appear to have similar overall priorities and—compared to the other groups—still pay considerable attention to local impacts. For national NGOs and finance and industry, the priority is clearly on national benefits rather than local impacts. In the case of NGOs, this dominance of the national level almost is primarily due to the high significance given to the national criterion "Electricity system costs", which alone represents 32.71 per cent of the 72.26. Nonetheless, as can be seen from the respective group ranking, NGOs did prioritize national over local criteria. Academia showed the least consideration for avoiding adverse local impacts. Concerns over mitigating negative impacts are secondary to structural developments and improvements on the national level.

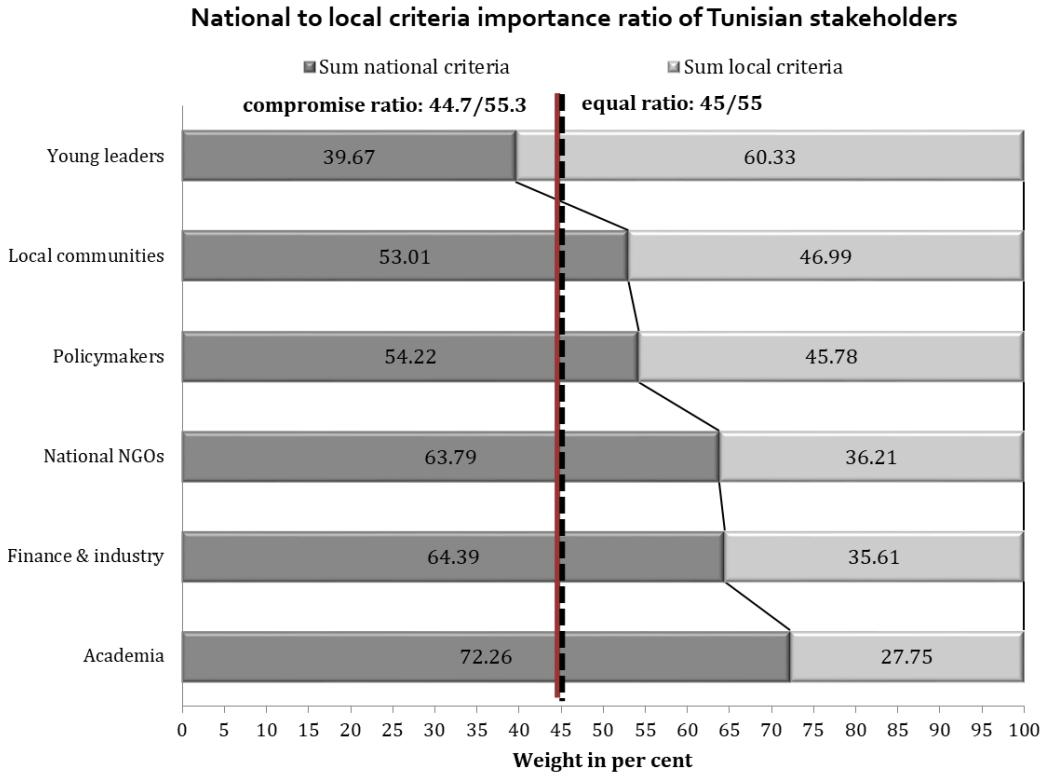

Figure 10: Importance ratio of national to local criteria across stakeholder groups. Black dashed line indicates the equal ratio, the red solid line represents the ratio of the compromise weighting.

3.4.4 Contestation and group conflict

The frequency of moves of a criterion up or down the ranking by participants, illustrates which criteria were the main themes in the final workshop. Figure 11 shows the accumulated total number of moves for each criterion throughout the process of the silent negotiation during the final workshop. "Safety" and "Electricity system costs" were moved the most across ranks, followed by "Pressure on local water security". As already suggested by the boxplot diagram, stakeholder groups showed highest diversity of opinions concerning these two criteria, which explains that they were such salient issues of discussion. The criteria with the least number of movements were "Technology and knowledge transfer" and "Domestic value chain integration". Their position on the third rank, thus, was barely an issue, neither was the last rank for "Pressure on local land resources". "Global warming potential", which was disputed along the question of to what extent global climate change mitigation should be a determining policy object was also on last position.

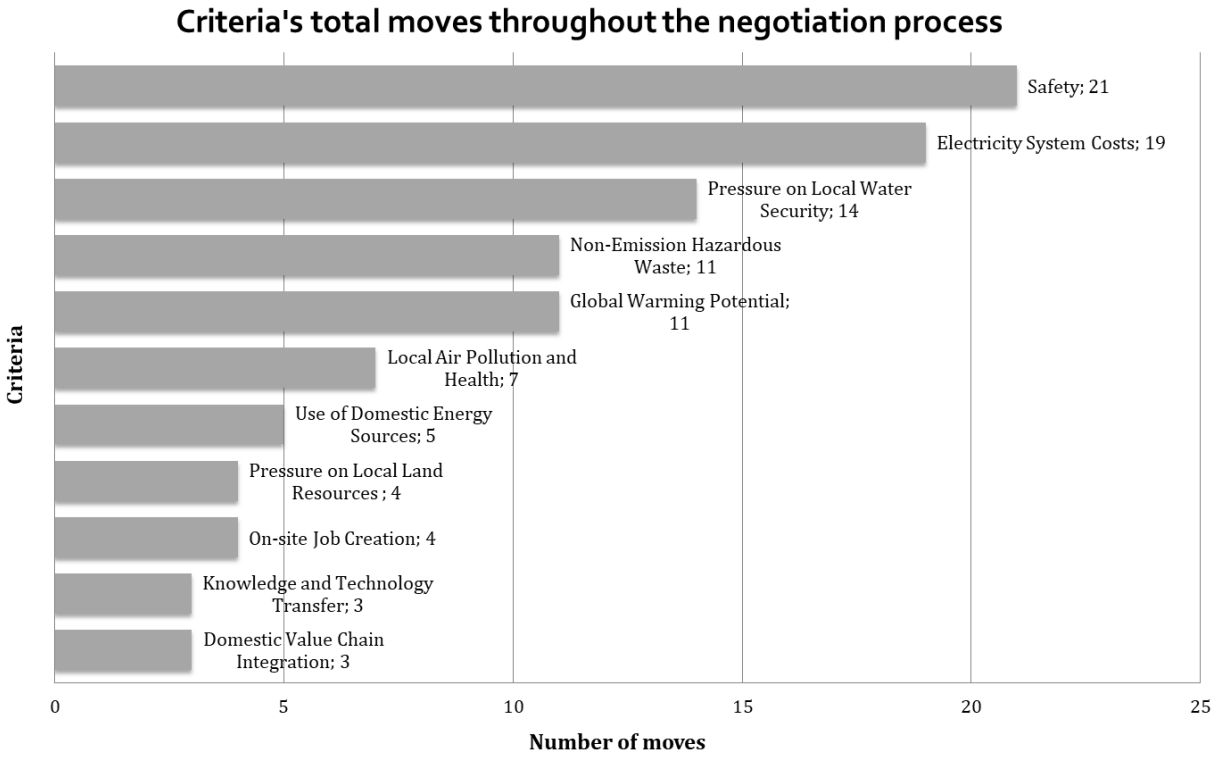

Figure 11: Total number of criteria movements during the silent negotiation of the final workshop

A closer look at the ranking of those criteria that were either frequently moved or of critical importance to all stakeholder groups involved in the negotiation process allows us to propose levels of contestation and agreement regarding the criteria's position in the ranking. The more a criterion was moved up and down the ranks, illustrated by the red lines in Figure 12, the more it was contested among particular stakeholder groups. When a criterion was no longer moved, the compromise concerning a criterion's position can be assumed.

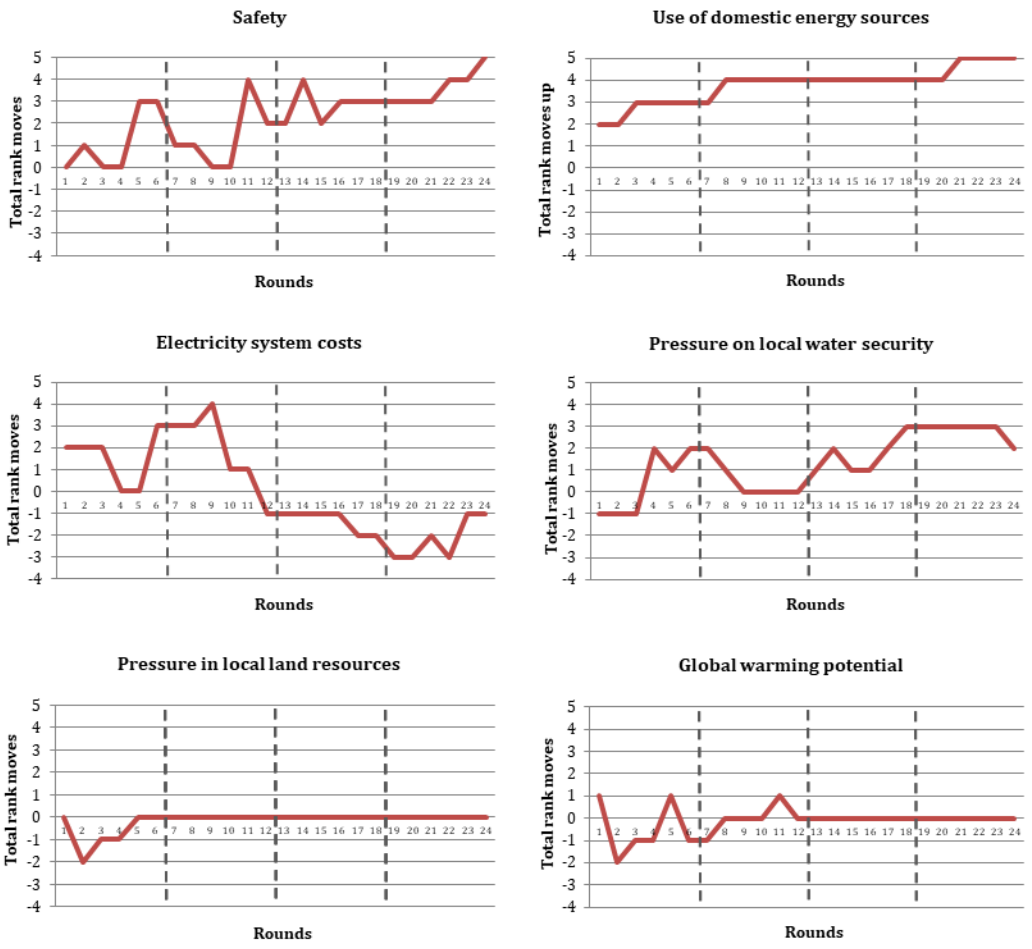

Figure 12: Level of contestation of relevant criteria.

Though the safety criterion was intensively debated as indicated by repeated movements across several ranks, the general tendency was that "Safety" was up the ranks. This suggests that participants converged during the process of silent negotiation on the opinion that the safety criterion is of primary importance. The top position of "Use of domestic energy sources" was not debated at all, since all groups sup-

ported the criterion's priority. It was only moved up occasionally to ensure that it stayed on the first rank. "Electricity system costs", which was also heavily debated, was rather steadily moved down the ranking except for four occasions. It appears that the second rank for the criterion was a position contested right until the end of the process. Looking at "Pressure on local land resources", it can be said with confidence that after only minor movements in the first round, participants agreed on the last rank.[18]

Uncovering the criteria that were contested and indicating the level of that contestation, raises the question of among which stakeholder groups such contestation took place. To get further insights into group contestation, Figures 13Figure 13 to 15Figure 15 depict the course of how the stakeholders moved the selected criterion. This analysis is limited to the three most debated criteria (see Figure 11). It must be emphasised, that this tracing is not an judgement on the absolute importance of a criterion by the respective groups, but must be interpreted in its relative importance vis-a-vis the other criteria. The differing lines of argumentation and opinions regarding these criteria were captured during the exercise on the vision 2050, aspirations and concerns, as well as the respective stakeholder group workshops and form the background to these contestations and diverging preferences.

"Safety" was the most moved criterion with a total of 21 moves. Policymakers and young leaders were the only group that put it on first position. It was of low or even least importance for academia and local communities and of moderate importance for national NGOs and finance and industry. Contrary to what could be expected from the individual group rankings, contestation on the safety criterion during the silent negotiation in the final workshop occurred between national NGOs and academia (see Figure 13). National NGOs used in each round at least one of their available moves to rank "Safety" higher. Academia on the other hand reacted to these movements on two occasions in the second and third round by moving the criterion down again. However, representatives of academia appear to have had a change of mind after the open discussion. They used one of their only two remaining moves in the final round to move the safety criterion one rank up again, resulting in its final position on first position. Interestingly, young leaders chose not to be involved, similar to policymakers, who only moved the criterion once in the first round.

[18] To allay any confusion on the criterion being on the last rank though it was moved up two ranks in the first round. During the silent negotiation, the land criterion was located at some points on higher ranks, but was then outranked by others in the process. Since no group used any of their available moves to rank the land criterion up again, it ended up on the last position, This strongly indicates agreement regarding that position among stakeholders.

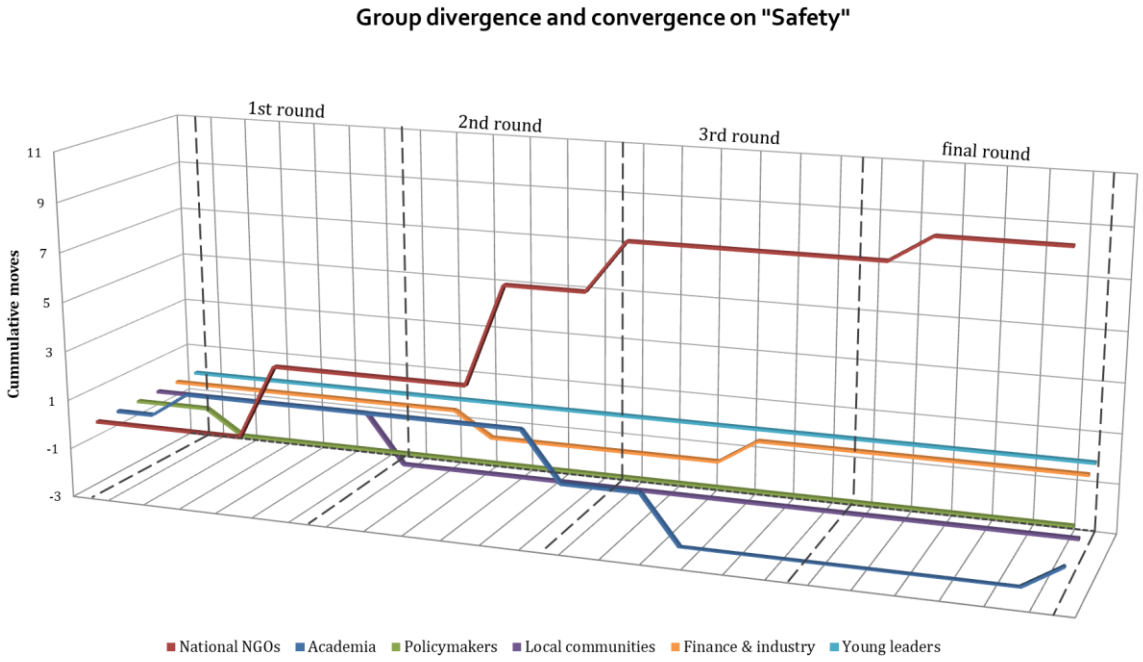

Figure 13: Group contestation and convergence on the criterion "Safety".

The groups' movements of "Electricity system costs" reveals the same tendency as already indicated in the boxplot diagram (see Figure 9). Young leaders moved the criterion down in every round, defending their position that electricity costs are of secondary importance compared to other challenges. With this position, they were in conflict with all the other groups. In the final round, policymakers used their remaining two moves to put the criterion from the fourth to the second position. Considering that the criterion until the end of the process was located on lower ranks, it was not national NGOs, who pushed for a priority importance of the criterion like in their own individual group ranking. Instead, they even moved it down with one of their remaining two moves in the final round. This suggests that representatives of this group had reconsidered their ranking in the process. Though concerned about the impacts of high electricity prices on consumers, local communities gave priority to other criteria based on the argument that the consumer price can be regulated through subsidies.

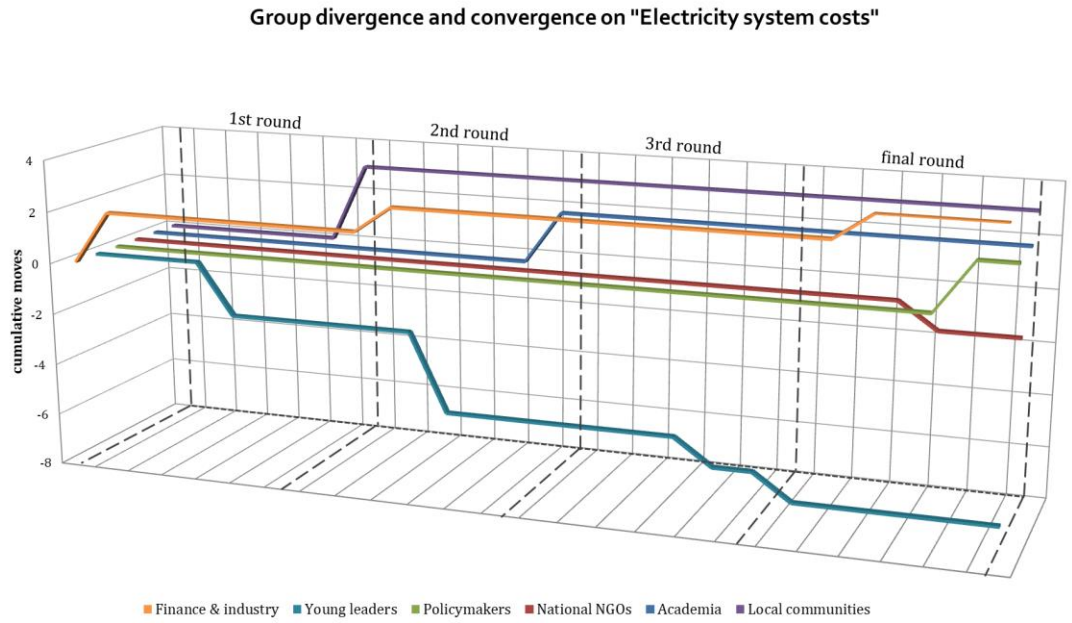

Figure 14: Group contestation and convergence on the criterion "Electricity system costs".

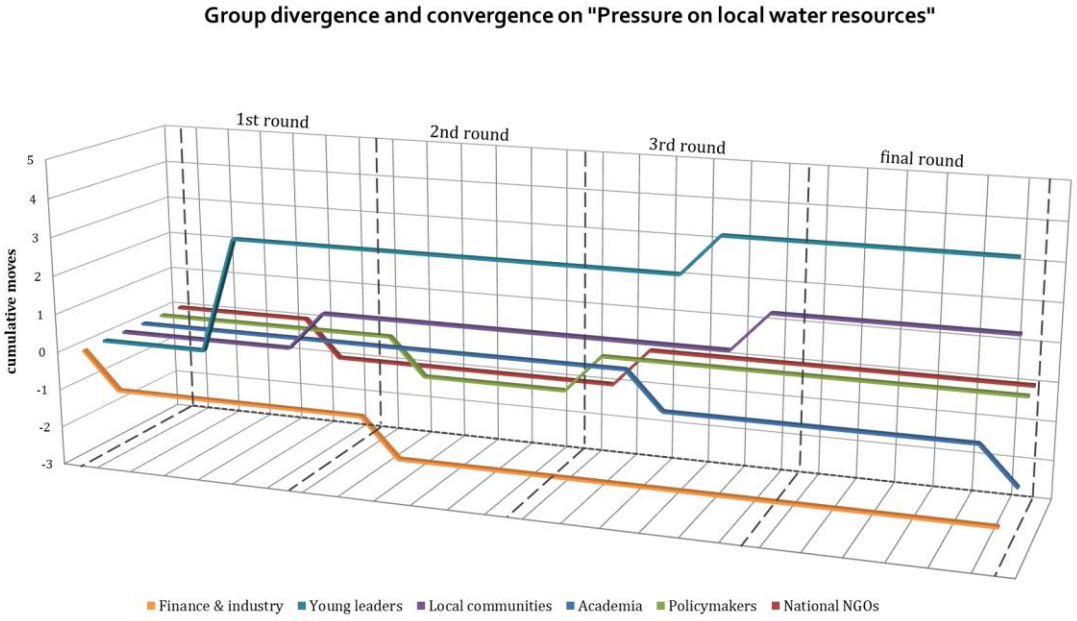

Figure 15: Group contestation and convergence on the criterion "Pressure on local water resources".

Young leaders, supported by local communities, ranked "Pressure on local water security" highly important in the first round, while policymakers, industry and finance, as well as national NGOs at first opposed this. Finance and industry remained passive on the criterion in the last two rounds, it was academia who led the contestation against the other groups by moving it down. Using their strategic position as the last group to draw the entire process, academia put the water criterion on its final position on the third rank, while all other groups had agreed to leave it in second position. In the last two critical rounds, academia acted against the preferences of the majority.

In conclusion, this analysis shows that some stakeholders surprisingly revised their position compared to their respective group workshops and reveal different, sometimes even contrary, preferences. Others entered the final negotiation with the objective to push for their interests. The most vigorous group in that last regard were young leaders, who did not shy away from confrontation with all other groups. While national NGOs were just as much outspoken and engaged in critical and intense discussions, they were also able to learn and revisit their position. These observations illustrate how fluid stakeholder preferences are and how this determines the contingent dynamics of discourse about visions and preferences among different interest groups.

3.5 Technologies' potential for societal support

3.5.1 MCDA ranking

In the multi-criteria decision analysis (MCDA) conducted with DecideIT 2.101, technologies receive scores for each criterion on a scale from 0 to 1 based on the attribute values and the stakeholders' compromise weightings of the 11 criteria. Figure 16 shows the score sums and indicates how much each criterion contributes to the total score. Rooftop PV and large-scale utility PV receive the highest scores, followed by onshore wind, utility hydroelectric, gas, and—with some distance—nuclear power. Coal and oil reached the lowest scores of alternatives. All renewable alternatives performed best along the criteria "Safety", "Use of domestic energy sources", "Non-emission hazardous waste", and "Local air pollution and health" (alongside nuclear). Solar technologies and nuclear outperform the other alternatives in terms of on-site job creation. The impact of "Global warming potential", "Technology and knowledge transfer", "Pressure on local land resources", "Domestic value chain integration" are either minor or negligible, because they were given low importance. Fossil alternatives score better the higher ranked criterion "Electricity system costs".

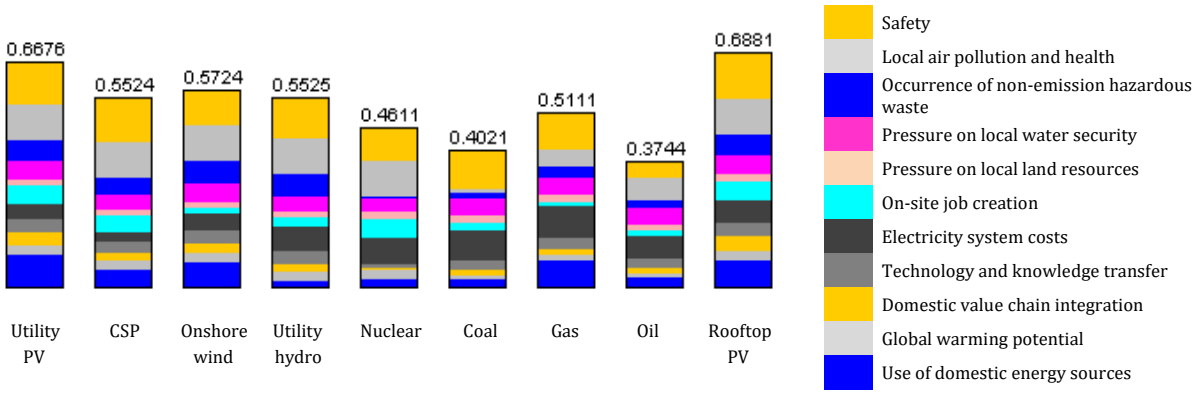

Figure 16: Final MCDA-scoring of the selected technologies.

Figure 17 presents the results of the MCDA evaluation. The ranking orders the technological choices according to their potential to cater to the needs and visions of the stakeholders based on compromise weighting elicited in the final workshop and the empirical data set (attribute values). Both PV alternatives—with a slight competitive edge for rooftop PV—outrank the other RE technologies as well as their fossil or nuclear counterparts. With quite some distance onshore wind, CSP, utility hydroelectric and natural gas follow each other closely. Nuclear outperforms coal and oil, with the latter being the worst possible alternative. The MCDA result can be compared to the direct technology ranking which participants did in the workshop questionnaire. The overall ranking is quite similar to the MCDA result.[19] PV clearly dominates over the other alternatives, followed by onshore wind. CSP and utility hydroelectric rank in the upper middle field and natural gas in the lower middle field. Differences can be observed among the least preferred options. Contrary to the MCDA result, we find nuclear at the very bottom, outranked by coal, which in turn is inferior to oil according to the direct preferences of the participants. This direct ranking of preferences confirms the very positive perceptions of RE-technologies and the bad perceptions of conventional and nuclear (except gas). It further indicated the widespread and high level of disapproval of nuclear power among stakeholders.

19 Participants were asked to rank the eight technologies according to their preferences. Rooftop and utility PV were not specifically distinguished. They were able to rank technologies on equal positions. The technologies were given scores between 0;1 based on their position in the ranking and the overall number of ranks. The scores were added up and then normalized.

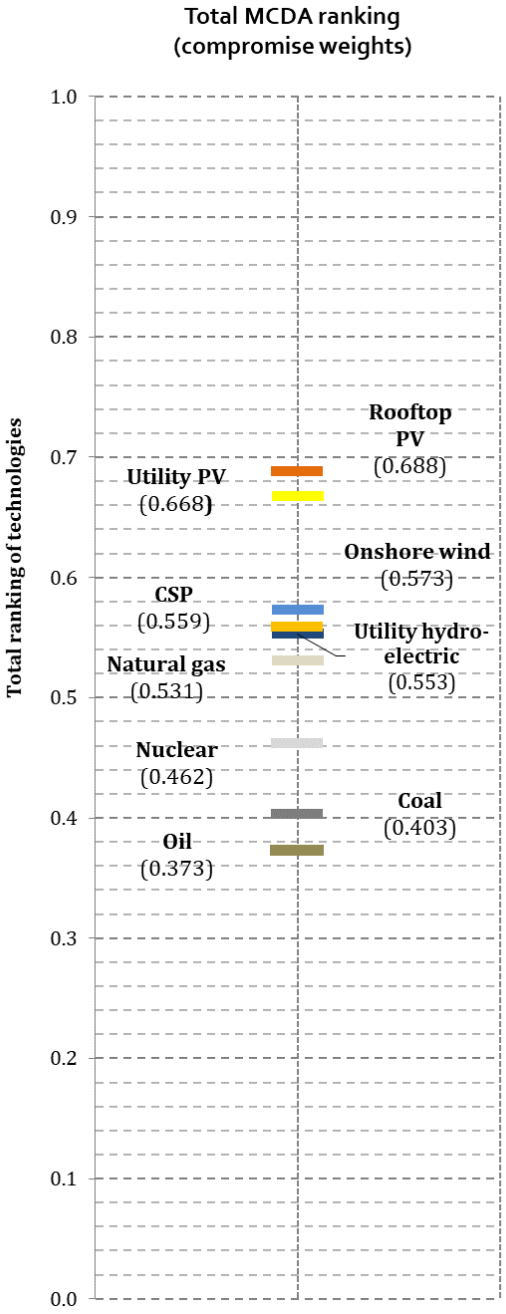

Figure 17: MCDA technology ranking based on the compromise criteria weights.

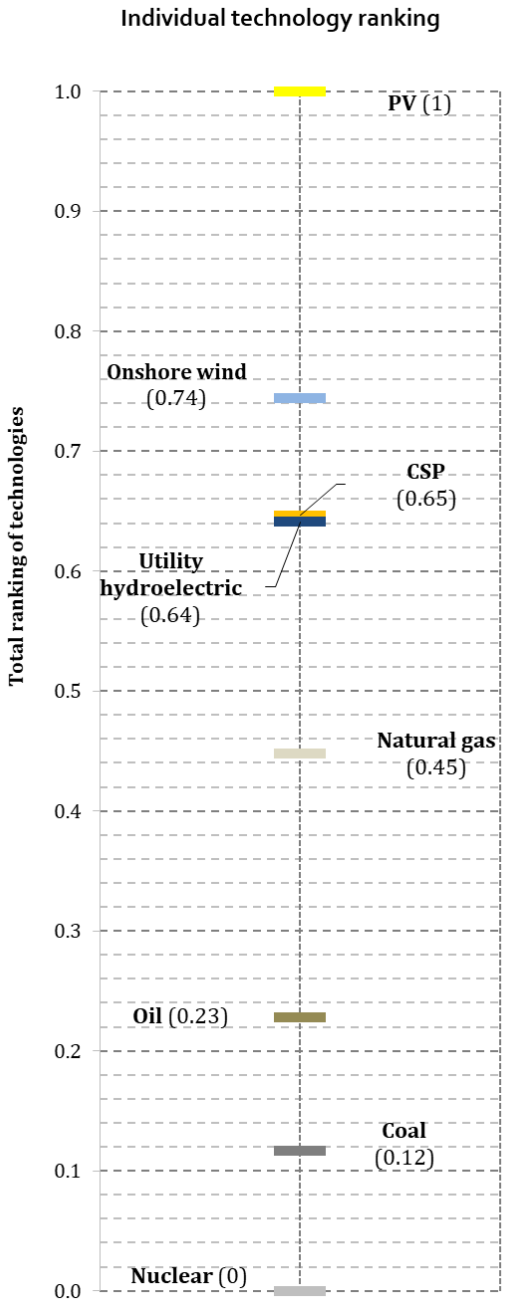

Figure 18: Individual ranking of technologies (survey result).

To evaluate the performance of all technologies in respect to the national and local criteria, the bubble graph in Figure 19 shows "Contribution to national energy planning goals" on the x-axis. The y-axis presents the ability of the technologies to avoid adverse impacts on the local level, labelled "Local impact sensitivity". The quadrants are drawn based on the mean values of all technology performances within the respective criteria subsets. The farther a technology moves to the right on the x-axis, the higher its potential contribution on the national level. The higher it moves on the y-axis, the less adverse impacts the technology potentially causes on the local level. Technologies located at the upper right quadrant performed best along both dimensions, those in the lower left quadrant perform worst. The coloured inner circle represents the installed capacity. The shaded circles signify the installed capacity that is planned by the government until the year 2030, thus representing the interim step within the 2050 plan.[20]

The planned expansion of both PV technologies is most promising in terms of beneficial impacts on the national and local level. Though onshore wind performs a little worse than PV in both dimensions, it is most likely to bring higher benefits for national energy planning than CSP or hydroelectric power. Gas performs moderately in both dimensions, but given its considerable advantage over coal, oil, and nuclear power, it can be evaluated as the preferable fossil alternative. Nuclear power most likely has the least contribution to national energy planning goals of all electricity-generation technologies at hand, though overall it only poses moderate adverse impacts on the local level. However, in the case of nuclear power, strong public sentiments and risk perceptions need to be prominently considered in addition to this impact-based evaluation. Both coal and oil prove to be of least utility to both dimensions.

[20] Tunisia's capacities and plans for cogeneration are indicated in purple and subsumed under gas. It does not constitute an additional technological choice. It was added for reasons of completeness to illustrate the role of cogeneration in the overall electricity mix.

Figure 19: Technology performance evaluation along national and local criteria (concerning co-generation, see Footnote 20).

3.5.2 Robustness analysis

To make a statement about the robustness of the comparative performance analysis, DecideIT 2.101 offers further tools of testing and analysis. The cardinal ranking in Figure 20 compares the performance of each alternative to the average performance of all others at a contraction level of 85 per cent. This means, that the bars represent the possible outcomes within a 15 per cent range surrounding the "most likely point" (see Chapter 2.1). Taking into account the entire range of these possible outcomes, some technologies show considerable overlaps. Three subgroups can be identified:

1. Rooftop PV and utility-scale PV;
2. Onshore wind, CSP, utility hydroelectric and gas;
3. Nuclear, coal and oil.

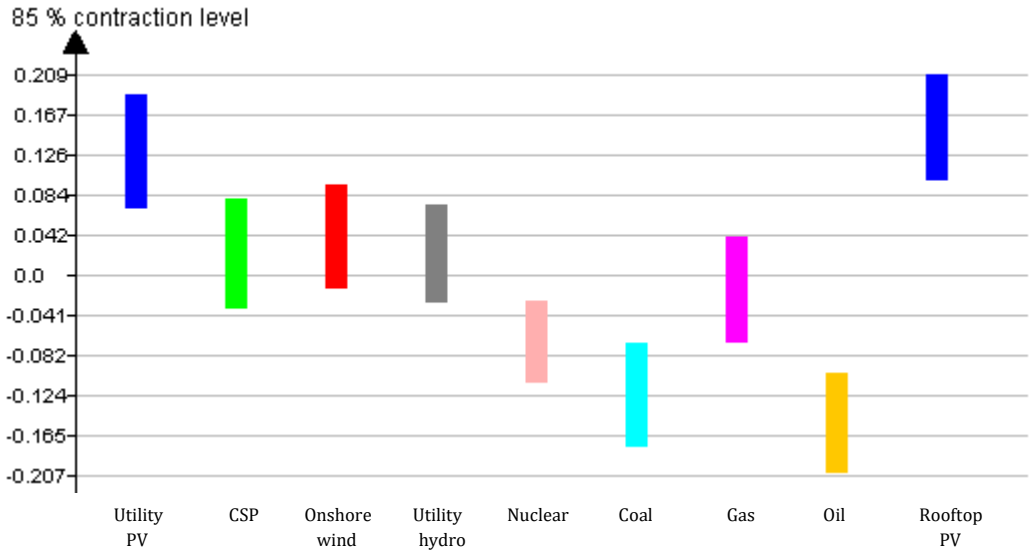

Figure 20: Cardinal ranking of technologies at a contraction level of 85 per cent.

A significant overlap can be observed for both PV technologies as well as for the subgroup of the remaining RE technologies CSP, onshore wind, and utility hydroelectric. Gas as well shows major overlaps with these three technologies. The outcome of nuclear partly overlaps with gas, just like coal with nuclear. While coal and oil overlap each other greatly as well, even their best possible outcome does not reach the level of quality of the worst possible outcome of either RE technology.

To gain more precise information about the technologies' relative performance to each other, technologies can be compared pairwise to identify the point of contraction (intersection), i.e. at which point one alternative performs with confidence better than the other (Danielson et al., 2007). The intervals of contraction are narrowed towards the "most-likely point" until one alternative dominates the other (Sundgren, Danielson & Ekenberg, 2009). The higher the intersection point, the more alike two alternatives in their potential outcomes are, making it more difficult to make a clear statement. The lower the intersection point, the higher the confidence that one alternative—even under circumstances of less favourable outcomes—is the better choice. DecideIT 2.101 sets the boundaries for confidence levels as follows: 0-80 per cent = "confident", 80-90 per cent = "mildly confident", 90-100 per cent = "not confident".

A systematic pairwise comparison was conducted based on subgroups identified in the cardinal ranking. In the first step, the three best performing alternatives in each subgroup were compared to each other The second step compared the worst performing alternatives with the best alternative in the next one to see the relative strength between the groups. In the final step, the respective best and worst alternatives within each group were compared to each other. Additionally, for matters of clarification, CSP was compared to large-scale utility PV and onshore wind, while onshore wind and CSP were further compared to utility hydroelectric power. Figure 21 exemplifies the pairwise comparison in a rectangular shape using rooftop PV in the top section and onshore wind in the bottom section of the graph. The x-axis shows the degree of contraction. Where the rectangular cuts through the x-axis lies the intersection point, indicating by how much rooftop PV outranks onshore wind. The intersection point between rooftop PV and onshore wind lies at 74.16 per cent, suggesting that the former outperforms the latter with "confidence". All pairwise comparisons can be found in the Annex.

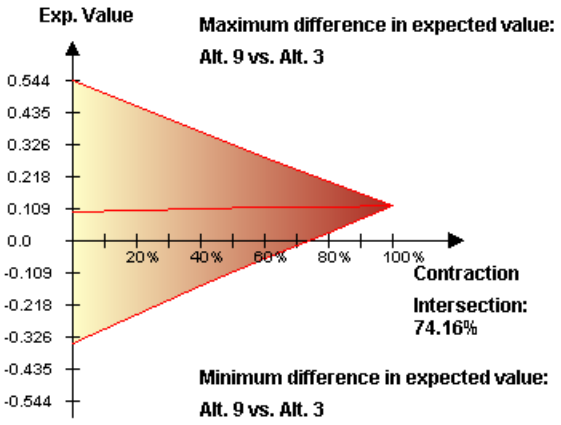

Figure 21: Pairwise comparison of rooftop PV and onshore wind.

Table 13 summarizes the results. Rooftop PV is with confidence the better alternative than wind. While no confident statement can be made regarding utility and rooftop PV, both alternative perform with confidence better than their solar thermal alternative CSP. No confident statement about the best performer can be made among onshore wind, hydroelectric power and CSP. Gas outranks nuclear with mild confidence, while nuclear and oil (and by that coal as well) are comparable in their performance.

Table 13: Results of the pairwise comparison

Alternatives compared	Contraction intersection point (%)	Confidence level
Rooftop PV > Onshore wind	74.16	Confident
Rooftop PV > Nuclear	37.14	Confident
Onshore wind > Nuclear	65.37	Confident
Utility PV > Onshore wind	80.35	Mildly confident
Gas > Nuclear	84.21	Mildly confident
Rooftop PV > Utility PV	95.36	Not confident
Onshore wind > Gas	86.9	Mildly confident
Nuclear > Oil	92.61	Not confident
Utility PV > CSP	78.24	Confident
Onshore wind > CSP	95.58	Not confident
Onshore wind > Hydroelectric	95.08	Not confident
CSP > Hydroelectric	99.97	Not confident

4 WORKSHOP DISCUSSIONS ON STAKEHOLDER PARTICIPATION

In the final session of the workshops, participants of the respective stakeholder group had the opportunity to openly discuss how they see the implications of their groups' outcome on national energy planning. By elaborating on how they envision their contribution in shaping Tunisia's energy transition towards sustainability, the following issues were addressed.

Strengthening local communities

The role of local communities in energy policies in general and in regard to project implementation in particular is of critical relevance to energy transitions. Policy-makers and local community representatives both demanded that energy projects be thoroughly prepared as regards local environmental and social impacts and require the approval of local residents as license to operate (SLO). To achieve SLO, systematic mechanisms for timely and meaningful community participation in the proj-ect planning process must be established. Though finance and industry repeat-edly acknowledged that project developers have to ensure the generation of local benefits, local community representatives expect these benefits not to be a local buy-in. Instead, energy projects need to contribute to sustainable communal devel-opment and generate substantial prospects for improving the quality of life. Fur-thermore, they must be complimented by grievance mechanisms throughout the

lifetime of the project with clearly defined mandates and responsibilities of state authorities and utility operators. People's complaints need to be effectively addressed and resolved in a transparent process to avoid growing frustration and opposition. For local communities to be meaningfully included in such processes in the future, it is necessary to start building up expertise and knowledge among local leaders and the general public. To make sure that outreach initiatives are successful, traditional door-to-door approaches must be considered as part of any awareness strategy. Considering the high expectations of local communities, project developers are advised to avoid building up unrealistic expectations (e.g., in terms of local job creation) and engage in a public dialogue on what the project can offer to the community.

Policy coordination & commitment

Some of the most critical aspects during the discussions were related to the lack of coordination and harmonization in the political process of strategic energy planning. Participants in the group of policymakers showed disappointment regarding the government's current energy plans. It was criticised that the national energy strategy was not duly coordinated among different political departments and state institutions, illustrating the lack of communication, information sharing and cooperation among state actors to ensure harmonization of sector policies and an integrated strategy. Furthermore, the designated targets were seen as not realistic compared to the country's actual circumstances and capabilities, thus resulting in deficient follow-through and delays in implementation. Instead, much more thorough and in-depth strategic planning including a concrete and feasible concepts of implementation and milestones are required. Different strategies, objectives, and interests of the different state actors in interest groups have to be harmonized. Clear mandates and responsibilities as regards designing, implementing and monitoring the energy transition have to be given to the actors to clarify roles and assign competencies. Consequently, new procedural mechanisms for mutual consultation and coordination have to be established.

Participation of civil society

For national NGOs, the primary claim is to be systematically included in commissions that monitor and supervise decisions and project implementations and to gain more influence on policymaking and in decision-making processes. In pursuit of that purpose, NGOs have to be better connected among each other on platforms to develop cooperative strength, visibility and leverage. In support of the development of a vivid civil society, the government should ensure access to information through adequate administrative mechanisms and different formats of publication and to keep publicly available online information up-to-date. However, a free and sovereign Tunisian civil

society has just started to develop and NGOs need time and capacities to professionalize to become knowledgeable and legitimate counterparts in the debate.

Improving research and innovation

Building up the research capacities of Tunisian universities is a critical aspect of generating local knowledge and expertise. Expectations towards academia is high, but cannot be met under current conditions. Policymakers emphasized the need for more thorough and in-depth research on the impacts of the government's energy plans, but participants of the academia workshop identified grave obstacles on the systemic, structural and the individual level to do so. Administrative procedures to acquire funding are cumbersome and complicated, preventing innovative research projects as well as cooperation among researchers. This lack of networking and collaboration among institutions as well as individual researchers to create synergies prevents mutual learning and building up competences. Another barrier is the lack of attractiveness of a scientific career due to low salaries and missing career development paths. On the institutional side, research departments not only lack funding, but clear research strategies and objectives that define themes and priorities. This is important for institutes as they need to systematically develop resources, knowledge and skills. Only then, participants concluded, can Tunisian universities offer the level of competences and quality that is needed to more closely work with domestic industries on innovations. The following recommendations can be made:

\ Prepare reforms of the university system in collaboration with universities;

\ Establish a think tank on policies for higher education within MESRS;

\ Found a national centre for basic research;

\ Build a joint Masters programme on strategic energy planning in collaboration with all large engineering schools;

\ Establish competence labs as knowledge hubs to promote synergies, innovation, and skill development in close linkage to industry partners.

Demonopolization and decentralization of the electricity sector

The demonopolization of the electricity sector and the development of an open electricity market would enjoy broad support from all stakeholders, including some actors among policymakers. The monopoly of STEG as the biggest producer, grid operator, sole buyer and distributer of electricity is perceived by as a primary challenge to a sustainable energy transition. Under the current regulatory framework, the Tunisian private sector has to cross high barriers to enter the electricity sector. Participants in all but one stakeholder groups—the exception was policymakers—argued unanimously for ending STEG's monopoly. A fundamental reform of the electricity sector would follow international standards by first aiming at separating pro-

duction, transmission and distribution (i.e. unbundling) and second by allowing private electricity providers to produce electricity and offer it to consumers based on prices regulated by the demand and supply.

STEG's argument in defence of the current structural framework is the technocratic perspective that managing the peak load and maintaining the stability of the grid requires centralized control. The conviction prevails that a massive undertaking like the national energy transition can only be managed and implemented through a dominating position of the state and through few key players in a centralized administrative system. At the same time, STEG is confronted with accusations of being opaque and uneconomic, raising serious concerns among stakeholders over good sector management, including managing investments and efficient project planning. Liberalizing the electricity market would be a radical step, even in international comparison. A reform of the electricity sector would have to be determined by the purpose the reform is supposed to achieve. The Tunisian private sector needs better prospects for business development through reliable access to and a higher share in Tunisian RE projects. This would build up domestic industrial capacities to develop a divers, competitive and innovative private sector which would contribute to economic growth, job creation and economic sovereignty.

The expansion of RE technologies offers the opportunity for decentralized electricity production for local consumption. Energy projects thus must be integrated into regional development plans to ensure that project plans coincide with other infrastructural and economic development measures. Local communities hope to capitalise on that opportunity by producing their own electricity. Their vision is that municipalities use RE-technologies to produce their own electricity. This vision needs to be viewed in the light of the decentralization efforts, which constitute a corner stone of Tunisia's ongoing political transformation. Granting municipalities more control and ownership over energy projects for auto-generation through substantial decentralization would signify a major step towards local sovereignty and democratic local governance.

Subsidies

Attitudes concerning subsidies of electricity were quite ambivalent across stakeholder groups, which is also suggested by the results of the workshop questionnaire. Participants were asked whether the state should continue subsidizing electricity to ensure lower costs for consumers in 2050. Only a slight majority reject subsidies in the future (Figure 22). While there is a principle consensus that subsidies for fossil fuel have to be removed, disagreement prevailed as to whether or not the state should subsidize RE technologies. Finance and industry were convinced that any subsidy system in place does not promote but rather hinders renewable energies.

According to their viewpoint, technology development and competitiveness can only unfold in a free, self-regulating market. Therefore, representatives of finance and industry call for the gradual, but rapid elimination of subsidies. Young leaders agree to the removal of subsidies with the argument, that these financial resources are better spent in infrastructural development. Representatives of local communities argued for the exact opposite. They propose to shift subsidies from fossil fuels to promoting green jobs and renewable energies and even increase subsidies in particular for residential rooftop PV. Against the background of the aspiration of local community representatives to capitalize on rooftop PV, this would translate into the state co-financing self-sufficiency of local communities. Interestingly, consideration in favour or against subsidies was argued primarily in economic terms and quite little in respect to adverse social impacts and the question of how such negative ramification for the low-income-classes could be compensated through a new pro-poor policy.

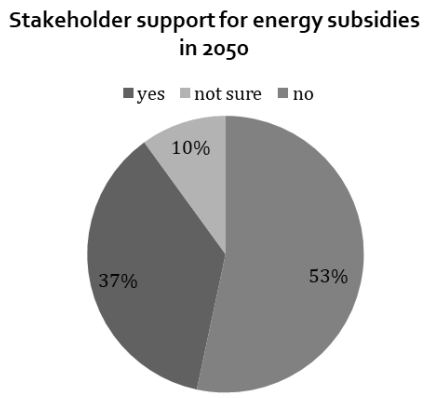

Figure 22: Stakeholder attitudes towards the continuation of electricity subsidies in 2050.

5 Conclusion

The workshop series of MENA SELECT offered a "niche of opportunity" to different stakeholders to constructively engage with each other for mutual learning and a constructive dialogue on balancing societal interests in the process of Tunisia's energy transition. Stakeholders shared the vision that the energy transition brings substantial, meaningful social change towards a modern, prosper, sovereign, peaceful and sustainable country. In response to the research aim to assess which electricity- generation technology has the highest potential for societal support, rooftop and utility PV are with distinction the most promising alternatives to achieve this vision. Both harmonize national energy planning goals with avoiding adverse local impacts in line with the stakeholder visions for sustainable development. Onshore wind is the third-best alternative, closely followed by CSP. Hydroelectric power and gas perform quite similar. Despite the fact that nuclear outranks oil and coal, all three alternatives can be seen as the least favourable options. All stakeholders expect RE technologies to play a vital role in Tunisia's future social, economic and environmental development. Stakeholders agreed in their optimistic view that RE technologies can tackle several of Tunisia's challenges. Of particular importance is decreasing Tunisia's import dependency and building up a robust, sovereign, innovative and divers economy based on RE technologies and offering socioeconomic prospects to all citizens.

However, stakeholders did not buy into the "technical fix" for a better future through RE technologies. They were very well aware of Tunisia's current challenges and limitations as regards establishing enabling institutional, political, legal and sociocultural conditions for a successful energy transition. Hence, workshop results concerning the second research question on preferences, expectations and lines of conflict determining support for the energy transition allows to extract four pivotal issues from the workshop discussions: 1) trade-offs between economic and social benefits, 2) establishment of inclusive energy transition management, 3) capacity-building and energy literacy and 4) electricity sector reform. Conflicting social interests, in this project represented by selected stakeholders, clash along these issues. These lines of contestation and conflict highlight the role of the state to manage the energy transition in a conflict-sensitive approach through participatory governance and discursive policymaking processes.

1\ Trade-offs between economic and social benefits

Stakeholders aspire to develop Tunisia's society into a progressive and modern knowledge society with a proactive civil society. Social justice and fairness, in particular across the country's regions and between social groups is of vital importance to stakeholders. Stakeholders expect that the energy transition increases public wel-

fare—in particular of those who have been politically and economically neglected. RE projects, which are primarily planned in the southern and interior regions of Tunisia must meet high demands over securing and improving livelihoods of the people. Hence, safety and a fair distribution of benefits must be key concerns in project planning and implementation. Thorough studies on environmental and social impacts must investigate potential impacts and risks not only on the project site, but within the larger regional developmental context as well. Knowledge production and analysis must rely also on local knowledge and perspectives by including communities in the study process. Based on these insights, local development plans must be drafted in conjunction with affected communities to ensure that the envisioned benefits actually match the communities' needs and are sustainable. To avoid expectations on both sides to rise too high and ultimately result in disappointment and frustration, any project's contribution to local development as well as its limits must be realistically and clearly communicated to the public. The inclusion and outreach to young people is of particular importance. Their vision and expectations are an essential contribution to mid- to long-term development strategies. Given the currently high social volatility and mobilization of frustrated youth, their voice is essential in the process of developing socially approved solutions to local challenges.

2\ Establishment of conflict-sensitive energy transition management

Energy transitions are contingent processes with uncertain paths and outcomes. The choice of technologies for the future electricity mix, which enjoy societal support, is the most salient, but least complicated task at hand for the Tunisian government. A much greater challenge will be to manage different policy sectors, align and monitor measures and programmes and to balance the different interests of various societal stakeholders. Diverging interests and contestation occur not only between state institutions responsible for energy planning on the one side, and interest groups from civil society or industry on the other. Disagreement concerning priorities and strategic measures also exist among relevant political and state actors. There is an urgent need to designate one institution that is responsible for coordinating strategic planning among the different political and state actors based on a clearly defined and robust mandate to bring stakeholders from all levels of society together.

The energy transition must be embedded within the overall political transition process and address Tunisia's most pressing social, economic and environmental challenges with strong commitment to enhance transparency, give voice to neglected stakeholders like local communities, NGOs and the young generation as well as alleviate regional and social disparities. This needs a clear appealing vision that the public can identify with. On the one hand, the shared vision for the energy transition developed in a national dialogue offers a common ground and a legitimatory narrative for systemic reforms. On the other, however, is societal support of the energy transi-

tion linked to substantial progress in reforming Tunisia's political and administrative structures as well as promoting more transparent and inclusive practices of governance. Further delay of the political transformation and stagnation of generating economic prospects is likely to undermine societal support for the energy transition. This poses a considerable challenge for the Tunisian government, but it does not have to face this task alone and it should not. Stakeholders are willing to be engaged in an inclusive and reflexive energy transition management and to play their part in establishing a cohesive and effective governance of the energy transition. State actors are recommended to make use of mutual learning and joint knowledge production in a reflexive process with different interest groups. This implicates a complicated and lengthy process, in which the state finds itself more in a rather unfamiliar managerial role than in the position in which it can make straight-forward decisions. But it enables a conflict-sensitive governance approach that balances interests while opening avenues for different strategic and operational solutions to social needs and challenges with a higher likelihood of achieving societal support.

3\ Capacity-building and energy literacy

The Tunisian energy transition must rely on Tunisian solutions, for which systematic knowledge-generation is a prerequisite. To achieve this, more facilitative conditions for building capacities need to be established on different levels. Ultimately, knowledge-generation is not merely a structural challenge but just as much one of mentality- and paradigm shifts among all actors towards more transparency, cooperation and knowledge-sharing. Innovative research stems from breaking down rigid institutional structures and establishing more flexible research formats and approaches through interdisciplinary collaboration. Educational policies and administrative structures of universities must be systematically evaluated to identify reform needs and direction. By setting clear research agendas and programmes, universities are better prepared to set up strategic networks and research collaborations to develop skills and competences. NGOs must professionalize and develop expertise and key competencies in policy advice to become critical, but constructive and reliable counterparts to policymakers. To encourage this development, civil society actors need to be included in governance and policy formation processes to imitate a broader societal discourse on the roadmap of energy transition and its implementation. State actors need to abandon the idea that they possess all relevant expert knowledge and instead find their roles as moderators and knowledge managers in the process of shared knowledge-generation, as they have to translate generated insights into political decisions. To achieve societal support, this cannot remain an elite debate among some expert institutions. Instead, intelligible information must be provided to the broader public to be anchored in a societal discourse which everyone can take part in. National awareness campaigns and the media must support the

general public in getting access to and following up on the debate. Local awareness and support initiatives can help to inform the local residents of their legal entitlements of raising their voice towards project developers and state institutions. To contribute to public debates as well as to influence policymaking and provide advice to policymakers, NGOs must train and professionalize. Stronger cooperation among each other and institutionalized networks can help to build capacities and public leverage. Access to information must be further improved in accordance with the law by improving quality and quantity of available information as well as administrative access to it.

4\ Electricity sector reform

Most stakeholders conceive STEG's sector monopoly and the lack of a free electricity market as impediments to a sustainable energy transition. The state company's total control over the sector raises concerns over intransparency and inefficient management. The private sector in Tunisia cannot compete with foreign direct investments in public bidding processes, and the current regulatory frameworks offer no protection of Tunisian business interests against the advantage of foreign direct investors. Domestic RE industries need a higher share in future energy projects. State support for energy start-ups and for enabling their access to the electricity market are key in developing Tunisian capabilities for innovative business development. Without the state's promotion of domestic entrepreneurs, Tunisia loses the opportunity to capitalize on RE technologies for developing a robust and competitive economy. Reforms in the electricity sector should, therefore, focus on improving the reliability of access to and share of the Tunisian private sector in new energy projects through making joint ventures with Tunisian companies and services an obligation for international investors. Furthermore, the procedures of the bidding process need to be clarified for the benefit of the Tunisian private sector.

The political decentralization that is currently underway offers the opportunity of local ownership of the national energy transition by strengthening local communities in their political and administrative responsibility and therewith their ownership of decentral energy projects. In line with local communities' aspirations for more sovereignty and control over local development and improving their livelihood, municipalities could cooperate with the national state level in designing a local energy infrastructure that finds local solutions to national transition goals. State–society relations would benefit from using the combined momentum of decentralization both in the political-administrative structures as well as in the electricity sector. Open and transparent local processes seeking people's support by sincerely including their voice rebuild trust in state–society relations, thus are a conflict-sensitive approach.

Balancing different interests is an inherently conflictive process when seeking a compromise. In the end, however, a consultative participatory multi-stakeholder dialogue can carve out common visions and interests as a basis for compromises. The initiated energy transition already started to shift established power relations in the electricity sector and will continue to do so. Stakeholders must engage in the idea that old practices will have to be replaced by new ways and get prepared for changes in their roles. Changing practices, i.e. the way people think and act based on their knowledge, skills and norms, is a gradual, non-linear bottom-up process. All stakeholders and the general public need to be aware that building up capacities is a mutual learning process, in which all involved actors should manage their expectations according to the collective learning curve and be patient with procedural amendments.

REFERENCES

Aaen, S. B., Kerndrup, S., & Lyhne, I. (2016). Beyond public acceptance of energy infrastructure: How citizens make sense and form reactions by enacting networks of entities in infrastructure development. *Energy Policy*, *96*, 576–586. https://doi.org/10.1016/j.enpol.2016.06.031

ANME, Agence Nationale pour la Maîtrise de l'Energie. (2012). *Maîtrise de l'énergie en Tunisie. Chiffres clés, 4ème édition*. Tunis.

Batel, S., Devine-Wright, P., & Tangeland, T. (2013). Social acceptance of low carbon energy and associated infrastructures: A critical discussion. *Energy Policy*, *58*, 1–5. https://doi.org/10.1016/j.enpol.2013.03.018

Berkhout, F., Smith, A., & Stirling, A. (2004). Socio-technical regimes and transition contexts. In *System innovation and the transition to sustainability. Theory, evidence and policy* (pp. 48–75). Northampton, MA: Edward Elgar.

Bijker, W. E. (1995). *Of bicycles, bakelites, and bulbs.Toward a theory of sociotechnical change*. Cambridge and London: The MIT Press.

Borking, K., Danielson, M., Davies, G., Ekenberg, L., Idefeldt, J., & Larsson, A. (2011). *Transcending Business Intelligence*. Stockholm: Sine Metu Productions.

Boutilier, R. G. (2014). Frequently asked questions about the social licence to operate. *Impact Assessment and Project Appraisal*, *32*(4), 263–272. https://doi.org/10.1080/14615517.2014.941141

Cohen, J. J., Reichl, J., & Schmidthaler, M. (2014). Re-focussing research efforts on the public acceptance of energy infrastructure: A critical review. *Energy*, *76*, 4–9. https://doi.org/10.1016/j.energy.2013.12.056

Danielson, M. (2005). Generalized evaluation in decision analysis. *European Journal of Operational Research*, *162*(2), 442–449. https://doi.org/10.1016/j.ejor.2003.08.056

Danielson, M., & Ekenberg, L. (2007). Computing upper and lower bounds in interval decision trees. *European Journal of Operational Research*, *181*(2), 808–816. https://doi.org/10.1016/j.ejor.2006.06.030

Danielson, M., & Ekenberg, L. (2016). The CAR Method for Using Preference Strength in Multi-criteria Decision Making. *Group Decision and Negotiation*, *25*(4), 775–797. https://doi.org/10.1007/s10726-015-9460-8

Danielson, M., Ekenberg, L., Idefeldt, J., & Larsson, A. (2007). Using a Software Tool for Public Decision Analysis: The Case of Nacka Municipality. *Decision Analysis*, *4*(2), 76–90. https://doi.org/10.1287/deca.1070.0088

Danielson, M., Ekenberg, L., Johansson, J., & Larsson, A. (2003). The DecideIT Decision Tool. In *Proceedings of the Third International Symposium on Imprecise Probabilities and Their Applications* (pp. 204–217). New York: Carleton Scientific.

Devine-Wright, P. (2007). *Reconsidering public attitudes and public acceptance of renewable energy technologies: a critical review* (Working Paper No. 1.4). Manchester: School of Environment and Development, University of Manchester.

Devine-Wright, P., Walker, G., Barnett, J., Burningham, K., Infield, D., Devine-Wright, H., Evans, B., & Wheatley, A. (2009). *Beyond Nimbyism: A multisidciplinary investigation of public engagement with renewable energy technologies: Full research report.* (ESRC End of Award Report No. RES-152-25-1008-A). Swindon: Economic and Social Research Council.

Döring, M., Schinke, B., Klawitter, J., Far, S., & Komendantova, N. (2018). *Multi-stakeholder dialogue and conflict sensitivity in energy planning. Towards a participatory approach in energy transition management* (MENA SELECT Working Paper). Bonn.

Eibl, F. (2017). *The Political Economy of Energy Subsidies in North Africa: The Untold Story* (OIES PAPER No. SP 38) (p. 30). Oxford: Oxford Institute for Energy Studies.

El-Hanchi, F. (2016, February). *Les objectives de la stratégie national de transition énergétique - 'Programme - ACTE'*. Powerpoint presentation presented at the Hotel Le Concorde, Les Berges du Lac.

El-Katiri, L., & Fattouh, B. (2015). *Brief Political Economy of Energy Subsidies in the Middle East and North Africa* (OIES Paper No. MEP 11). Oxford: Oxford Institute for Energy Studies.

Figueira, J., & Roy, B. (2002). Determining the weights of criteria in the ELECTRE type methods with a revised Simos' procedure. *European Journal of Operational Research*, *139*(2), 317–326. https://doi.org/10.1016/S0377-2217(01)00370-8

Geels, F. W. (2011). The multi-level perspective on sustainability transitions: Responses to seven criticisms. *Environmental Innovation and Societal Transitions*, *1*(1), 24–40. https://doi.org/10.1016/j.eist.2011.02.002

Geels, F. W., & Schot, J. (2007). Typology of sociotechnical transition pathways. *Research Policy*, *36*(3), 399–417. https://doi.org/10.1016/j.respol.2007.01.003

Harrabi, M. (2014, September). *Situation et persepctive de développement des energies renouvelables et de l'efficacité energétique a la STEG*. Presented at La cogénération au service de l'entreprise pour une croissance durable et perenne, Tunis.

Horchani, A. (2007). Water in Tunisia: A National Perspective. In *Agricultural Water Management: Proceedings of a Workshop in Tunisia*. Washington, D.C.: National Academies Press. https://doi.org/10.17226/11880

JICA, Japan International Cooperation Agency, & Tokyo Electric Power Services. (2014). *Preparatory Survey on Rades Combined Cycle Power Plant Construction Project in Tunisia* (No. 14–007). Retrieved from http://open_jicareport.jica.go.jp/pdf/12181814.pdf

Meadowcroft, J. (2009). What about the politics? Sustainable development, transition management, and long term energy transitions. *Policy Sciences*, *42*(4), 323–340. https://doi.org/10.1007/s11077-009-9097-z

MEMER, Ministry of Industry, Energy and Mines, & ANME, Agence Nationale pour la Maîtrise de l'Energie (2014). *Stratégie nationale de maîtrise de l'énergie: Objectifs, moyens et enjeux*. Tunis.

Nahali, M. A. (2014). Rationaliser la subvention énergétique au coeur du dialogue économique national. *L'Énergie*, (89), 4–7.

ONE. Office National de l'Énergie. (2017). *Conjoncture Énergétique* (Rapport mensuel). Tunis: Observatoire National de l'Énergie.

Palinkas, L. A., Horwitz, S. M., Green, C. A., Wisdom, J. P., Duan, N., & Hoagwood, K. (2015). Purposeful Sampling for Qualitative Data Collection and Analysis in Mixed Method Implementation Research. *Administration and Policy in Mental Health and Mental Health Services Research*, *42*(5), 533–544. https://doi.org/10.1007/s10488-013-0528-y

Pictet, J., & Bollinger, D. (2005). The silent negotiation or how to elicit collective information for group MCDA without excessive discussion. *Journal of Multi-Criteria Decision Analysis*, *13*(5–6), 199–211. https://doi.org/10.1002/mcda.392

Rotmans, J., Kemp, R., & van Asselt, M. (2001). More evolution than revolution: transition management in public policy. *Foresight*, *3*(1), 15–31. https://doi.org/10.1108/14636680110803003

Schinke, B., Klawitter, J., Döring, M., Komendantova, N., Irshaid, J., & Bayer, J. (2017). *Electricity Planning for Sustainable Development in the MENA Region Criteria and indicators for conducting a sustainability assessment of different electricity-generation technologies in Morocco, Jordan and Tunisia*. Bonn: BICC.

Seghezzo, L. (2009). The five dimensions of sustainability. *Environmental Politics*, *18*(4), 539–556. https://doi.org/10.1080/09644010903063669

Shove, E., Pantzar, M., & Watson, M. (2012). *The dynamics of social practice. Everyday life and how it changes*. London, Thousand Oaks, New Delhi, Singapore: Sage.

Smythe, K. R. (2014). An Historian's critique of sustainability. *Culture Unbound*, *6*, 913–929.

Sundgren, D., Danielson, M., & Ekenberg, L. (2009). Warp effects on calculating interval probabilities. *International Journal of Approximate Reasoning*, *50*(9), 1360–1368. https://doi.org/10.1016/j.ijar.2009.04.008

Valkenburg, G., & Cotella, G. (2016). Governance of energy transitions: about inclusion and closure in complex sociotechnical problems. *Energy, Sustainability and Society*, *6*(1). https://doi.org/10.1186/s13705-016-0086-8

van der Horst, D. (2007). NIMBY or not? Exploring the relevance of location and the politics of voiced opinions in renewable energy siting controversies. *Energy Policy*, *35*(5), 2705–2714. https://doi.org/10.1016/j.enpol.2006.12.012

Voß, J.-P., Bauknecht, D., & Kemp, R. (Eds.). (2006). *Reflexive governance for sustainable development*. Cheltenham, Glos, UK ; Northampton, MA: Edward Elgar.

Wittmayer, J. M., Avelino, F., van Steenbergen, F., & Loorbach, D. (2017). Actor roles in transition: Insights from sociological perspectives. *Environmental Innovation and Societal Transitions*, *24*, 45–56. https://doi.org/10.1016/j.eist.2016.10.003

World Bank. (2013). *Vers une meilleure équité: Les subventions énergétiques, le chiblage et la protection social en Tunisie* (Note Politique No. Rapport n . 82712-TN). Washington, D.C.: World Bank.

World Bank. (2014a). *Corrosive subsidies* (MENA Economic Monitor No. 91210). Washington, D.C.: World Bank.

World Bank. (2014b). *Une vision stratégique pour le secteur Tunisien de l'énergie. Réflexion sur des thèmes prioritaires* (Report No. 88965- TN). Washington, DC: World Bank.

ANNEXES

	Criteria	Objective		Indicators	Units	Sub-Indicators	Utility PV	Roof-top PV	CSP	Onshore Wind	Utility Hydro	Nuclear	Coal	Gas	Oil
1	**Use of Domestic Energy Sources**	The technology should decrease the dependence on foreign energy imports by tapping into domestic energy sources that are either available today or could be exploited in the mid- to long-term	1.1	Current domestic potential of each technology's energy carrier to decrease energy import dependence today	Qualitative with 0-100 descriptive scale, maximize		51.50	47.00	29.00	40.00	8.00	4.00	10.00	50.00	20.00
			1.2	Future domestic potential of each technology's energy carrier to decrease energy import dependence by 2040/50	Qualitative with a 0-100 descriptive scale, maximize		70.00	53.00	36.00	49.50	13.00	21.00	15.00	50.00	15.00
2	**Global Warming Potential**	The technology should contribute to the mitigation of climate change	2.1	Total lifecycle Greenhouse Gas Emissions (GHG)	Quantitative (CO_2-eq g/kWh), minimize		46.00	44.00	22.00	12.00	4.00	16.00	1001.00	469.00	840.00
3	**Domestic Value Chain Integration**	The technology should have a high potential to use components and services provided by domestic industries throughout the entire value chain	3.1	Existing potential for the integration of domestic industries to manufacture a significant share of components and provide essential services during the Manufacturing, Construction and Installation (MCI) and Operation and Maintenance (OM) phases of the technology	Qualitative with a 0-100 descriptive scale, maximize		50.50	58.00	30.00	35.50	30.00	4.00	20.00	20.00	24.50
4	**Technology and Knowledge Transfer**	Based on existing policies, the technology should have a high potential to benefit from technology and knowledge transfer in order to stimulate future domestic value-added in electricity-generation	4.1	Effectiveness of educational policies to foster skill development and R&D	Qualitative with a 0-100 descriptive scale, maximize		50.00	50.00	41.00	45.50	50.00	20.00	50.00	35.00	36.00
			4.2	Effectiveness of industrial policies to enhance industry linkages between domestic and foreign firms geared towards horizontal technology transfer	Qualitative with a 0-100 descriptive scale, maximize		50.00	45.00	45.00	47.50	42.50	7.50	27.00	42.50	40.00
5	**Electricity System Cost**	The electricity system cost of the technology should be as low as possible in order to not constitute a burden for the countries overall budget	5.1	Electricity-generation cost measured as Levelized Cost of Electricity (LCOE)	Quantitative (€/MWh), minimize		99.00	111.60	200.00	75.00	90.10	97.75	52.25	65.00	149.22
			5.2	Estimated additional integration cost at increasing penetration levels based on uncertainty/variability and distance/location	Qualitative with a 5-step descriptive scale, minimize	Variability / Uncertainty	3.00	3.00	2.00	5.00	2.00	2.00	2.00	1.00	1.00
						Distance / Location	5.00	1.00	4.00	3.00	2.00	1.00	1.00	1.00	1.00
6	**On-Site Job Creation**	The technology should have a high potential to create direct on-site jobs over the entire lifetime of the power plant	6.1	MCI: Average amount of labor in FTE person years per MW	Quantitative (FTE person years/MW), maximize		8.21	n.a.	12.96	6.83	8.74	13.82	6.98	3.50	3.79
			6.2	OM: Average amount of labor in FTE permanent jobs per MW	Quantitative (FTE jobs/MW), maximize		0.83	n.a.	0.41	0.15	0.24	0.54	0.19	0.17	0.26

7	**Pressure on Local Land Resources**	The technology should cause minimal additional pressure on valuable land resources in terms of amount and value of required land in order to avoid the deprivation of any locally relevant livelihood resources	7.1	Land requirement: The area of land directly required by the technology at the site of its deployment	Quantitative (ha/MW), minimize		2.77	0.00	3.61	0.31	n.a.	0.42	0.11	0.05	0.05
			7.2	Land value: The importance of the land surrounding typical project sites for providing livelihood resources and services to adjacent communities	Qualitative with a 5-step descriptive scale, minimize	Land use potential	1.00	1.00	1.00	4.75	n.a.	2.00	n.a.	2.14	3.00
						Residential proximity	0.00	n.a.	0.20	2.10	n.a.	0.40	n.a.	1.15	1.65
8	**Pressure on Local Water Security**	The water consumption of the technology should be appropriate to the local water risk context and cause minimal pressure on local water security	8.1	Average operational water consumption of each technology	Quantitative (L/MWh), minimize		31.23	n.a.	317.88	1.26	n.a.	1611.95	629.51	421.63	316.80
			8.2	Average water risk at typical project sites of each technology based on the Gassert et al. (2014)	Qualitative with a 5-step descriptive scale, minimize		3.17	n.a.	3.84	3.53	n.a.	3.00	n.a.	3.62	3.56
9	**Occurrence and Manageability of Non-Emission Hazardous Waste**	The disposal of non-emission hazardous waste produced during the operation of the technology as well as the risk stemming from national waste management capabilities should be low in order to minimize adverse consequences on human health and the environment	9.1	Disposal of non-emission hazardous waste	Qualitative with a 0-100 descriptive scale, minimize		1.00	1.00	2.00	1.00	1.00	5.00	5.00	3.00	4.00
			9.2	Potential national capabilities to manage the disposal of the respective types of non-emission hazardous waste	Qualitative with a 0-100 descriptive scale, maximize		53.50	58.00	50.00	70.00	70.00	20.00	46.50	40.00	26.50
10	**Local Air Pollution and Health**	The amount of air pollutants (NO_x, SO_2 and PM) emitted by the technology should be low in order to minimize pressure on local air quality and health risks for people in adjacent communities	10.1	Air pollutants (NO_x, SO_x, and $PM_{2.5}$) emitted by O&M activities of power plants	Quantitative (kg/MWh), minimize	$N0_x$	0.00	0.00	0.00	0.00	0.00	0.00	203.97	57.14	4.39
						SO_2	0.00	0.00	0.00	0.00	0.00	0.00	191.49	0.00	6.62
						$PM_{2.5}$	0.00	0.00	0.00	0.00	0.00	0.00	9.22	0.19	0.30
			10.2	Premature deaths by $PM_{2.5}$/MWh of electricity produced (radionuclides for Nuclear)	Quantitative, (deaths/MWh) minimize **(E-09)**		0.00	0.00	0.00	0.00	0.00	12.3335	15253.4	19598.9	13682.6
11	**Safety**	Severe accidents from the construction, operation and maintenance of electricity generating technologies, as well as during the transport and storage of resources and equipment, should be minimized in order to reduce accidents resulting in fatalities within and outside power plants	11.1	Fatalities from severe accidents in T&S and O&M of large-scale power plants	Quantitative (fatalities/MWh), minimize **(E-09)**		0.00	0.00	0.00	6.11	3.12	0.062	0.94	9.09	43.9
			11.2	Potential of regulatory and operational emergency preparedness and response capabilities of the private and public sector to mitigate and manage the risk of catastrophic accidents with maximum and severe consequences during the construction and operation phase of each technology	Qualitative with a 0-100 descriptive scale, maximize		55.50	70.00	60.00	40.00	53.50	20.00	40.00	57.50	53.00

Table 14: Agenda of the stakeholder workshops

	Agenda item	Activity
MORNING SESSION	Introduction to the workshop and energy planning for sustainable development	Presentation by the moderator
	Building a vision of sustainability for 2050	Participatory method
	Technology introduction	Presentation by the moderator
	Aspirations and concerns regarding the technologies in the context of the vision 2050	Participatory method
	Technology perceptions	Moderated round of discussion
	Introduction of evaluation criteria and gap analysis	Presentation by the moderator/open discussion
	Joint lunch	
AFTERNOON	Silent negotiation: criteria ranking and weighting	Participatory method
	Stakeholder participation in national energy planning	Open discussion
	Presentation of MCDA-results, synthesis and workshop conclusion	Presentation by research team/open discussion

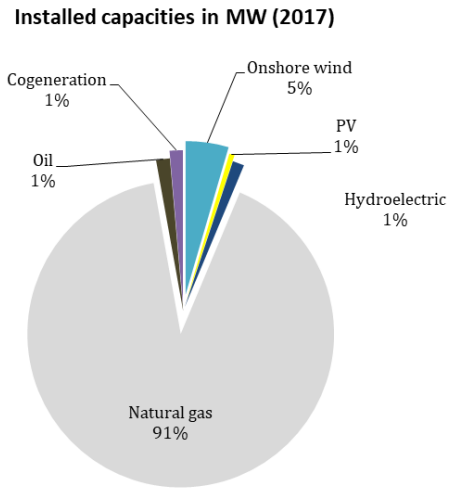

Figure 23: Installed capacities per fuel source in 2017 (MENA SELECT power plant inventory).

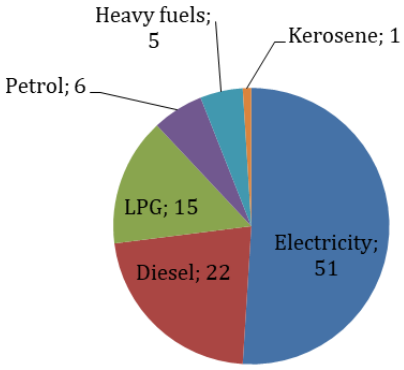

Figure 24: Distribution of subsidies per product in 2013 (World Bank 2013).

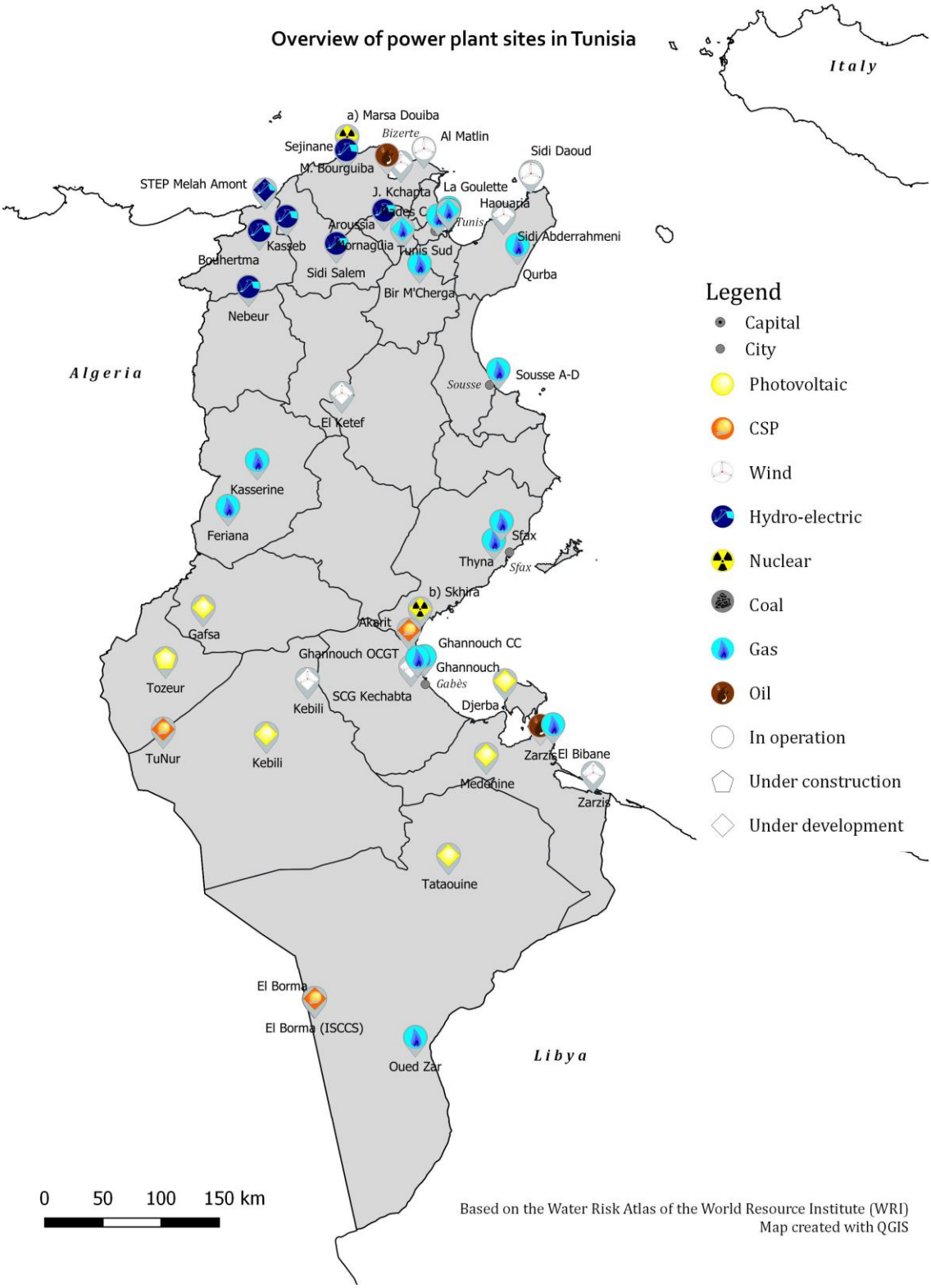

Figure 25: Power plant inventory Tunisia showing the location of existing and planned power plants (2017).

Table 15: Accordance of MCDA evaluation criteria with stakeholder visions, aspirations and concerns

Preselected sustainability criteria		Policy-makers	Finance & industry	Academia	National NGOs	Local communities	Young leaders
Contribution to national energy planning goals	Use of domestic energy sources	✓	✗	✓	✓	✓	✓
	Global warming potential	✓	✓	✗	✓	✓	✓
	Domestic value chain integration	✓	✓	✗	✓	✗	✗
	Technology & knowledge transfer	✓	✗	✓	✓	✗	✗
	Electricity system costs	✓	✓	✓	✓	✓	✓
Local impact sensitivity	On-site job creation	✓	✓	✓	✓	✓	✓
	Pressure of land resources	✓	✓	✓	✓	✓	✓
	Pressure on water resources	✓	✓	✓	✓	✓	✓
	Non-emission hazardous waste	✓	✓	✓	✓	✓	✓
	Air pollution & health	✓	✓	✓	✓	✓	✓
	Safety	✗	✓	✓	✓	✓	✗
	Procedural justice	✗	✗	✓	✓	✓	✓
	Distributional justice	✗	✓	✓	✗	✓	✓

Table 16: Qualitative inter-group comparison of criteria importance based on a five-step descriptive scale from "Least" to "High"

	Use of domestic energy sources	Global warming potential	Domestic value chain integrati-on	Technolo-gy and know-ledge transfer	Electricity system costs	On-site job creation	Pressure on land resources	Pressure on local water security	Non-emission hazardous waste	Local air pollution and health	Safety
Young leaders	High	Mode-rate	Least	Modera-te-low	Least	Least	Least	High	Mode-rate	Mode-rate	High
National NGOs	Least	Least	Modera-te-low	Modera-te-low	High	Least	Least	Least	Least	Least	Least
Local communi-ties	High	Least	Modera-te-high	Least	Modera-te-high	Modera-te-high	Modera-te-low	Modera-te-low	Least	Modera-te-high	Least
Academia	High	Modera-te-low	Modera-te-high	High	Modera-te-high	Least	Least	Modera-te-low	Least	Modera-te-low	Least
Finance & Industry	High	Mode-rate	Mode-rate	Mode-rate	Modera-te-low	Mode-rate	Least	Least	Least	Modera-te-low	Mode-rate
Policyma-kers	Modera-te-high	Modera-te-low	Modera-te-low	Least	Modera-te-high	Modera-te-low	Least	Modera-te-low	Least	Modera-te-low	High
Compro-mise	High	Least	Mode-rate	Mode-rate	Modera-te-high	Modera-te-high	Least	Mode-rate	Mode-rate	Modera-te-high	High

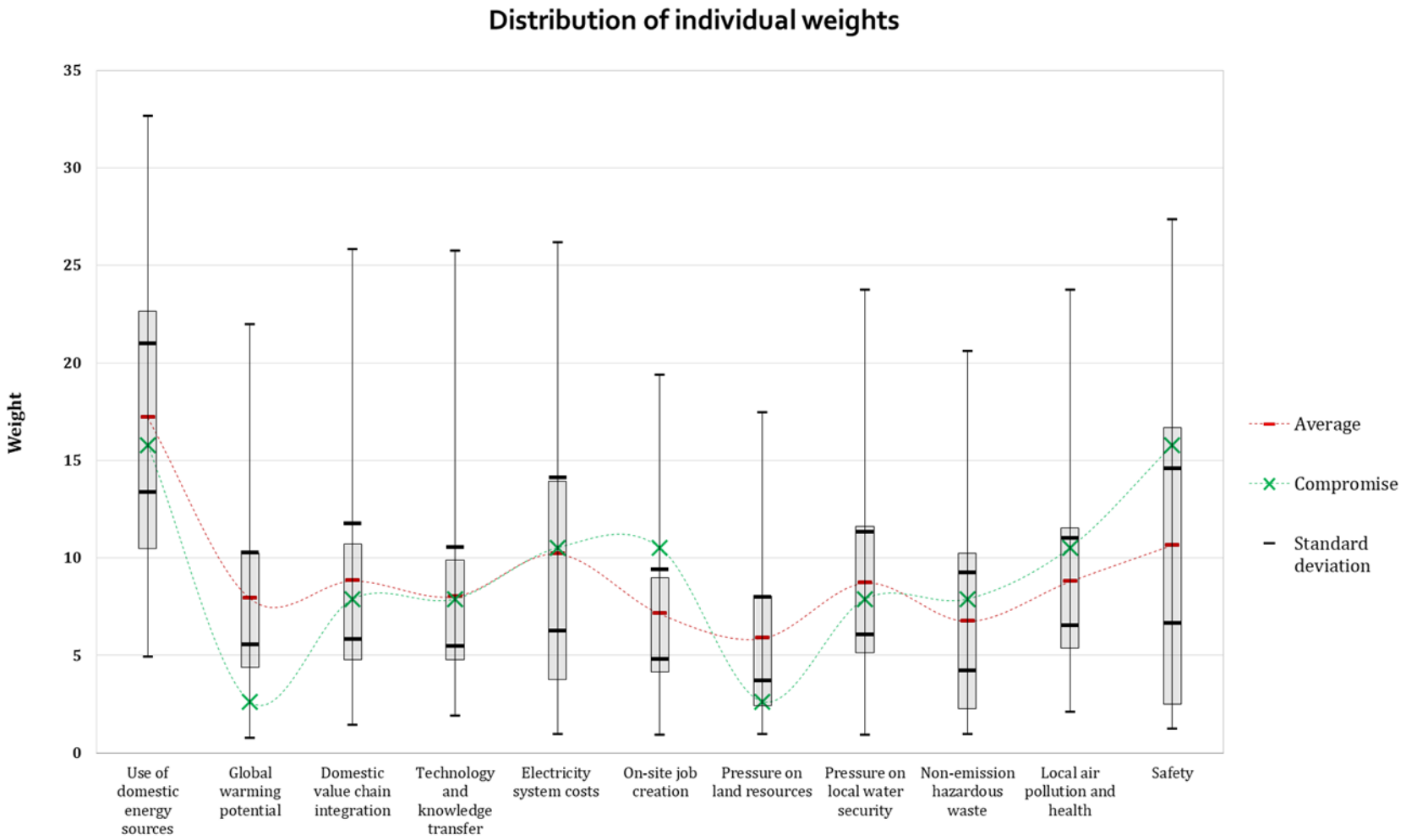

Figure 26: Distribution of individual criteria weights of stakeholder workshop participants. The red line indicates the arithmetical mean, the green cross the compromise solution achieved in the final workshop, and the grey shaded box the area between the lower and the upper quartile (i.e. containing 50 per cent of all stakeholder weights around the mean value). Whisker ends represent the maxima and minima. The black bars indicate the standard deviation.

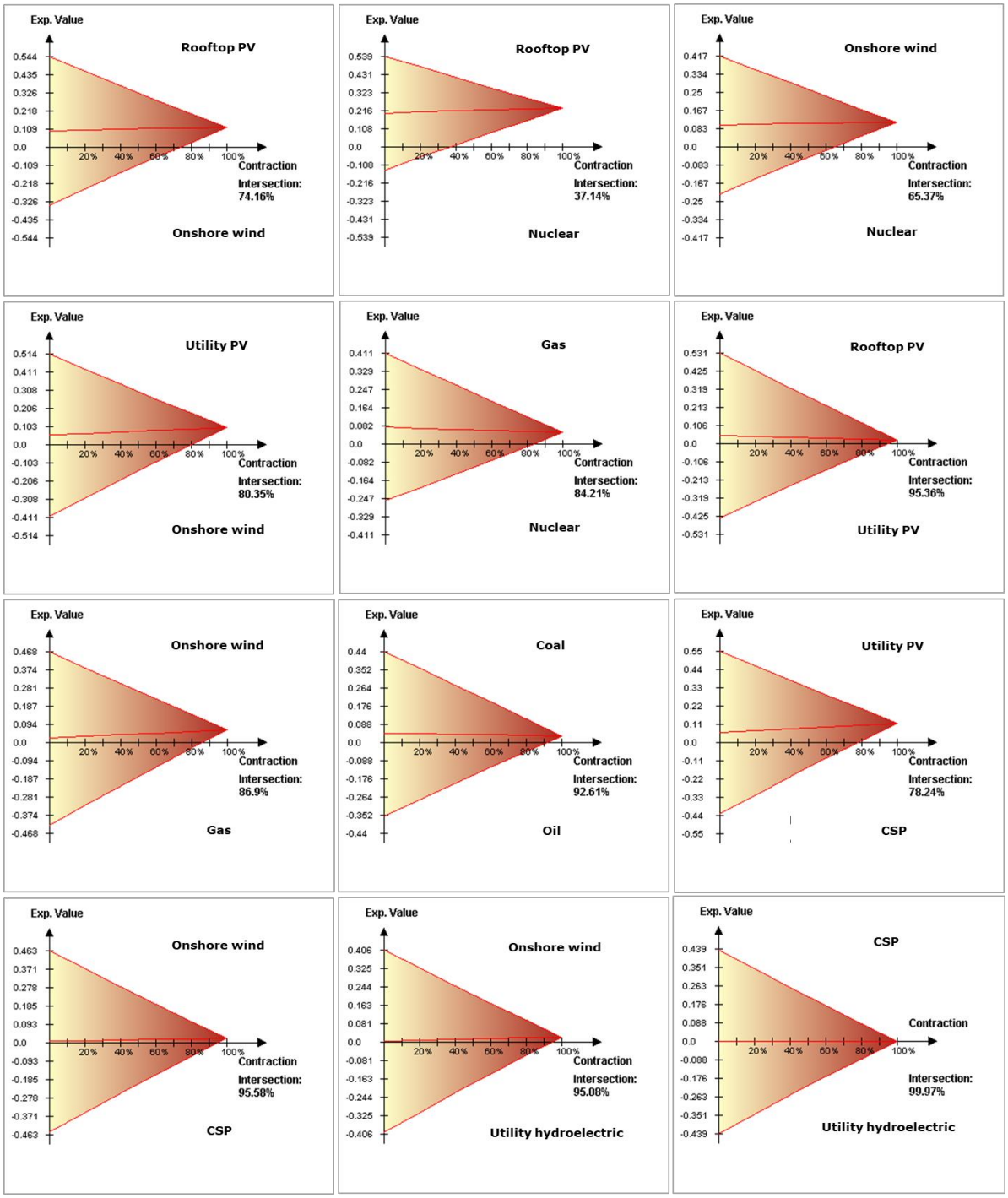

Figure 27: Pairwise comparison of selected technologies to indicate confidence levels.

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