

**Working paper**

# Dynamics of Energy Transition in Morocco: Centralized versus Decentralized Options

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## Abstract

This paper is based on qualitative in-depth open question interviews with relevant stakeholders from public authorities, experts, NGOs as well as private sector organisations at the local, regional and national levels about their visions of centralized and decentralized energy transition options as a way of fulfilling the Morocco's climate, energy, and regional development goals. The questions were around three big thematic blocks: vision of energy transition, discourse about centralized and decentralized energy solutions and participatory governance of energy transition. Key results highlighted the importance of awareness raising measures about costs and benefits of energy transition and available technological solutions. Such raising awareness programs also included the small-scale renewable energy projects realised in Morocco. The awareness rising and knowledge transfer projects are necessary to facilitate distributed deployment of renewable energy technologies. On the other hand, expectations about socio-economic development, including job creation processes and multiplier effects for local economies, are major drivers of social and public acceptance of large-scale renewable energy projects, including, concentrated solar power (CSP) stations. Awareness raising is also needed for local communities to facilitate participation in deployment of small-scale energy generation projects. The existing experience in Austria with distributed energy generation was discussed with the Moroccan stakeholders. There is a vivid interest of stakeholders in Morocco about the Austrian decision-making processes, namely, Climate and Energy Model (CEM) process, including the existing networks of CEM managers and opportunities for stakeholders' engagement in frames of energy groups, existing in such regions as CEM Freistadt,.

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## 1. Introduction

The energy mix of Morocco is currently heavily dependent on imports of fossil fuels as Morocco needs to cover 93.9% of its energy demand with costly imports of oil, gas and coal. Also strong growth of 5% per year on demand for primary energy and of 7% per year for electricity is driving an increasing demand for energy and raising energy bills.

The government of Morocco is recognizing these challenges and settled an ambitious target to become less energy dependent energy self-sufficient and even more, to become an exporter of green energy from wind, solar and hydro power. The country has set ambitious plans for the deployment of renewable energy sources for electricity generation and initiated different programs to deploy renewable energy sources and to cover 42% of its total electric

capacity by 2020 already (Schinko, et.al, 2019).

Morocco is going through energy transition. Currently several large-scale concentrated solar power (CSP), and Solar Photovoltaic PV stations are planned or under construction in different regions of Morocco. The Noor Solar Complex in Ouarzazate is the first CSP station, which is already in operation in Morocco. It is also the flagship project and the first large scale CSP station in the Middle East and North Africa region.

Taken into reference large scale size of the project as one block of such station generates 160 MW (Terrapon-Pfaffaet *al.*, 2017) of electricity and according to the Moroccan Solar Plan several stations are planned in the country, the deployment of CSP will have a huge impact for the economy of the country. Therefore, the evaluations of social and environmental impacts of such stations are essential (Komendantova et al., 2019)

Such large-scale projects as CSP deployment will also inevitable lead to energy transition in the country as well as to the societal transformation in the regions where the projects are planned. In order to develop participatory compromise oriented solutions it is essential to understand views and opinions of different stakeholders involved into the decision-making processes on deployment of solar power and into energy transition. It is also essential to understand existing centralised and decentralised energy transition options. Here the example of the Austrian decision-making processes, such as the Climate and Energy Models (CEM) regions process, could be a best practice (Komendantova et al., 2018).

The aim of this paper is to summarize the results of the various discussions on energy transition in Morocco, conducted with the relevant stakeholders also in light of experience existing in other regions such as in Austria in frames of the climate and energy model regions. As well as Morocco, Austria also has ambitious goals to reach 34% of gross final energy consumption from renewable energy sources by 2020 (LOCSEE, 2012). The country is pursuing this goal in frames of the climate and energy model regions, which are mainly rural or semi-rural regions and where investment into renewable energy sources is also seen as a factor of socio-economic development.

While discussing the Austrian experience with our interview partners, our interviews and roundtable discussions were guided by the following questions:

- What are the approaches to assure and implement energy transition?
- What are the barriers and drivers of energy transition?
  - Technical barriers;
  - Institutional barriers;
  - Economic and financial barriers;
  - Legal and administrative barriers; and,

- Social barriers;
- What are the solutions adopted in Morocco to accelerate energy transition?

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## 2. Energy transition in Morocco

### 2.1 Key features of the energy transition in Morocco

Morocco launched the energy transition in order to respond the rising demand on power and to green its energy sector. The energy transition has the following underlying overall goals: i) Reaching over 52 % of installed electricity production capacity from renewables by 2030; ii) Reducing energy consumption by 15 % by 2030 compared to business as usual (BAU) scenarios; iii) Substantially reducing fossil fuel subsidies; iv) and Substantially increasing the use of natural gas, through infrastructure projects allowing liquefied natural gas imports, and building the distribution infrastructure.

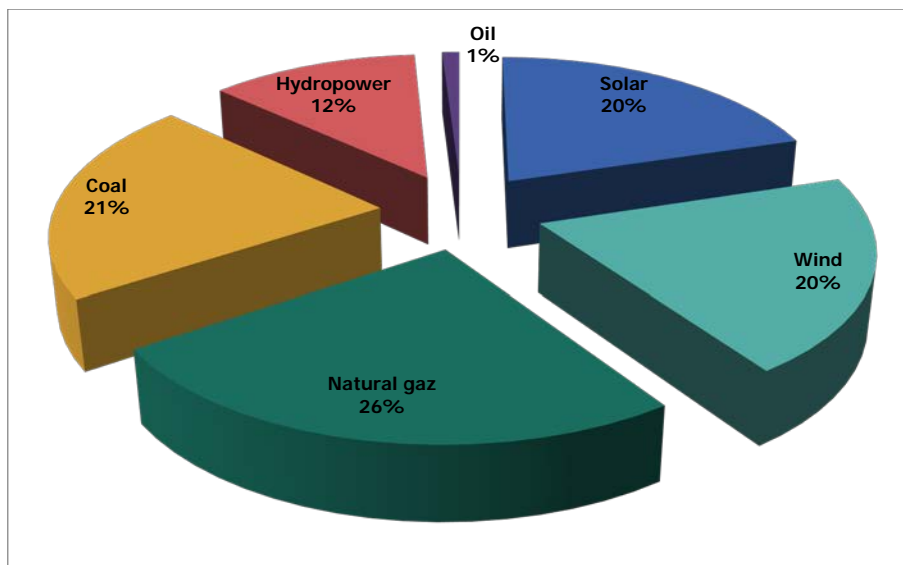


Figure 1: the planned power mix<sup>1</sup> by 2030 (Jamea, EM., 2018)

As the figure 1 shows, it is planned to increase significantly the share of renewable energies in the Moroccan electrical energy mix will reach 20% for solar, 12% for hydropower and 20% for wind by 2030. This will make more than half of the installed electricity generation capacity in 2030 based on renewable energy resources.

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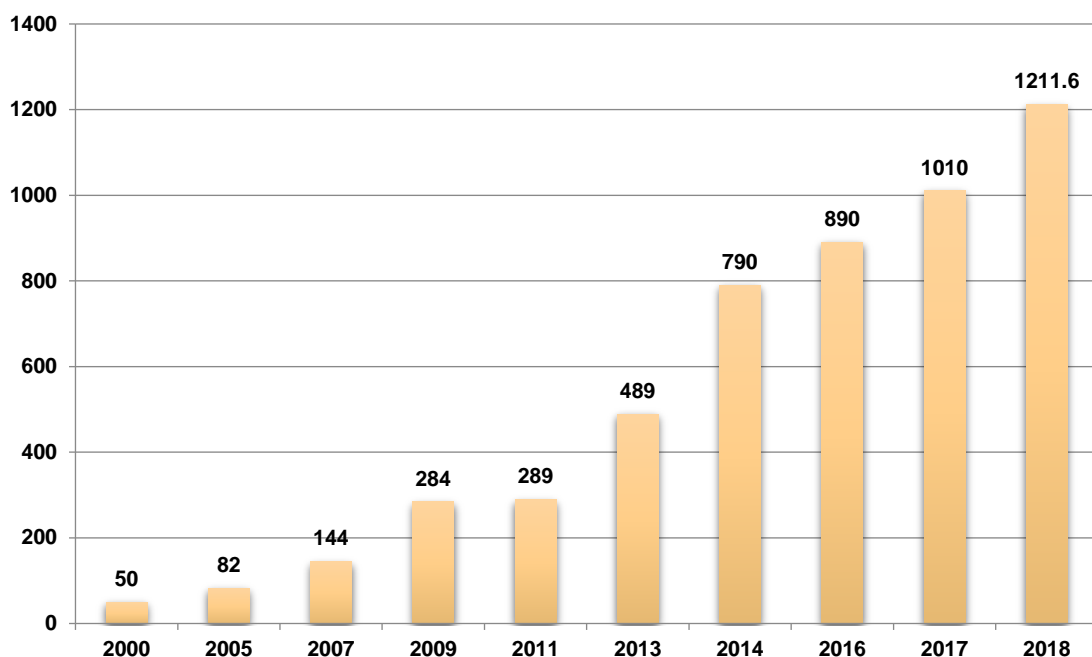
<sup>1</sup> Own calculation based on data from the national energy strategy

## 2.2. Large scale centralized projects

The Government of Morocco established the Moroccan Agency for Solar Energy (MASEN) as a private company, with public shareholders, and with the overall mandate to implement initially the Moroccan Solar Plan and starting from 2015 to implement various Moroccan renewable energy programs (for solar, wind and hydropower). MASEN (which became the Moroccan Agency for Sustainable Energy) focuses on developing large-scale solar energy projects (Quitow, et al, 2016) by adopting competitive bidding process open to national and international solar energy projects developers as Independent Power Producers (IPPs). Public private partnership (PPP) agreements are signed among the national utility, the selected developers, MASEN and the Government of Morocco. For example, MASEN signed a power purchase agreement (PPA) for the entire electricity output of NoorO I over 25 years with the developer; while MASEN and the National Water and Electricity Board (ONEE), which is the national utility, signed a second PPA in which ONEE will buy all of the electricity from MASEN at the grid price.

On the other hand, Morocco is also focusing on developing large-scale wind energy projects both through competitive bidding process and by authorizing private development of wind energy projects that would supply electricity to private consumers connected to the high voltage and very high voltage grids.

By the end of 2018 the volumes of installed Renewable Energy based power capacity made 3818.6 Megawatts (MW), from which 1211.6 MW was wind power installed capacity, 827 MW was solar energy capacities and 1780 MW was hydropower capacity.



**Figure 2: Evolution of the installed wind energy capacity in Morocco (Jamea &**

**Zeji, 2018)**

### **2.3. Small scale decentralized projects**

In parallel of large-scale deployment of renewable energy technologies led essentially by MASEN, decentralized renewable energy projects have also been developed. So far, almost 50,000 households (Jamea, 2015) in remote areas have access to electricity through solar home systems (SHMs). Further, the use of solar PV for water pumping in the agricultural and water sectors is quite diffuse in Morocco.

In addition, few small-scale solar PV projects, with less than 2 MW capacities, have been developed by private firms and factories for their own consumptions. Solar lanterns are used for public lighting in different large, medium and small towns in the country.

The city of Marrakesh implemented several pilot projects that could be considered as part of large efforts to energy transition and climate protection at the local level. Among these projects are the efficient public lighting in Marrakech, Medina bikes or electrical buses as well as solar PV parking, solar energy charging points for cellphones and laptops batteries and thematic gardens.

#### ***2.3.1 Efficient public lighting project***

It is the first project regarding the public lighting systems in the city. All public lightings points were changed to Light Emitting Diode (LED) bulbs contributing to reduce electrical consumption by the public lightings to more than 60%. This allowed the reduction of the bills that the council of the city pays for electricity. In addition, the project contributed to raising awareness among households and businesses and helped to adopt more energy efficient equipment and therefore to reduce their energy bills.

The project was managed by the council of the city in cooperation with the national energy investment company based in Rabat. The latter contributed significantly to the funding of the project, leveraging the mobilization of the required capitals, and addressing one of the key challenges of energy transition in Morocco – availability of investment and of initial capital.

With regards to technology deployment; the whole project was assigned to a consortium of Spanish and Moroccan companies, while equipment deployed were imported and some of them manufactured locally. Engagement of an international firm was mainly based on their competitive bid for the project and their competencies and experiences in implementing similar projects. The project works efficiently. It has helped also to promote energy efficiency sector in the city of Marrakech and to build local expertise and competencies that serve for the maintenance of the project itself but also in developing energy efficiency projects at the households and business levels.



### **2.3.2 Ecofriendly transportation systems**

The Medina bikes project is another interesting project, which the city of Marrakech launched with regards to transition to more eco-friendly transportation systems. The project foreseen deployment of public rent bikes and was promoted by local and international institutions (Supported by United Nations Industrial Development Organization (UNIDO), Global Environmental Facility (GEF) and implemented by the Environment Ministry of the Kingdom of Morocco). The project has set up several points to store public bikes for rent against a fee. 300 Bikes are located in different points in the city of Marrakesh. The project is run by a private firm. The project outcomes are assessed to be limited due to the relatively high fee to rent the bike and the considered “complex” procedure to get the bike paying by credit card.

The Electrical buses project is a transport system using high capacity electric buses with dedicated lanes. These electric buses have autonomy of 4 hours and require a charging time that lasts one hour. There are several charging points for the buses. The buses are charged using solar electricity produced by the 1 MW Solar PV project in Marrakesh. The project faced some challenges before its launching and its operation is not fully satisfactory. The reason is that the electric buses serve areas that are not densely populated. Another question remains with regards to population adhesion to this project. However, transport remains one of the sectors highly emitting of CO<sub>2</sub> in Morocco and still lot of efforts has to be done in order to green this sector. Urban transportation remains problematic for the country in terms of its comforts as well as in terms of environmental impacts. Both electrical transportation systems such as Rapid Buses or Trams and the bike projects are very important and pertinent concept to be scaled up and additionally developed. Marrakesh remains very promising city to develop the electrical buses and bikes systems.

### **2.3.3 Solar PV Parking project**

The Solar PV Parking project was promoted by international, national and local institutions. It consisted at building solar PV over parking shelter at the city hall and at the administration of the region Marrakesh Safi. The project was built by Moroccan and Swedish firms with strong engagement of local technicians. The project was aimed to serve as a model for different applications of solar energy technologies. Consequently, oil stations in the city of Marrakesh and alongside the highways (Marrakesh – Casablanca; and Marrakesh – Agadir) have also built solar PV parkings.

### ***2.3.4 Solar energy charging points for cellphone and laptops batteries***

The Solar energy charging points for cellphone and laptops batteries project was promoted by local, national and international institutions and consists in installing solar trees (with dozens of small solar panels) that serve to generate electricity for charging cellphone and laptops batteries for free.

### ***2.3.5 Thematic gardens***

The thematic gardens were developed in order to raise awareness about environment protection in the city of Marrakesh. The related projects were promoted by international, national and local institutions. Their development was done with a strong involvement of local associations and experts. Just in front of the city hall, a garden with thematic focus on climate change and sustainable development was built and it does contain an open museum dedicated to climate change and sustainable development. Arts sculptures made by dozen of Moroccan artist are permanently exposed at this Garden. The project raises awareness about the transition to more sustainable mode of life and eco-friendly society and about the culture of green economy and environment protection.

## **2.4. Awareness raising, research and development**

Alongside with the above-mentioned small-scale projects, several local and national socio-economic actors are contributing in the realization of energy transition through small scale projects and initiatives at the local levels. In the following text, meaningful examples from Marrakesh-Safi region are presented:

### ***2.4.1 Centre de Développement de la Région de Tensift (CDRT)***

It has adopted a holistic approach to address energy transition that favors covering several projects in different sectors and with engagement of several socio-economic actors. The Centre de Développement de la Région de Tensift (CDRT) carries out activities and projects that promote the expansion of cultures and arts in the region of Marrakesh Safi. CDRT focuses only on the Marrakesh Safi region.

The center has reached several partnerships with institutions such as the council of the region, provincial councils and communes from the Marrakesh Safi region. In addition, the center has also reached partnerships agreements with local associations from the whole territory of the Marrakesh Safi region. The partnership approach serves mainly to mobilize the key actors and

engage them in the various projects and activities that the Center is developing and implementing across the region.

In addition, the center carries out institutional building, trainings and capacity building for regional, provincial and local institutions as well as for active development associations on the thematic of environmental protection and climate change. The center also conducts studies related to the diagnosis and assessment of climate change impacts in the region and how the region could address the climate related challenges. The center conducts as well as studies related to waste management in urban areas and how to address and manage sustainable urban transportation systems.

#### ***2.4.2 Association des enseignants de sciences de la vie et de la terre (AESVT)***

It adopts more efforts that address education for children and raising awareness with regards to sustainability and energy transition. The association is very active at the level of schools with raising awareness campaigns and parallel educational programs that address the challenges related climate change and daily life of students' parents. This approach is based on the concept that children educate their parents. AESVT focuses on future generation and partners with high schools, schools and regional academic institutions. AESVT manages the Center of Environmental Education which has built a descriptive water cycle of the region of Haouz. This center has conducted several awareness programs for students of schools and high schools in the Haouz region. It also carried out a study to measure air pollution with the financial support of the IRD (research Institute for Development) to determine the black spots in the city of Marrakech. Another awareness-raising study on rational use of water for households was conducted in collaboration with the German International Cooperation Agency (GIZ).

#### ***2.4.3 Mawarid***

It is an association engaged and committed to contribute to protection of environment and climate. The association is mainly active at the level of the city of Marrakesh and targets youth generation using social media tools and other tools that are more attractive for the youth. The association organizes periodically raising awareness programs for example addressing the use of bikes as transportation means within the cities, wastes recycling methods and management, plogging, a car free day in Marrakesh. The association states that it is working to place environmental sustainability at the heart of public policy and debate.

#### **2.4.4. Green Energy Park**

It is managed by IRESEN, a national funding agency and research center that focuses on innovation, Research and Development (R&D) to contribute to the transition to sustainable energy and more green economy. The Institute carries out the following activities with regards to energy transition:

- Financing R&D and innovation projects that involve research /academic centers and industrial firms from the private sectors: the projects are related to innovative solutions, prototyping, technology adaptation, data bases set-up etc.
- Infrastructures in service of innovation and researchers and also to create a large infrastructures network for research. By this strategy the institute seeks to set up several platforms of R&D covering the field of renewable energies aiming at networking these platforms in a group for Applied Research Platforms.
- Manage the green energy park that is used for several research activities for example to characterize PV modules, assess and compare the technical performances of various PV systems and technologies

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### **3. Methodology**

Our research methodology was based on several methods of stakeholders' dialogue, which included open and semi-open stakeholders' in-depth qualitative interviews as well as focus group discussions. Interviews were conducted in form of in-depth qualitative interviews with foreseen time of around two hours. Relevant stakeholders (public, public authorities at all scales, experts, Non-governmental organizations NGOs, and enterprises) on the local, regional and national level were interviewed on their vision about centralized and decentralized energy transition options as a way of fulfilling Morocco's climate, energy, and regional development goals. The interviewers explored the interviewees' narratives in order to ascertain their awareness of the Morocco's goals, their opinions on the desirability of the goals, and particularly on the renewable energy sources deployment strategy as a way of meeting the goals.

The following questions aimed to guide the discussion however should not limit it. Further relevant for stakeholders' questions were identified during the interviews. In particular, questions were around three big thematic blocks: vision of energy transition, discourse about centralized and decentralized energy solutions and participatory governance of energy transition. The following questions were included:

### **Visions of energy transition:**

- Do you think an energy transition is necessary?
- What are the most important issues for energy transition (energy generation, energy efficiency, mobility etc.)?
- Which role energy transition can play for your region?
- Is energy transition necessary to reach: a) goals of climate change mitigation, b) goals of energy security, or c) goals of regional socio-economic development?
- What is the role of the regional scale for transition of the current Moroccan energy system?
- What is necessary to promote regional energy transition? (e.g. should there be a focus on technology or on individual behavioral change? Change the underlying circumstances e.g. tax system, funding? Is more cooperation between regions the key? Involvement of residents or companies?)
- Where do you think the major change should take place towards low-carbon transition of the currently energy system? At the level of individual behavior? At the level of municipalities and communities where deployment of infrastructure takes place? At the level of the region and country which settles targets? At the level of international and supra-national policy and frameworks which drive climate changes mitigation?
- How do you assess public interest in energy transition, in general, and renewable energies, in particular?

### **Costs and benefits of regional energy transition:**

- What benefits do you perceive from the implementation of a regional energy transition for your region (economic, social, ecological)?
- Are there any co-benefits, if yes who/which sectors benefit from processes in your region?
- Do you perceive an equal distribution of benefits? (E.g. between local and national level, between population groups?)
- What are the costs and risks of a regional energy transition? Who carries those? Are the costs justified?
- How should cost be distributed between energy consumers, government and energy companies?

### **Participatory governance of regional energy transition:**

- Who, do you think, should be involved into decision-making on energy transition, in general? (E.g. in the identification of the need for the project, identification of the location)
- Are they involved?
- Do you think, should inhabitants and lay people be involved into decision-making on energy transition and to which extent?
- To which extent can these stakeholders be involved?
- At what time should stakeholders be involved?
- Which forms of involvement would you recommend?
- Concerning information on energy policy and energy issues: What kind of information do you trust? Information by whom (ministries, project developers, regional authorities, local authorities, environmental groups, science)?

In addition, we visited all mentioned in the background section large-scale and small-scale energy transition projects as well as mentioned research and development centers and awareness raising institutions. We conducted roundtable discussions on the sites of the visits to these organisations.

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## 4. Results

Local communities, such as the community of Ikka Ighan, have visions about development, which considers sustainability and which is based on the implementation of renewable energy projects, such as solar energy projects. Representatives of the communities believe that such projects can give impulses to socio-economic development.

The perceptions of economic benefits of renewable energy sources are also connected with possibilities to substitute more expensive fossil fuels. For example, farmers in the region of Doukkala are worried about the rising expenses to cover gasoline used for irrigation. Currently almost 50% of all expenses for farmers are to cover energy costs. These worries are connected with climate change such as the lack of precipitation and spatial and temporal irregularities of precipitation. Nowadays, farmers are modifying the engines of their cars to use bottled gas because the gas is heavily subsidized in Morocco and the government attributes an annual budget of 800 Million euros for subsidizing gas. Currently the government is considering removing the public subsidies for gas. This would be an opportunity to stimulate deployment of electro-mobility however farmers are missing the awareness about such available options and financial incentives. However, they still perceive that solar energy technology would be the technology with the highest potential to be used in agriculture. The usage of the wind energy seems to be too complicated for farmers.

At the level of the local institutions, there is a lack of specific knowledge about energy transition, namely, who should be involved into energy transition. The level of awareness about energy transition among inhabitants is also low. Actually, inhabitants are enthusiastic about participation at the renewable energy projects however they consider participation more as some kind of employment rather than shaping decisions making processes. Inhabitants are also aware about single renewable energy projects however the level of awareness about energy transition as a process is much lower.

The local communities are proposing following measures, which will help them to adapt and to participate in energy transition. The first and absolutely necessary condition is the training for stakeholders about the existing options of energy transition as well as various forms of awareness raising campaigns among inhabitants are required. The local population needs different awareness raising measures about various aspects of energy transition. Also local civil society organizations who work with inhabitants on the topics of energy transition need further capacity building measures.

The second measure should focus on the strengthening of cooperation among different stakeholders, especially considering stakeholders at the local level. Such cooperation might increase efficiency and sustainable implementation of renewable energy projects. There is a need in a special committee, which would connect the implementation companies and projects developers such as MASEN and the local stakeholders through facilitated cooperation. So the area of cooperation between local governance level and project developers and private sector stakeholders requires further attention and improvement. At the same time, strong cooperation already exists between representatives of local governments and civil society organizations.

Third, in regards to the large-scale projects, representatives of communities believe that the level of participation in the large-scale projects should be increased and that the potential options for such increase include lobbying and advocacy. To strengthen participation of local communities in decision-making processes there is a need to strengthen the implementation of the existing regulations because actually the Moroccan regulatory framework provides the local communities with a mandate to act as a local development driver. Further mechanisms should be established to facilitate the dialogue between communities, where CSP stations are planned or under construction, and MASEN as well as other stakeholders who are involved into decision-making processes about CSP industry in Morocco.

The local communities also name several challenges, which exist for implementation of renewable energy projects, including both small scale and large-scale projects. Among these challenges is the lack of infrastructures, both social and physical, as well as the lack of plans for urban development.

Generally speaking, the energy transition in Morocco is a more top down then bottom up and participatory policy process, which does not address concerns from some stakeholders that existing dependency of Morocco on oil imports, will be replaced by a new dependency on

imports of renewable energy technologies. As currently energy transition is a top down process with support from the highest governance institutions of the country, the different options of energy transition are not frequently discussed. Decentralized energy generation in Morocco is mainly connected with the deployment of the smart grids systems. However, the current legal framework still limits connections of renewable energy systems to the national grids. Access to the grids is currently the major barrier, which limits further development of decentralized energy generation. Also deployment of decentralized energy generation projects frequently lacks financing and further options to identify innovative financing solutions are needed.

Energy efficiency was another frequently discussed topic. The energy efficiency measures in Morocco include lighting and energy efficiency measures in the housing sector. Currently various initiatives are being developed to provide financing incentives and to strengthen investment into energy efficiency measures for industrial and commercial companies as well as to support the Moroccan banks in development of the necessary in-house expertise to support energy efficiency projects. There are also areas for improvement such as the implementation of the energy audits, which should become mandatory, and strengthening of cooperation among various stakeholders involved into implementation of the energy efficiency measures.

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## 5. Policy recommendations

In frames of our research we conducted qualitative in-depth open question interviews with relevant stakeholders. Each interview lasted for around two hours. The stakeholders were from public authorities, experts, NGOs as well as private sector organisations at the local, regional and national levels. Interviews were about their visions of centralized and decentralized energy transition options as a way of fulfilling Morocco's climate, energy, and regional development goals. The questions were around three big thematic blocks: vision of energy transition, discourse about centralized and decentralized energy solutions and participatory governance of energy transition.

Our results allowed us developing the following policy recommendations: about the need of awareness raising measures on energy transition, about the need of water-energy nexus and about the need to address socio-economic expectations from deployment of renewable energy sources.

First, there is a need in further awareness raising measures and information of inhabitants in Morocco about costs and benefits of energy transition as well as about the available technological solutions. Rather than being the mass media measures, such awareness raising efforts could include demonstration projects on technology. These demonstration projects could include the organisation of visits for representatives of different communities to the Noor power station and discussions about social, economic and environmental impacts of the CSP



stations for national development goals as well as for development of communities where the stations are being constructed.

There are several interesting small-scale renewable energy projects and awareness raising and knowledge transfer projects are necessary to facilitate deployment of technology further on the territory of Morocco. These projects include deployment of PV capacities for small-scale water pumping stations, which would serve the needs of local communities. Construction of small demonstration projects is essential in order that inhabitants learn about how technology works and can be maintained.

Second, further discussions about water-energy nexus while considering large-scale deployment of CSP power stations are essential taken into consideration high volumes of water required for functioning of the power stations, deployment of power stations mostly in desert areas, impacts of climate change on water availability and further technological developments, which allow reduction of water consumption by the power stations.

Third, expectations about socio-economic development, including job creation processes and multiplier effects for local economies, are major drivers of social and public acceptance of CSP stations by local communities but also to participate in deployment of small-scale energy generation projects. Further research and implementation measures are needed to understand how local development component, such as providing impulses for socio-economic development of communities hosting the power stations, could be secured at the phases of construction, operation and management of the power stations.

Finally, discussions showed vivid interest of stakeholders in Morocco about the Austrian decision-making processes, namely, CEM process, including the existing networks of CEM managers and opportunities for stakeholders' engagement in frames of energy groups, existing in such regions as Freistadt.

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