Green Energy for the Arab Spring – Employment from renewable energy and energy efficiency in Tunisia

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Abstract:
Economic impacts of "green strategies" and increases in renewable energy and energy efficiency are the subject of much analysis in developed countries. However, the Middle-East-North-Africa (MENA) region exhibits large scale potential for renewable energy and energy efficiency. This paper analyses the economic impacts of such a strategy for Tunisia, the country where the so-called Arab Spring 2011 started. It shows that employment generated strongly depends on the type of green measure and on the country's ability to integrate the production of green technologies.
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1. Introduction

Strategies to increase the contribution of renewable energy to the energy system and to enhance energy efficiency of industries and households are on the agenda of many countries. The motifs are manifold: using the domestic potential for energy generation and thus increasing energy security or lowering energy consumption with energy efficiency measures will decrease import dependence and decentralized electricity generation can improve access to electricity for remote and rural areas. On a larger scale, clean energy generation and energy efficiency contribute to climate change mitigation and resource protection and therefore to the well-being of all countries.

Additionally, there is increasing evidence that the support of new technologies will accelerate industrial development and support economic growth and competitiveness. Several studies (Lehr et al. 2011, Ragwitz et al. (2009), Rutovitz et al. (2009)) show that, given the respective policy support and a target oriented policy instrument mix, renewable energy and energy efficiency increases exhibit positive effects on the labor market, on qualification and innovation. Thus far, in depth analyses on these effects has predominantly been provided for industrialized countries.

For developing countries or emerging economies, the discussion on overall economic effects or more specifically, employment effects of renewable energy and energy efficiency is only at its beginning. The research and action program, the International Agency for Renewable Energy (IRENA) for 2012 will have a focus on these issues. IRENA launched a side event to the Durban Conference 2011 under the headline "Exploring opportunities for local manufacturing as a means to reduce capital costs, create local employment opportunities, and improve trade balances" (IRENA in Durban, 2011, Prospects for the African Power Sector, Scenarios and Strategies for Africa Project).

Thus far, the effects of decentral applications such as PV in India or energy efficiency in rural areas such as efficient stoves in Africa have been analyzed. These studies are rather project specific in the context of development policies. The activities of emerging markets and their own activities such as Tunisia have not been studied in depth. At the latest since the interest in

projects such as DESERTEC and Mediterranean Solar Plan, these activities receive more attention recently. Moreover, national activities such as the Tunisian Solar Plan (PST) harbor development chances and opportunities for the creation of high skilled employment in production and operation maintenance, which are important especially in the context of recent changes in the region.

Against this background GWS (Osnabrück) and Alcor (Tunis) analyze employment effects of the Tunisian Solar Plan until 2016 and beyond. The timeframe of the analysis has been set until 2030. The goal of the study is threefold:

- On the level of policy analysis prerequisites and frameworks for a successful implementation of the Tunisian Solar plan are developed from comparison with international case studies (Report 1).
- On the level of macroeconomic labor market analysis the past experiences with Tunisian energy management programs (Report 2) and future chances from the Tunisian solar plan and further measures of energy management has been analyzed (This report, Report 3).
- In terms of capacity building the Tunisian energy agency (ANME) will be enabled to improve its estimates of employment effects of future measures with the respective tools (Implementation and training in Tunis, March 2012).

This paper summarizes the results. Itis organized as follows. The next section explains our approach and chapter 3 introduces the scenarios for the future development of renewable energy and energy efficiency. The scenarios are given in terms of capacities installed, investment necessary, import quota assumed and export levels. Section 4 explains the main drivers of employment from renewable energy and energy efficiency increases and puts a perspective on the results that can possibly be expected from the experience in other countries. Section 6 gives results and Section 7 concludes.

2. Methodology

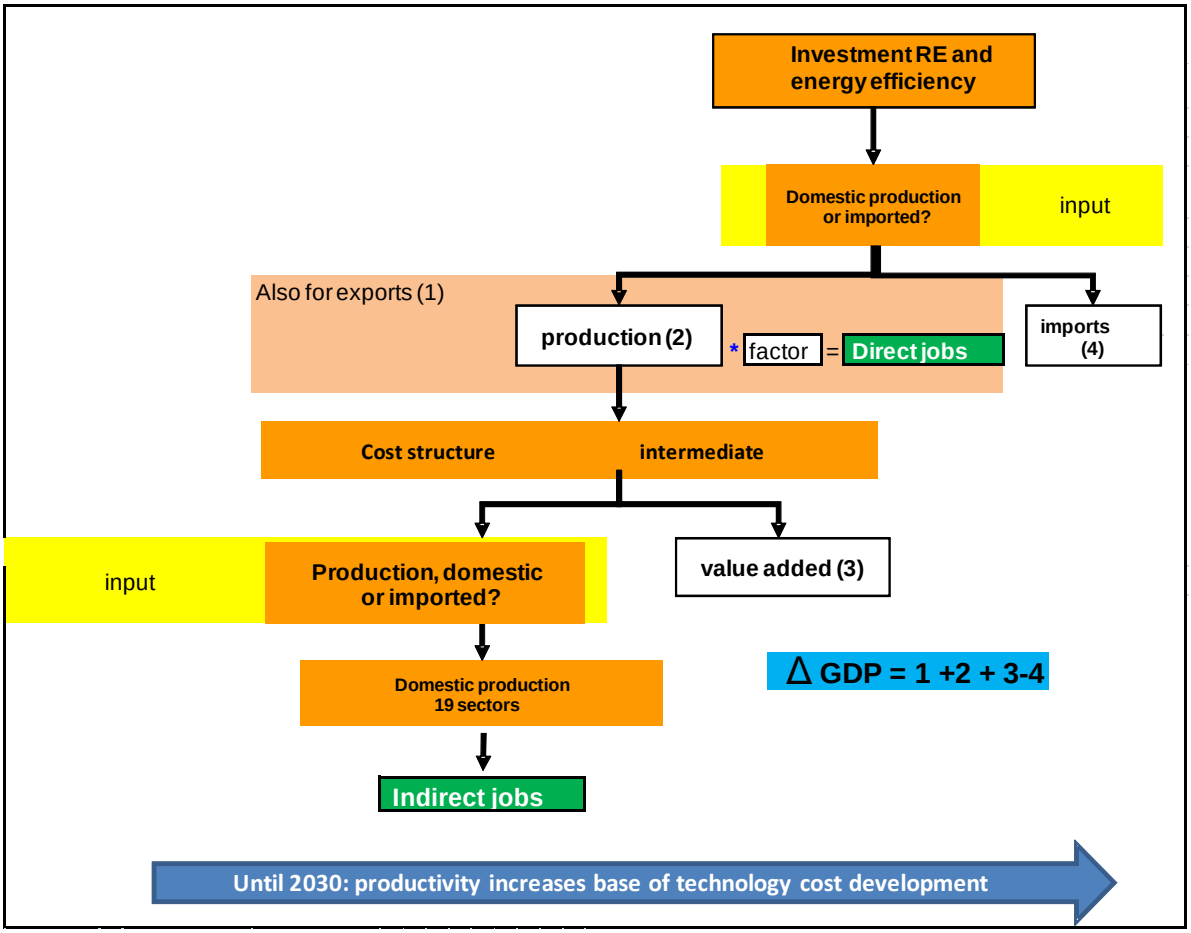
2.1. Modeling employment effects of increases in renewable energy and energy efficiency

A variety of approaches has been applied to model the economic impacts of renewable energy increases in developed countries. For developing countries, not all of these approaches are transferable. The approach chosen here tries to combine country specific data, where available, because the employment impacts hinge on the productions structure of the respective country, the capacity level and the skills of the workforce as well as the natural resources for renewable energy.

Thus, we apply an adjusted Input-Output approach embedded in a small model of Tunisia. Our approach is a combination of technology-specific Input-Output tables, labor-intensities of the respective production, country-specific Input-Output Tables and country specific statistical data. From the technology specific tables, we derive information about the cost structure of 5 different renewable energy (RE) technologies and on the increase in energy efficiency of buildings and in the main industry sectors. Depending on the shares of imported goods and services and the domestic production we can obtain domestic employment by combining these tables with the domestic input-output structure.

To combine as much knowledge as possible we suggest this two-stage procedure. The demand for renewable energy installations in Tunisia is modeled according to the Tunisian Solar Plan until 2016, translated into the necessary investment paths. The most important scenario parameters are investment in renewable energy and energy efficiency as well as the share of domestic production for domestic and international installation. Domestic production creates domestic demand for further inputs, following the domestic production structure given in the Tunisian input-output tables, while imports will create jobs and value added in the producer countries. Figure 1 shows the drivers of employment creation along the value chain. Investment in renewable energy and energy efficiency technologies can be produced nationally or it can be imported. For the domestic production of the technologies, employment is in a first step of the value chain created in the production facility. Indirect effects come from inputs (materials, planning, services and technical components) if they are also domestically produced. If the products are competitive on international markets, exports will add to this production and create additional value and employment. Total employment is the sum of direct and indirect employment and this holds true for the production of windmills, solar panels and energy efficiency technologies as well as for their operation and maintenance.

Figure 1: Employment creation along the value chain.



2.2. Scenarios

The future development path of renewable energy and energy efficiency in Tunisia is still subject to much discussion. The most recent contributions to this discussion are:

1. The Tunisian Solar Plan (PST), on energy efficiency and renewable energy in electricity and heat
2. "Renewable energy production in Tunisia, perspectives and opportunities until 2030 (Production d'électricité renouvelable en Tunisie - Perspectives et opportunités a l'Horizon 2030) GIZ/ANME, October 2010
3. The strategic study on the energy mix for the electricity production in Tunisia, part 5" Models and scenarios", Wuppertal Institute and Alcor, January 2012

The latter two studies focus on electricity generation.

The targets for renewable energy and energy efficiency in the Tunisian Solar Plan are set for 2016 and 2030. For renewable energy, the PST sets a target of 1000 MW capacity installed by 2016 and of 4600 MW capacity installed by 2030. The conventional capacity development reaches 5100 MW by 2016 and 7000 MW by 2030. Therefore, renewable energy will reach a share of 16% of total capacity installed by 2016 and the respective share by 2030 will be up to 40%. Comparing these target values with the scenario suggested below, one has to keep in mind, however, that the shares of renewable energy in electricity generated will be less, since conventional energy has a much higher energy/capacity ratio.

All in all, investment in renewable energy is dominated by PV after 2020, when the competitiveness of PV will be fully reached. Before, large investment sums goes into wind energy, concentrating solar power generation (CSP) will start later, as already mentioned. The PROSOL support program led to a successful start of solar thermal water heaters (SWH) in Tunisia and this success story is continued in the scenario. On all RE technologies together, a total of more than 8.3 billion DT will be spent until 2030. All investment and all other monetary information in the scenarios is in TD^{2011}. Changes to the grid are not contained in this exercise, because of the difficulty to separate costs for grid expansion due to renewable energy expansion from the necessary grid expansion due to higher electricity consumption due to economic growth. Following current knowledge from international studies, the additional costs from grid expansion due to RE are rather marginal.

Energy efficiency measures had to be taken from a variety of sources:

1. The Tunisian Solar Plan foresees a decrease in primary energy us by 40% until 2030.
2. KfW Programme of Activities Project Idea Note, (PoA-PIN), (Promo-Isol), Date of Submission: 19.11.2010 (Version 02)
3. Climate Change and Energy in the Mediterranean, Plan Bleu, EIB 2008
4. Mécanisme Financier pour le développement, de l'Efficacité Énergétique et des Énergies Renouvelables dans les pays sud- et est-Méditerranéens

From this body of literature the energy efficiency scenario has been developed. It comprises energy efficiency measures in the residential sector and in the industrial sector. Households can save energy by insulation of their homes, replacement of conventional light bulbs with energy efficient lamps and by buying energy efficient appliances, such as refrigerators, stoves, washers, TVs and computers. Industry can improve energy efficiency with efficient equipment. Additionally, the energy efficiency section of our scenarios contains the diagnostic banks for vehicles and co-generation processes.

The distribution of energy savings between households and industry is shown in Table 1.

Table 1: Energy savings from energy efficiency measures in GWh

		2016	2030
residential	56%	-20.279	-67.596
industry	44%	- 16.007	-53.356

Plan Bleu and own calculation

Apart from the monetary and physical quantitative framework data on renewable energy and energy efficiency of the scenario, it has to be completed with further assumptions on industrial integration and opportunities on regional and international markets of the relevant Tunisian industries.

2.2.1. Imports

To determine domestic value added and imports, our analysis starts with a renewable energy system readily installed and producing electricity or heat or, respectively, an energy saving appliance or an insulated building ready to save energy. This is the product that corresponds to our investment data. From this viewpoint we look back and analyze what has been necessary to get the system ready to work, i.e. material inputs, labor input in intermediate products, installation and planning. Then we look forward and determine the requirements to keep the system in operation, i.e. we determine material inputs and labor for operation and maintenance.

Starting with an example from the renewable energy technologies, for this type of analysis we have to determine which share of all windmills in a planned wind park is imported and which components can be produced in Tunisia. Going back along the economic value chain, we further look at the inputs to the wind park in terms of material inputs, planning and installation. Again, we have to ask: which part of these inputs can be produced in Tunisia? Information has been taken from international studies, the Tunisian Solar Plan, the study “Renewable energy production in Tunisia, perspectives and opportunities until 2030 (Production d’électricité renouvelable en Tunisie - Perspectives et opportunités a l’Horizon 2030) GIZ/ANME, October 2010” and from discussions with Tunisian experts.

GIZ and ANME (2010) choose an employment factor approach based on data for 2008 from the European Wind Association for the wind energy estimates. The shares of turbine produc-

tion, installation and production of other components are determined in terms of employment and integration rates are set for each share. The integration rates used are not mentioned in the study. The Tunisian Solar Plan derives an integration rate of 43% of the installation of a wind park at Bizerte. In our study, we use the share of domestic value added in the production of windmills plus the share of domestic value added in all input sectors. The actual setting of these shares has been discussed with Tunisian experts. **Fehler! Verweisquelle konnte nicht gefunden werden.** gives an overview of the setting used for import quota of all RE technologies. These settings are adjustable in the modeling tool, which is made available to ANME and GIZ.

The intermediate input structure is the result of a survey done in international RE industries. The results are extensively documented in Lehr et al. (2011). SWH, solar power water heaters already are quite successful in Tunisia and domestic production already exists today. Though most of the production is assemblage, this part will increase over the years. Some further inputs will be produced domestically.

2.2.2. Exports

In the first report of this study international success stories have been analyzed. One important driver of the success of the renewable energy industry and the energy efficiency industry lies in the opportunities on international markets, which result in exports to other countries. For the Tunisian case, thus far exports from the solar water heater production have been observed. Given the large amounts of PV installations foreseen in the DivRen scenario, we also included PV exports in our analysis. Other exports can develop from component production for the wind industry. All scenario settings are summarized in Table 2.

Table 2: Scenario inputs; investments by different activities

	Renewable energy					Energy Efficiency					
	Wind	PV	CSP	Biogas	SWH	Building material	Efficient Light bulbs	Efficient household appliances	Efficient equipment (industry)	Transport	Co-generation
Installation											
	[mnTD]	[mnTD]	[mnTD]	[mnTD]	[mnTD]	[mnTD]	[mnTD]	[mnTD]	[mnTD]	[mnTD]	[mnTD]
2011	92	0	0	11	60	41	2	23	98	1	52
2015	92	167	376	10	51	40	2	21	90	1	52
2020	169	296	282	9	46	38	2	19	82	1	52
2025	205	357	206	8	41	36	2	17	59	1	52
2030	100	150	313	8	39	34	1	15	53	1	52
Operation & Maintenance											
	[mnTD]	[mnTD]	[mnTD]	[mnTD]	[mnTD]	[mnTD]	[mnTD]	[mnTD]	[mnTD]	[mnTD]	[mnTD]
2011	4	0	0	1	1	-	-	-	-	1	2
2015	18	4	8	3	6	-	-	-	-	1	2
2020	53	22	53	6	10	-	-	-	-	1	2
2025	101	47	84	9	15	-	-	-	-	1	2
2030	130	56	127	12	19	-	-	-	-	1	2
Imports of whole systems											
	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2011	90	85	90	85	40	75	50	50	90	-	-
2015	90	70	90	85	40	65	40	40	90	-	-
2020	80	65	80	85	30	60	40	40	80	-	-
2025	70	65	70	85	20	50	30	30	80	-	-
2030	70	60	70	85	10	50	30	20	80	-	-
Imports of production inputs: services											
	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
2011	50	-	80	-	-	-	-	-	-	-	-
2015	50	-	80	-	-	-	-	-	-	-	-
2020	40	-	50	-	-	-	-	-	-	-	-
2025	40	-	50	-	-	-	-	-	-	-	-
2030	40	-	50	-	-	-	-	-	-	-	-
Exports											
	[mnTD]	[mnTD]	[mnTD]	[mnTD]	[mnTD]	[mnTD]	[mnTD]	[mnTD]	[mnTD]	[mnTD]	[mnTD]
2011	-	0	-	-	9	-	-	-	-	-	-
2015	-	0	-	-	7	-	-	-	-	-	-
2020	-	22	-	-	7	-	-	-	-	-	-
2025	-	31	-	-	7	-	-	-	-	-	-
2030	-	13	-	-	8	-	-	-	-	-	-

3. Results

3.1. Benchmarking – what do we expect to come out?

For a first very rough estimate of employment to be expected from the Tunisian Solar Plan and beyond, it pays to look at other countries' experience. The first report in this study gave an overview of international experience. Germany ranks highest in Europe in terms of employment and also in terms of capacity installed. The German economy is a very export oriented economy with a strong orientation towards the production of machinery, electrical appliances and optical and electrical instruments. Therefore, Germany used its strength to develop the new sector of renewable energy technologies. RE technologies for more than 100 billion € have been installed in Germany until 2010. In comparison, the scenario analyzed in this framework for Tunisia comprises a total of 7.2 billion € between now and 2020. In the beginning, most of the German PV systems had to be imported from Japan, most wind installations from Vestas in Denmark. Meanwhile, large PV companies have evolved and are currently going through a consolidation phase, because the market lately sees very large competitors for instance from China. But it is not only direct employment in the wind turbine production or the PV module production. Moreover, due to the industrial structure of Germany, more than half of the 370,000 jobs in the renewable energy sector are hidden in the production of intermediaries or inputs to this production.

For Tunisia the starting point is different. The industrial structure is not as far developed and a large share of the renewable energy systems will be imported at the initial phase. If Tunisia had the same per capita installation as Germany, the same production structure and the same export opportunities, roughly 35,000 jobs would be attained. Somewhere between this number and the 3,500 jobs created over the last 5 years, we should expect our results to lie.

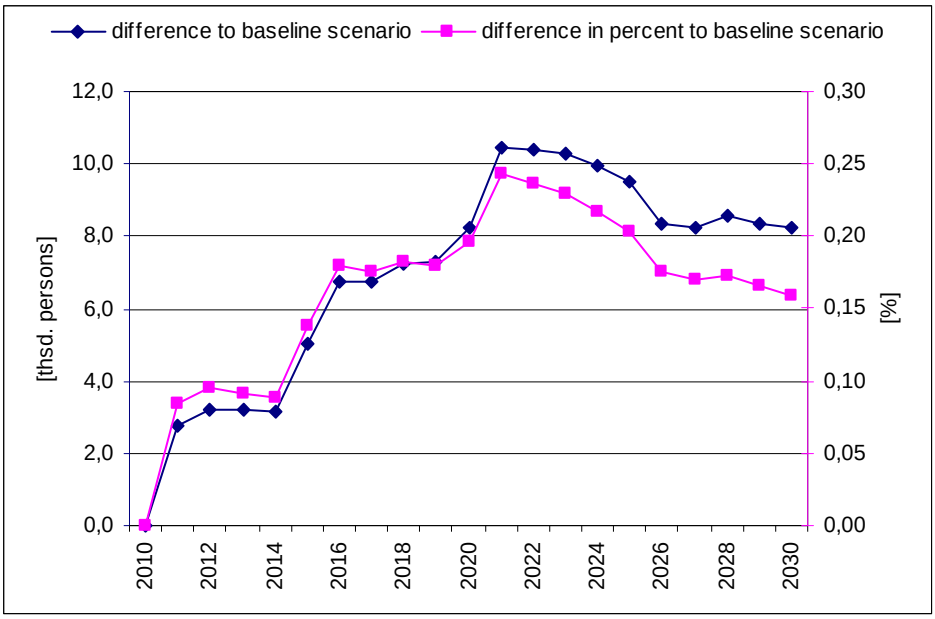
A smaller, less industrialized country might provide the better benchmark. Portugal has 11,950 people working in the RE industry. It has 2,857 MW of wind energy installed, roughly as much as the RE scenario foresees for Tunisia. 3,000 People work in the wind industry. 34,153 MW of photovoltaic power are installed and 1,500 people work in the respective industry. Portugal has no CSP as of yet, so there are no comparable numbers. Portugal supports renewable energy technologies with a combination of feed-in tariffs, fiscal support and a tendering procedure for wind energy. Whilst at the beginning of the support mechanisms in 2004 most products had to be imported, meanwhile Portugal has several companies which produce technology inputs for the wind industry and especially for the solar industry. Efacec provided inverters, transformers and switchboards for 5.3 million Euro to the Czech Republic in 2010 and in 2011 11.2 million € to a Greek project. Service companies plan and implement projects worldwide.

3.2. Modeling results

As pointed out, employment effects from renewable energy and energy efficiency increase hinge on investment and domestic production structure. Our baseline scenario does not include any additional renewable energy or energy efficiency investments. The model suggested allows for the change of investment AND for an adjustment of the production capabilities of Tunisia. Together with experts from Germany and Tunisia, a scenario has been developed which foresees certain investment paths and production structure (cf. Chapter 3). If Tunisia releases local content requirements for international investors, as China did, or includes these in e.g. a tendering procedure for wind installations as Portugal did, the import quota will be less than currently assumed.

With the given structure, the Tunisian Solar Plan will lead to more than 10,000 additional jobs in Tunisia. In the following, this scenario will be called S1: ER+EE (renewable energy + energy efficiency).

Figure 2: Additional employment from the PST (S1 ER+EE)



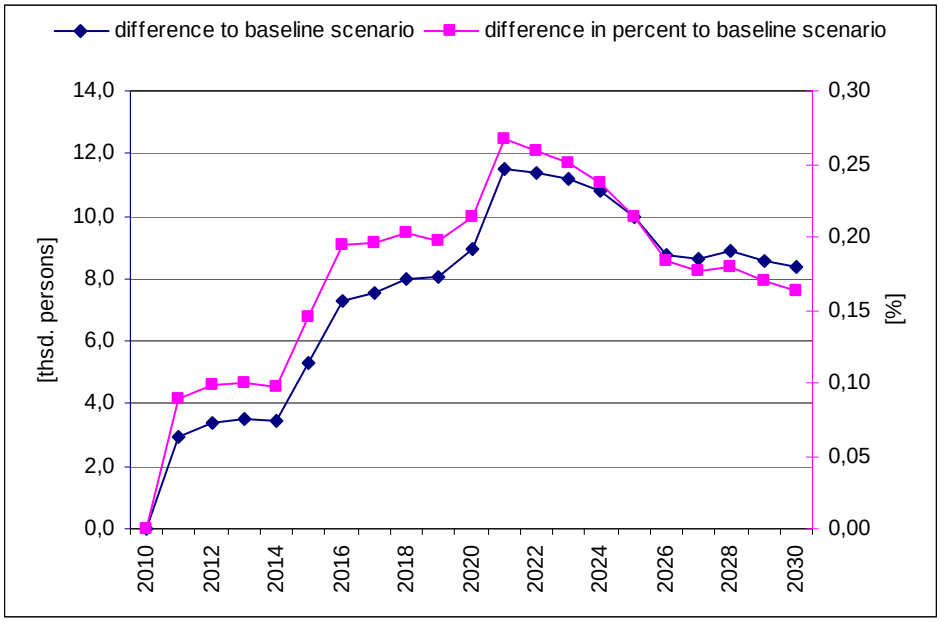
Source: GWS, Alcor, WI – own calculation

The shape of the curve reflects the investment paths and productivity growths. The employment effect is rather small initially, because large shares of the new systems will be imported. Only small inputs are locally produced.

If imports are lowered to 10% (on average, Scenario S2 ER+EE integration) employment can rise to more than 20,000 people or more than 0.6 percent of overall employment. This can be considered as the maximum attainable employment from the given investment path. Again, towards the end of the simulation horizon, productivity gains and RE cost decreases will be leading to less employment from the same investment impacts.

The Tunisian Solar Plan gives an estimate for domestic integration of production for the wind industry. If we simulate employment effects using the suggested 43% of integration starting in 2011, the results shift from the original 10,000 jobs to a new total of more than 12,000 jobs (S3 ER+EE integration eolien). This shows the possible benefits of a successful integration strategy.

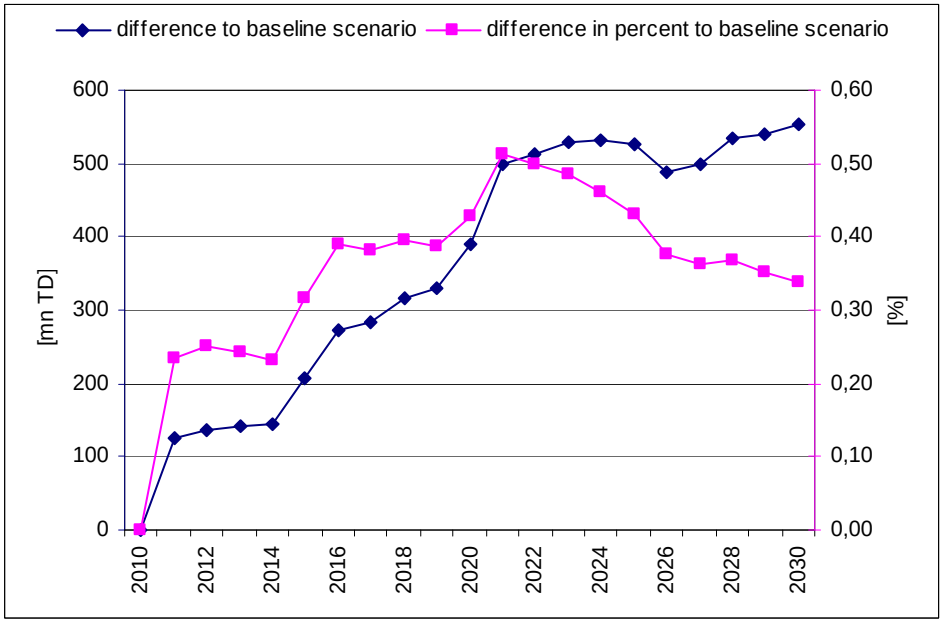
Figure 3: Employment effects with high domestic integration for wind energy (S3 ER+EE integration eolien).



Source: GWS, Alcor, WI – own calculation

The overall GDP effects are positive throughout the scenarios analyzed. As has been pointed out above, no financing mechanism has been built into the partial model. Investment in the Solar Plan is considered additional to the economy. The Solar Plan does not include information on a burden sharing process such as a feed-in tariff or other instruments. If such an analysis is necessary, the model will have to be supplemented by new modules.

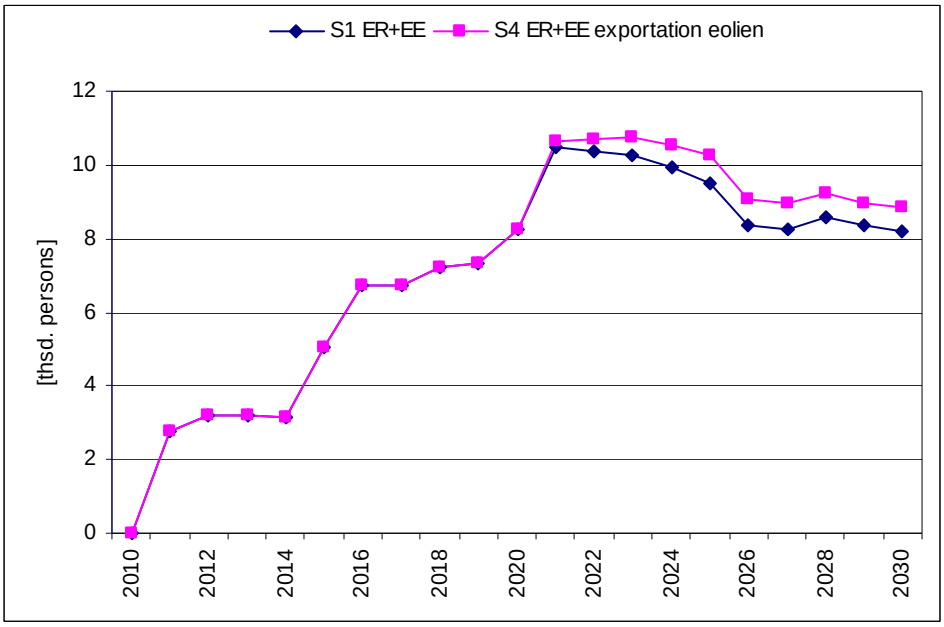
Figure 4: Development of Real GDP, difference from baseline scenario in absolute and percentage terms. (S1 ER+EE)



Source: GWS, Alcor, WI – own calculation

If we consider exports in the wind sector and if we assume that Tunisia exports from 2021 until 2030 around 800 million TD[2011], we find aggregate employment even further increased. The new scenario shows that employment will be further stimulated with around 200 persons.

Figure 5: Employment from additional exports in the wind sector, differenc to baseline scenario (S1 ER+EE and S4 ER+EE exportation eolien).



Source: GWS, Alcor, WI – own calculation

Real GDP will differ from the base run by up to 375 million Dinar or 0.4%. **Fehler! Verweisquelle konnte nicht gefunden werden.** shows real GDP and its components for scenario S1 ER+EE. Real GDP shows an average growth rate of around 5.8% for the years between 2010 and 2030. The economic improvement in this scenario is mainly driven by the development of gross fixed capital formation and exports. Gross fixed capital formation will determine roughly one quarter of real GDP by the end of the projection horizon. Exports will constantly increase compared to the baseline scenario as well. But the negative trade balance will remain until 2030 due to the also increasing import flows.

4. Discussion and Conclusions

The question of impacts of renewable energy plans and policies becomes increasingly important for developing countries. In this paper we have suggested a data based and theory-oriented methodology, which can be applied to many developing countries. Only few data requirements have to be fulfilled. On the policy level, the results help the Tunisian government to design the renewable energy and energy efficiency policy according to different policy goals.

Concerning the choice of modelling approach, it seems to be easy to handle and successful in grasping the important aspects of the problem. A full economic model, however, is advisable if different policy measures are to be modelled.

Concerning the renewable energy mix in Tunisia, what can we learn from our exercise?

The answer to this question is not as straightforward as one might hope, because it depends on a variety of factors. From comparison of employment generated per 100 million Dinar investments, energy efficiency in buildings generates the most employment, followed by solar water heaters and PV installations. Wind energy and CSP follow. However, these results were obtained given a certain import structure (see the scenario at a glance, above) of the respective industries. Solar water heaters have been successfully implemented in the PROSOL framework and lead to the second largest employment/ 100 million Dinar. PV generates the third largest amount of employment, though no large Tunisian production of panels has been assumed. Though the production facilities can be easily imported and implemented in any country, as the Chinese example shows during the last couple of years, new production capacities do not seem feasible under the current consolidation phase on international PV markets. Tunisia should benefit from falling PV prices and realize the employment opportunities in installation and in the production of electric and electronic components of PV systems. A more detailed analysis of the production possibilities in this sector could make industrial policies more specific.

Wind energy does not contribute as many jobs as the first three technologies but provides chances for technology development. Currently, GIZ analyzes the wind energy sector in a separate study at the microeconomic company level.. The results of this analysis can be integrated in the modeling tool to adjust domestic production shares. Thus far, only the experience from projects built until 2010 and expert judgments have been included in our analysis. However, the chances for an ambitious technological development and also chances for exports are very high in the wind industry, because component manufacturing leads to additional demand for inputs from other Tunisian production sectors.

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References

[1] ISI (2009): ISI, Ecofys, EEG, Rütter + Partner Socioeconomic Research + Consulting, LEI, SEURECO. EMPLOY-RES - Employment and growth impacts of sustainable energies in the European Union, Karlsruhe.

[2] Lehr, U., Lutz, C., Edler, D., O'Sullivan, M., Nienhaus, K., Nitsch, J., Breitschopf, B., Bickel, P. & Ottmüller, M. (2011): Kurz- und langfristige Auswirkungen des Ausbaus der erneuerbaren Energien auf den deutschen Arbeitsmarkt, Studie im Auftrag des Bundesministeriums für Umwelt, Naturschutz und Reaktorsicherheit, Osnabrück, Stuttgart, Berlin, Februar 2011.

[3] Rutowitz/Atherton 2009; Energy sector jobs to 2030: a global analysis, 2009, J. Rutowitz, A. Atherton. Prepared for Greenpeace International by the Institute for Sustainable Futures, University of Technology, Sydney.

[4] GIZ/ANME (2010), Renewable energy production in Tunisia, perspectives and opportunities until 2030 (Production d'électricité renouvelable en Tunisie - Perspectives et opportunités a l'Horizon 2030), October 2010

[5] WI/Alcor (2012), The strategic study on the energy mix for the electricity production in Tunisia, part 5" Models and scenarios", January 2012