Influence of large-scale deployment of concentrated solar power on North African countries: socio-economic aspects

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Background

In the year 2008 the European Union launched the Mediterranean Solar Plan (MSP) to develop renewable energy capacities of the Mediterranean region. The plan foresees deployment of renewable energy capacities, mainly solar and wind, by 2020 (ENPI, 2010). Speaking about solar, the plan foresees implementation of large-scale concentrated solar power (CSP) plants with capacities up to 200 MW as well as small commercial CSP plants with capacities below 50 MW (RAL, 2010).

Another initiative to deploy solar and wind capacities in the North African region is driven by industry and is known as "Desertec Industrial Initiative". It was launched in 2009 on the basis of the Desertec concept, which studied the ways to satisfy European energy needs with energy mix including renewable electricity from the North African region (Czisch, 2005, German Aerospace Agency, 2005, 2006 and 2009, Desertec 2008). The shareholders of Desertec Industrial Initiative (DII) are solar and wind companies, banks, transmission operators etc. The long-term goal of DII is to satisfy about 15% of Europe's electricity demand by 2050 with power produced from sun and wind in the deserts of North Africa.

If MSP and DII succeed in their goal to deploy large volumes of renewable energy capacities in the region, this might influence employment situation in North Africa significantly as the expectations regarding creation of employment opportunities in green industries are optimistic (EPIA, 2006). The reports of interest organizations and NGOs are full of such sentences as that "we are currently at the beginning of the area of clean-technology jobs, which will be the greatest opportunity for wealth and global competitiveness since the advent of computer and Internet" (CleanEdge, 2009) and provide estimations like that globally up to 2 million people will be employed just in CSP sector by 2050 (Greenpeace International, SolarPaces and ESTELA, 2009).

If these estimations will come true, deployment of renewable energy capacities foreseen by DII and MSP can influence significantly socio-economic development of the region, where currently the unemployment rate is one of the highest in the world. Only 45.3% of population in active age is employed, 42% of all employed are working poor, earning less than US $2 a day and the total unemployment rate increased by 25% between 1997 and 2007 (ILO, 2009). The unemployment rate among young people is the highest in the world when 25% of the world's unemployed youth resides in the region (World Bank, 2007). The number of officially registered unemployed women reached 32.2% in 2008 but the number of unemployed women is even higher as only 20% of all women in working age have employment.

The difficult employment situation is additionally influenced by demographic situation. Middle East and North Africa (MENA) region has one of the fastest growing populations in the world. In average MENA population grows by 2% per year or nearly 7 million people. Only between 1970 and 2001 the population grew up from 173 million people to 386 million people. The fertility rate per woman declined from 7.0 births in 1960 to 3.6 births in 2001. But it is still expected that MENA population will double its current number by 2050 partly because of its young age structure, when more than 30% of population are at the age below 15 and unprecedented number of young women is reaching the reproductive age (Roudi-Fahimi et al., 2002).

Previous studies

Currently to our knowledge two most prominent studies were conducted on evaluation of employment impacts from deployment of CSP capacities. The study conducted by the National Renewable Energy Laboratory (NREL), based in the United States of America, estimated impacts from deployment of CSP capacities in California. The study conducted by the European Solar Thermal Electricity Association (ESTELA) evaluated impacts from deployment of CSP capacities in the Mediterranean region.

To evaluate employment opportunities in the CSP industry, NREL developed the Parabolic-Trough Job and Economic Development Impact Model (JEDI-CSP). This Input-Output model represents an adjusted version of the JEDI model, created in 2002 to evaluate

impacts from deployment of wind technologies, which was later expanded to CSP technology. The JEDI-CSP evaluates employment effects of deployment of 100 MW of CSP power in California. The results show that during construction phase 455 job-years in direct employment and 3.500 job-years in indirect employment will be created. The main assumption of NREL is that the balance of plants equipment as well as all construction, installation and engineering works are provided by domestic suppliers and manufactured in California (NREL, 2008).

The estimates of ESTELA are based on a mixture of qualitative and quantitative methods and tell us that deployment of 20 GW of CSP capacities in the Mediterranean region will create up to 200.00 man/year jobs by 2020 only in construction of installations and manufacturing of components. All these are direct jobs. The main assumption of ESTELA is that 50% of components necessary for CSP installations will be manufactured in Europe and 50% in North Africa (ESTELA, 2009).

Based on these two studies, we identified two research questions:

- How many direct and induced working places will the deployment of CSP capacities, at the scale foreseen by MSP or DII, create in the North African region?
- What will be the sensitivity of the number of jobs created by CSP industry towards different shares of components, management and engineering services produced in the region?

Methods and results

As the goal of our research was to estimate direct and induced jobs we use an input-output (I-O) model. These models in comparison to analytical studies, which usually calculate only numbers of direct jobs, allow estimation of induced jobs by using the multiplier effect. The review of existing literature showed as well that Input-output (I-O) models were used most frequently for analysis of impacts of renewable industries on national employment (Kammen et al., 2004).

As a main tool, we use the JEDI-CSP model, which to our knowledge it is the only existing model, which was explicitly developed to capture of employment effects from CSP (Stoddard, 2006). We adjust JEDI-CSP to local conditions on the basis of such parameters as

construction costs, including materials and labor[1], equipment costs[2] as well as other costs[3], costs of personnel, services[4] and financing[5].

We use data for these parameters from databases of international, national and multilateral organizations like World Bank, United Nations, International Energy Agency, German Aerospace Agency and North African offices for statistics.

We base our modeling work on two assumptions, which we take from NREL studies of construction processes of CSP plants and logistic issues (NREL, 2008). First, we assume that the share of materials for construction such as concrete rebar, equipment, roads and site preparation is constant under all four scenarios and makes up to 95% of local production. Second, we assume that labor for field erection is to a bigger part done by local people. We model 80% of local labor for site-work and infrastructure, field erection, support structures, piping, electrical works.

The second step of research was to model sensitivity of the number of direct and induced jobs generated by the CSP industry according to the share of components produced in the North African countries. We follow four assumptions:

- when all high and medium technology components are produced outside North Africa,
- when 40% of components are manufactured locally,
- when 60% of components are manufactured locally,
- when all 100% of components are manufactured in North African countries

[1] Sitework and infrastructure, field erection, support structures, piping, electrical, labor subtotal
[2] Mirrors, heat collection elements, thermal exchange storage tanks, heat exchange, heat transfer system equipment, heat transfer and storage fluids, stream turbines and generators, electrical and solar equipment, water treatment, metal support structure, interconnection piping, electronics and control, balance of plant
[3] Freight and transport, engineering and project management
[4] Costs of personnel such as operations, administrative, power plant maintenance, field maintenance and costs of materials and services such as water, water treatment with chemicals, fuel as motor vehicle gasoline, field parts and materials for plant equipment
[5] Debt financing (percentage financed, years and interest rate), equity financing and repayment (percentage equity, individual and corporate investors, return on equity and repayment term), tax parameters (local property tax rate, assessed value (percent of construction costs), taxable value, local property taxes and local sales tax rate), insurance such as percentage of capital cost and insurance cost, land purchase parameters such as land purchase cost, number of acres, percentage and years financed, interest rates

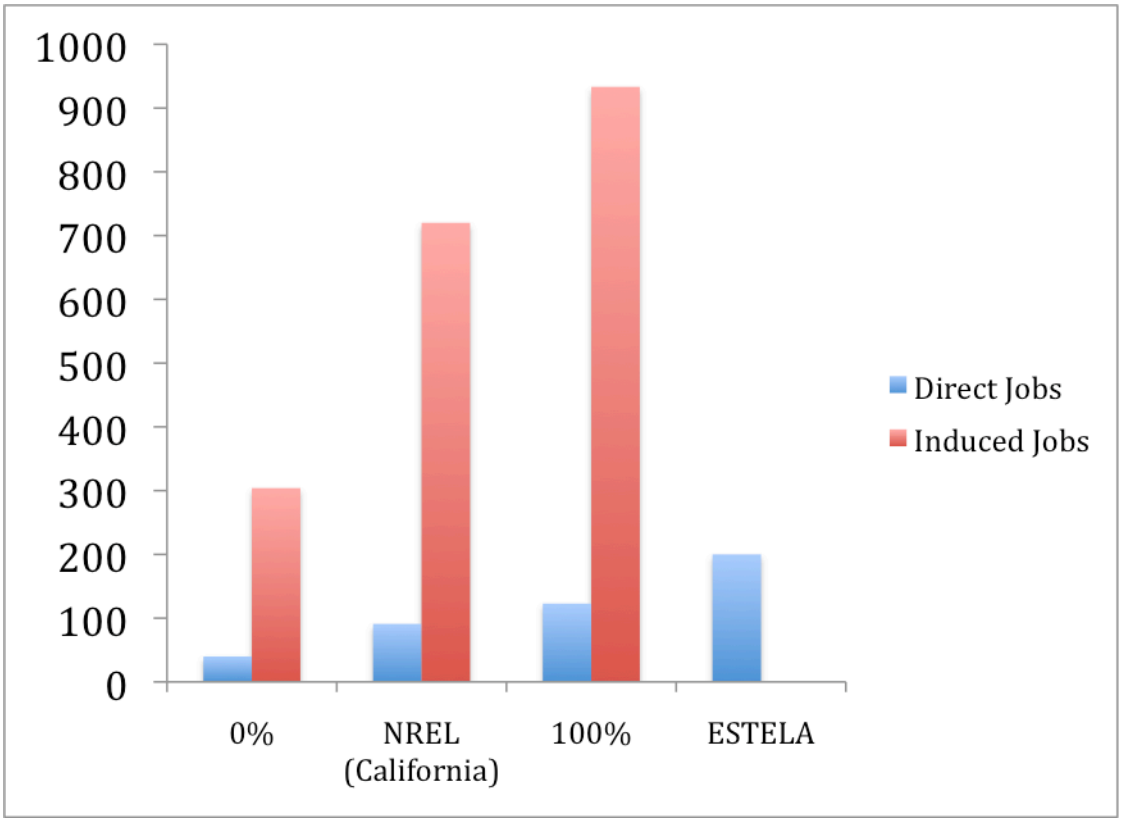
To be able to compare these results with estimations produced by NREL, we calculate the number of job-years produced by installation of 100 MW of CSP capacities (table 1).

Table 1: number of job-years created per 100 MW of CSP capacities

Jobs years per 100 MW	0%	40%	60%	100%
Planning and Construction	74	83	146	151
Materials and Components	126	240	284	463
Total Direct Jobs	200	323	430	614
Induced Jobs	1.520	2.455	3.268	4.666

The results allow us making two important conclusions. First, the number of job-years created in case when all components are manufactured locally exceeds the number of job-years created when all components are manufactured abroad by more than factor 3 (614 jobs comparatively to 200 jobs). Second, in case when all components are manufactured locally 100 MW of CSP capacities in North Africa create more jobs than 100 MW of CSP capacities in California (614 jobs comparatively to 455 jobs). The number of induced jobs is as well higher (4.666 jobs comparatively to 3.500 jobs). Our hypothesis is that the lower level of wages in North Africa in comparatively to California causes this difference. Even though the detailed answer to this question was out of the scope of this article and needs to be further researched.

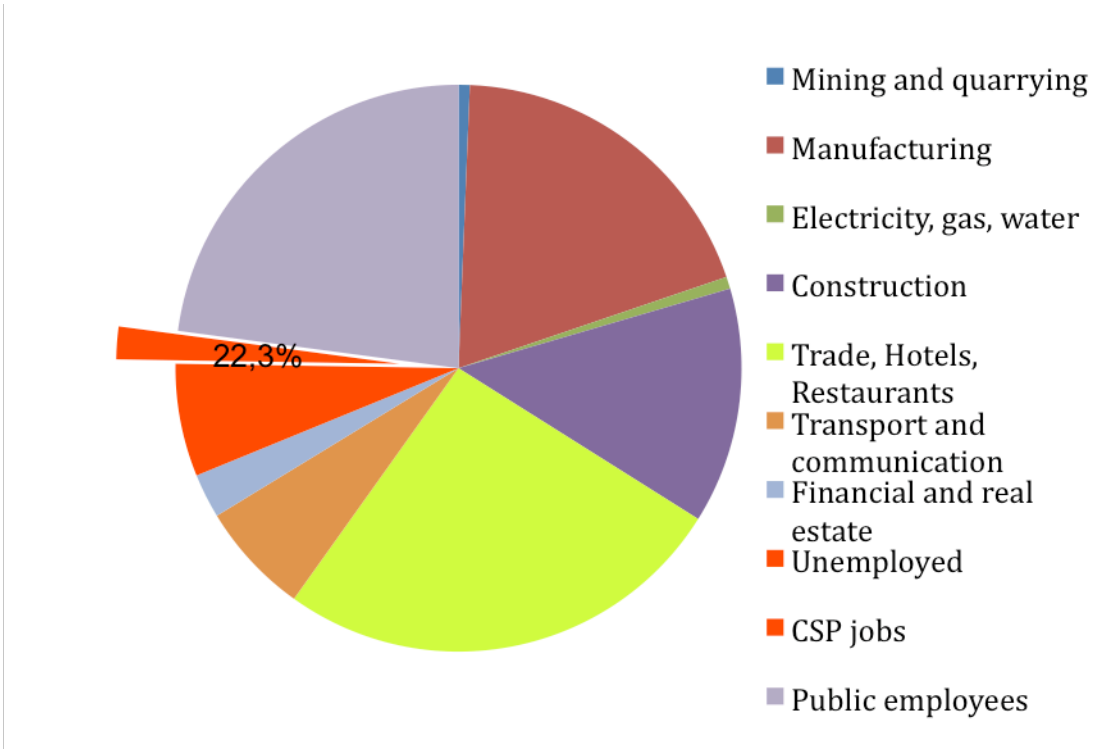
Further on we scale up the number of jobs generated per 100 MW up to 20 GW of CSP capacities to be able to compare our estimates with estimates given by ESTELA on employment creation caused by implementation of CSP (picture 1).



Picture 1: Scaled up comparison (thousands of job-years)

The methods used by ESTELA allow estimations of only direct job-years and do not catch induced employment. Our estimations tell that in case when all components are manufactured locally, the deployment of MSP, namely of 20 GW of CSP capacities, will create 122.600 direct jobs and more than 900.000 induced jobs. When all components are manufactured abroad MSP will bring to North African only 40.000 direct jobs and less than 300.000 induced jobs. The estimations of ESTELA are higher, saying that MSP will create 200.000 direct jobs, from which 40.000 will be in manufacturing in Europe.

Another interesting question was to see the meaning of these numbers mean on example of one concrete country. We took Morocco, as this country has an average unemployment rate in the region (picture 2).



Picture 2: Case study of Morocco, employment situation by sectors
Source: International Labor Organization, 2009

If we assume that all 20 GW of CSP capacities will be deployed in Morocco than 122.600 generated direct jobs can provide employment for one year for 22.3% of all unemployed people. The impact of induced jobs will be even greater and can provide employment for all unemployed people and to offer alternative employment for people occupied in other economic sectors.

Conclusions

Conducted research lead us to three important conclusions. First, CSP could contribute to employment at a level comparable with other sectors. Looking at one particular case of Morocco, only direct jobs can give employment to more than 22% of all unemployed people. Second, the induced effects from CSP deployment will be much larger than direct effects. Taken example when all components are manufactured locally, induced employment will make more than 900.000 job-years in comparison to 122.800 direct job-years. Third, increasing the share of locally manufactured high- and medium-technology components affects job creation by a factor 3, comparing two cases when all components are manufactured abroad, which will generate around 40.000 direct job-years, and the case when all components are manufactured locally, which will generate 122.800

direct job-years.

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