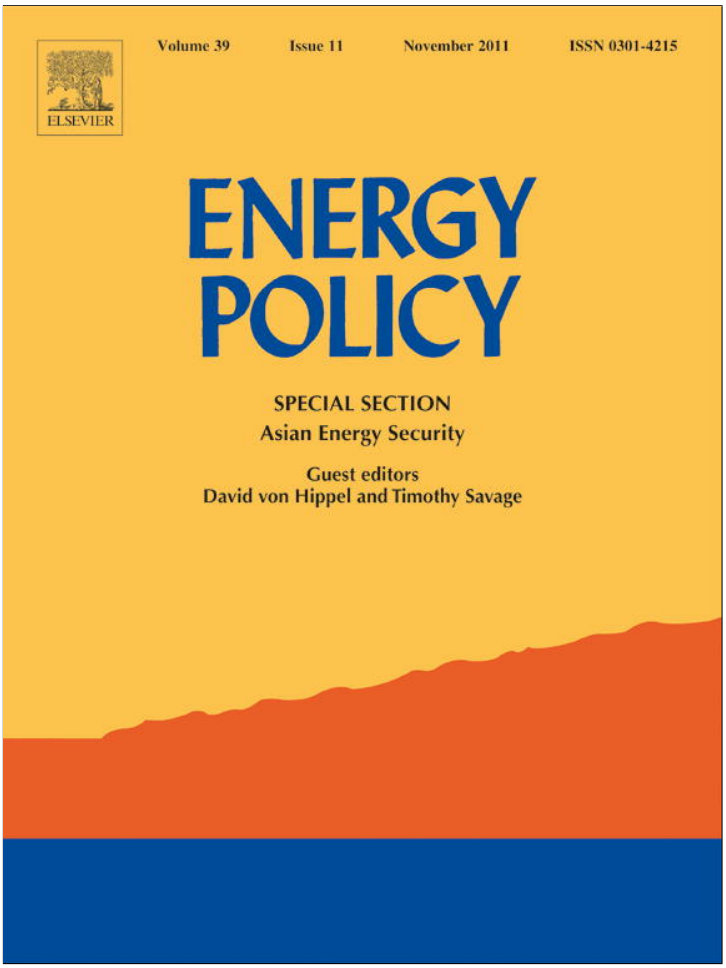

Energy Policy 39 (2011) 7184–7190

Contents lists available at SciVerse ScienceDirect

Energy Policy

journal homepage: www.elsevier.com/locate/enpol

Employment impacts of solar energy in Turkey

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ARTICLE INFO

Article history:
Received 3 August 2010
Accepted 18 August 2011
Available online 8 September 2011

Keywords:
Solar energy
Employment impacts
Turkey

ABSTRACT

Solar energy is considered a key source for the future, not only for Turkey, also for all of the world. Therefore the development and usage of solar energy technologies are increasingly becoming vital for sustainable economic development. The main objective of this study is investigating the employment effects of solar energy industry in Turkey. Some independent reports and studies, which analyze the economic and employment impacts of solar energy industry in the world have been reviewed. A wide range of methods have been used in those studies in order to calculate and to predict the employment effects. Using the capacity targets of the photovoltaic (PV) and concentrated solar power (CSP) plants in the solar Roadmap of Turkey, the prediction of the direct and indirect employment impacts to Turkey's economy is possible. As a result, solar energy in Turkey would be the primary source of energy demand and would have a big employment effects on the economics. That can only be achieved with the support of governmental feed-in tariff policies of solar energy and by increasing research-development funds.

1. Introduction

Energy is a vital source since it is one of the major inputs for the industry, as a prerequisite for sustainable development. Energy is also prominent for social development since it facilitates life through heating, lighting, transportation and it contributes to education and scientific studies. The current global trends in energy supply and consumption are environmentally, economically and socially unsustainable. Therefore, a lot of countries have focused on solar energy. To avoid carbon emission, to protect the environment to secure the energy supplies at the national level are very important issues, but the primary driving force for solar energy is much more likely the employment, the job creation or the contribution to regional economy and income improvement. Compared to fossil-fuel power plants, renewable energy generates more jobs per unit of installed capacity, per unit of power generated and per dollar invested (UNEP, 2008). Solar PV has the highest average job multiplier with a large gap between it and the next highest renewable technologies (geothermal and solar thermal) (Wei et al., 2009).

2. Employments impacts of solar energy in the world

Solar energy has provided millions of households with income, activities and employment up to 2009. The solar energies sector stood up well to the recession with over 100,000 jobs created in 2009 in EU-27, photovoltaic sectors (121,800 jobs in 2009) and solar thermal (48,970 jobs in 2009) provide most of these job creations (Observ'ER, 2010). The range of employment options goes from highly-skilled, research-related jobs in the design and manufacturing of solar energy products to jobs requiring a lower level of knowledge, for instance the maintenance of renewable energy systems and operations.

Some independent reports and studies that analyze the economic and employment impacts of the world solar energy industry have been evaluated in this study as summarized in the Appendix. These studies, which focus on calculating the employment impacts of the renewables industry, can be divided into two main types, which are named as direct and indirect jobs. The direct employment includes the job opportunities created in the manufacturing, delivery, construction/ installation, the project management and operation and maintenance (O&M) of the different components of the technology, or the power plant, under the consideration. The indirect employment includes jobs in the supply chain such as manufacturing of steel and other supplies. Most of these studies reported jobs in the amount of the labor required to manufacture the equipment or build a power plant, which can deliver a maximum of one megawatt of power. The different methods, assumptions, time horizons and unique countries of focus make it difficult if not impossible to accurately compare the results of different studies. For some of the studies, the authors used as some interview models with some important players and projects in the industry and concluded the employment figures of the ratio of the installed power. Some studies that focus on calculating the employment impacts of the renewables

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doi:10.1016/j.enpol.2011.08.039

industry have been used input–output models (I–O). I–O models calculate the direct employment but also account for the indirect jobs that are induced through multiplier effects of the industry under consideration.

According to the European Photovoltaic Industry Association (EPIA)—Greenpeace studies, more jobs are created in the installation and servicing of PV systems by 2030, that around 10 million full-time job opportunities would be created by the development of solar power around the world. Based on the information provided by the industry, it has been assumed that 10 jobs per MWp (megawatt peak) are created during production and about 33 jobs per MWp during the process of installation. Wholesaling of the systems and indirect supply (for example in the production process) each one create 3–4 jobs per MWp, research adds another 1–2 jobs per MWp (EPIA, 2008a). The Electric Power Research Institute (EPRI) report includes estimates of job creation from solar energy that construction employment rate is 7.14 jobs/MWp for PV, operating employment rate is 0.12 jobs/MWp for PV (EPRI, 2003). According to the European Renewable Energy Council (EREC) Report, with the expected growth of solar thermal, more than half a million people will be employed in the solar thermal sector in just a few decades. For CSP Power Plants, every 100 MWp installed will provide 400 full-time equivalent manufacturing jobs, 600 contracting and installation jobs and 30 annual jobs in O&M (EREC, 2009). Job creation impact of CSP development information that is given by the Abengoa Solar in Solucar Platform-Sevilla for 500 MWp is as follows (Abengoa Solar, 2010):

- 2,000 jobs for manufacturing of some components (assuming 50% local sourcing).
- More than 1,500 jobs during construction.
- Around 100 highly qualified staff will be needed throughout the plant's lifetime.
- More than 300 jobs for operation and maintance during the entire life of the plant.

In most countries, the renewable energy production is increasing, therefore opening new business opportunities for industrial development. Increased industrial activities will create job opportunities named Green jobs. "Green jobs" and "green-collar jobs" are new brand and therefore ambiguous terms (Center on Wisconsin Strategy, The Workforce Alliance, The Apollo Alliance, Greener pathways, 2008). Solar panel installers, solar lab technicians, etc. will be middle-skill jobs requiring more than high school education. Financial analysts and engineers are also required as high-wage jobs in the solar industry and they directly contribute to the building of a green economy. The green jobs require a wide range of skills including:

- Professional project development skills associated with the exploitation of business opportunities (e.g. financial management, business planning, project management legal skills, marketing and sales & services).
- Technical skills associated with the manufacture, construction and installation of renewable energy projects (e.g. electrical, mechanical, civil, combustion, process, electronics, software and environmental engineering).
- Specialist technical skills in engineering, environmental and planning at a professional level associated with consultancy services, project development and R&D activities.
- Specialist knowledge of complex form manufacturing, such as gear profile manipulations, modeling and design.
- Skills necessary to develop and maintain a fuel supply system for energy crops.
- Power system design and engineering, which includes special software and hardware.
- Control skills to allow for monitoring more complex networks that result from increased renewable projects.

2008 United Nations Environment Program (UNEP) International Labor Organization (ILO) study on green jobs conducted in collaboration with the World Watch Institute reports that there were 170,000 jobs in PV, 624,000 jobs in CSP sector in the world by 2008. The job potential will be higher in the developing countries than in industrialized countries mainly due to lower labor costs (UNEP and SEFİ, 2009). According to the SET-Plan of EU, the total public and private investment needed in Europe over the next 10 years is estimated as 16 billion EURO. Up to 15% of EU electricity could be generated by solar power in 2020 as a result of such a program coupled with market-based incentives. When this target is achieved, more than 200,000 high-skilled job opportunities could be created (EU, 2009). The PV industry can be of great importance to Europe in terms of wealth and employment, with 59,000 PV related jobs in the EU in 2010 if the targets are met, and a figure of 100,000 jobs would be realistic if export opportunities are exploited. (JRC, 2008). The Solar Energy Research Education Foundation (SEREF) has produced maps illustrating the growth of jobs likely to result from growth in the solar energy industry for the USA. They got help from Google Earth Outreach and Google.org to produce the maps using Google Earth technology. The maps show over 400,000 new jobs due to solar energy industry growth by the year 2016 (Gearthblog, 2009).

3. Solar energy in Turkey

The Republic of Turkey (Turkey) is located between the two continents as a natural bridge connecting Europe and Asia. Therefore, it has an increasingly important role to play as an 'energy corridor' and 'energy hub' in between the major oil and natural gas producing countries in the Middle East and Caspian Sea to Europe. In addition, Turkey, with its young population, growing energy demand per person, fastest growing urbanization, and economic development, has been one of the fastest growing power markets in the world for the last two decades. Electricity has been one of the most important energy inputs for industrial development in Turkey. The main objective of the energy policy of Turkey is to meet the energy needs of an increasing population and a growing economy in a continuous, quality and secure manner at a minimum cost in a competitive free market environment. As shown in Fig. 1, 48.0% electricity production derived from natural gas, 29.1% from coal-lignite and 19.5% from renewable energy sources (hydro, wind and geothermal) (DPT, 2009). Due to insufficient domestic resources, 97% of natural gas, 93% of fuel oil, 20% of coal-lignite demand for electricity generation has been imported (TEÜAŞ, 2008). At current projections, the energy sector of Turkey by 2023 will require USD

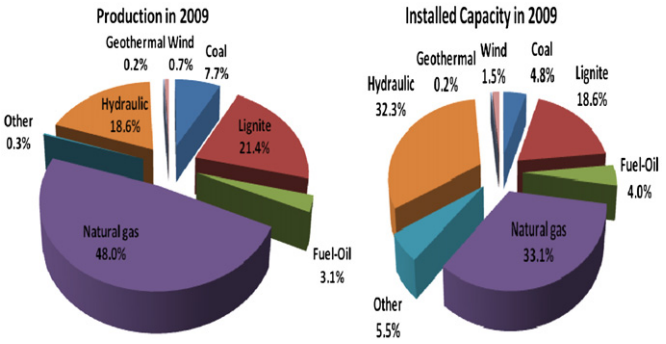

Fig. 1. Electric production and installed capacity by resource type in Turkey at 2009.
Source: DPT, Medium Term Program 2010–2012, September 2009.

130 billion of investment and electricity demand by 2020 will be 420,000 GWh. In 2007, Turkey spent a total of USD 33.9 billion and in 2008 USD 48.2 billion importing energy supplies and related materials (Türkyılmaz, 2010).

Announced development plans of Turkey, the main objectives of its energy policy are to ensure sufficient, reliable and economical energy supplies in order to maintain economic and social development, to meet the growing energy demand, reform and liberalize the energy sector to increase productivity and efficiency and to advance transparency. However, specific strategic plans, and targets focusing on solar energy have not yet been announced and published by the government.

At the end of December 2010 the Turkey's Parliament announced a change in the legislation for renewable energy resources market in Turkey. The new legislation regulates the volume of energy the state allows to buy and determinates new feed-in-tariffs for the different kinds of renewable energy resources. The law limits the total production of licensed solar energy companies to 600 MWp annually until December 31, 2013, and then authorizes the cabinet to determine the limits afterwards. The law guarantees a price of 13.3 USD cents per kilowatt-hour for energy from solar energy. These prices will cover energy firms that are established between May 13, 2005, and December 31, 2015. For energy purchases from companies founded later than December 31, 2015, new prices defined by the Cabinet will be implemented. The prices for the new companies will not exceed the current figures, the law said. The new legislation to use more renewable energy should have been much more encouraging. It's a start but the tariffs are too low to attract international investors. According to many environmentalists, market analysts and solar developers, the solar industry in Turkey could become one of the biggest in the world if its government offered solar producers as much regulatory and financial support as the governments of Germany and Spain, which offer solar producers generous feed-in tariffs.

At least 60 countries—37 developed and transition countries and 23 developing countries—have some type of policy to promote renewable power generation. The most common policy is the feed-in tariff (FIT). By 2007, at least 37 countries and 9 states/provinces had adopted feed-in policies, more than half of which have been enacted since 2002. Strong momentum for FIT continues around the world as countries enact new feed-in policies or revise existing ones. At least 44 states, provinces and countries have enacted renewable portfolio standards (RPS), also called renewable obligations or quota policies. There are many other forms of policy support for renewable power generation, including capital investment subsidies or rebates, tax incentives and credits, sales tax and value-added tax exemptions, energy production payments or tax credits, net metering, public investment or financing, and public competitive bidding (EPIA, 2008b).

Fortunately, non-profit organizations and research networks are continuing their efforts on a solar energy roadmap for Turkey. One of these, UFTP (the National PV Technology Platform in Turkey) has completed a PV roadmap for Turkey (October 2009). The objectives are (UFTP, 2009):

- Establish the first solar energy plant with a capacity of 20 MWp/year by second quarter of 2012.
- Installed power target of 4 GWp by 2020, locally produce 50% of panels, cells and inverters by 2020.

Academicians and industry representatives have been working on the roadmap for solar energy in Turkey that have been presented at the conference Solar Future 2010, dated 11–12 February 2010, and organized by ICAT (the International Center of Applied Thermodynamics) and Yeditepe University. The vision for the roadmap is to provide at least 30 percent of the electricity of Turkey's energy by 2020, providing consumers and energy providers with affordable, reliable, secure and diverse solar energy. Market, research and development, installed capacity targets and related important issues have been included by roadmap for PV, CSP and Solar heating and Cooling. Despite all the uncertainties of the legislation period in Turkey for solar energy, the targets of solar roadmap are very important figures for strategy and politics of solar energy in Turkey as shown Table 1 (ICAT, 2010).

4. Employment impacts of solar energy in Turkey

The positive impacts of an increasing share of solar energy on the mitigation of climate change and on decreasing the dependence of energy imports are indisputable. Solar energy technologies stand out in the way of creating direct employment. In addition, goods and services are required from other industries thereby indirectly providing employment via subcontractors and suppliers. Secondly, foreign trade plays a role. Foreign trade undoubtedly introduces a challenge to the employment effect analyses. This issue of foreign trade is expected to become increasingly prevalent in the future as the number of large solar energy companies expanding to international status increases. Gross employment is the result of the sum of direct and indirect employment derived from the national and international turnover of domestic companies. While this figure is always positive, there are counterbalancing effects and the total —net—employment effect can be positive or negative. Because of this reason in this study the employment impacts of a power generation project have been analyzed with the following figures, which were based on estimates for calculating direct employment of solar energy in Turkey.

PV jobs created:

- 346 jobs/MWp for installation 2.7 jobs/MWp operation and maintanace (Federal Ministry for The Environment, Nature Conservation and Nuclear safety, ZWs and DLR, 2007).

Table 1
Solar roadmap target figures.
Source: ICAT.

Subjects	PV			CSP		
	2010	2020	2030	2010	2020	2030
Domestic production of PV and CSP parts		30%	60%		70%	100%
Domestic production of grid connection		60%	80%		–	–
System installation cost (EURO/Wp)	3	1.7	1	2.8	2	1
Total power installed capacity (MWp)		4,800	7,000		200	1,000
Power generation cost (EURO cent/kWh)		12	6		6	4

- 10 jobs/MWp of PV panel production capacity, 36 additional jobs/MWp installed capacity in the wholesale, retail, installation and maintenance services sector (JRC, 2008).

CSP Jobs created:

- Every 100 MWp installed will provide 400 full-time equivalent manufacturing jobs, 600 contracting and installation jobs, and 30 annual jobs in O&M (EREC, 2009).

Table 2 shows employment impacts of solar energy in Turkey with target value from solar roadmap. As as result, totally direct employment are approximetly 200,000 persons of solar energy power plant in Turkey. Validity of these figures depends on the government's support and employment policies. In order to grow a successful and sustainable solar market, stable and supportive policies and regulations are needed over an extended period of time. Fluctuating or short-term policies do not provide the support needed for investment in large-scale solar power projects, which depending on the technology; take 1–5 years to place in service.

Direct employment impacts are the jobs directly installed by the project in the region on installation, operating and maintenance and service facilities. Indirect employment impacts are also referred to as the "multiplier" impacts of each dollar spent in the region. These impacts are created when a dollar is spent on goods or services produced by suppliers in the region. For example, if a dollar is spent on equipment manufactured in the region, the manufacturer spends a portion of this dollar to hire additional employees, expand production and purchase goods and services. The degree to which a dollar spent on a particular industry is re-spent in the region is the "multiplier" for that industry. There are also multiplier impacts created by other expenditures. This multiplier is usually estimated for regional economics, using an economic base technique. Because some industries (sectors) tend to induce more local purchase per export dollar than others, different sectors of an economy have different multipliers. Therefore, economists also estimate sect oral multipliers, which indicate the change in total economic activity (employment, income, or output), generated by a one unit change in exports of a given sector. In some sectors the multiplier effect is high; in some of them it is very low. USA Central Bank (Fed) has made an analysis, which gives an idea about the multiplier effect. According to the research, the industry with the highest multiplier effect is 2.87 in automobiles and vehicle manufacturing sector. Others multipliers effects are (Ateş, 2010):

- Food and tobacco production 2.61.
- Agriculture 2.33.
- Construction 2.27.
- Public investment 2.22.
- Defense 1.91.
- Service sectors 1.49–1.39.

The development of any type of solar energy project generates direct employment impacts on the economy. On the other side, the indirect effect on employment consists in all those jobs created in those other sectors in the economy that supply inputs to the industries that directly provide goods and services to the project. The multiplier effect is a number that indicates by how much a certain economy is going to grow due to a certain project development taking into account both direct and indirect effects. That is, for every monetary unit invested in the project, how much money is generated in the economy as a whole? The general formula to compute the multiplying effect (M) is: Multiplier=Total effects/Direct effects (Caldeś, 2009). If multiplier effect of solar energy in Turkey is theoretically accepted as 2, total employment effects of solar energy would be 350,000–450,000 people. According to the TUİK report dated 15.4.2010, the overall unemployment rate is 13.5% in total and the rate is 15.6% is urban areas, 40.1% of the unemployed are university graduated (highly educated and skilled). The unemployed count in 2010 is a total of 3,361,000 people. 3,026,000 of these unemployed people have work experience. Solar energy will create high skilled jobs due to technology marketing and research and development functions in Turkey. If solar power technology is used in electricity production with a skilled workforce, high unemployment rates will be significantly less in Turkey. The following factors also have additionally significant economics impacts altough they can not be calculated exactly:

- Market attractiveness as an investment location for multinational firms.
- Sales revenue of solar industry and multiplier effects of these revenues into economy.
- Value-Added Taxes (VAT).
- Social insurance institution (SGK) effects.
- Income tax effects for employment and instutions.

In the long run additional effects such as growing export capabilities may be important. An industry that is able to produce investment goods for the renewable energy industry (photovoltaic cells etc.) can increase value by exporting these goods. There may be positive effects on the economy and unemployment as far as the exported goods contain parts crafted domestically. This is of course, related to a lot of macroeconomic factors determining the comperative advantage of one country against other countries in the same industry. This comperative advantage may be higher in industries with high technological specificness than in other areas.

5. Conclusion

Turkey has the potential to be an example of success in the solar energy economy, but the additional efforts are needed. As an initial step, the government of Turkey should set strategic targets for the growing a sustainable solar energy market. Solar energy systems should be immediately placed in Turkey's energy production policy to meet the increased demand for energy. It is necessary to plan the use of solar energy by cost effective methods. The local production of solar energy technology can reduce the investment

Table 2
Employment impacts of solar energy in Turkey in 2020.

Subjects	PV	CSP	**TOTAL**
Construction budget (EURO/Wp)	3–1.7	2.8–2	
Installed power (MWp)	4,800	200	
Investment (million EURO)	14,400–8,160	560–400	**14,960–8,560**
Employement/MWp	37–46	10	
Total employement (person)	**177,000–220,800**	**2,000**	**179,600–222,000**

Table A1
Employment and economics impacts in different studies for countries.

No	Year	Author	Study	Countries	Contents	Time horizon	Funding/ınvestment	Job/employee
1	2010	Bloomberg, New Energy Finance	Presentation 2010, http://www.newenergyfinance.com/free-publications/presentations/	World-wide	Clean energy	2009	USD 145 billion	
2	2009	EREC	Renewable Energy Technology Roadmap 20% by 2020	Europe Union	Solar thermal	2009		20,000 full-time jobs
				World-wide	PV	2007	EURO 14 billion	119,000 people, For CSP Power Plants, every 100 MW installed will provide 400 full-time equivalent manufacturing jobs, 600 contracting and installation jobs, and 30 annual jobs in O&M
3	2009	EU	Investing in the Development of Low Carbon Technologies (SET-Plan), COM(2009) 519 final	Europa Union	Solar power electiricity	2020	EURO16 billion	200 000 skilled jobs
4	2009	JRC	PV Status Report	Tawian	PV	2010	EURO 645 million	10,000 jobs created after law in 2009
5	2009	Bezdek, R.H.	American's Solar Energy Societies Estimating the Jobs Impacts of Tackling Climate Change	USA	Renewable energy and energy efficiency	2007	USD100 billion	9 million jobs, $100 billion in corporate profit, and more than $150 billion in federal, state, and local government tax revenue
						2030	USD 4.3 trillion sales	37 million jobs
6	2009	O'Sullivan, M. (DLR), Edler, D., (DIW), Ottmüller, M.,(ZSW), Lehr, U., (GWS)	Gross Employment from Renewable Energy in Germany in the Year 2008	Germany	PV	2008	EURO 5.2 billion	57,000 jobs. In total the turnover from the German PV industry is estimated at €5.2 billion. Taking into account operations and maintenance
					CSP		EURO 1.2 billion	17,400 jobs
7	2009	RWI	Economic impacts from the promotion of renewable energies: the German experience	Germany	Solar Industry	2008		74,000 jobs
8	2009	Universidad rey Juan Carlos	Study of the effects on employment of public aid to renewable energy sources	Spain	PV	2008		14,500 direct jobs 1.112517241 Investment (in M€)/job
9	2008	EPIA, Greenpeace	Solar Generation V—2008, solar electricity for over one billion people and two million jobs by 2020	world wide	PV	2030		By 2030, around 10 million full-time jobs it has been assumed that 10 jobs are created per MW during production and about 33 jobs per MW during the process of installation. Wholesaling of the systems and indirect supply (for example in the production process) each create 3–4 jobs per MW. Research adds another 1–2 jobs per MW
10	2008	JRC	PV Status Report	World wide	Renewable energy and energy efficiency	2008	USD 148 billion	
				Europa Union	PV	2010		59,000 PV related jobs , a figure of 100,000 jobs would be realistic if export opportunities are exploited
				World wide	PV			10 jobs per MW of capacity, 36 additional jobs per MW installed capacity in the wholesale, retail, installation and maintenance services sector
11	2008	US Department of Energy	Solar Energy Technologies Program, Multi year Program Plan 2008–2012	world wide	Energy supply	2011	USD 22 trillion	

12	2008	EUROGIA +, EUREKA Initiative	White book, part 1, version 1	Europa Union	Renewable energy	2008		500,000 direct and indirect employees, 900,000 new jobs by 2020 in Industry, Service and Universities and research Laboratories
13	2008	UNEP, SEF ALLIANCE	Why Clean Energy Public Investment Makes Economic Sense -The Evidence Base	USA—California	Green Energy and PV	2007		450,000 new jobs, 15,000 new jobs generated per billion dollars of expenditure on Photovoltaics . The estimates of jobs generated by PV differ by a factor of 8, from as few as 7.4/MW to as many as 51/MW
14	2007	Federal Ministry for The Environment, Nature Conservation and Nuclear safety, ZWs and DLR	International Workshop "Renewable Energy: Employment Effects" Models, Discussions and Results, 2007		PV			34.6 jobs/MWp for insatllation 2.7 jobs/MWp operation and maintanace
15	2006	Stoddard, L. , Abiecunas, J., and O'Connell, R. NREL	'Economic, Energy, and Environmental Benefits of Concentrating Solar Power in California'	USA	CSP	2006	USD 628 million /100 MW capacity	94+13 jobs /100 MW
16	2006	Bremer Energy Institute	Renewable energies—environmental benefits, economic growth and job	Germany	Renewable energy	1996–2006	EURO 10 billion	100,000 new jobs
17	2006	Federal Ministry for the Environment, Nature Conservation and Nuclear Safety	Renewable Energy Employment Effect; Impact of the Expansion of Renewable Energy on the German Labor Market	Germany	renewable energy	2020		300,000 (gross employment) by 2020
18	2005	MED-CSP, German Aerospace Center (DLR),	Concentrating Solar Power for the Mediterranean Region Final Report, Institute of Technical Thermodynamics Section Systems Analysis and Technology Assessment	MEDA Countries	Renewable energy	2050		2 million direct and indirect jobs
					PV			19 direct jobs/year during construction, 26 direct jobs during operation (20 years)
					CSP			20 direct jobs/year during construction,
19	2004	Kammen, D. M., Kapadia, K., Fripp, Matthias, UNIVERSITY OF CALIFORNIA BERKELEY	Putting Renewables to Work: How Many Jobs Can the Clean Energy Industry Generate? REPORT OF THE RENEWABLE AND APPROPRIATE ENERGY LABORATORY	USA	PV	2020		5.65 person-years of employment per million dollars in investment (over 10 years)
20	2004	Boira-Segarra, I. (Mott McDonald)	Renewable Supply Chain Gap Analysis, Study on behalf of the Department of Trade and Industry, January 2004	UK	Renewable energy	2020		£15 billion to £19 billion capital expenditure, 17,000 to 35,000 jobs could be sustained by the industry
21	2003	Environment California Research and Policy Center,	Renewable Energy and Jobs Employment Impacts of Developing Markets for Renewables in California	USA , California	PV	2001		7.14 jobs/MW for PV for construction, 0.12 jobs/MW for opration

costs significantly. The government, the universities and the companies should be encouraged by financial support to research and develop the uses of solar energy all around the country. The role of the government in formulating and implementing favorable policies for solar energy development is vital. But the private sector, which has the capacity to mobilize funds, needs to be involved in the renewable energy development.

Appendix

See Table A1.

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