Estimating economic impacts of introducing domestic content requirement in Indian solar policy using input output analysis

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Highlights

- **System cost modeling for grid connected ground mounted solar PV power plants under DCR and open categories for India**
- **Estimation of output, income and employment multipliers associated with DCR & open categories of solar power plants**
- **Analyzing distributive efficiencies associated with scaling up of grid connected solar PV in terms of qualitative differentiation of employment generation under DCR and open categories**

Abstract

Direct and indirect economic impacts of attaching domestic content requirements (DCR) in Indian solar policy are analyzed using Input output analysis. Methodology involves construction of an Independent solar I-O block for both DCR and open categories of solar deployment in India and integrating it as a new sector in , 2011 national input output table obtained from world input output databases (WIOD). The analysis tracks Inter industry transactions involved in installing a unit of grid connected ground mounted photovoltaic solar power capacity in India. Results show that although DCR based solar projects incur high initial installation costs, they also have significantly higher net positive impacts on Indian economy in terms of output, income and employment provisioning. Further, distributive efficiencies associated with quality of employment generated favors DCR deployments. Thus, contrary to the existing criticism for DCR's trade distorting potential, this study provides justifiable evidence towards policy instrument's potential to bring inclusiveness of local and regional developmental concerns while scaling up renewable energy technologies (RETs) in emerging economies.

Key Words: Regional Development, Domestic content requirement, Renewable energy, value structures, Input-output analysis

1 Introduction:

Input-Output analysis has been widely used to study impacts of policy changes on the energy sector. Currently there exists a growing body of literature dealing with study of socio economic impacts associated with scaling up RETs in both developing and developed economies. This research work aims at mapping socio economic impacts of using DCR as a policy instrument in Indian solar policy through input output analysis. The work differentiates itself by estimating distributive efficiencies of the employment generation associated with DCR based deployments in India.

India, being a tropical country has immense potential for solar power generation. In the year 2009, Government of India launched National Solar Mission (NSM) for systematically scaling up solar deployments in the country. NSM aims at strengthening preexisting solar manufacturing base in India along with laying an ambitious target to deploy 20GW (MNRE, 2009) of grid-tied solar power capacity by 2022 [1,2]. The mission initially attached stringent domestic content requirements (DCR) prohibiting installation of imported Crystalline-Silicon (C-Si) solar panels for NSM supported projects [3].

The DCR clause came under scrutiny for its trade distorting and economically taxing characteristics and was recently readjusted to capture emerging prices of the dynamic solar PV generation landscape in phase II of NSM (commenced, January 2014). Therefore first round bidding for second phase of NSM involving bids for deployment of 750 MW solar generation capacity provide equal allocation (375 MW each) for both DCR and open category projects

1. The NSM provides a range of incentives for not only Grid connected solar PV but also Solar thermal and stand alone installations catering to demand side.
2. The current NDA government has revamped the targets to 100 Giga Watt of grid tied solar installation predominantly PV based.
3. NSM projects are central(federal) government initiatives , State governments have discretionary powers to opt for imported panels
4. DCR Projects: In the study refer to only PV based installations in India which use indigenously manufactured C-Si solar panel, NDCR refers to open category installations with imported solar panels under National Solar Mission

This research uses Input output (I-O) framework for comparative estimation of direct and indirect impacts associated with installing 375 MW of grid connected ground mounted solar PV capacity under both DCR and non DCR categories. The paper goes beyond existing body of literature by empirically estimating impacts of using a policy instrument like local content requirement in renewable energy policies through I-O analysis.

The results of the study indicate that although DCR based projects are perceived to have higher deployment costs, they also have significantly higher net positive impacts on Indian economy. The estimated results show that gross direct and indirect output in case of DCR projects would be 2.6 times more than NDCR projects and the total employment generation potential is 2.2 times more. The two policy options also show a distinct difference in the quality of sectoral labour compensation generated during respective installations. The study demonstrates that DCR based projects generate more high skill and low skill labor compensation compared to NDCR projects which generates more medium skill labor compensation. Thus, reflecting on the distributive efficiencies of employment generation while scaling up solar power under DCR and non DCR conditions.

The paper is structured in five sections followed by references. After the introduction i.e. first section, section two provides brief literature review for the research undertaken. Section three details methodological overview and data sources for the work followed by Results and Discussion in section four. Section five provides conclusion for the research.

2 Literature Review

The literature review delineates relevant literature pertaining to interdisciplinary research undertaken in this study. The section discusses various policy aspects for renewable promotion followed by some classical IO studies pertaining to energy sector. The review also discusses current trend of transition in prevalent perception regarding socio economic impacts of scaling up renewable energy technologies within regional boundaries.

Unprecedented growth in renewable energy sector is a global phenomenon. This growth has largely been policy mediated with policy documents citing a wide variety of socioeconomic benefits like diversification of energy supply, enhanced regional and rural development opportunities, creation of domestic industry and opportunities for boasting exports to promote renewable energy scale up.(Allan et al , 2011; Rio and Burguillo, 2008, 2009; Reddy et al 2007) .

Acceptance of RET promoting policies largely depend on their perceived ability to contribute towards regional sustainable development. Therefore, although potential usefulness and legality of policy instruments like Local/Domestic Content Requirements (LCR/DCR) have been regularly contested on premise of their trade distorting impacts and lower allocative efficiencies, they are actively endorsed by recently formulated renewable energy policies of many countries (Kuntse & Moerenhout (2013).

This paper investigates impacts of DCR content in Indian solar policy. The existing DCR clause in Indian solar policy has been scrutinized in studies like Shrimali and Sahoo (2014) and Sahoo & Shrimali (2013) pointing towards deficiencies in Indian solar innovation system. These studies conclude that DCR criteria should be removed in order to make Indian solar sector globally competitive along with opening a possibility to leverage trade benefits associated with open markets in the solar sector. The studies do not account for regional socio economic benefits in terms of employment generation

Traditionally I-O analysis has been used for policy impact analysis in energy sector. For instance, studies mapping Dollar Energy Employment (DEE) impacts characterizing energy and input required to produce output needed to meet consumer demand (Folk and Hannon 1973; Hannon, 1972 ; Chapman , 1974) have been very common in the earlier literature. Further, Lainer et al. (1998) used I-O analysis to measure emissions, employment and other macro economic impacts derived from energy efficiency and low carbon technologies.

With global endorsement of the green agenda national level policies for promotion of renewable energy scale up have been assessed using IO methodologies. The main focus of these studies have been to determine the employment generating capacities of renewable energy deployment. The initial studies include studies by US DOE (1992) & Cook (1998) for USA , followed by Ecotech (1999) study on Agenda 2020 promoted by European Union.

The positive effects of RETs deployment have been analyzed in studies like (Cioba et al., 2004; Kulistic et al., 2007; Madlener and koller 2007, Allan et al., 2008; Kamen). There are many studies dealing with whole energy system planning under an integrated frameform using IO based analysis(Pfaffenberger et al., 2003; Umweltbundesamt, 2004; Hillerbrand et al., 2006; Lehr et al., 2008).

Further, assessment of technology specific macroeconomic impacts of renewable deployment by IO analysis have been done by studies like Kulistic et al. (2007) for determining net impacts of biodiesel production on Croatian economy and Caldes et al.(2008) for determining the economy wide impacts of policy goals to install 500 MW of solar thermal capacity in Spain. Recently studies like Malik et al. (2014) dealing with analyzing impacts of biofuel refining in Australia and Baer et al. (2015) analyzing job generation impacts of cogeneration in USA , have used an economy wide Input-Output frame work.

Cai et al. (2011) investigated relationship between green economy and green jobs in China using both analytical and IO models the study indicated that as the share of renewable energy which has an indirect employment impact increased for every one percent increase in share of solar PV generation there could be 0.68% increase in total employment in China.

Although job generation impacts of RETs are widely researched, there is a growing body of literature pointing towards ambiguities in forecasted values of green job creation associated with renewable energy deployment. For example very recently a study by Cameron et al (2015) point towards significant uncertainties in quoted figures for job creation potential of RETs, both across and within the existing studies. In the Indian context a study by Jain & Patwardhan, (2013) analyse impacts of renewable energy policies in India and conclude mixed impacts of scaling RETs for Indian economy depending on character and configuration of specific RETs.

Further a study by Cox et al (2015) find a negative unconditional cross price elasticity between labour demand and rising electricity prices due to renewable installation. The study shows that increase in electricity prices is leading to output reduction with low and high skilled labour being impacted more than medium skilled Resulting adverse distributional effects and potential overall job losses by renewable energy deployment.

Cai et al's (2014) study on distributional employment impacts of renewable and new energy development (RNE) in China report aggravation of gender inequality in the new, fast growing renewable energy sector in China

The literature review indicate that initial studies forecasting impacts of newly formulated national renewable energy policies reported positive socio economic impacts of RET scale up but as the deployment actualized various repercussions of on going scale up regime also became evident. The current paper focuses on estimating impacts that policy instrument like a domestic content requirement would bring on factor value creation while scaling up grid connected ground mounted solar power plant in an emerging economy like India. The next section details methodology and data sources used for estimating direct and indirect impacts of introducing a protectionist policy instrument in the form of domestic content requirement enabling growth of Indian solar sector.

3 Data Sources & Methodology

This research traces impacts of adding grid connected utility scale solar PV plants under DCR and non DCR conditions on intersectoral productive relations in Indian economy using input output analysis. The study is scaled to simulate existing targets under phase II round one of NSM involving bids for deployment of 375 MW solar capacity each under differentiated categories of DCR and non DCR (NDCR) or open category project deployment.

The methodology section includes three subparts. First subsection details methodology and data sources involved in constructing solar block for both DCR & NDCR projects. Subsection two details the methodology and data sources for the IO analysis conducted for this research work followed by subsection three dealing with methodology and data sources used to analyse distributive efficiencies of employment generation for work.

3.1 Constructing the solar block

The study introduces solar generation as a new production activity for Indian economy through construction of a separate final demand vector. Independent solar I-O blocks for both DCR and non DCR deployment are constructed and integrated as an additional sector in 35x35 national input output table (2011) available in world input output databases (WIOD).

Miller & Blair (1986) propose two approaches to capture new economic activity: i.e. through construction of a new final demand vector or through addition of new elements in technical coefficient table of an economy. Both the approaches assume already existing technical coefficients

As there is no substantial contribution of grid connected PV solar based power generation is in Indian energy mix till 2011 a solar production block is designed using expert data integrating engineering principles as elaborated later in the text. Direct coefficients for employment and household income were used to estimate output multipliers. Table 3.1 (a & b) delineate solar block formulated for both DCR and NDCR projects.

Both solar blocks compile data at purchaser's price obtained from 2013, MNRE benchmark pricing which include prices for C-Si PV panels, mounting structure, power conditioning unit, construction, preoperative costs, operation and maintenance and financial intermediates of ground mounted solar power plant in India. Followed by adjustments for existing fiscal elements like applicable subsidies, VAT, excise duty and incurred transportation costs.

The DCR block is differentiated by dissociation of solar panel manufacturing Industry into inputs for manufacturing module, wafer and cells within the economy while in case of non DCR solar blocks , solar panels feature in the imports column. The constructed solar blocks are added at a new sector (36th) in already existing 35X35 IO table obtained from WIOD data base. The following subsection details the IO analysis undertaken

Table 3.1 (a) Solar Block for DCR power projects

Inputs Solar Sector	Solar Panels	Balance of Operation	Charge Controller and Switches	Inverter	Construction and Civil Work	Land Transport	Water Transport	Insurance Pre-operative Cost	Financing Cost	Project Management Cost	Land acquirement
Sector Concordance for WIOD IOT	**Solar Sector (36)**	Basic & Fab Metal **(12)**	Electrical & Optical equipments **(14)**		Construction **(18)**	Surface travel **(23)**	Water Travel **(24)**	Financial Intermediation **(28)**			Capital formation

Input Solar Sector	**Module**						**Cell**					**Silicon Wafer**
Sector concordance	Packaging	JB, Ribbon, Back sheet	Frame	Electricity	Maintenance	glass	Screen	Energy	Chemicals	Maintenance	Metal Paste	IMPORT
Sector Concordance for WIOD IOT	Paper & pulp(7)	Basic & Fab Metal (12)	Basic & Fab Metal(12)	Electricity supply (17)	Machinery (13)	Other non metal (11)	Basic & Fab Metal (12)	Electricity supply(17)	Chemical (9)	Machinery (13)	Basic & Fab (12)	Solar Sector (36)

Table 3.1 (b) Solar Block for Non DCR power projects

Inputs Solar Sector	Solar Panels	Balance of Operation	Charge Controller and Switches	Inverter	Construction and Civil Work	Land Transport	Water Transport	Insurance Pre-operative Cost	Financing Cost	Project Management Cost	Land acquirement
Sector Concordance for WIOD IOT	IMPORT Solar Sector **(36)**	Basic & Fab Metal **(13)**	Electrical & Optical equipments **(15)**		Construction **(23)**	Surface travel **(23)**	Water Travel **(25)**	Financial Intermediation **(28)**			Capital formation

3.2 Input Output Analysis

I-O methodology facilitates integrated analysis by assessing direct and indirect economy wide impacts of growing solar sector on all other sectors of Indian economy. The study uses the basic Leontief I-O model of linear equations tracing out sources of each sectors inputs, whether they are purchased from other firms in the economy, imported or contributed by labour (wages and salaries). It also provides sales of each sectors output with sales to other industry and of final demand along with consumption, gross fixed capital formation.

The information from IO table has been utilized in the general form of Leontief model

$X=AX+Y$ (1)

Where A is the matrix of technical coefficient, X the vector of sectoral output and Y is the vector of sectoral final demand component. Eq 1

$X= (I-A)^{-1}$ (2)

Where I is an identity matrix, Matrix $(I-A)^{-1}$ of interdependence. Each element of that matrix indicate total (direct & indirect requirement of sector i for final demand output of sector j).

The study uses Matlab Simulink for estimating Leontief inverse. Along with 35 sector national IO table (2011) for India from World Input output database (WIOD). The database also provides associated annual Socio Economic Accounts (SEA) providing industry wide wages and employment by skill type.

Its assumed that grid connected solar PV installations is a new economic activity thus all fixed assets are newly purchased and calculated through perpetuary inventory method (Quang Viet, 2000). This is to make block maximally adjusted to existing national pecuiliarities.

A commodity flow table was created to ensure balanced supply and use of inputs and or outputs of solar block and adjusted to conventional form of I-O table. The output of solar sector is in the form of electricity directly connected to the grid, the new sector is assumed to supply its entire output to the electricity sector. The study initially simulates the inter industry exchanges involved in an year when the solar power plant is installed.

The industry specific literature indicates (Bridge to India, 2013, MNRE, 2013) that on an average it takes 10 months for solar power plant to start its operation fully after successful land acquisition. Therefore in the year of commissioning (t) output equivalent to 2 months of solar generation is considered with average normative capacity utilization factor of 19 % (CERC, 2009) prevalent in India. The year t includes all the inputs required for installing the solar power plants along with factor inputs in terms of labour and capital formation and output in terms of 2 months of power generation. MW of solar power generated was converted to million dollars of value using latest input output table for India(2007) adjusting for inflation and currency depreciation.

Input ouput linkage in terms of Leontief coefficients were obtained for the two scenarios. These were used to obtain value of output, income and employment impacts on the economy due to solar power plant deployment under DCR and open categories.

3.3 Estimating distributive efficiencies of solar deployment

Further, distributive efficiencies of DCR and NDCR deployment in terms of type of labour compensation generated with DCR and non DCR based solar deployment was estimated on the basis of the total sectoral direct and indirect output generated and sectoral employment coefficient for India (WIOD Socio Economic Accounts (SEA). The accounts provides data for sectoral labor distribution in terms of low skilled labour, medium skilled labour and high skilled labour. The data was used to estimate job compensation distribution under DCR and NDR categories for India.

The study involved estimating economic activity associated with manufacturing components and deployment of grid connected ground mounted solar power plant in India in the commissioning year calibrated to 2011 IO table in WIOD. The model assumes an existing manufacturing capacity fulfilling the input demands for 750 MW of solar deployment along with 375 MW of solar panel manufacturing. Thus the capital creation associated with increasing manufacturing capacities have not been included in this study. Although DCR as policy instruments are primarily used to provide protection to nascent developing Industrial sector the research focus in this paper lies in estimating the comparative socio economic impacts of DCR and open categories of solar deployment in India. The next section details relevant finding for the research work undertaken.

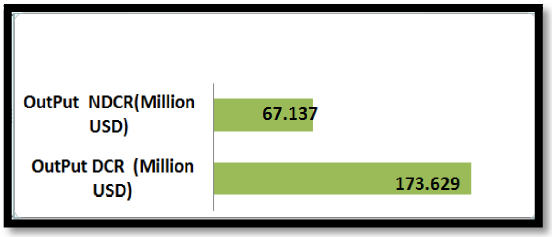
4 Result & Discussion

The results show that using DCR content in solar policy favorably impact Indian economy in terms of increased output, employment and income generation. The study estimated direct and indirect economic outputs associated with deployment along with output multipliers for DCR and NDCR deployment. Values obtained for top ten sectoral multipliers are presented in Table 4.1. The results show that other non metallic minerals sector provides highest backward linkage relationships followed by solar sector in both DCR and non DCR conditions with multipliers of 5.16 & 4.39 respectively. High value of multipliers indicates a strong interrelation of sector with other sectors and ability to induce direct and indirect impacts in Indian economy.

Table 4.1: Sector specific Output multipliers DCR, Non DCR and No solar inclusion

DCR Output Multiplier			NDCR Output Multiplier			W/o Solar Output Multiplier	
Other Non-Metallic Mineral	6.47		Other Non-Metallic Mineral	6.03		Other Non-Metallic Mineral	5.81
Solar Sector	5.16		Solar Sector	4.39		Manufacturing, Nec; Recycling	3.00
Basic Metals and Fabricated Metal	4.62		Electrical and Optical Equipment	3.54		Rubber and Plastics	2.84
Electrical and Optical Equipment	3.85		Manufacturing, Nec; Recycling	3.2		Basic Metals and Fabricated Metal	2.72
Machinery, Nec	3.6		Basic Metals and Fabricated Metal	3.19		Construction	2.7
Construction	3.42		Construction	3.18		Transport Equipment	2.65
Manufacturing, Nec; Recycling	3.41		Rubber and Plastics	2.92		Machinery, Nec	2.65
Transport Equipment	3.2		Machinery, Nec	2.86		Electrical and Optical Equipment	2.62

The sectors showing net gain in output also experience employment gains. Further, the analysis indicated that DCR deployments shows 2.2 times more employment generation (direct & indirect) than projects under NDCR scheme (Fig4.2).



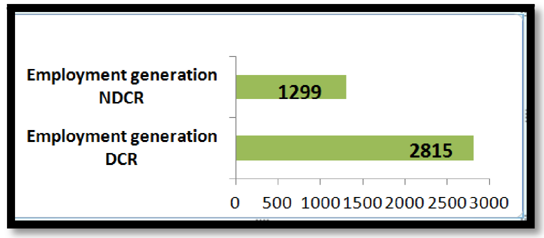


Figure4.1: Gross output change under DCR & NDCR projects. Figure 4.2: Employment generation (Direct & indirect) under DCR and NDCR projects.

The distribution of economy wide labor compensation due the DCR and non DCR projects is estimated with the help of WIOD, SEA database. The results indicate that NDCR or open category projects would generate more medium skilled labor compensation (Fig 4.3) than DCR projects while DCR based installations would lead to greater generation of labor compensation in low and high skilled labor group as illustrated in the figure 4.4 & 4.5.

Recent literature dealing with employment impacts of renewable energy policies (Rivers, 2013) indicate that local socio economic benefits from renewable energy policies are only possible when elasticity of substitution between labor and capital is low and when capital is not internationally mobile. Further, the benefits would accrue when labor intensity of renewable generation is high as compared to conventional generation.

In case of solar PV sector possibility of high skilled permanent employment generation predominantly occurs during manufacturing stage, followed by a small number associated with operation and maintenance of the plant (Rio & Buiguillio, 2010). Furthering this is the fact that at present there exists a strong trend towards vertical integration of solar PV manufacturing sector instrumented by use of fully automated assembly lines leading to greater probabilities of labor capital substitution in the sector. This also further reduces future possibility pertaining to international fragmentation of factors or splicing of supply chain thus concentrating manufacturing of solar panels in a region or territory which already has monopoly in the market.

Fig 4.3 : Sectorwise Labour Compensation profile for medium skilled labor in DCR and non DCR installation

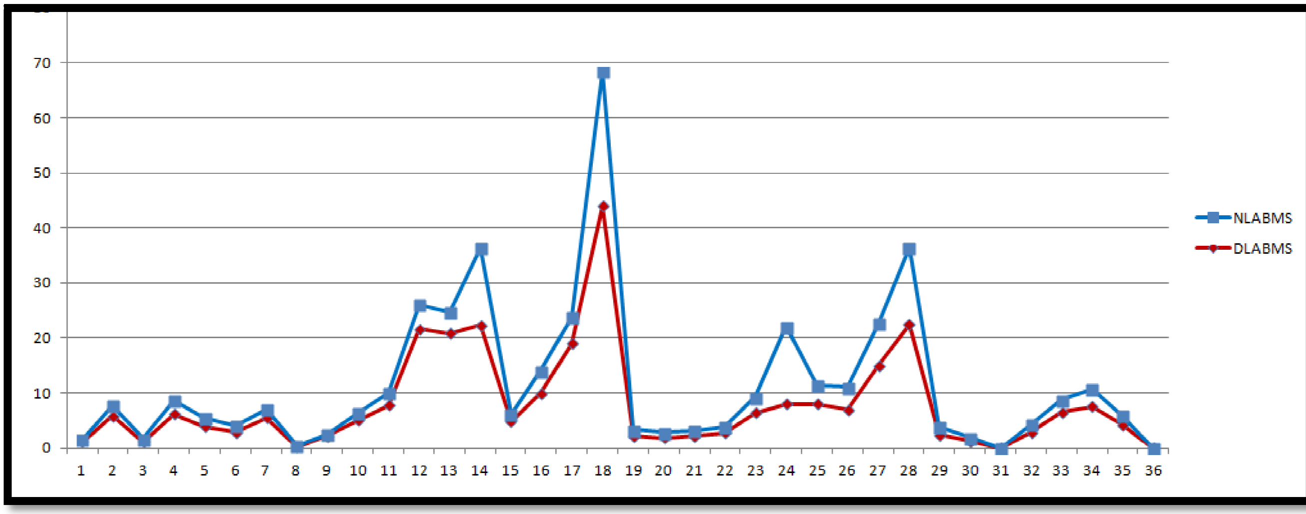


Fig 4.4 : Sectorwise Labour Compensation profile for low skilled labor in DCR and non DCR installation

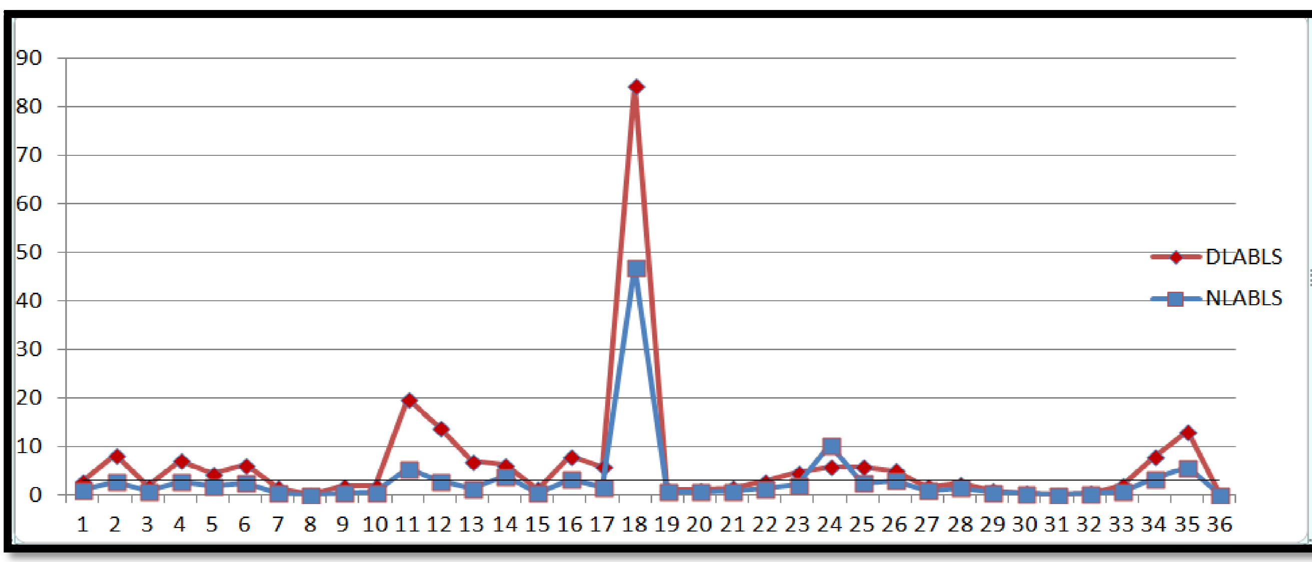
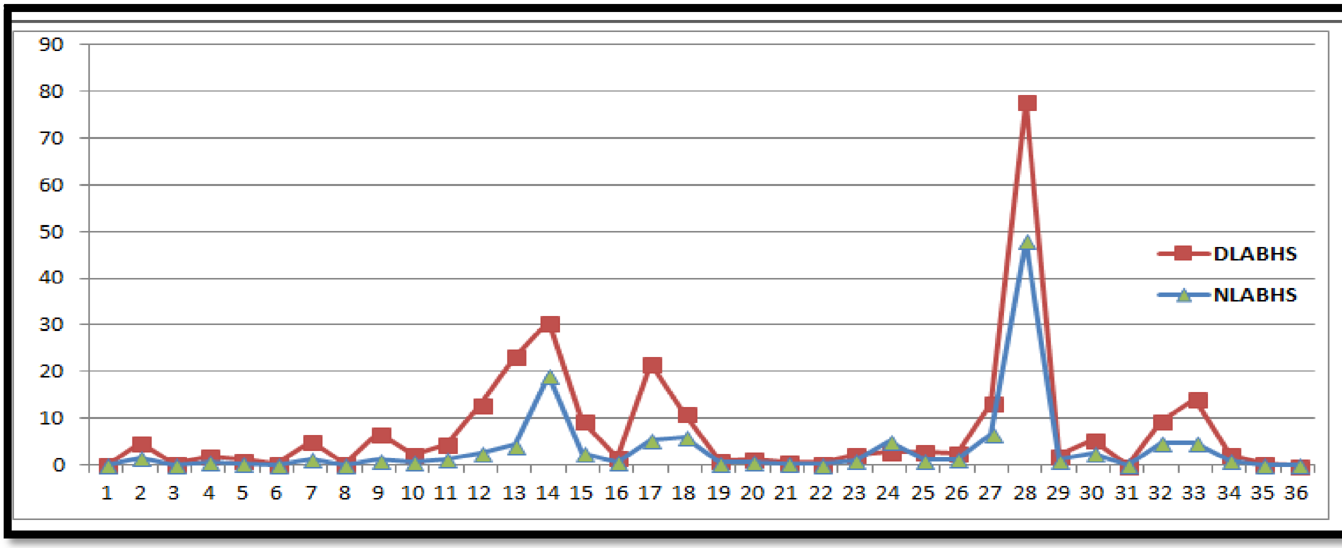


Fig 4.5 : Sectorwise Labour Compensation profile for high skilled labor in DCR and non DCR installation



According to Veloso (2000) welfare effects of DCR are well established primarily in the cases where there exists a generic gap between social and private opportunity costs of resource use by an industry or when there is a strong possibility of learning and knowledge spillover associated with foreign manufacturer investing in developing economies. The authors argue that for efficiently leveraging economic growth opportunities rendered by National Solar Mission, strategies to home the capital associated with solar manufacturing becomes critically important. Policy instruments like DCR have potential to play a pivotal role in homing the characteristically mobile capital of solar PV manufacturing by providing an opportunity of long term stable solar market demand and also ensuring domestic employment creation.

5 Conclusion

Ensuring sustainable supply of energy is a unique challenge Indian economy posed with conditions of energy poverty, greater climate change vulnerabilities and high population growth rates. Thus policies formulated for renewable energy scale up and deployment have to scrutinized for their efficiency to meet multiple goals focusing towards sustainable economic growth and domestic employment. The results of this research in terms of output, income and employment generation strongly indicate that DCR based deployment may initially be expensive in terms of levelised cost of solar electricity generated but has the potential to emerge as an effective endogenous growth policy aligned to accrue better distributive efficiencies towards economic sustainability in India.

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ANNEXURE **Table 1: Solar Block for DCR Projects**

Products at purchasers price	Intermediate Industries												Total Economy	Gross capital Formation	Total industry output at base price
	Solar Sector (36)	Basic & Fab Metal (12)	Paper (7)	Other non Metals(C11)	Chemicals (C9)	Maintenance (19)	Electricity (17)	Construction (18)	Electrical & Optical equipments (14)	Financial Intermediation (28)	Water travel (24)	Surface Travel (23)			
Solar Silicon wafers (Imported)	193.43	0	0	0	0	0	0	0	0	0	0	0	193.43	0	193.43
Backsheet, ribbon,Frame, Screen, metal paste	0	103.79	0	0	0	0	0	0	0	0	0	0	103.79	0	103.79
Hot Galvanized Steel Frames	0	21.9	0	0	0	0	0	0	0	0	0	0	21.9	0	21.9
Packaging	0	0	4.84	0	0	0	0	0	0	0	0	0	4.84	0	4.84
Glass	0	0	0	24.18	0	0	0	0	0	0	0	0	24.18	0	24.18
Chemicals	0	0	0	0	14.5	0	0	0	0	0	0	0	14.5	0	14.5
maintenance	0	0	0	0	0	29.01	0	0	0	0	0	0	29.01	0	29.01
Electricity	0	0	0	0	0	0	14.5	0	0	0	0	0	14.5	0	14.5
Ground Leveling & civil work	0	0	0	0	0	0	0	27.56	0	0	0	1.10	28.66	0	28.66
Wires & transmission, Switches charge controller infrastructure,	0	0	0	0	0	0	0	0	33.64	0	0	0	33.64	0	33.64
Invertors	0	0	0	0	0	0	0	0	26.50	0	0.55	0.34	26.84	0	26.84
Insurance	0	0	0	0	0	0	0	0	0	1.72	0	0	1.72	0	1.72
contingency	0	0	0	0	0	0	0	0	0	5.16	0	0	5.16	0	5.16
Interest during construction	0	0	0	0	0	0	0	0	0	17.20	0	0	17.20	0	17.20
Project Management	0	0	0	0	0	0	0	0	0	3.44	0	0	3.44	0	3.44
Financing Cost	0	0	0	0	0	0	0	0	0	3.44	0	0	3.44	0	3.44
pre operative cost	0	0	0	0	0	0	0	0	0	3.44	0	0	3.44	0	3.44
Water Transport	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Land transport	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Land Cost	0	0	0	0	0	0	0	0	0	0	0	0	0	10.32	10.32
VAT	0	2.28	0.106	0.531	0.319	0	0	0	0	0	0	0	3.232	0	3.236
Net Custom duty	0*	0	0	0	0	0	0	0	0.76	0	0	0	0.76	0	0.76
Subsidy	0	0	0	0	0	0	0	0	(-1.20)	0	0	0	-1.20	0	-1.20
Total Output at Base Price	193.43	127.97	4.95	24.71	14.82	29.01	14.5	27.56	59.7	34.4	0.55	1.44	533.04	0	542.81

Net custom duty 5.5% and subsidy on panel import 4.2% , VAT @ 2.2 % All values adjusted to Million USD (2011) exchange rate 46.42 (WIOD database), custom duty is wavered for solar grade semiconductors

	Solar Sector(36)	Basic & Fab Metal (12)	Construction (18)	Electrical & Optical equipments (14)	Financial Intermediation (28)	Water travel (24)	Surface Travel (23)	Total Economy	Final Expenditure	capital Formation	Total industry output at base price
Solar Panel (Imported)	189.27	0	0	0	0	18.91	1.79	0	0	0	209.97
Hot Galvanized Steel Frames	0	21.94	0	0	0	0	0	0	0	0	21.94
Ground Leveling & civil work	0	0	27.56	0	0	0	1.10	0	0	0	28.66
Wires & transmission, Switches charge controller infrastructure	0	0	0	33.64	0	0	0	0	0	0	33.64
Invertors	0	0	0	26.50	0	.55	.34	0	0	0	27.39
Insurance	0	0	0	0	1.72	0	0	0	0	0	1.72
contingency	0	0	0	0	5.16	0	0	0	0	0	5.16
Interest during construction	0	0	0	0	17.20	0	0	0	0	0	17.20
Project Management	0	0	0	0	3.44	0	0	0	0	0	3.44
Financing Cost	0	0	0	0	3.44	0	0	0	0	0	3.44
pre operative cost	0	0	0	0	3.44	0	0	0	0	0	3.44
Water Transport	0	0	0	0	0	0	0	0	0	0	0
Land transport	0	0	0	0	0	0	0	0	0	0	0
Land Cost	0	0	0	0	0	0	0	0	0	10.32	10.32
VAT	0	0.504	0	.76	0						1.264
Net Custom duty	11.37	0	0	1.58	0						12.95
Net Subsidy (-)	(-)9.27	0	0	-1.20	0						-10.47
Total Output at Base Price	191.37	22.444	27.56	61.28	34.4	19.46	3.23	359.744			370.064

Table 2: Solar Block for NDCR Projects or Open Category Projects

References

Allan, G.J., McGregor, P.G., Swales, J. K., 2011. The importance of revenue sharing for the local economic impacts of a renewable energy project: A social accounting matrix approach. Reg. Stud. 45 (9), 1171-1186

Alvarez, G.C., Jara, R.M., Julian, J.R.R., Bielsa, J.I.G., 2009. Study of the Effects on Employment of Public Aid to Renewable Energy Sources , Madrid, Spain: King Juan Carlos University.

Baer,P.,Brown, M.A., Kim,G.,2015.The job generation impacts of expanding industrial cogeneration. Ecological Economics,110, 141-153

Böhringer,C. , Keller, A., Van der Werf, E.,2013. Are green hopes too rosy? Employment and welfare impacts of renewable energy promotion. Energy Economics 36, 277-285

Cai, W. , Wang, C. , Chen, J. , Wang, S., 2011. Green economy and green jobs: Myth or reality? The case of China's power generation sector. Energy, 36 (10), 5994-6003.

Caldés, N., Varela, M., Santamaría, M., Sáez, R., 2009. Economic impact of solar thermal electricity deployment in spain. Energy Policy 37 (1), 1628-1636.

Cameron, L., Van Der Zwaan, B., 2015. Employment factors for wind and solar energy technologies: A literature Review. Renewable and Sustainable Energy Reviews 45, 160-172

Ciorba, U., Pauli, F., Menna, P., 2004. Technical and economical analysis of an induced demand in the photovoltaic sector. Energy Policy 32 (8), 949-960

Cook, C., 1998 The Maryland solar roof program : state and industry partnership for PV residential commercial viability using state procurement process In: Proceeding of second world congress of Photovoltaic Solar Energy Conversion, Vienna, 6-10 July, 3425-3428

Cox, M., Peichl, A.,Pestel, N., Siegloch,S.,2014. Labour demand effects of rising energy prices: Evidence from Germany, Energy Policy 75, 266-277

D., Kapadia, K., Fripp, M.,2004. Putting renewables to work: how many jobs can the clean energy industry create Report of the renewable and appropriate energy laboratory, University of California, Berkeley, CA

Del Rio, P., Burguillo, M., 2009. An empirical analysis of the impacts of renewable energy deployment on local economy, Renewable and Sustainable Energy Reviews. 13, 1314-1325

Del Rio, P., Burguillo, M., 2008. Assessing the impact of renewable energy deployment on local sustainability: Towards a theoretical framework, Renewable and Sustainable Energy Reviews, 12 (9), pp. 1325-1344;

ECOTEC Research & Consulting Limited., 1999. The impacts of renewable on employment and economic growth. Draft Final Report: Main Report. ALTENER Project 4.1030/E/97-009

Folk, H., Hannon, B. 1973. Energy: Demand, Conservation, and Institutional Problems, pp. 159-173. Macrakis M.S. (Ed), Massachusetts Institute of Technology, Cambridge, MA, USA

Government of India 2010; Mission Document Jawahar Lal Nehru National Solar Mission http://mnes.nic.in/pdf/mission-document-JNNSM.pdf accessed Dec 12, 2014

Government of India, Ministry of Finance, Notification No 12, 2012 , Customs URL : http://www.cbec.gov.in/ub1213/cs12-2012.pdf accessed on April 14, 2015

Hannon, B., 1972. System energy and recycling: A study of beverage industry, Document No. 23, Center for Advanced Computation, University of Illinois, Urbana, IL

Heavner, B., Del Chiaro, B.,2003. Energy and jobs-employment impacts of developing markets for renewables in California, Environment California, , Research and Policy Center;

Herendeen, R., Sebald, A., 1974. The Dollar, Energy and Employment impacts of Air, Rail and Automobile passenger transportation. (96), Centre for Advanced computation document

Hillebrand, B., Buttermann, H., Behringer,J., Bleuel, M., 2006. The expansion of renewable energies and employment effects in Germany. Energy Policy 34(18), 3484–94.

International renewable energy Agency , 2015. 2014 Renewable Energy & Jobs: IRENA, Abu Dhabi

Jain, M., Patwardhan, A., 2013. Employment outcome of renewable energy D, Implications of Policies in India, Economic and Political weekly Vol XLVIII, (7) pp 84-89

Kulišić, B., Loizou, Rozakis, S., Šegon, V.,2007. Impacts of biodiesel production on Croatian economy .Energy Policy, 35 (12), 6036-6045

Kuntze J-C. and T. Moerenhout, 2013. Local content requirements and the renewable energy Industry: a good match? ICSTD Working Paper.
URL: 〈http://ictsd.org/downloads/2013/06/local-content-requirements-and-the-renewable-energy-industry-a-good-match.pdf accesses March3, 2015

Lainer, J., Bernow, S., DeCicco, J., 1998. Employment and other macroeconomic benefits of an innovation-led Climate Strategy for the United States. Energy Policy 26 (5), 425–433.

Lehr,U., Nitsch, J., Kratzat, M., Lutz, C., Edler, D., 2008. Renewable energy and employment in Germany. Energy Policy 36 (1), 108–117.

Leontief, W., 1966. Input–Output Economics. Oxford University Press, New York

Lo´ pez, L M., Sala, JM., Mı´guez, JL., Lo´ pez,LM., 2007. Contribution of renewable energy sources to electricity production in the autonomous community of Navarre (Spain): a review. Renewable and Sustainable Energy Reviews. 11(6) 1244–59.

Madlener, R., Koller,M.,2007. Economic and CO_2 mitigation impacts of promoting biomass heating systems: an Input–Output study for Vorarlberg, Austria.. Energy Policy 35(12),6021–6035

Malik, A.,Lenzen, M., Neves Ely. R., Dietzenbacher, E., 2014. Simulating the impacts of new industries on the economy: The case of biorefning in Australia. Ecological Economics,107, 84-93

Marcel, T., Los, B., Strehrer R, de Vries, G., 2013. Fragmentation, Income and Jobs, An analysis of European competitiveness , GGDC Research memorandum GD-130. Groningen: Groningen Growth and Development Centre, University of Gronongen.

Marcel, T., ed. 2012. The World Input-Output Database (WIOD): Contents, Sources and Methods, WIOD working paper 10, http://www.wiod.org/publications/papers/wiod10.pdf
Miller, R. E., Blair, P. D., 1985. Input Output analysis: Foundations and Extensions. Prentice Hall, Eaglewoods Cliffs, N.J.

Ministry of New and Renewable Energy, 2010. Jawaharlal Nehru National Solar Mission (JNNSM): Towards building solar India. Ministry of New and Renewable Energy, MNRE

Ministry for New and Renewable Energy, the Government of India, 2010, Human Resource Development Strategies for Indian Renewable Energy Sector, MNRE,

Government of India, 2007, Ministry of Statistics and Planning India, 2007 Input Output Table for India

Pfaffenberger,W.,Nguyen,K.,Gabriel,J.,2003.ErmittlungderArbeitspla¨tze und Bescha¨ ftigungswirkungenim Bereichdererneurbaren Energien. Studiedes Bremer EnergieInstitutsimAuftragderHans-Bo¨ cler-Stiftung.Bremen

Quang Viet V., 2000. Measurement of Fixed Capital Stock and Consumption of Fixed Capital in the Handbook on Linking Business Accounts to National Accounts for Non Financial Corporation Sector, in OUN, 2000. Studies in Methods, Series F No. 76, Handbook of National Accounting, Links between Business accounting and national accounting sales No ST7ESA/STAT/SER.F/76, New York

Reddy, V., Uitto, J., Frans,D., Matin, N.,(2006) Achieving global environmental benefits through local development of clean energy: The case of small hilly hydel in India, Energy Policy, 34(18):4069-80

Rivers, N., 2013. Renewable energy and Unemployment: A general equilibrium analysis, Resource and Energy Economics, 35 (4) pp 467-485

Sahoo, A. , Shrimali, G., 2013, The effectiveness of domestic content criteria in India's solar mission, Energy Policy 62, 1470-1480

Shrimali, G., & Sahoo, A., 2014, Has India's Solar Mission increased the deployment of domestically produced solar modules? Energy policy 69, 501–509

Sastresa, E. L., Uson , A.A., Bribia C.Z. Scarbellini S,(2010) Local impacts of renewable on employment, Assessment Methodology & Case Study, Renewable and Sustainable Energy Review 14, pp 679-690

Skills and Occupational Needs in Renewable Energy,2011 , ILO, Skills and Employability Department, International Labour Office, Geneva; Occupations, 1., http://www.ilo.org/wcmsp5/groups/public/-dgreports/-dcomm/-publ/documents/publication/wcms_172572.pdf, ISCO-08-Structure, Group Definitions and Correspondence Tables, International Labour Office

Umweltbundesamt, (2004) Hintergrundpapier: Umweltschutz and Beschäftigung, , Umweltbundesamt, Berlin;
URL: http://unctad.org/meetings/en/Contribution/DITC_TED_13062013_Study_ICTSD.pdf

US, Department of Energy,1992. Economic impact of a photovoltaic module manufacturing facility , Report, US DOE

Veloso, F., 2001. Local Content requirement and Industrial development: Economic Analysis and Cost Modeling of the Automotive Supply Chain, PhD dissertation submitted to Massachusetts Institute of Technology

World Input Output Database, National Input Output Tables, URL: http://www.wiod.org/new_site/database/niots.htm accessed March 23,2015

World Input Output Database, Socio Economic Accounts , URL: http://www.wiod.org/new_site/database/seas.htm accessed March 23,2015