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Envisaging Economy-wide Context of Employment & Skills- Green Jobs in India

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Abstract

The Indian economy is going through transformative changes both structurally and demographically. The country is currently progressing to the peak of its demographic window, with about 65% of the population being under the age of 35. This demographic shift is indicative of a surplus in the working populous and a low dependency ratio in upcoming years, which presents the premise for leapfrogging the country's development. This premise is further bolstered by the country's commitments to adopting sustainable avenues for greening the economy in the advent of impacts from climate change. The transition into a green economy requires both economic restructuring and a shift in employment structure. Hence, at its core, it is primarily a human capital issue, which requires significant investments in education, skill development and job creation.

Anticipating skill needs and changes in the occupational structure of transitioning sectors is crucial for a smooth and just transition to a green economy. Using a constructed 2018-19 IOTT we assess the implications of expansion in certain key sectors for decarbonization in Energy, Agriculture and Sustainable Mobility sectors on employment across occupational groups in India. The job creation potential of a major policy initiative in the renewables sector in India; "Green Energy Corridor" was also estimated. Our findings indicate an overall high reliance on elementary occupation groups among the studied sectors that reflect upon the highly informal characteristics of the Indian economy. While an expansion renewal energy such as Wind and manufacturing of batteries have a diverse requirements from varied occupational groups.

Keywords: Green Jobs, Renewables, Skill Gap, Employment Structure,

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1. Introduction

The Entwined Nature of Demography and Economy

One of the seminal texts that connects demography with economy would be by the English clergy and economist, Thomas Robert Malthus, *An Essay on the Principle of Population as It Affects the Future Improvement of Society;* wherein he forbade uncontrolled population growth, in order to preserve economic prosperity and resource sufficiency (Malthus, 1798). Malthus's proposition considered the mismatch between arithmetic progression in food supply to that of an unsustainable geometric progression in population, albeit failing to considered the effects of technological change. The industrial revolution in the later decades lead to remarkable rise in agricultural harvests and food supply along with overall rise in health and sanitary conditions, thus dismissing the prevailing Malthusian notion. Yet the resurgence of the so-called Neo-Malthusian thought, came during the 1960s, which saw rapid population growth globally, due to lowered mortalities post the stability in global powers along with development and spread of medicine and scientific knowledge. The claims this time not only were limited to resource scarcities from overpopulation but extended over to environmental degradation from the resulting overconsumption (Mellos, 1988).

The primacy of Neo-Malthusian discourse pertaining to the acceptable demographic patterns for economic development has been determining the course of population policy since the 1970s. This triumph was witnessed moreover in developing countries especially China and India, where certain drastic population control measures were motivated by the Neo-Malthusian viewpoint (Follett, 2020). Furthermore, even though debates over the coercive nature of the policies were certainly raised at the time and particularly in India, leading to a period of political instability. Yet, over the decades the paradigm has been towards the prevention of detrimental economic impacts that may arise from rapid population growth.

Since the late 1980s, deliberations over the influence of demographic factors on economic development have taken a new turn over the concept of "demographic dividend" particularly in the case of developing countries, again at forefront of discussion being the Asian countries of China and India (James, 2008). The emphasis shifting from the size and growth to the age structure of the population and its effects on the economy (Bloom, et al., 2003). A demographic dividend occurs when in a country the larger proportion of the population is composed of the working-class, along with a low dependency ratio. This takes place under circumstances of a declining birth rate paired with a rise in the working age population. This phase of the population is also called to be

the demographic window and is a successor to a period of high fertility rates accompanied by low mortality rates. In the first phase, the primary portion of the population are under 15 years, hence there is a high dependency ratio at the base of the age pyramid that forms the base for the transition to occur in the next stage. In the second phase, there is a rapid fall in fertility, resulting in a peak in the working population, consequently resulting in a fall in dependency ratio. This phase of demographic transition can serve as an effective catalyst for structural transformations into high productivity sectors in the economy. Subsequently, in the third phase, there is an ageing population hence, again there is a rise in the dependency ratio (Lee & Mason, 2006). The realization of this phenomenon is often dependent upon the nature and pace of fertility decline in the transition period from the first to the second phase. As in many of the developed nations the period of the demographic window, went unnoticed mostly due to a slow and pacing decline in the fertility rates. Although, in countries like China, India and other Asian counterparts, the effects are quite evident.

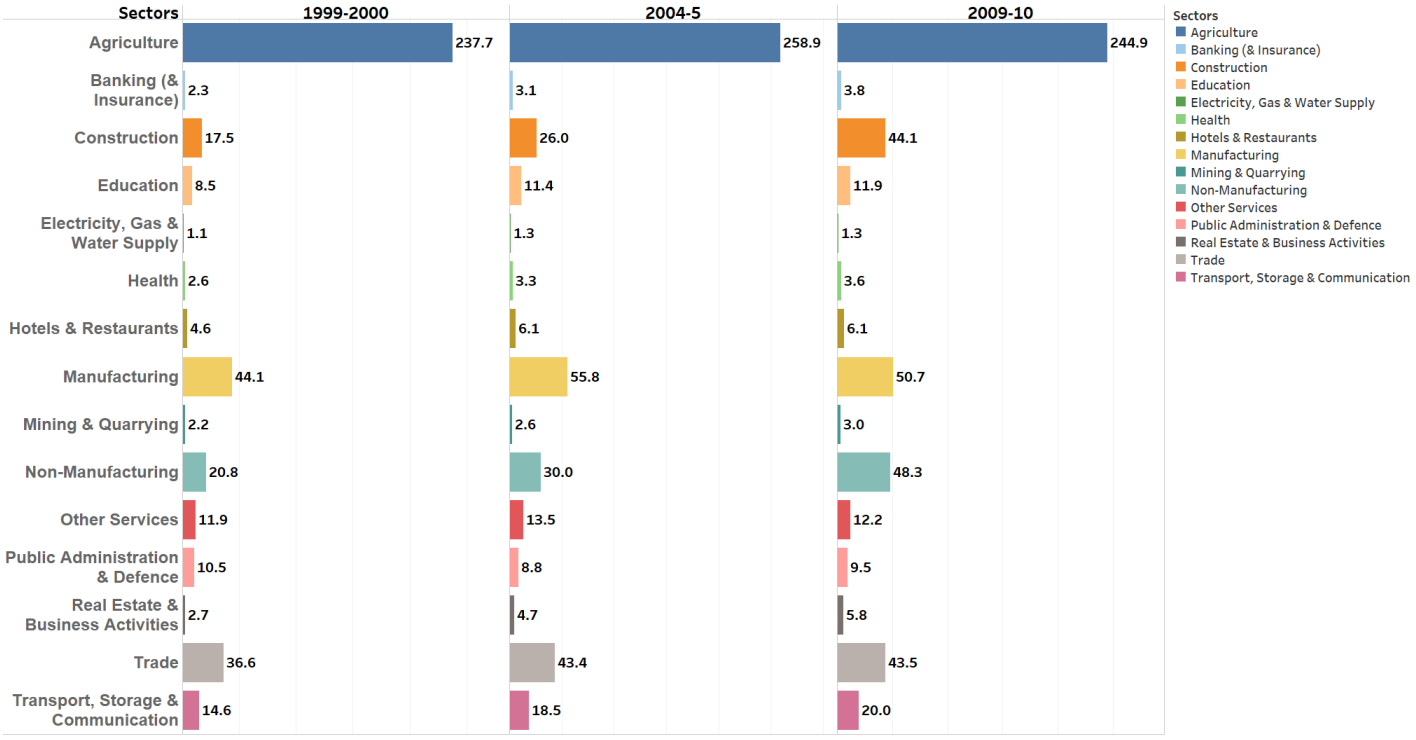
As Bloom, Canning, & Malaney (1999) put forth *"The young and old tend to consume more output than they generate, unlike working age individuals, whose contribution to output and saving tends to be more than commensurate with their consumption"*. The rationale for the economic impetus during the demographic window has been studied and decomposed essentially to 3-4 reasonings, among which some are at the household level and while others take place at the macroeconomic levels. Firstly, during the phase of demographic dividend stemming from lower birth rate there is an expected increase in savings as the primary component of earlier expenditures that went into childcare is currenly a surplus at the household level, along with increased life expectancy (Mason, 1988; Lee, Mason, & Miller, 2000). Furthermore, a declined fertility rate consequently encourages women labour force participation thus giving a significant boost to economic activity (Bloom, et al., 2009). A supposed increase in life expectancy can be achieved from household surplus going towards improvement in healthcare due to reduced childcare spendings, that can lead to quality of life and producitivity enhancements, resulting in higher economic output and growth. Furthermore, public spendings by the government over supporting the depenedency group can be largely shifted towards capital and human resource development during this period (Miller, Martinez, Saad, & Holz, 2008). Yet these effects aren't as such driven autonomous and rather, require conducive economic environment with an accompanying policy setup that supports employment creation oppurtunities for the population, in order to be absorbed in the most productive way in the economy (Mitra & Nagarajan, 2005). As the changes in the population pyramid may create a supply side surplus but accordingly the labour demand from the economically productive units has to be present (Bloom & Finlay, 2009).

Chandrasekhar, et al. (2006) find that by the start of 1970s, a high fall in the dependency ratio had well begun in India, hence estimating the start of the demographic window within somewhere in the mid-1970s. As per their estimates, India is going to have a dropping dependency ratio up about the lowest of 48 by 2025, thus marking the peak in the working populous and will last until 2050. Revised estimates in the Economic Survey of India (2018-19), mark this period to be 2041 with about 59% of the population as part of the working age (20-60 years). In case of India,

Chandrasekhar, et al., (2006) emphasize the major deficit in the government spending pertaining to effective education and skill development that can facilite the working age population towards productive employment avenues. The persistence of a skill gap in the workforce has always been of a primal concern for policymakers and firms in India (Majumdar, 2016; Mehrotra, et al., 2012). Furthermore, a developing country such as India, certainly stands amongst the outlier among its Asian counterparts. Contrary to the conventions of a developing economy; wherein, economic growth is marked with a shift in sectoral compositions from agriculture to industries, India rather had a shift from agriculture to service sector during the 1990s (Ansari, 1995). Even though as Kochhar, et al. (2006) point out till 2000s the service sector as such wasn't a positive outlier, as its contribution to Gross Value Added (GVA) and employment was certainly below the other countries.

Additionally, the reforms during the 1990s period of liberalization in India the pattern of growth was defined by highly capital-intensive heavy industry that did not create non-agricultural jobs at a rate required for structural transformation. This was in contrast to the other East Asian countries where early investments in human capital was complimented with an active industrial stratergy into labour-intensive manufacturing sectors enabling absorption of the rising working populations at a significantly a progressive rate in comparision to India (Mehrotra, 2020). While the service sector contribution to GVA has increased at quite a pace over the years, but it still continues to be a unremarkable when it comes to share of employment composition in the economy. Hence, even though there has been changes in the GVA composition in the Indian economy, the workforce participation remained largely unchanged.

Figure 1: Sectoral Employment (in millions) for years 1999-2000 | 2004-05 | 2009-10



Source: NSSO Surveys (multiple rounds)

The sectoral stagnancy in workforce pariticipation in a rapidly growing economy has resulted both in rise of unemployment levels, as well as a period of jobless growth. The aspects and dimensions of skilling India is vast with new entrants into the labour markets being about 12.8 million of the population annually (Mehrotra, et al., 2014). While, it is expected that about 109.73 million skilled workers would be in demand. Along with, the requirement of reskilling and upskilling of the already present 170 million farm sector and 128.5 million non-farm sector workers in the economy (Government of India, 2015).

Hence, there have been several policy impetus towards leveraging the current demographic dividend. A "Coordinated Action on Skill Development" was proposed and approved in 2008 in lieu of the 11th Plan objective of inclusive growth and development, through foundation of a pool of skilled workforce that meet the varied sectoral employment requirements of the economy (Planning Commission, 2008). This initiative was further complemented by the adoption of National Skills Development Policy in early 2009. The formation of the Ministry of Skill Development and Entrepreneurship (MSDE) in 2015, along with the launch of the Skill India mission in the same year has further brought a resurgent wave towards the skilling landscape in India. The present policy fervour has been an attempt at renewed recuperation of capturing the boons of the entrusted demographic endowment, which requires convergence in efforts and outcomes of varied policy spheres. Furthermore, India has also build collaborations with international organizations such as the International Labour Organization (ILO) and Organisation for Economic Co-operation and Development (OECD) towards assessing the economy's skill gap.

One of the key initiatives for reviving jobs in India in a multistakeholder approach is the Green Jobs initiative, which is a joint initiative by the ILO, the United Nations Environment Programme, the International Organization of Employers, and the International Trade Union Confederation. It aims for inclusive growth for reduction in poverty through an environmentally sustianable pathway for "just transition" by bringing converengence in environmental, economic and social pillars of development.

In our present study we have build a input output transaction table (IOTT) for year 2018-19 using the supply use tables (SUT) for the same years along with the sectoral labour groups built from the periodic labour force survey (PLFS) unit level data. The attempt here has been to study the occupational composition associated some of the key green sectors of the economy. Towards, this one of the major task was towards disaggregation and formulation of the renewables sector of Solar and Wind energy from the parent electricity sector. The successive analysis has been:

- Asessing the employment potentials of considered to be green (renewables and organic agriculture) and greening (batteries as proxy for sustainable mobility) sectors based on varying skill levels associated with the respective occupational categories.
- Measuring the sensitivities to external shock in terms of additional final demand for some of the key green sectors.

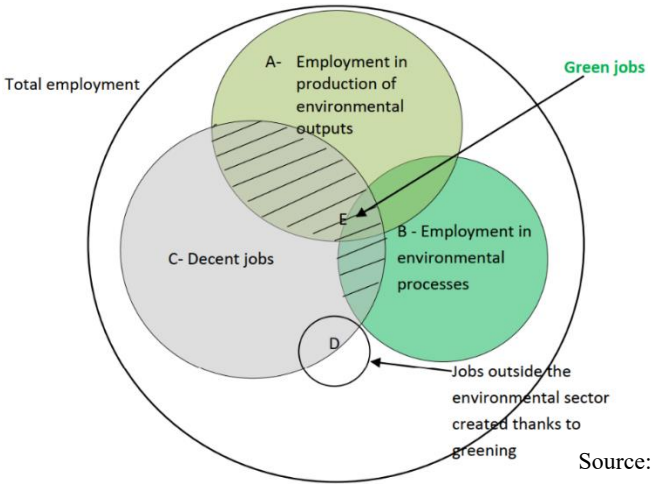
- Employment implications of the National Green Energy coridor policy towards growth in employment across varied occupational groups.

The successive sections provide a brief on the dimensions of green jobs and their premise in Indian economy, followed by higlights on some of the key economywide studies pertaining to green jobs. Latter sections brief about data and methodology of the study, followed by results, future scope and conclusion.

Green Jobs; converging economic and demographic transitions in India

ILO defines green jobs as, *"Green jobs are defined as jobs that reduce the environmental impact of enterprises and economic sectors, ultimately to levels that are sustainable"* while also acknowledging the criterion for these jobs to be classified as decent work (Gregg, et al., 2015).

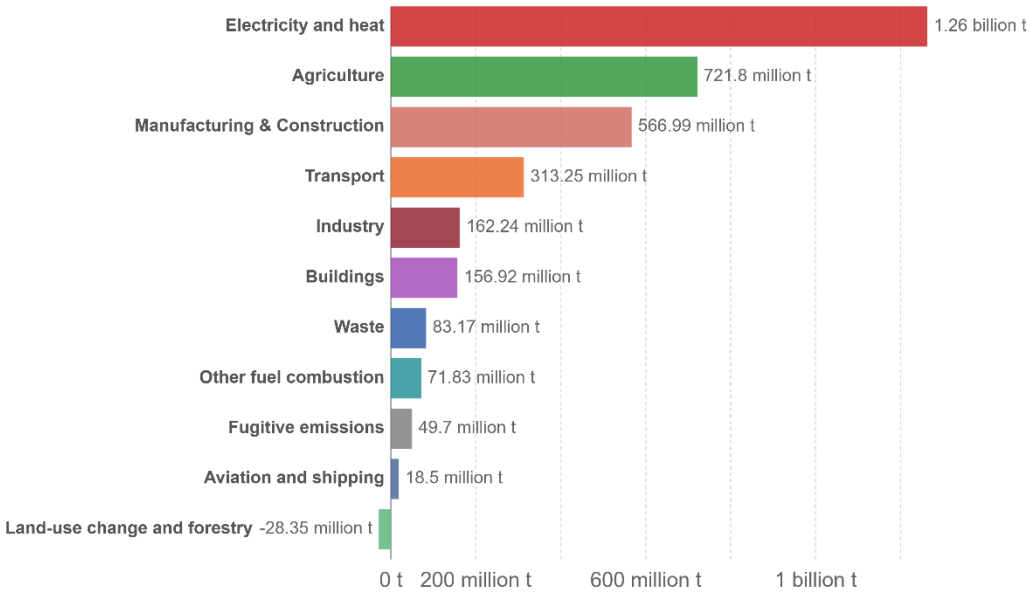
Figure 2: Relationships between total employment, employment in environmental activities and decent



Source: Gregg et al., 2015

Thus, green jobs are recognized to be a subset of employment in production and processes associated with environmental activites while meeting the aspects of decent work. The agenda for promotion of green jobs is relevant across SDGs 8, 11, 12, 13, 14 and 15. In this aspect, green jobs are critical to India's decarbonization stratergy towards transitioning into green economy and its commitments for achieving net-zero emissions by 2070 during the COP 26 (PIB, 2022). The premise of green jobs not only align with priorities for green transition of the economy but also aid towards expansion of India's employment sectors in order to create to create jobs and enchancement in standards of living. Thus, building synergies between economic growth, social inclusion and environmental sustainability. Although, for achieving simultaneous green transitions in both economic and demographic scenario at same pace requires synchronicity across varied policy dimensions; among which the four crucial policy dimensions being towards industrial policy (through development and adoption of green technology), skill development policy (anticipating the skill requirements and occupational structure of green transition), employment policy (facilitating and bridiging requirements of industry with the skilled workforce) and environment policy (setting standards for environmental protection and resource conservation).

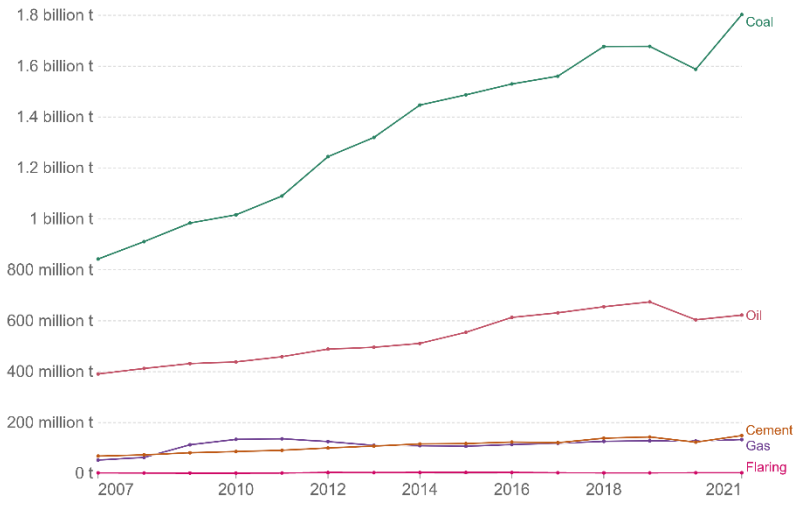
Figure 3: Greenhouse gas emissions (CO2eq) by sector, India, 2018



Source: (Ritchie & Roser, 2020)

Three key sectors that have high potential towards these goals in the Indian economy constitute of agriculture, sustainable mobility, and renewable energy (Sarma, 2020). As observed in Figure 3, these three sectors are among the highest contributors to sectoral GHG emissions in India. Given, the recent streamlined policy incentives in these sectors the potential for occupational orientation towards green jobs holds great promise for generating green jobs that aid in emission reductions.

Figure 4:CO2 emissions by fuel or industry, India (2007-2021)

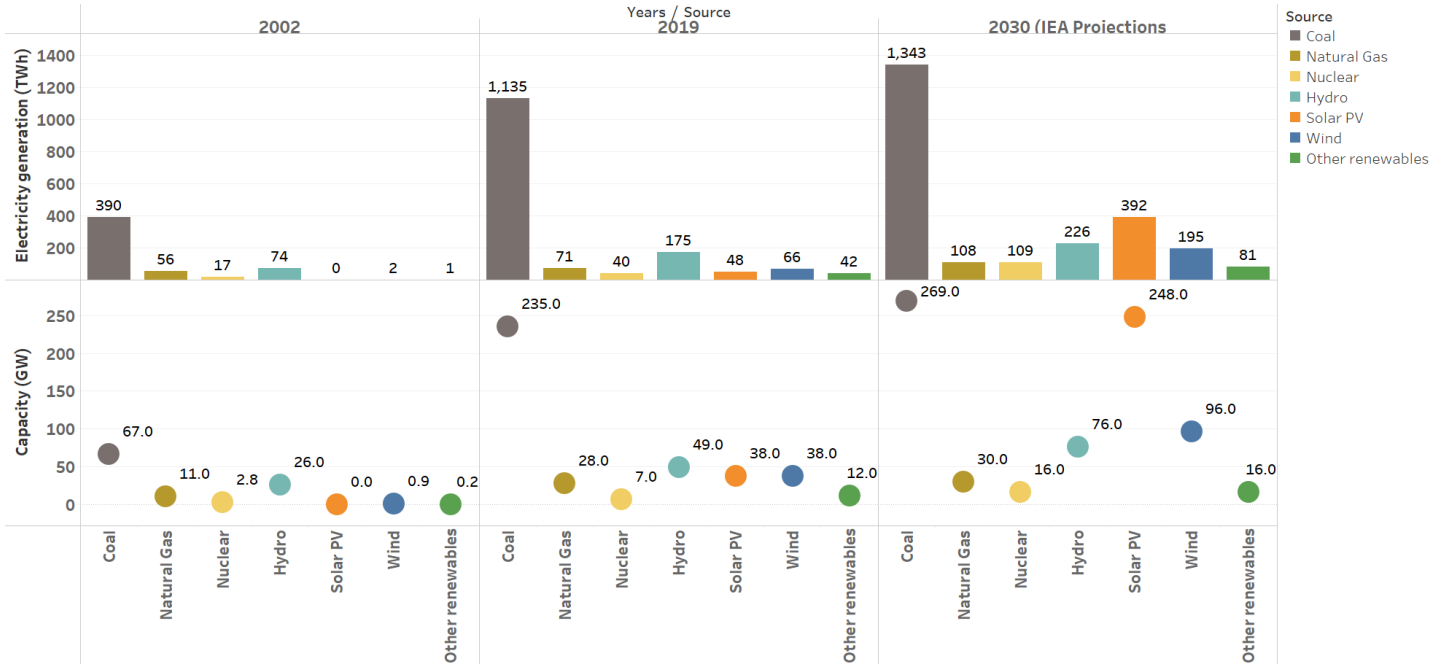


Source: (Ritchie & Roser, 2020)

The electricity sector in India has been dominantly reliant on conventional sources of fossil fuels for meeting its energy requirements, as can be observed from Figure 4; among the fuels coal is

also the dominant contributor to GHG emissions among the fuel sources. Even though there has been attempts towards promotion of the renewables with establishment of Commission for Additional Sources of Energy (CASE) in 1981 post the 1970s energy crisis. It is only in recent years, an aggressive resurgence into clean energy transition has taken place which can be traced to launch of National Solar Mission in 2010 (Kuldeep & Ghosh, 2020). India has been aggressive in energy transition especially in Solar PV and Wind sector with several estimates indicating by 2030 India's power capacity from both these sectors will account for about 45 percent driven from falling technology costs, cheaper finance and better grid integration (IEA, 2021).

Figure 6: Electricity Generation (TWh) and Capacity (GW) across varied sources



Sum of Electricity generation (TWh) and sum of Capacity for each Source broken down by Years. Color shows details about Source.

Source: (IEA, 2021)

Along with transition in energy sector India has also been striding towards Electric Vehicle (EV) transititon. Automobile sector accounts for 49 percent of the manufacturing sector output. Estimates suggest an expected 30 percent penetration of EVs in vehicle sales that will result in 18 percent reduction in CO emissions and 4 percent reduction in GHG emissions (CEEW, 2020). Under, Faster Adoption and Manufacturing of (Hybrid and) Electric Vehicles (FAME) that promotes indigenous manufacturing and assembly of electric vehicles. Further, in Phase-II of the programme the aim is for setting up of 2636 charging stations in 62 cities, which creates additional growth in charging station manufacturing sector and jobs. The EV transition albeit also has several trade offs in terms of loss in production and employment in Oil sector, along with loss in significant government revenues generated from tax on sale of oil and petrol. These trade-offs can be balanced if pre-emptive planning for revenue diversification and aid in job shifts is carried in a phased manner.

Anticipating skill needs in an Economywide Framework

The use of an economywide framework either in form of an Input Output Transaction Table (IOTT) or an extended Social Accounting Matrix (SAM) to calculate the employment implications (through direct and total employment multipliers of varying policy scenario is quite widespread in IO literature. There have been several studies which explore the employment effects of green economy transition particularly in the context clean energy transition in terms of direct and total job creation potential of the emreging renewables sector across varying regions (Markandya, et al., 2016; Markaki, et al., 2013; Madlener & Koller, 2007; Hondo & Moriizumi, 2017). Similarly, in case of India potential of Green Jobs in an economywide framework has been explored by particularly two studies (ILO, 2018; Pollin & Chakraborty, 2015). The ILO (2018) study use the 2007-08 national IO table for India to introduce five of six sectors are specific to greening economy; forestry and logging, watershed development, wind energy, and metro transport services, wind turbine generator (WTG) manufacturing and rail transport services (other than metro) to calculate the direct and indirect job potentials of these sectors. The study by Pollin & Chakraborty (2015) use an IO framework in combination with the 68th National Sample Survey (NSS) round unit level data of 2011-12 to explore the job creation potentials of the renewable sectors.

But one of the first study to explore the structural composition of the economy and the implications of it on skill and education requirements through occupation structure was by Kutscher (1989). In his study he explored the implications of a structural change in the US economy from an industry viewpoint in relation to the occupational structure of the economy and its inference on skill and educational requirements. In similar lines, in the context of green jobs the only study to consider the effects of green economy transition and its effect on creating jobs across different occupational groups has been by Allan & Ross (2019). Their findings convey the transition into low-carbon economy requires upskilling across sectors and occupations and is not limited to only core green sector. Such studies exploring the effects of economic transition on occupational groups is vital for anticipating the skill gap and the paths for inclusive skill development.

2. Data and Methodology

Data Construction and Sources

In the present study we use the Indian 2018-19 SUTs for constructing a 79x79 2018-19 IOTT. Furthermore, we have disaggregated the electricity sector to introduce two new sectors of renewables; Electricity from Solar Energy and Electricity from Wind Energy. The IO table has been modified by splitting the electricity sector into 'Solar energy', 'Wind energy' and 'Other electricity sources'. Thus, bringing the new IOTT into an 81x81 commodity by commodity matrix.

Due to unavailability of information on the sector-wise electricity consumption by type, either in physical units or monetary terms, the output flow from the three electricity sectors has been determined based on the existing share of power generation from solar (2.53%), wind (4.1%) and

other electricity sources (93.6%) in 2018-19 (Niti Aayog, 2021). The input structure for introducing the Solar Energy and Wind Energy sector was computed from secondary sources (Latunussa, et al., 2016; Mali & Garrett, 2022).

To study the job creation potential and implications on the varying occupational groups of the considered green sectors along with envisaging the impact of policy scenarios; the labour rows were imputed from the 2017-18 PLFS unit level data pertaining to labour participation in both principal and secondary status of activity.

The periodic labour force survey replaced the earlier employment and unemployment survey of National Statistical Office (NSO) which used to be conducted after every five years. The importance of availability of labour force data at more frequent time intervals motivated the formulation of PLFS in April 2017 to provide vital employment and unemployment statistics; Worker Population Ratio, Labour Force Participation Rate, Unemployment Rate etc. PLFS collects both the principal status and subsidiary status of employment pertaining to associated industry, classified as per National Industrial Classification – 2008 codes (NIC-2008) and the occupation group as per National Classifications of Occupation – 2004 (NCO-2004).

NIC-2008 is of five digit classification with 21 sections, 88 divisions, 238 groups, 403 classes and 1304 sub-classes. It is a revision of NIC-2004 and matches International Standard Industrial Classification (ISIC) rev. 4 up to four digits. The respective NIC codes were matched with each sector of 2018-19 IOTT to ascertain the sectoral labour classification; wherein, for certain sectors the division was done at sub-class level while for others the entire divisions were considered.

The labour rows were further disaggregated into nine occupational groups as per NCO-2004 codes. The aim behind the nine occupational groups as per NCO-2004 has been towards creating a structured set of mutually exclusive and well-described categories that reflect upon the skill levels associated with different occupations or job roles.

The use of NCO-2004 codes go beyond creation of collection and dissemination of national statistics, it is also used for determination of worker's compensation, matching jobseekers with job vacancies, and management of employment-related migration by the government and other organizations. The NCO-2004 follow the same structure as International Standard Classification of Occupations (ISCO) – 88 as formulated by ILO, while tweaked to considered the Indian scenario. In the Indian context, informal training and experience has also been considered along with formal education to determine the skills necessary to perform the tasks and duties of a given job. The NCO-2004 is a four-digit code structure with 10 broad single digit divisions, 30 sub-divisions identified by the first two digits, 439 families and 2945 occupations.

Table 1: National Classifications of Occupations-2004 and associated Skill Level

NCO 2004 Divisions	Title	Skill Level
1	Legislators, Senior Officials, and Managers	Not Defined*
2	Professionals	IV
3	Associate Professionals	III
4	Clerks	II
5	Service Workers and Shop & Market Sales Workers	II
6	Skilled Agricultural and Fishery Workers	II
7	Craft and Related Trades Workers	II
8	Plant and Machine Operators and Assemblers	II
9	Elementary Occupations	I
X	Workers not Classified by Occupations	-

PLFS unit level data is a sample dataset with person wise record of 433339, collected across the quarters for 7024 villages and 5776 urban blocks. Each observation also has associated weight which was used for computing the national level aggregates of industry specific labour as per varying occupational groups.

Method of Analysis

The basic IO model can be represented in the following equations:

$$X = AX + F \ldots\ldots(1)$$

Where,

X = Vector of Total Output from each sector (nx1)

$$X = \begin{pmatrix} x_1 \\ \vdots \\ x_n \end{pmatrix}$$

A = Technical coefficient matrix (nxn), representing the share of inputs towards producing one unit of Output from the respective sector ($\therefore \sum a_{in} = 1$)

$$A = \begin{pmatrix} a_{11} & \cdots & a_{1n} \\ \vdots & \ddots & \vdots \\ a_{n1} & \cdots & a_{nn} \end{pmatrix}$$

F = Vector of Final Demand (nx1)

Thus, the solution to equation (1) is:

$$X = (I - A)^{-1} * F \ldots\ldots (2)$$

The $(I - A)^{-1}$ element, also known as the Leontief inverse, represents the total (both direct and indirect) requirements of the output levels to match the unit changes in exogenous accounts.

The direct employment coefficients were conceived by sectoral employment (per occupation group) /sectoral output ratios, which provide the employment per unit output of a sector. These employment coefficients provide the direct employment effect of a unit increase in the final demand for the particular sector. Further multiplying the direct employment multipliers with the Leontief inverse provides us with the total employment multipliers representing the both direct and indirect employment changes from an unit increase in final demand.

$$T_{ni} = e_{ni} * (I - A)^{-1} * F \ldots\ldots (3)$$

Where,

T_i = Total Employment for Sector (n) and Occupational Group (i)

e_i = Direct Employment coefficients (No. of employed / Total Output) in each Sector (n) as per Occupational Group (i)

$e_{ni} * (I - A)^{-1}$ = Total Employment Multipliers in each Sector (n) as per Occupational Group (i)

In our study we have assessed the job creation potentials of three aspects of green jobs which can be primarily associated with job roles considered that are either core green sectors or activities towards greening:

Renewables (core green): We have considered two types of renewables; i) Electricity generated from Solar Energy and ii) Electricity generated from Wind Energy. The electricity sector has six sub-class pertaining power generation:

35101	Electric power generation by hydroelectric power plants
35102	Electric power generation by coal based thermal power plants
35103	Electric power generation by non-coal based thermal (e.g. diesel, gas)
35104	Electric power generation and transmission by nuclear power plants
35105	Electric power generation using solar energy
35106	Electric power generation using other non-conventional sources

The direct labour engaged in Solar Energy has been considered for those persons whose industry code (NIC code) was 35105 (Electric power generation using solar energy). Although, for Wind Energy there aren't specific NIC-2008 codes. Hence, to determine the labour engaged in Wind Energy the persons with associated industry code (NIC code) of 35106 (Electric power generation using other non-conventional sources) was taken into consideration. Given, the persons engaged

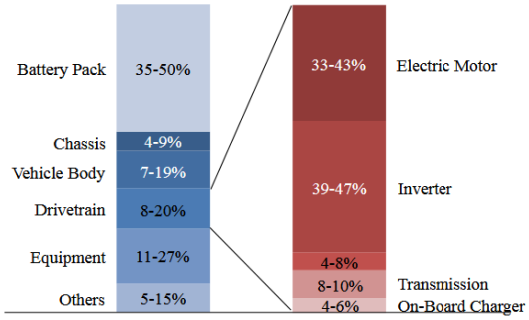
in Hydroelectric power plants have separate industry code, Wind energy is dominant among the non-conventional sources.

Organic Agriculture (core green): Since, Paddy is the only industry class (112) with disaggregation between those engaged in inorganic and organic farming. We have considered the persons engaged with the following associated NIC codes for estimating the job creation potential of organic agriculture which is a core green sector:

1121	Organic farming of basmati rice
1122	Organic farming of non-basmati rice
1123	Inorganic farming of basmati rice
1124	Inorganic farming of non-basmati rice

Sustainable Mobility (greening): Since, the Motor Vehicle industry has no disaggregation between conventional and electric vehicles (EV), it is difficult to gauge the EV penetration in automobile manufacturing from the secondary sales figures as EV was still in nascent stages for the time period we have considered in our study. Although, manufacturing of battery packs is a major component for both EV and associated charging stations (Kochhan, et al., 2017) we have considered the job potentials in manufacturing of battery as a proxy for sustainable mobility.

Figure 7: Cost Structure of Electric Vehicle



Cost structure of a battery electric vehicle

Source: taken from (Kochhan, et al., 2017)

3. Results and Analysis

The composition of total labour calculated from final demand among the nine occupational group indicate a dominance of skilled agricultural and fishery workers and those engaged in elementary occupations and were seen to be belonging primarily of the rural population; these two occupational divisions comprise more than half (54.3%) the total labour. Among the skilled agricultural and fishery workers, the major industry engagement is in sectors pertaining agricultural farming, manufacturing of food products and trade. The major crops of those engaged in farming is particularly in paddy and then in other foodgrains and leguminous crops. While, the major industry of engagement among the elementary occupations comprises of; at top most construction, trade, transport services and again, agricultural farming and manufacturing of food products. The latter pertaining to elementary occupations is expected since labour engaged as

agricultural labour (NCO-2004 subdivision 92) also contribute in construction sector given the seasonal nature of agricultural sector.

Figure 8: Occupational Composition of Total Labour (as per Final Demand)

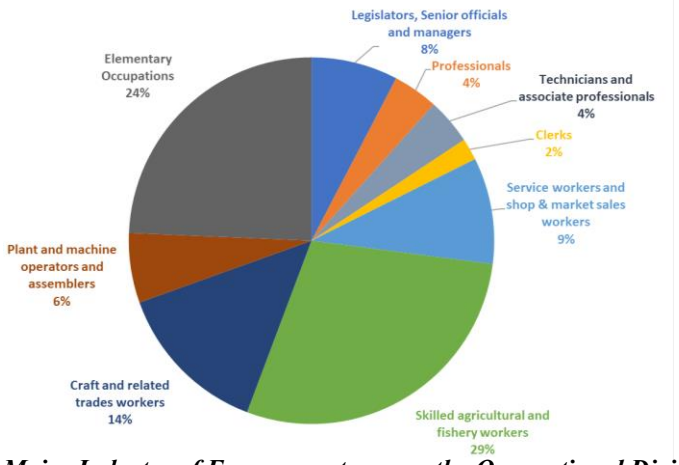
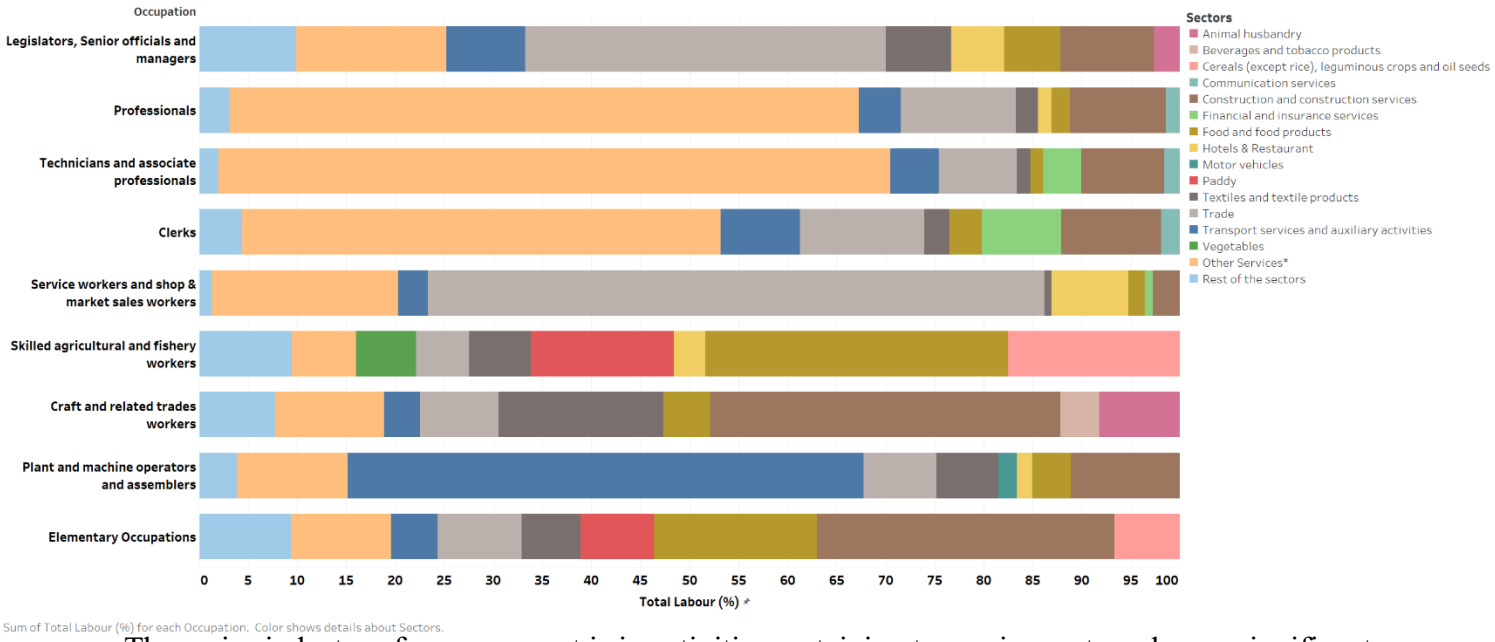


Figure 9: Major Industry of Engagement among the Occupational Divisions (1-9)



The major industry of enagagement is in activities pertaining to service sector where a significant percentage of total labour is engaged in Trade, Hotel & Restaurants and Transport services across the occupational divisions. Transport and auxilary activities which constitute of transport in land, air, water, railways and supporting transport activities are dominant especially among plant & machine operators and assemblers, this is due to majority of this group being classified under sub-division 83 as Drivers and Mobile-Plant Operators. Construction and construction services account also have a significant percentage across sectors given that it is one of the major non-agricultural job in the Indian economy. Communication and Finance services are significant among the upper occupational divisions, especially Finance and Insurance services among the Associate Professionals and Clerks. Also to note, Customer Services (NCO-2004 sub-division 42) is a sub-division under Clerks hence significant percentages are observed in both Communication and

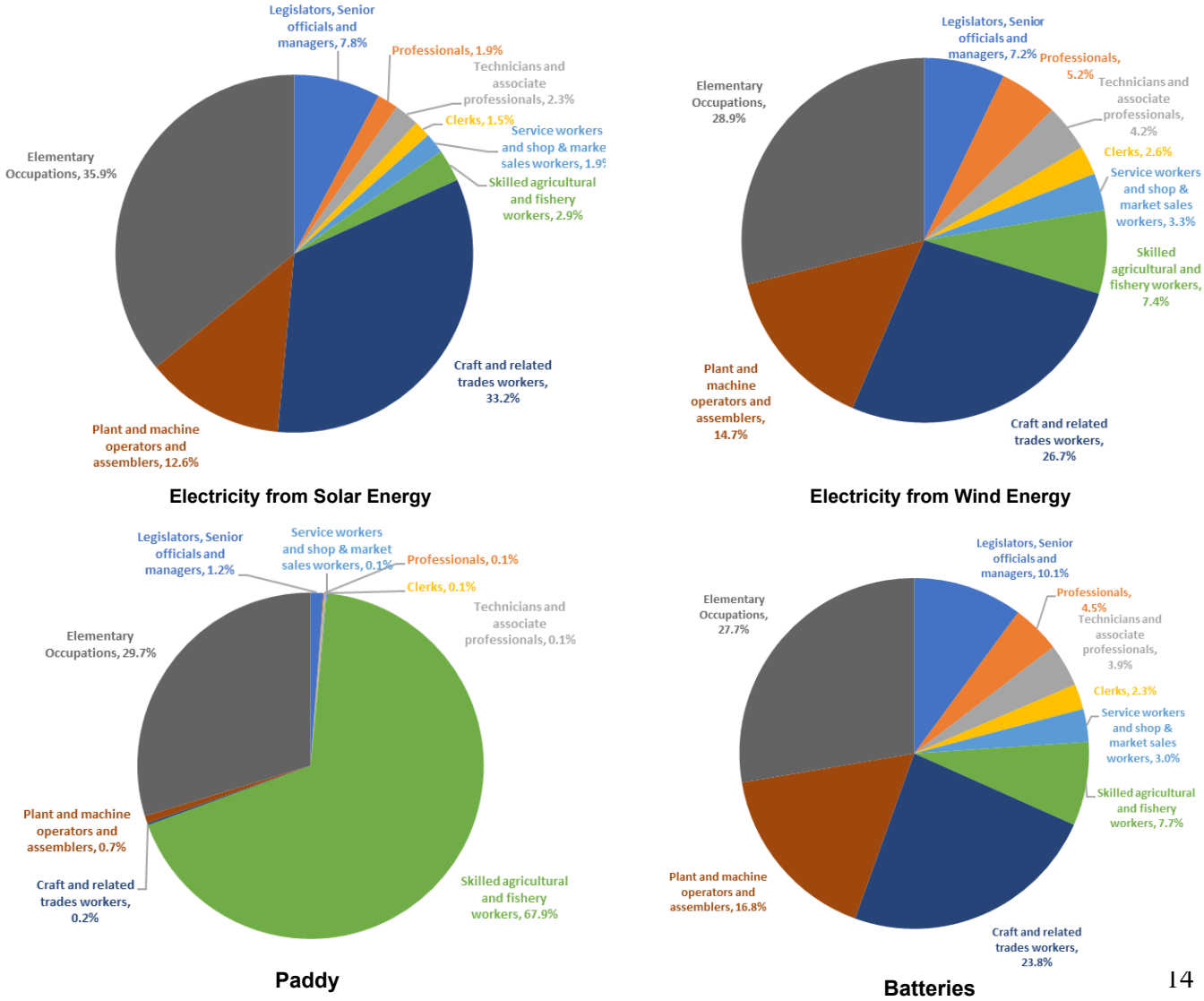
Finance & Insurance Services. Trade is the dominant industry among the Service Workers & Market Sales Workers. Among occupational divisions pertaining to professionals and Techinicians & Associate Professionals reflect common industries which are primarily service sector oriented activities with certain major services being communication and finance.

The major manufacturing sectors that are among the top industry of engagement across occupational divisions comprise of; Manufacturing of food products, Textile & Textile Products, and Motor Vehicles in case of Plant & Machine Operators and Assemblers. While, as mentioned earlier the major primary activity industry are constituted of agricultural farming in Paddy and other foodgrains & leguminous crops.

Green & Green Sector Employment Sensitivity to Final Demand

To gauge the job creation potential among varying occupational groups we considered a 1 million rupees additional final demand shock in four sectors: i) Electricity from Solar Energy, ii) Electricity from Wind Energy, iii) Paddy and iv) Manufacture of Batteries.

Figure 10: Sectoral Employment Sensitivity across varying Occupational Groups



It is observed that among the four considered sectors the sectors the presence of Elementary Occupations requirement among the considered sectors. Elementary Occupations are composed primarily of informal labourers involved in varying activites from primarily marginalized farm hands in agriculture to informal blue collar jobs in Mining, Construction, Manufacturing and Transport. Their significant presence across all four sectors also reflects the highly informal and unorganized characteristics of employment in the Indian economy. Furthermore, the presence of Skilled Agricultural and Fishery Workers is somewhat significant across all the four sectors, which is not surpirising in case of Paddy but in case of other manufacturing sectors such results are primarily due to high backward and forward linkages between manufacturing, energy and agriculture sector.

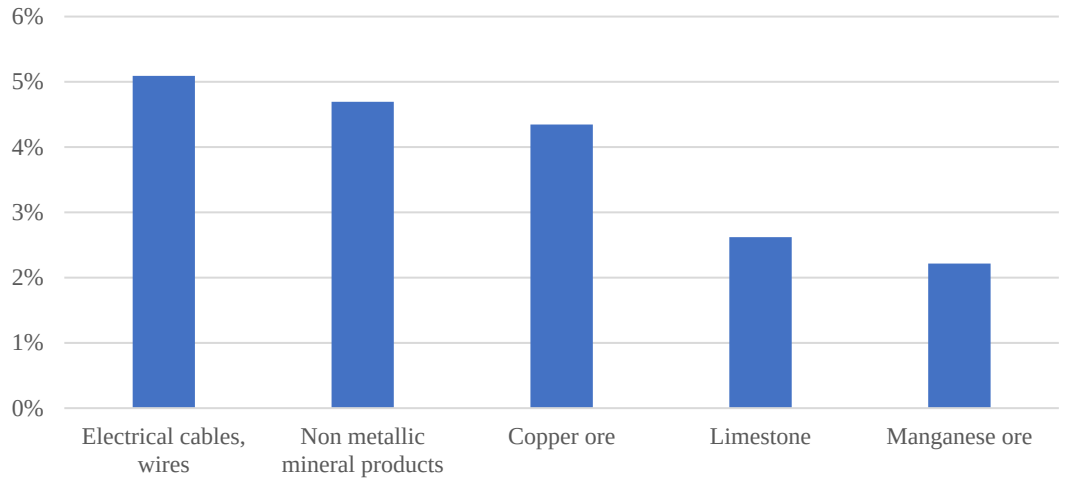
In case of the energy sectors of Solar and Wind, the occupational requirements are similar in composition, where after Elementary Occupations there is high requirement of Crafts & Trade Workers, followed by Plant & Machine Operators and Assemblers. These two occupational divisions are core to the energy sectors both in terms of direct employment as well as through backward linkages for intermediate inputs into these industries. Crafts & Trade Workers comprise special trade specific job roles such as Electricians, Mechanics, Wireman, etc. who are involved both in core energy sector job roles as well as anciliary job roles for supplying the intermediate inputs from sectors such as Non-Mineral Mineral Products, Iron & Steel sectors where already the job roles under occupational divison-7 is above average compared to other sectors in the economy. Plant & Machine Operators and Assemblers involve various core blue collar manufacturing job roles involved in power generation as the NCO-2004 Group- 816 Power Production and Related Plant Operators is under this occupational division, the direct job potential for the job roles in this occupational division is directly associated with expansion in Energy sectors. In case of manufacturing of batteries similar occupational composition are found as that of Wind energy, both of these sectors have a wider total labour requirement, while also encompassing the highest percentages upper occupational division of Professionals and Technicians & Associate Professionals. Thus, indicating expansion in these job roles certainly require highly specialized skilled manpower from the upper education brackets of the workforce.

In case of Paddy, the primary occupational divisions are from Skilled Agricultural and Fishery Workers and Elementary Occupations although identifying core green jobs pertaining organic farming is not possible from the NCO-2004 occupation structure. Yet, from NIC-2008 division of the organic Rice and inorganic Rice products and those engaged directly in these activities indicate barely 9% of employment in organic Rice across the occupational divisions. Although, among the Skilled Agricultural Workers although, it is about 16% of the total occupational division-6 employment pertaining to Paddy. Hence, signifying the potential for further promotion and incentives towards adoption of organic rice, particularly organic Basmati Rice, which has high export potentials.

Green Energy Corridor – Policy Scenario

The Green Industry corridor was envisioned by the Government of India for faster integration of Renewable Energy sources in the national electricity grid. To this end, a total outlay of Rs. 34,141 crores were allocated by the Ministry of Power for the development of inter-state transmission system and control infrastructure across renewable rich States of Andhra Pradesh, Gujarat, Himachal Pradesh, Jammu and Kashmir, Karnataka, Maharashtra, Rajasthan, Madhya Pradesh and Tamil Nadu (MoP, 2015). Given that the government has a target of achieving 450 GW RE capacity by 2030 of which 420 GW is allocated for solar (280 GW) and wind (140 GW), the total outlay has been split into 66% (Rs. 22,533 crores) and 33% (Rs. 11,267 crores) based on their share of 420 GW capacity.

Figure 11: Inter-Industry Impact of Green Energy Corridor



The major impacts inter-industry impact of the Green Energy Corridor project is on the core input sectors which having high backward linkages to Electricity from Solar Energy and Electricity from Wind Energy. Furthermore, the job creation potential of the Green Energy Corridor project was assessed for Electricity from Solar Energy and Electricity from Wind Energy.

Table 2: Employment Generation across Occupational Groups from Green Energy Corridor Project

		Solar		Wind	
SR. NO.	OCCUPATION TYPE	Total Jobs	% change from Baseline	Total Jobs	% change from Baseline
1.	Elementary Occupations	2,43,127	35.9%	58,587	28.9%
2.	Craft and related trades workers	2,24,857	33.2%	54,084	26.7%
3.	Plant and machine operators and assemblers	85,105	12.6%	29,757	14.7%
4.	Legislators, Senior officials, and managers	52,917	7.8%	14,504	7.2%
5.	Technicians and associate professionals	15,230	2.3%	8,469	4.2%
6.	Rest of the occupation types	55,263	8.2%	37,315	18.4%
7.	Total		6,76,499		2,02,714

The employment potential of Solar is significantly higher compared to Wind, which is expected due to higher investments into Solar compared to Wind. Although, observing the occupational types the Wind energy sector has higher diversity in job potentials based on percentage change from baseline scenario for rest of the occupation types compared to Solar. This is cause Wind has higher diversity in backward linkages compared to Solar. Furthermore, Solar is more reliant on elementary occupations, which could also be a potential avenue of skill training towards formalizing the associated labour groups in Elementary Occupations during the lifetime of the project from construction to operations.

4. Conclusion

It is of critical priority for anticipating the skill requirements and gaps for a developing country like India, which is bestowed with a demogrpahic dividend and yet has about 30% of its working age population under NEET (Not in Education, Employment or Training). While, penetration of vocational training towards gainful employment hasn't been streamined since the primary TVET institutions, the Industrial Training Institutes (ITIs) themselves require a reorientation to industry requirements. The TVET system in India, which had its inception during the Second Five Year Plan in the 1950s, was able to for a large extent, keep pace with the paradigmatic frame of a planned economy. The Second Five Year plan not only laid the foundations for promoting manufacturing sectors as the primary growth drivers of the economy but also framed the required TVET ecosystem to meet the demands of public and private enterprises in lieu of a centrally planned economy (Maitra & Maitra, 2019). But in the post liberalization period the quantum jump in GDP from pre-liberalization period growth rate of 3.5 percent per annum to 6.4 percent per annum in 1990s to the peak of 8.4 percent in 2000s to 2010s did not entail the economic growth in same manner into job growth. Since economic growth should had also simultaneously translated into a transition from agriculture to manufacturing, non-manufacturing industry and services sectors. However, low levels of education in the labour force, particularly among those engaged in agriculture, hindered this transformation in the workforce. Hence, the key intervention that the Indian economy requires is anticipating the changes in economy and matching the employment patterns.

In our study we have attempted to envisage the policy effects on occupation groups belonging to varying skill levels in the economy in lieu of also exploring the premise of green jobs for certain key sectors. The results indicate the job potential associated with core green transition sectors, that is pertaining to renewables as well as sustainable mobility do require significant number of upper management and professionals and hence, cater to the upper brackets of the educated workforce. While across the sectors the major presence of the Elementary Occupation group signify the high levels of informal and unorganized characteristics of the economy. Hence, the recommended approach would be towards upskilling of the lower occupational groups in the due course of associated project development.

Green jobs in India certainly present a converged solution to multiple challenges; leveraging the demogrpahic dividend for growth, while meeting the requirments of a green transition to tackle climate change. The approach has been to identify manpower requirement of key manufacturing and developmental projects at local level for fostering introduction and adoption of green technologies and practices, while facilitating green skilled workforce through trainings at local Technical and Vocational Education and Training (TVET) institutions. In this direction the formation of the Skill Council Green Jobs (SCGJ) under the National Skill Development Mission has been a key marker towards concretion of green jobs in the economy.

The establishment of SCGJ is promoted by Ministry of New and Renewable Energy (MNRE) and Confederation of Indian Industry (CII) with an attempt towards building a platform for confluence between stakeholders from industry, academia, and government to collaborate on the development of green jobs in India. The council is also responsible for developing the skill standards and certification for green jobs in India and bridging the industry requirements in transition towards a green economy. In this regard, the Sector Skill Council's core efforts and objectives have been to create skilled workforce in the green sector, providing employment opportunities for young people and contributing to India's sustainable development goals targets and commitments. Towards identification of manpower requirement and anticipating the skilling requirements across the economy stemming from direct employments in particular sectors; an IO framework proves to be vital. IO complimented with occupational skilling profile of the workforce is key to such interventions. If leveraged appropriately, they address to a certain extent the earlier mentioned Neo-Malthusian argument of resource burdens and environmental degradation associated with population size.

5. Future Scope of the Study & Limitations

In our study one of the major limitations has been in reliance of a cross sectional dataset. We have considered the IOTT and employment structure for only one year, whereas to extend the scope a time series comparison of economic and employment structure using multiple IOTTs would provide more insights into the aspects changing requirements of the industry and if they are met. Although, to conduct such an exercise it would require building multiple IOTTs and also data on the employment structure at regular periods. Prior to the PLFS, the NSS employment and unemployment survey (EUS) used to be conducted after every five years, hence the pre 2017-18, the data available is for year 2011-12. Furthermore, since our prospects for comparison would had been pre-COVID periods the comparability between NSS-EUS and PLFS is of concern given there have been questions upon the inter-comparability between the two datasets due to difference in survey frame and formulation of the sample multipliers (Kaushal, 2019; Jajoria & Jatav, 2020). Although, future rounds of PLFS certainly hold great premise for conducting such an exploration into the aspects of changes in economic structure in association with the employment structure over a period. Furthermore, the adoption of revised NCO-2015 codes which have been aligned with the National Skills Qualification Framework (NSQF) reflect the true comparision beetween difference in skills within and across occupational division and hence, provide more sector specific

skilling requirements. In our study one of the major dimensions which we haven't explored yet but look towards completing in the final version is the associated average wages of sector specific occupational groups to reflect upon the quality of job. Along, with penetration of vocational training in combination with general and technical education to gauge the sector specific diversities in this aspect; as to which sectors are more oriented to what kind of skilling or education. Apart from that, the conventional limitations to any IO study persists; which is that nature of analyis is static and does not consider employment elasticities or change in production structure.

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Appendix- IOTT 2018-19 | NIC-2008 Concordance

Activity	Code	Description
Paddy	0112	Growing of rice
Cereals (except rice), leguminous crops and oil seeds	0111	Growing of cereals (except rice), leguminous crops and oil seed
Fibre crops	0116	Growing of fibre crops
Sugarcane	0114	Growing of sugar cane
Coconut	01261	Growing of coconut
Tobacco	01150	Growing of tobacco
Tea & Coffee	01271 01272	Growing of tea Growing of coffee
Rubber	01291	Growing of rubber trees
Fruits	0121 0122 0123 0124 0125 0126	Growing of grapes Growing of tropical and subtropical fruits Growing of citrus fruits Growing of pome fruits and stone fruits Growing of tree and bush fruits and nuts Growing of oleaginous fruits
Vegetables	0113	Growing of vegetables and melons, roots and tubers
Other Food Crops	0119 0129	Growing of other non-perennial crop Growing of other perennial crops
Animal Husbandry	014	Animal production
Forest and logging	02	Silviculture and other forestry activities
Fishing	03	Fishing
Coal and Lignite	05	Mining of coal and lignite
Natural Gas	062	Extraction of natural gas
Crude petroleum	061	Extraction of crude petroleum
Iron ore	071	Mining of iron ores
Manganese ore	07293	Mining of manganese ore
Bauxite	07292	Mining of aluminium ore (bauxite)
Copper ore	07291	Mining of copper ore
Other Metallic minerals	07210 07294	Mining of uranium and thorium ores Mining of chromium ore (excluding 07299)
Limestone	08107	Mining/quarrying of limestone, lime shell, and other calcareous minerals including calcite, chalk and shale

Other non-metallic minerals	081 089	Quarrying of stone, sand and clay Mining and quarrying n.e.c. (excluding 08107)
Food and food products	10	Manufacture of food and food products
Beverages and tobacco products	11 12	Manufacture of beverages Manufacture of tobacco products
Textiles and textile products	13 14	Manufacture of textiles Manufacture of wearing apparel
Leather and leather products	15	Manufacture of leather and related products
Wood and wood products except furniture	16	Manufacture of wood and products of wood and cork except furniture; manufacture of articles of straw and plaiting materials
Paper, Paper products and newsprint, publishing, printing and allied activities	17 18	Manufacture of paper and paper products Printing and reproduction of recorded media (excludes publishing activities)
Furniture & Fixtures	31	Manufacture of furniture
Rubber products	221	Manufacture of rubber products
Plastic products	222	Manufacture of plastic products
Petroleum products	192	Manufacture of refined petroleum products
Coal tar products	191	Manufacture of coke oven products
Chemicals (Major organic/ inorganic)	2011 2013	Manufacture of basic chemicals Manufacture of plastic and synthetic rubber in primary forms
Fertilizers and pesticides	2012 2021	Manufacture of fertilizers and nitrogen compounds Manufacture of pesticides and other agrochemical products
Paints, varnishes and lacquers	2022	Manufacture of paints, varnishes and similar coatings, printing ink and mastics
Drugs & medicine	21	Manufacture of Pharmaceuticals
Soaps, cosmetics and glycerine	2023	Manufacture of soaps, detergents, cleaning and polishing preparations, perfumes and toilet preparations
Synthetic fibres, resin	203	Manufacture of man-made fibres
Other chemicals and chemical products	2029	Manufacture of other chemical products n.e.c
Cement	2394	Manufacture of cement, lime and plaster
Non-metallic mineral products	23	Manufacture of non-metallic mineral products (excluding 2394)
Find and steel Ferro alloys	241	Manufacture of basic iron and steel

Iron and steel casting and forging and foundries	243	Casting of metals
Non-ferrous basic metals (including alloys)	242	Manufacture of basic precious and other non-ferrous metals
Hand tools, hardware	2593	Manufacture of cutlery, hand tools and general hardware
Miscellaneous metal products	25	Manufacture of fabricated metal (excluding 2593)
Tractors and other agricultural implements	2821	Manufacture of agricultural and forestry machinery
Industrial machinery for food and textile industry	2825	Manufacture of machinery for food, beverage and tobacco
	2826	Manufacture of machinery for textile, apparel and leather
Industrial machinery (except food and textile)	282	Manufacture of special-purpose machinery (excluding 2821, 2822, 2825, 2826)
Machine tools	2822	Manufacture of metal-forming machinery and machine tools
Other non-electrical machinery	281	Manufacture of general-purpose machinery
Electrical industrial machinery	271	Manufacture of electric motors, generators, transformers and electricity
Electricity from solar energy	35105	Electric power generation using solar energy
Electricity from wind energy	35106	Electric power generation using other non-conventional sources
Electricity from other sources	35101	Electric power generation by hydroelectric power plants
	35102	Electric power generation by coal based thermal power plants
	35103	Electric power generation by non-coal based thermal power plants
	35104	Electric power generation and transmission by nuclear power.
Electrical cables, wires	273	Manufacture of wiring and wiring devices
Batteries	272	Manufacture of batteries and accumulators
Electrical appliances	275	Manufacture of domestic appliances
Communication equipment	263	Manufacture of communication equipment
Other electrical machinery	279	Manufacture of other electrical equipment
Electronic equipment, including TV	261	Manufacture of electronic components
	262	Manufacture of computer and peripheral equipment
	264	Manufacture of consumer electronics

Medical precision, optical instrument, watches and clocks	265 266 267 268	Manufacture of measuring, testing, navigating, and control equipment Manufacturer of irradiation, electromedical and electro therapeutic equipment Manufacture of optical instruments and equipment Manufacture of magnetic and optical media
Ships and boats and rail equipment	301 302	Building of ships and boats Manufacture of railway locomotives and rolling stock
Motor vehicles	291 3091	Manufacture of motor vehicles Manufacture of motorcycles
Bicycles, cycle-rickshaws	3092	Manufacture of bicycles and invalid carriages
Aircrafts and spacecrafts, other transport equipment	303 3099	Manufacture of aircrafts and spacecrafts other related machinery Manufacture of other transport equipment n.e.c
Gems and jewellery and miscellaneous manufacturing	321	Manufacture of jewellery, bijouterie and related articles
Construction and constriction services	41 42 43	Construction of buildings Civil engineering Specialised construction activities
Gas	352	Manufacture of gas; distribution of gaseous fuels through mains
Water supply	360	Water collection, treatment and supply
Trade	451 453 46 45401 45402 47	Sale of motor vehicles Sale of motor vehicle parts and accessories Wholesale trade except of motor vehicles and motorcycles Wholesale or retail sale of new motorcycles, mopeds, scooters and 3 wheelers Wholesale or retail sales, parts and accessories for motorcycles, mopeds, scooters and 3 wheelers Retail trade, except the motor vehicles and motorcycles.
Repair & Maintenance of Motor vehicle	452 45403	Maintenance and repair of motor vehicles Maintenance and repair motorcycles, mopeds, scooters and 3 wheelers
Hotels & Restaurant	56	Food and beverage service activities

Transport services and auxiliary activities	49 50 51 52	Land, transport and transport via pipelines Water transport Air transport Warehousing and support activities for transportation (excluding 521)
Storage and warehousing	521	Warehousing and storage
Communication services	61	Telecommunications
Financial and insurance services	64 65 66	Financial service activities, except insurance and pension funding Insurance, reinsurance and pension funding, except compulsory social security Activities auxiliary to financial service and insurance activities
Other Services* Ownership of dwellings, Renting of machinery & equipment, Real estate services, research & development services, legal services, other business services, computer related services, public administration and defence, education services, human health and social care services, community, social and personal services, recreation, entertainment and radio & TV broadcasting and other services	68, 69, 70, 71, 72, 73, 74, 75, 77, 78, 79, 80, 81, 82, 84, 85, 86, 87, 88, 90, 91, 92, 93, 94, 95, 96, 97, 98	Real estate activities Legal and accounting activities Activities of head offices; management consultancy activities Architectural and engineering activities; technical testing and analysis Scientific research and development Advertising and market research Other professional, scientific and technical activities Veterinary activities Renting of machinery and equipment Rental and leasing activities Employment activities Travel agency, tour operator, reservation service and related activities Security and investigation activities Services to buildings and landscape activities Office administrative, office support and other business support activities Public administration and defence; compulsory social security Education Human health activities Residential care activities Social work activities without accommodation Creative, arts and entertainment activities Libraries, archives, museums and other cultural activities Gambling and betting activities

		Sports activities and amusement and recreation activities Activities of membership organizations Repair of computers and personal and household goods Other personal service activities Activities of households as employers of domestic personnel Undifferentiated goods/service activities of private households for own use.