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ECONOMIC EFFECTS OF RENEWABLE ENERGY IN EGYPT

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ABSTRACT

Energy fuels global economic activity. As populations expand, living expand, living standards improve and consumption rises, total demand for energy is expected to increase by 21% by 2030 (IEA, 2015). At the same time, growing concerns over climate change are prompting governments worldwide to seek ways to supply energy while minimizing greenhouse gas emissions and other environmental impacts. Decisions made today on energy sector investments and infrastructure lock in associated costs and benefits for at least a few decades. The objective of this study is a capture and measure the effects of renewable energy deployment on the basis of a holistic macroeconomic framework on the Egyptian economy. More specifically, the study quantitative evidence of the macroeconomic impacts of renewable energy deployment in Egypt. This paper depends on the descriptive analysis to show the impact of renewable energy sources on the macroeconomic indicators in Egypt such as economic growth and unemployment rates. Egypt's statistical information and indicators show that the country is in a transitional phase with respect to energy security and dependency. The Egyptian renewable energy deployment model is heavily based on large scale projects, while decentralized renewable energy solutions received sporadic attention. The employment effect of renewable energy expansion is one of the key valued economic factors, with an estimate of around 29000 job opportunities based on the currently announced pipeline of projects.

Keywords: Renewable Energy Sources, Economic Growth, Egypt

1. INTRODUCTION

Located in the north-eastern part of Africa, the Arab Republic of Egypt is bordered by the Mediterranean Sea to the north and the Red Sea to the east, and is therefore at the crossroads between Europe, the Middle East, Asia and Africa. With an area of over 1 million square kilometers (km2), Egypt is the world's 30th-largest country, the majority of the landscape being desert with a few scattered oases. Of the total population, 95% is concentrated along the narrow Nile Valley and Delta, corresponding to only about 5% of the total land area (World Bank,

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2017). In 2016, the population exceeded 95 million inhabitants, with those aged between 15 and 29 years representing 27% of the population (CAPMAS, 2017). Egypt is the most populous country in North Africa and the Arab region and the 15th most populous in the world, with half of its residents living in urban areas.

Egypt is a lower-middle income country and economic activity is concentrated in the services, industrial and agricultural sectors, with their respective contributions of 55%, 33% and 12% to gross domestic product (GDP) (Trading Economics, 2017). The country's fast-growing population is putting a strain on existing infrastructure and services. In 2015, 28% of the total population lived below the national poverty line, with an even higher rate of 60% recorded in Upper Egypt. Furthermore, the unemployment rate reached 12% in mid-2016 (comprised mainly of 26% of the youth group aged between 15 and 29 years), up from a 9% unemployment rate prior to 2011 (Trading Economics, 2017).

Energy fuels global economic activity. As populations expand, living expand, living standards improve and consumption rises, total demand for energy is expected to increase by 21% by 2030 (IEA, 2015). At the same time, growing concerns over climate change are prompting governments worldwide to seek ways to supply energy while minimizing greenhouse gas emissions and other environmental impacts. Decisions made today on energy sector investments and infrastructure lock in associated costs and benefits for at least a few decades. They also strongly influence how effectively the energy sector underpins growth across the economy. The energy sector influences the vibrancy and sustainability of the entire economy – from job creation to resource efficiency and the environment. Major shifts in the sector can have a strong ripple effect throughout the economy as evidenced in Japan following the 2011 earthquake, or by the recent volatility in oil prices. Making the energy supply more cost effective, reliable, secure and environmentally sustainable thus contributes to the long-term resilience of economic development.

The objective of this study is a capture and measure the effects of renewable energy deployment on the basis of a holistic macroeconomic framework on the Egyptian economy. More specifically, the study quantitative evidence of the macroeconomic impacts of renewable energy deployment in Egypt.

This paper depends on the descriptive analysis to show the impact of renewable energy sources on the macroeconomic indicators in Egypt such as economic growth and unemployment rates.

The plan of this paper will be as follows: Section (2) shows energy for development in Egypt. Section (3) Present the available renewable energy in Egypt. Section (4) shows economic analysis of renewable energy in Egypt. Conclusions and Challenges and presented in Section (5).

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2. ENERGY FOR DEVELOPMENT IN EGYPT

The sustainable Development Strategy: Egypt Vision 2030 (MOP, 2015) was announced in February 2016 and is indicative of the country's aspirations to achieve a competitive, balanced and diversified economy by 2030 to secure sustainable development in a protected environment for all Egyptians. The strategy identified a set of targeted development indicators to be reached by 2020 and 2030, among which several indicators relate to energy and set significant renewable energy penetration targets, as depicted in Table 1.

Table 1: Development indicators of Egypt's Vision 2030

Targeted development indicators	2016*	2020	2030
GDP real growth (%)	4.2	10.0	12.0
GDP per capita (USD)	3436	4000	10000
Inflation rate (CPI, annual %)	11.8	8.0	5.3
Industrial development rate (%)	5.0	8.0	10.0
Industry share of GDP (%)	12.5	15.0	18.0
Energy sector share of GDP (%)	13.1	20.0	25.0
Renewables' share in primary energy (%)	1.0	8.0	12.0
Renewables in electricity production (%)	1.0	21.0	32.5
Women in workforce (%)	22.8	25.0	35.0
Unemployment rate (%)	12.8	10.0	5.0
Poverty rate (%)	26.3	23.0	15.0
Acute poverty (%)	4.4	2.5	0.0

* Data for 2016 are actual data for the year, s stated in the Sustainable Development Strategy report, which references 31 indicators (MOP, 2015).

Note: CPI = consumer price index.

The Egyptian energy sector is a key driver for the socio-economic development of Egypt, representing around 13% of current GDP and thus making economic growth in the country contingent upon the security and stability of energy supply. Since 2007, Egypt has experienced an energy supply deficit due to the rapid increase in energy consumption and the depletion of domestic oil and gas resources, shifting its position as a net hydrocarbon exporter for the last three decades to that of a net importer. This has brought a set of challenges to the energy sector, including electricity shortages, caused in part by the decline of domestic gas production, as natural gas is the main source of electricity, accompanied by highly subsidised energy prices, with negative financial implications for already dwindling government revenues.

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In response, the Government of Egypt has taken bold steps to adopt an energy diversification strategy with increased development of renewable energy and implementation of energy efficiency, including assertive rehabilitation and maintenance programmers in the power sector. The deployment of renewable energy technologies is gaining momentum, such that the total installed capacity of renewable energy stands at 3.7 gigawatts (GW) (mainly 2.8 GW of hydro and 0.887 GW of solar and wind) with a commitment from the government to develop an additional 10 GW of wind and solar projects by 2022, whereby renewables would contribute to 20% of the electricity mix (IRENA, 2018).

3. AVAILABLE RENEWABLE ENERGY IN EGYPT

This part covers Egypt's available renewable energy resources, their current status and their future development potential. It also addresses the enabling environment and related regulatory framework for renewable energy.

Renewables can have a myriad of benefits: renewable energy technologies can often provide a secure and reliable energy alternative, while investment in local renewable energy infrastructure and services can create significant local added value through job creation and boosting local economic growth (IRENA, 2017). Moreover, power provided by renewables would free up depleting hydrocarbon reserves, reducing distortion of the energy markets by alleviating the heavy burden subsidies place on government finance and investment.

Egypt enjoys an abundance of renewable energy resources with high deployment potential. These are mainly hydro, wind, solar and biomass. Since the late 1970s, the Egyptian government has initiated programmes for demonstrating, testing and evaluating different renewable energy applications and technology systems in co-operation with various countries and international entities, including France, Germany, Italy, Spain, Denmark, Japan, the European Union and the United States. The co-operation between these entities translated into the installation of solar water heaters (SWHs) in new cities, solar industrial process heat systems (SIPHS), wind farms and photovoltaic (PV) applications in water pumping, cold stores and desalination plants, as well as biogas digesters in rural areas.

The establishment of the NREA in 1986 (through Law No.102 of the year 1986) was an important milestone in efforts to develop renewable energy sources in Egypt. The NREA focuses particularly on wind and solar technologies and has recently expanded its focus to include biomass development. Other national institutions have also devoted efforts to biomass development, among them the EEHC and the Ministry of Environment.

3.1. Renewable energy contribution to primary energy production

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The contribution of renewable energy resources to primary energy production stood at 4% in 2009/10, mainly from hydro (3%) and wind (1%). Their contribution is expected to reach a total of 8% by 2021/22 and 14% in 2034/35, corresponding to 22.8 Mtoe in that year. On the basis of those contributions, renewable energy is expected to make up 20% and 42% of electricity generation in 2021/22 and 2034/35, respectively (EU, 2015). The average growth rate for renewable energy in primary energy supply reaches 7.3%.

3.2. Renewable energy contribution to installed power capacity

The total installed capacity of renewable energy sources in expected to reach 19.2 GW by 2021/22 and increase to 49.5 GW and 62.6 GW in years 2029/30 and 2034/35 respectively. Table (2) shows the development of installed electric capacity for the different renewable technologies from 2009 to 2035 (EU, 2015). The MOERE and the Ministry of Investment and International Cooperation have recently modified the long-term energy strategy, maximising the contribution of renewable energy in the capacity mix to 42% in 2035, alongside maximising energy efficiency measures. The subsections of renewable energy technologies deployed in Egypt.

Table 2: Evolution of installed renewable energy power capacity in GW

Type of power station	2009/10	2021/22	2029/30	2034/35
Hydro	2.8	2.8	2.9	2.9
Wind	0.5	13.3	20.6	20.6
PV	0.0	3.0	22.9	31.75
CSP	0.0	0.1	4.1	8.1
Total	**3.3**	**19.2**	**50.5**	**62.6**

Based on: EEHC (2016), Egyptian Electricity Holding Company Annual Report 2015/16: EU (2015a), "Integrated Sustainable Energy Strategy", Eversheds and Price water house Coopers (2016), Developing Renewable Energy Projects: A Guide to Achieving Success in the Middle East, Fourth Edition.

3.3 RENEWABLE ENERGY POTENTIAL AND USE

Hydroelectric energy

The main hydro resource in Egypt is the River Nile, with the highest potential in Aswan where a series of power stations are located totaling 2800 MW, with corresponding electric generation of 13 545 GWH annually, Hydroelectricity represented almost 50% of the Egypt's total generated electricity in the 1960s and 1970s. However, due to the increase in the share of thermal power

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stations, electricity from hydro resources represented only 7.2% of the total electricity generated in 2015/16 (EEHC, 2016).

Hydropower is the most mature of the renewable energy technologies in Egypt, with an average rate of growth in energy generated from hydropower plants of 1.2% per year during the period 2011/12 to 2015/16. In this context, several projects have been realised and the breakdown of hydroelectric stations in 2015 is depicted in Table (3).

Table 3: Hydroelectric stations and their capacity

Station	Capacity (MW)	Annual generated electricity (GWh)
High dam	2100	9484
Aswan 1	280	1578
Aswan 2	270	1523
Esna	86	507
Naga Hamady	64	453
Total	**2800**	**13545**

Based on: EEHC (2016), Egyptian Electricity Holding Company Annual Report 2015/16: EU (2015a), "Integrated Sustainable Energy Strategy", Eversheds and Price water house Coopers (2016), Developing Renewable Energy Projects: A Guide to Achieving Success in the Middle East, Fourth Edition.

An additional four hydroelectric plants are being developed at Assiut in Upper Egypt with a capacity of 32 MW, and are due to become operational by late 2018.

In 2015, plans to build a 2400 MW pumped storage hydroelectric plant in Attaqa were initiated, due for completion in 2022 (Andritz, 2016). This project is due to operate at peak hours, based on water flowing from an upper to a lower reservoir with a 28-metre height difference. In the off-peak period, the flow is reversed and the upper reservoir will refill normally by using the turbines as pumps and the generators as motors.

The electricity needed to operate the motor generators is produced by surplus power capacity available during off-peak periods. A conditional contract was signed with Sanyo in China for building the plant subject to the acceptance of the technical and financial offers by the MOERE and EEHC. The project is expected to start operation in late 2022.

Wind energy

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According to Egypt's Wind Atlas (Wind Atlas for Egypt Measurement and Modelling 1991-2005), the country is endowed with abundant wind energy resources, particularly in the Gulf of Suez area. This is one of the best locations in the world for harnessing wind energy due to its high stable wind speeds that reach on average between 8 and 10 m/s at a height of 100 meters, along with the availability of large uninhabited desert areas.

Moreover, promising new regions have been discovered east and west of the Nile River in the Beni Suef and Menya Governorates and El-Kharga Oasis in the New Valley Governorate. They offer wind speeds that vary between 5 and 8 m/s and are suitable for electricity generation from wind and other applications such as water pumping. Presents the new wind atlas published in 2016 on IRENA's Global Atlas platform, measured at a resolution of 1 km and a height of 200 metres.

Concentrated solar power

The first solar thermal integrated combined-cycle power plant was constructed in the Kuraymat area with a total capacity of 140 MW, including 20 MW as a solar component and 120 MW as a gas-fired combined-cycle plant, funded primarily by the Global Environment Facility, The total area of the integrated solar field is about 644000 square metres (m^2), with a total solar collector area of 1920 m^2 containing 53760 mirrors.

The total electricity generated from the power plant was 164 GWh/ year in 2015/16. Accordingly, the total annual reduction in conventional fuels as a result of utilizing solar energy in the Kuraymat power plant is estimated at about 10000 tonnes per year, and consequently avoided CO_2 emissions are estimated at about 20000 tonnes.

In 2015, EETC and the NREA initiated a tender for a new concentrated solar power (CSP) plant through the BOO system with a capacity of 100 MW. However, offers have yet to be received. Separately, a study financed by GIZ (the German development agency) in November 2013 suggested boosting electricity output by adding CSP facilities at existing Egyptian power plants. This would enhance the supply from, and effectively start to "hybridise", those largely gas and oil-fired plants (EGHLJC and Egypt ERA, 2013).

Solar water heating

In the early 1980s efforts were directed towards the development of SWH applications in industry. As a first step, the MOERE imported 1000 SWHs of 100 to 500 liters per day capacity and tested selected samples in different types of application, as well as renting others to the public.

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This initiative resulted in the establishment of several private-sector companies for the assembly and manufacture of SWHs in Egypt. Moreover, the Ministry of Housing and Urban Communities issued a decree in 1986 for the mandatory use of SWHs in new cities, which resulted in the installation of solar water heaters equivalent to 800000 m^2 coverage. However, as a result of the highly subsidised energy prices and the mismanagement of the dissemination process due to the lack of experienced personnel and awareness, the market went into decline until 2013.

By 2013, the New Urban Communities Authority (NUCA) had started introducing SWHs in new cities in co-operation with EU countries. Currently, there are 22 companies listed in the registry of the Federation of Egyptian Industries (FEI) with a scope of activities including the production and/or the import of solar thermal technology. About 12 to 14 of those companies are currently involved in manufacturing, while the remaining serve as importers, such that the total installed capacity amounts to about 750000 m^2.

Egypt has proven potential for the industrial application of SWHs in process heat and solar thermal systems as a result of several demonstration projects that were implemented in the food and textile industries in the early 1990s. Thus, a USD 5 million project was launched at the end of 2014 by the Ministry of Trade and Industry for small and mediumsized enterprises (SMEs), to promote low-carbon technologies, mainly solar thermal, for cooling and heating in industrial applications (UNEP, 2014).

Biomass

Egypt has large resources of biomass from agricultural waste, animal dung and urban solid waste. Agricultural waste totals about 35 million tones annually, 40% of which is used for feeding animals, the rest being available for energy purposes (equivalent to 5 Mtoe/year). Urban solid waste averages 0.5 kilograms per person per day, amounting to almost 10000 tonnes per day in greater Cairo alone (GIZ, 2014).

Different biomass technologies have been demonstrated in Egypt, in particular for the production of biogas from animal waste in rural areas, as well as for the collection and briquetting of agricultural waste. Such technologies create jobs in villages and reduce the migration of young people to the big cities.

The Ministry of Environment, in co-operation which Ministry of Local Development, is currently leading a programme for the treatment of municipal solid waste in large cities (GIZ, 2014).

The Bioenergy for Sustainable Rural Development Project (BSRD) (EEAA et al., 2013), led by the Egyptian Environmental Affairs Agency (EEAA), was initiated in 2009 and funded by the

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United Nations Development Programme and the Global Environmental Facility. The project aims at encouraging young graduates to become entrepreneurs, while providing special support to women and consideration to rural areas.

The project has achieved remarkable progress in developing and disseminating biogas digesters and establishing Bioenergy Service Providers (BSPs) to support the market penetration of bioenergy in the country. The resultant BSPs are companies that are founded to provide job opportunities for young graduates through on-site training on the construction, curing, feeding and gas production of biodigesters in rural areas.

During three years of its operation, the BSRD developed and operated 960 biogas units of different sizes in 18 Egyptian governments. Twenty registered BSPs were established and spread across Egyptian villages, providing their services to more than 1000 families. The BSRD is considering a FIT regulation for biomass systems similar to that for wind and solar issued by the Prime Minister in October 2014 (EEHC, 2016).

4. ECONOMIC ASPECTS OF RENEWABLE ENERGY IN EGYPT

This part addresses some of the economic aspects of renewable energy in Egypt. It highlights some relevant statistical information and indicators, and discusses Egypt's situation with respect to energy security and dependency. The issues of energy intensity, the energy-bill, and subsidies are discussed in detail and benchmarked against other neighboring countries. The economic activities associated with the renewable energy value chain of significance to Egypt are further analyzed. This part then elaborates on the employment effect of renewable energy expansion in view of the progress achieved and the announced plans. In brief, this part tries to explore how renewable energy growth in Egypt can be driven by both energy and economic considerations.

As explained in the previous part, Egypt is endowed with abundant renewable energy sources, and is moving ahead to more reliance on renewables. With around 90 million inhabitants, and within a challenging political context, it seems that the social structures are becoming more stable; in response to positive state actions to improve the economic situation and to address business development concerns. Egypt's physical characteristics make it suited for RE power scale-up, particularly wind and solar. Egypt's favorable conditions; besides the abundant sunshine and windy locations, include the low number of rainy days, and plenty of unused land close to road networks and electrical transmission grids. The electrical grid is extended, covering about 99% of the Egyptian population. Over and above, Egypt has the assets of the human resources and the industrial base that can be adapted to serve the renewable industry locally and regionally.

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Along with the enhancement of local manufacturing capacities, the implementation of RE projects would lead positive impacts on developing rural and new communities in the vast desert as well as exporting the excess green energy to neighboring countries and Europe via Mediterranean interconnection links. It is important to remember that over 9 GW of solar and wind power will be added to the Egyptian power mix by the year 2020, motivated by ambitious and credible incentive structures mainly through a generous Feed-in Tariff (FIT) announced in September 2014 and a competitive bidding scheme.

The economic impact of RE represents a vital dimension of any development or investment strategy. Until recently, the Egyptian RE development relied mostly on large-scale electricity generation through mega project plans. To ensure the political endorsement, public acceptance, and financiers' interest, it has been vital to focus on the socio-economic dimensions congruent with governments and stakeholders expectations. Several issues are decisive in this respect, such s demography, economic growth and activity structures. In addressing the perceived higher costs of RE investments, political actors and promoters rest on the promise of higher positive economic benefits, such as job and local business development opportunities.

Living in nearby villages and cities. The previous examples showcase how RE deployment brings social added value on top of economic value. Another example is the off-grid rural solar electrification program funded by UAE covering several villages. This program improves access to electricity and provides new possibilities of learning improvement through evening house lighting and provision of appliances and household solutions fostering improved health conditions. Adding to that, increased well-being can be created through securing local high quality jobs.

The increased access to business opportunities, employment, training and education, coupled with the enhanced access to and from the renewable energy development regions and the availability of funding, e.g. through developers' corporate social responsibility programs, are all contributors to improving the standard of living and the social infrastructure.

The beauty of renewable energy deployment; on national, regional and local levels, is that it influences positively and respects the relationships between economic activities, people's social and cultural particularities and biophysical environment. There is much overlap between different impacts, and there are many valued socio-economic components that interact; for instance health and wellbeing, sustainable land access and traditional/ alternative use, protecting heritage and cultural resources, equitable business and employment opportunities, adequate services and infrastructure, and adequate sustainable income and lifestyle.

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Unfortunately, in Egypt, no study has researched in sufficient detail the impact of existing and proposed renewable energy developments on different valued socio economic components.

One of the key valued economic factors is employment, where renewable solutions offer significant opportunities. Egypt enjoys a wide and diversified labor market, which can be considered an important technological asset, notably with respect to large wind power projects. For other technologies, the capacity building activities for manpower vary from one technology to the other, and vary from being diligently pursued through structured courses in few cases, to being ad-hoc on the job random and infrequent in other cases. Even for the wind power projects, satisfying the manpower needs for achieving the announced targets and ambitions may represent a challenge.

There is clear evidence that RE&EE sectors are increasingly contributing to worldwide job creation. The RE value chain phases with the highest labor intensity involves installation, production maintenance and operation, whereas for EE, this holds true for the building sector, which is booming in Egypt and is labor intensive. If SMEs account for 90% of global economic activity and at least 50% of employment, the same logic applies to clean energy jobs, for which SMEs are currently primarily responsible, especially in the RE&EE sub-sectors. According to REN21's, an estimated 6.5 million people worldwide work directly or indirectly in the RE sector, and as SME creation in the supply and demand of energy solutions becomes more mainstream, the share of clean energy employment is set to become even more significant. An interesting illustration comes from the results of the MENA CSP Scale-Up Investment plan, developed by the World Bank and the African Development Bank. Results showed that if Concentrated Solar Power (CSP) projects of up to 5GW are to be installed in Algeria, Egypt, Jordan, Morocco and Tunisia by 2020, it is estimated that, in case of 60% domestic manufacturing of the CSP value chain, and these five countries could create between 64,000 and 79,000 local renewable energy jobs by 2025. Of these jobs, 45,000 to 60,000 would be in construction and manufacturing sectors, and 19,000 in operation and maintenance.

In terms of Energy Efficiency (EE), contributions to global job creation have been difficult to estimate. A recent study by MEDENEC shows that by 2030, between 1.2 million and 1.6 million jobs could be created in the energy efficiency sector provided the right policy support is present.

SMEs are the principal economic actors and employers in the world. This is not different for Egypt. In fact, they represent over 90% of registered companies and employ over 70% of the labor force in most of the Arab economies, including the informal sector. SMEs can boost their energy efficiency and introduce renewable energy technologies, which are often local and small-scale by nature.

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The Global Wind Energy Council estimates that employment in regular operations and maintenance work at wind farms contributes 0.33 jobs for every megawatt of cumulative capacity. Accordingly, about 17 Jobs should be sufficient for each 50 MW. However, the local context should be taken into consideration. The wind farms are located in arid desert areas, with a high capacity factor (more operating hours per year), high temperatures, high turbulence and sandy weather, which result in an accelerated wear and tear of components and higher rate of failures after few years. Such an issue urges more employment in O&M activities. To date, considering only the announced plans in Egypt for additional capacities, large wind farms capacities would exceed in total 7 GW by the year 2020, with a possibility to further increase. Realizing such plans will require within the next few years preparing about 2,500 of qualified staff only for the O&M, and this workforce has to be at the level of quality consistent with international standards in this field to ensure the sustainability of the business. Qualified human resources are required not only for O&M, but also for all stages of development: resource assessment, project engineering, and installations. Over and above, qualified human resources are needed for the manufacturing of plant equipment and components, as developing local industries is one of the objectives for developing renewable energy projects. The case is similar for solar electricity generation. According to a survey by ESTIA, for solar thermal power plants, every 100 MW installed will provide 400 full-time equivalent manufacturing jobs, 600 contracting and installation jobs, and 30 annual jobs in O&M. The approach of ad-hoc on the job training can no more be implemented if large-scale sustainable renewable energy projects are intended.

With reference to the current installed capacities, the total investments for both solar and wind energy projects currently exceed U$$ 1.3 billion. Such investments have been assigned through governmental agreements betwee3n the Egyptian and donors' sides. Although this sum represents 25 years of investments in renewable energy, in the first half of the year 2015 NREA signed contracts estimating about U$$ 500 million to install around 400 MW, mainly from wind (340 MW) and partially from PV. Over 6000 employees are engaged in establishing these projects. Direct and indirect jobs are around 3500 and 2600, respectively.

Around 116 local and international companies are already qualified to install the FiT utility-scale projects; totaling 4000 MW. In the same context. More than 100 PV rooftop companies have been certified to work in the Egyptian market. Based on an IRENA report issued in 2014, job opportunities generated due to these activities would be around 29000 divided between direct and indirect opportunities (22000 and 6000, respectively). Potential direct job opportunities will include 13000 jobs in the manufacturing sector, 8500 jobs for erection, and 1000 in operation and maintenance. It is well known that achieving these numbers will take a lot of effort, but the

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benefits will be enormous, as it is said "climbing the hill is difficult, but the view from there is magnificent".

5. CONCLUSIONS AND CHALLENGES

This part reveals the renewable energy growth in Egypt can be driven by economic considerations alongside with energy supply and security drivers. Key economic aspects of renewable energy in Egypt have been highlighted. Egypt's statistical information and indicators show that the country is in a transitional phase with respect to energy security and dependency. A significant step in 2014 was the launch and implementation of gradual reform of energy subsidies, through a cost recovery energy pricing system, whereby it substantially decreased subsidies for gasoline, diesel, and natural gas and adopted a five-year plan to phase out subsidies in the electricity sector, while managing the social and economic vulnerability to shocks in energy prices and preserving the limited hydrocarbon wealth, diversifying the economy and improving ability of renewable and sustainable energy technologies to reach grid parity cost.

In addressing the perceived higher cost of sustainable energy investments, political actors and promoters rest on the promise of higher positive socio-economic benefits, such s job and local business development opportunities. The economic activities associated with the renewable energy value chain can be among the main drivers for increased rates of deployment. Egypt has the assets of the human resources and the industrial base that can be adapted to serve the renewable industry locally and regionally. In particular, the solar and wind energy sectors can be a driver for innovation and motivate the society to be at the forefront of innovative technologies. The implementation of renewable projects would also contribute to developing rural communities, through improved access to electricity and provide new possibilities of learning improvement through evening house lighting and provision of appliances and household solutions fostering improved health conditions. Adding to that, increased well-being can be created through securing local high quality jobs.

The Egyptian renewable energy deployment model is heavily based on large scale projects, while decentralized renewable energy solutions received sporadic attention. Even when a FiT pricing scheme was adopted, small scale decentralized systems had a small share of 300 MW compared to 4000 MW for medium and large scale projects. The decentralized systems are identified to be of higher value on local levels and promote higher business and employment opportunities. Among different renewable energy technologies, PV market is taking the lead, where over 100 companies are currently providing the services of supply, installation and maintenance of PV systems. Some donor-supported programs also piloted decentralized PV and biogas systems within developmental oriented projects, targeting rural and poorer areas. However, a key challenge facing Egypt is to increase the public appetite and subsequently the market volume for decentralized renewable energy solutions in different sectors, such s solar pumping for irrigation, hybridization of renewables with diesel for electricity and heat generation in industry and tourism sectors, etc.

The added value of establishing RE projects exceeds the value of electricity and jobs created. For example, wind projects at Zafarana triggered and impressive development of resorts and hotels on neighboring coastal areas after creating the necessary infrastructure (roads, electricity grid, water pipelines, etc.). However, such developments were not planned in advance, but were due to several overlapping conditions and circumstances, and the question remains if the newly allocated areas for RE projects would create a similar positive impact.

There is a clear need to research, in sufficient detail, the impact of existing and proposed renewable energy developments on different valued socio economic components, such s health and well-being, sustainable land access and traditional/alternative use, protecting heritage and cultural resources, equitable business and employment opportunities, adequate services and infrastructure, and adequate sustainable income and lifestyle. It is highly recommended to initiate such research.

The employment effect of renewable energy expansion is one of the key valued economic factors, with an estimate of around 29000 job opportunities based on the currently announced pipline of projects. The educational and vocational training activities for providing the needs of skilled human resources vary from being diligently pursued through structured courses in few cases, to being ad-hoc on the job random and infrequent training in other cases. Even for the wind power projects, satisfying the manpower needs for achieving the announced targets and ambitions may represent a challenge. Accordingly, it is of high importance to address this issue through standardized curricula delivered by dedicated service providers subject to highly efficient quality schemes.

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