The Socio-Economic Impacts of Renewable Energy and Energy Efficiency in Egypt
Local Value and Employment

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Dag-Hammarskjöld-Weg 1-5
65760 Eschborn, Germany
E – info@giz.de
www.giz.de

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Dr. Steffen Erdle, Head of Project – E: **Steffen.erdle@giz.de**

Produced by:

Regional Center for Renewable Energy and Energy Efficiency (RCREEE)

Hydro Power Building (7th Floor)

Block 11 - Piece 15, Melsa District

Ard El Golf, Nasr City, Cairo, Egypt

www.rcreee.org

Ms. Rana El-Guindy, Senior Specialist – E**: Rana.elguindy@rcreee.org**

Dr. Maged K. Mahmoud, Technical Director – E**: Maged.mahmoud@rcreee.org**

Title:

The Socio-Economic impacts of Renewable Energy and Energy Efficiency in Egypt - Local Value and Employment

Authors:

Dr. Ulrike Lehr
Maximilian Banning
Dr. Anhar Hegazi
Eng Ahmed Youssef

About RCREEE

The Regional Centre for Renewable Energy and Energy Efficiency (RCREEE) is an independent intergovernmental regional organization which mission is to facilitate, increase and mainstream the adoption of renewable energy and energy efficiency practices in the Arab region. RCREEE teams up with regional governments and global organizations to initiate and lead clean energy policy dialogues, strategies, technologies and capacity development in order to increase Arab states' share of tomorrow's energy.
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About RE-ACTIVATE

RE-ACTIVATE is a regional project for "Promoting Employment through Renewable Energy and Energy Efficiency (RE/EE) in the Middle East and North Africa (MENA) (RE-ACTIVATE)", funded by the Federal Ministry for Economic Cooperation and Development (BMZ) and implemented by GIZ in cooperation with RCREEE to support the national (Egypt) and regional cross-border cooperation and knowhow transfer on employment promotion through RE/EE in the MENA region.

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For further information or to provide feedback, please contact Rana El-Guindy (**Rana.elguindy@rcreee.org**)

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Abbreviations

ADB	African Development Bank
AGEE	Arbeitsgemeinschaft Erneuerbare Energie Statistik (German Statistics Group for Renewable Energy)
ANME	Agence Nationale pour la Maîtrise de l'Énergie, Tunisian Agency for Energy Efficiency
BOO	Build-own-operate
COMTRADE	United Nations Trade Statistics
CSP	Concentrated Solar Power
EE	Energy Efficiency
EF	Employment Factor
ENCPC	Egypt National Cleaner Production Center
EORA	Input Output Data Group
EU	European Union
EUREM	European Energy Manager Program
FTE	Full time equivalent
GACIC	German Arab Chamber for Industry and Commerce
GCC	Gulf Countries
GDP	Gross Domestic Product
GTAI	Germany Trade and Invest
GW	Giga Watt
IDE/JETRO	Institute of Developing Economies-Japan External Trade Organization
IEA	International Energy Agency
IEA-RETD	International Energy Agency Renewable Energy Technology Deployment
ILO	International Labor Organization
IO	Input Output
IRENA	International Renewable Energy Agency
JEDI	Jobs and Economic Development Impact
kWh	Kilowatt hour

L.E.	Egyptian Pound
LAS	League of Arab States
LOE	Level of effort
LSO	Lighting System Optimization
m2	Square meter
m3	Cubic meter
MASEN	Moroccan Agency For Sustainable Energy
MENA	Middle East North Africa
MMBTU	Million British Thermal Units
MSO	Motors System Optimization
MW	Mega watt
MWh	Megawatt hour
MWth	Megawatt hour thermal
NGO	Non-government organization
NREA	New and renewable energy authority
O&M	Operation and Maintenance
OECD	Organization for Economic Co-operation and Development
PAGE	Partnership for Action on Green Economy
PQO	Power Quality Optimization
PV	Photovoltaics
PVC	Polyvinyl carbonate
RE	Renewable Energy
RE&EE	Renewable Energy and Energy Efficiency
RIO+20	United Nations Conference on Sustainable Development (UNCSD)
SAM	Social Accounting Matrix
SDG	Sustainable Development Goals
SME	Small and Medium Enterprise
SSO	Steam System Optimization
SWH	Solar Water Heater
ToR	Terms of reference
UAE	United Arab Emirates

UN	United Nations
UNEP	United Nations Environmental program
UNIDO	United Nations Industrial Development Organization
UNITAR	United Nations Institute for Training and Research
US	United States
US$	United States Dollar
VDMA	German Machinery Association

Executive summary

Renewable energy (RE) expansion and energy efficiency (EE) increases exhibit several benefits in different aspects such as environmental quality, climate change mitigation or economic impacts in terms of savings, value creation and domestic employment. Taking advantage of these benefits comes with several prerequisites. The main pillars are a reliable expansion path and plan, an implementation strategy and a reliable mechanism to put the strategy in the right track.

To control what has been achieved, on one hand, and what can be expected along the expansion path on the other hand, a monitoring tool and a transparent monitoring process should be implemented. The main reason why we need to see where the country stands at any given point in time, is to fine-tune incentives or adjust and strengthen the instruments if necessary. Monitoring therefore helps to detect underperformance. It also serves the detection of successes, which will support the development along the paths by encouraging the continuity of the successful strategies and incentives.

On a global scale, RE has experienced unprecedented growth and deployment, with dramatic price declines. International studies on the effects on employment are now covering more countries and becoming increasingly refined. Similarly, impacts on employment along the value chain are much better understood worldwide.

Investment in renewable energy and energy efficiency equals additional demand for wind turbines, towers, PV modules, solar water heaters, efficient motors, air-conditioners etc. Employment is created from planning and design of a wind farm or a solar field, installation of the wind farm, and operation and maintenance of the systems. Direct employment can be thought of as people who work in planning and design services, who manufacture the tank of a solar water heater, who work in the bulb factory and who operate a biogas facility.

Thus far, there has been already 1040 MW of wind power and around 484 MW of solar power installed, under construction or in the process of being planned and commissioned in Egypt. This level of installation leads in comparable neighboring countries to an employment impact of more than 500 people (e.g. Tunisia, RE-Activate 2016) – but what does it mean in Egypt? This report has the main objective of answering this question.

The first part of this report will give an overview of the different employment assessment methods for renewable energy projects as well as the increase of energy efficiency established in the literature. Furthermore, it will describe international experiences with applying different methods and it will explain the different results. The focus lies on the applicability in the Arab region, in particular in Northern Africa with a special focus on Egypt.

The second part then turns into the development and application of, a customized excel based tool, to measure employment from renewable energy and energy efficiency in Egypt, under the current situation and under different assumptions and scenarios in the future. It is based upon an approach, which comprises the inclusion of direct and indirect effects. This approach is developed and described in Section 3 in Part 2, after an outline of the current energy and economic situations in Egypt. To understand the tool, an understanding of the data used is crucial. Hence, the data collection process is described in details in this section

Moreover, and since the quality of future applications will hinge on the improvement of the database, the study provides a well-structured data collection plan to follow in the coming three to five years in order to fill the tool with more accurate, updated and reliable data to get more strong results that can reflect the real situation in the future. Following this data collection plan and it will help to accurately use the tool in the future.

Using the tool and applying it to past developments and different scenarios in the future yielded to first, conservative, estimates of employment from renewable energy and energy efficiency in Egypt. The results of the calculations explained in detail in the third part of this chapter, showed that more than 8,800 people had their income from renewable energy and energy efficiency in the year 2016 in Egypt. This number can increase in the future to more than 65,000 people by 2030, under the right framework conditions. Section 4 of this report shows the results of the future development of employment under different scenarios in detail.

Seeing the current conditions and results obtained by the project and based on the set of scenarios that were suggested and their results, it is highly recommended for the Public Institutions, the regional and international organization as well as the policy maker to work hand in hand in the near future trying to achieve the renewable energy targets that has been already decided by the Egyptian Government.

Furthermore, and as proved by running different scenarios, more economic impacts from the same investment can be obtained if the domestic industry becomes more involved. Hence, the focus in the future should be on developing more labor intensive production, such as blade production for wind turbines because this shows to be advantageous in the scenario. If this industry is expanded, there might be room for exports and becoming a regional hub.

On the issue of knowledge increase and capacity building, systematic data collection should be pursued. First suggestions for the oncoming years have been made in the data collection plan as detailed in the rest of this report.

Part I Methods and International Results

1 Introduction

The methodology of the assessment of employment from renewable energy and energy efficiency has been developed over the past years and the consensus about the methods of choice is rather high. Renewable energy not only differs in terms of environmental impacts resulting from conventional energy, also the economic impacts follow different economic channels. While conventional energy generation, especially from fossil fuels involves large mining activities, the fuel from wind, solar and hydro energy sources requires “harvesting instead of mining”. The fuel as such does not require any economic activity. Labor on the other hand is necessary to build, operate and maintain the renewable energy system. Since the labor statistics as well as the further statistics on the energy sectors are developed from energy generation which is dominated by conventional fuels, the economic impacts from renewable energy expansion often require additional calculation, ideally based on primary statistics and surveys.

However, surveys are time consuming and costly. Therefore, the literature developed methods to deduct and transfer information from existing studies to new estimates. International agencies such as IRENA or the ILO as well as NGOs such as Greenpeace contributed to the comprehensive picture of jobs estimates in relation to green energy, energy efficiency and green jobs in total. For the policy maker, past successes are as relevant and interesting as forecasts of future developments. The estimation methods suggested the need to work for both time horizons, the past and the future. By and large, the data situation for renewable energy installation, potential and employment is rather good, while the same does not hold true for energy efficiency. Here, data gaps are larger, interest groups are less focused and more scattered and driven by the interest of single sectors or single energy consumers.

The literature on employment in renewables often distinguishes **direct and indirect** employment. The underlying economic concept is that any production, such as hydro turbines, is produced by people working directly in a turbine factory (such as Voith, Hunan, or Alstom) and causes production in those economic sectors, which produce the necessary materials for the turbine factory. Therefore, total additional employment from an additional turbine comprises jobs in the turbine factories (direct jobs) and jobs in the steel industry, in the metal shaping industry, in the cable industry etc. (indirect jobs).

The employment factor approach is a method to measure direct jobs. The relation of direct and indirect jobs depends on the development level of the respective industry. If the industry is domestically integrated, i.e. most intermediate goods are also domestically produced, the factor is typically around two, meaning as many indirect jobs are caused by production as direct jobs are accounted for. If most inputs are imported, the factor is much smaller

For the different phases of the value chain, the following definitions of direct and indirect jobs hold:

- Manufacturing: direct jobs are found in the production of electricity or heat generating system itself be it turbines, PV modules, solar water heaters, efficient pumps or improved windows. Indirect jobs are connected to all intermediate goods used in the production of the above.

- Construction and installation: Direct jobs are in the construction works, such as digging, building of a dam (hydro), brick works, concrete works, pipes, buildings for the operation, buildings for storage etc., and indirect jobs are in the production of building material and building machinery. Jobs in planning and design of the wind farm, the solar field or the efficient building can be considered direct or indirect. The tool developed in this project considers them as direct jobs in installation.
- Operation and maintenance: Direct jobs are in controlling the performance, bookkeeping, accounting, cleaning, repairs, replacements, greasing, etc. and indirect jobs are in the production of replacement parts, greasing material, computers etc.

The methods introduced here work in principal for both fields: energy efficiency and renewable energy. As far as possible, the description will stay neutral to the technology, be it an EE or an RE technology.

Employment Factors to **measure direct jobs**: Multiply Jobs per Megawatt with the Megawatt installed

- Plus regional adjustment, country specific data, data from existing projects. Separate analysis for installation and O&M

Input-Output Approach: include indirect jobs from services, manufacturing, planning

- Plus regional adjustment, country specific data, data from existing projects. Separate analysis for installation and O&M

Economic model: include net effects of future Renewable Energy and Energy Efficiency Scenarios

- Helps to show effects of economic instruments such as taxes etc.

Figure 1: Measurement of employment from renewable energy

The ILO (ITC 2013) writes on the issue of green jobs: *“Various methodologies for the assessment of employment effect of policy scenarios exist; they offer means for both the identification and quantification of existing jobs and for projecting how effective policies and investment programmes can be in providing new green employment. The selection of which tools are most appropriate for carrying out a study is largely dependent upon the questions that it sets out to answer. For example, will the study set out to estimate current or potential jobs? Will it take only a ‘snapshot’ or is it intended to take a more dynamic or longer-term view? Should it also analyse occupational and skills needs and income distribution? Not only are different methodologies suited to answering different questions, but their selection is also dependent on other factors such as the available budget and most importantly, the type and quality of data that is available.”*

A three tier approach (see Figure 1) from simple, one dimensional, only regarding direct jobs, via a more complex gross job analysis, including indirect jobs to a full picture of the economy with all feedback loops suggests itself. Each approach will be discussed in turn.

2 The Employment Factor Approach

2.1 Definitions and method

Employment factors measure the number of jobs created per unit of produced product or service. They are often applied to estimate employment in the energy sector. The measure is job per capacity installed expressed in physical units, such as megawatt for electricity-generating technologies (MW) or heat-producing technologies (MWth), or square meter solar water heater panel surface. For renewable energy fuels they may be expressed in jobs per million liters of production or in jobs per petajoule (i.e., by unit of energy content). The data for calculating employment factors can in principle be derived from a number of sources. These might include data from a broad industry survey; from specific enterprises or projects; from feasibility studies and technical literature specifications (Breitschopf, Nathani and Resch, 2011).

Surveys and inventories can provide a simple and effective way of assessing how many jobs related to RE and EE activities exist in specific sectors, regions or countries. A survey is usually carried out in the form of a questionnaire sent out to relevant companies, government departments or analysts, whilst an inventory commonly draws on a national or regional database to provide employment statistics. Some of these studies are comprehensive and relevant, whilst others only offers a snapshot, or 'scale-up' a more limited review so that it can provide an estimate of RE&EE jobs for a whole country or region. Inventories and surveys, if repeated consistently over a prolonged period, can also provide a useful measure of the extent of the new employment triggered by RE&EE policies.

Figure 2: Value chain phases

Source: Own graph.

Employment factors differ along the value chain: construction and installation is more labor intensive than manufacturing or operation and maintenance (O&M). Each phase has its own basic employment factor in terms of Jobs/ (physical unit). Each phase has a different relevant reference amount. In construction and installation new capacities over the building time of a new installation are relevant, in manufacturing, the amount of turbines and generators produced in a country drives employment and for the operation and maintenance phase, total capacity installed is the important input.

Countries differ in their economic structure, there capabilities as well as the speed and size of the economic development. Therefore, several authors suggested adjustment with regional factors for productivity, economic development and different stages of the value chain. Rutovitz and Harris (2015) suggested one of the most comprehensive approaches. Regional adjustment is based on relative productivity measured by GDP/employment;

individual factors hold for installation, manufacturing and O&M and shares of local manufacturing are set.

Schematically, the approach works as follows:

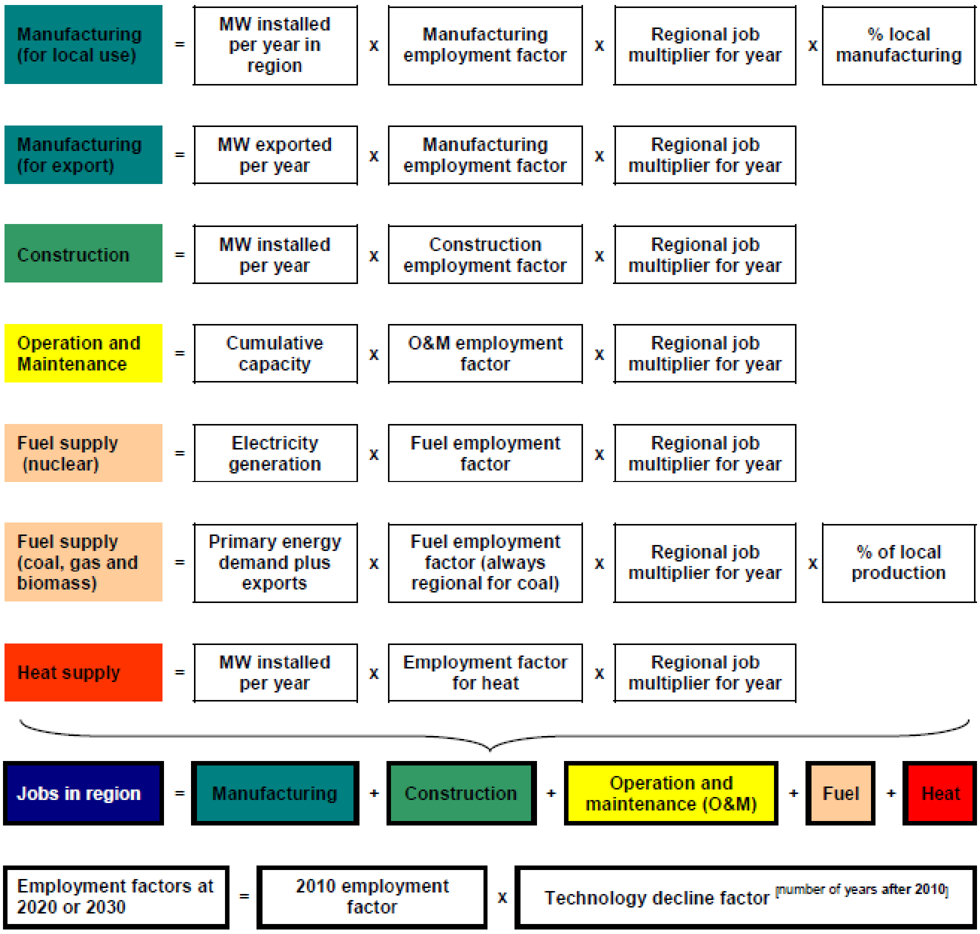

Figure 3: Employment factor approach

Source: Rutovitz 2012

Lehr, Walter and Nieters (2017), followed this suggestion for the calculation of global employment from large hydro power plants and they even improved it by taking country specific adjustment with labor intensities for construction, manufacturing, machinery and electronics into account. Further, the authors took the building time of the power plants into consideration and adjusted it for own production versus imports and exports. International trade data are used for the latter adjustment.

The main equations to calculate RE employment from this approach are the following:

(1) $$jobs_{country,phase,year} = EF_{country,phase,year} * relevant\ MW_{country,phase,year}$$

with

(2) $$EF_{country,phase,year} = \frac{\left(\frac{jobs}{output}\right)_{country,phase,year}}{\left(\frac{jobs}{output}\right)_{US,phase,year}} * EF_{US,phase,year}$$

"Phase" in equation 1 and equation 2 denotes the phase of the value chain, i.e. phase ϵ {manufacturing, installation, O&M}.

Any country can serve as the benchmark country – preferably one with several and recent values obtained in a transparent method.

The employment factors for large hydro for United States, which serve as a starting point for the analysis in Lehr, Walter and Nieters (2017), are 6 jobs/MW for installation, 1.5 jobs/MW for manufacturing and 0.3 jobs/MW for O&M in the year 2012. EFs are higher before and lower after 2012, both due to productivity growth. By assumption, productivity grows by the same amount as in the respective economic sector. Any country can serve as reference as long as the following conditions are met:

- Literature value obtained with thorough methodology for each value chain phase;
- Data available on each economic sector of interest for all years of interest to base the calibration upon.

"Country" in the equations above denotes the country where the large hydro power plant or pumped storage is located. "Sector" denotes the sector used for calibration. To transfer employment factors from one country to another, relative labor intensities from international statistics in selected sectors (see equation 2) are used. For the installation phase, the authors apply relative labor intensities from the construction sector. The manufacturing phase reflects relative labor intensities in the machinery sector and O&M for most countries reflects relative labor intensities in the aggregated manufacturing sector (for more details on O&M see below).

Table 1: OECD employment factors

	Construction time	Construction/ Installation	Manufactur-ing	Operations & Maintenance
Years	Job years/ MW		Jobs/MW	Jobs/MW
Coal	5	11.2	5.4	0.14
Gas	2	1.3	0.93	0.14
Nuclear	10	11.8	1.3	0.6
Biomass	2	14.0	2.9	1.5
Hydro-large	2	7.4	3.5	0.2
Hydro-small	2	15.8	10.9	4.9
Wind onshore	2	3.2	4.7	0.3
Wind offshore	4	8.0	15.6	0.2
Solar Photovoltaics	1	13.0	6.7	0.7
Geothermal	2	6.8	3.9	0.4
Solar thermal	2	8.0	4.0	0.6
Ocean	2	10.2	10.2	0.6
Geothermal - heat		6.9 jobs/ MW (construction and manufacturing)		

Source: Rutovitz et al (2015)

The "relevant MW" denotes the physical base of the respective calculation in the different phases along the value chain. For O&M, the relevant base is the capacity installed; installation refers to an even distribution of all installations over an installation time of four years; manufacturing refers to domestic production of all turbines, generators and transformers including production for exports.

2.2 Adjustment to Egypt

According to the LAS/IRENA/RCREEE Overview 2016 "*Egypt secured its leading position for the region in wind energy, by commissioning the new 200 MW Gulf of El-Zayt project on the Red Sea coast. The total solar photovoltaic (PV) installed capacity in Egypt reached around 90 MW, predominantly due to the PV rural electrification programme, supported by the UAE, and the feed-in tariff small-scale programme.*"

In 2015, installation of wind energy in Egypt totaled 745 MW, PV 90 MW and Hydro 2876 MW.

As an example, we show how we would calculate employment from operation and maintenance for this existing installation following the employment factor approach. In the following, we use the Jobs/MW installed factors from Rutowitz and Harris (2012). The above table gives jobs per unit electricity generated. This may be a sensitive quantity for those technologies, which require less work if they are operated less. But for solar energy, e.g., this does not hold true. Some power plants may even require more work, when operating less, such as large hydro. In summary we suggest: operation and maintenance should also be in relation to capacities installed.

Wind energy has an O&M employment factor of 0.2 jobs/MW based upon European studies. Multiplication is straight forward and gives 210 jobs, assuming the same labor intensity and the same activities in Egypt and in Europe. The factors need to be regionalized with the help of one of the following data:

- Data on labor productivity in relevant economic sectors
- Data on capacities: who provides O&M?
- Data from the sites, surveys and interviews with the owner and operator of specific sites in Egypt.

Thus far, the result of the simple multiplication can be considered as a lower threshold for the jobs associated with O&M.

For solar, capacity installed leads to the lower threshold of 145 jobs and for large hydro we find 865 jobs. This first, very crude estimate gives us a lower border of 1220 jobs from O&M.

In later sections of this report, this example will be reconsidered with the more comprehensive approach and updated data from Egypt.

3 Input Output Analysis

3.1 Introduction

A more comprehensive assessment is based upon the renowned economic analysis tool of Input-Output-Tables. It covers next to direct employment also indirect effects throughout the economy, such as deliveries of all economic sectors to installation, production and operation of RE and EE. The ILO recommends the use of IO tables in its Green Jobs training program[1] explicitly mentions renewable energy and energy efficiency job assessments as one example for this approach. The feasibility of the approach hinges on the availability of the respective statistical data. For Egypt, Input-Output-Tables of good quality exist and are not outdated. In the suggested approach, they will be complemented with data of the latest economic development.

The last stage of assessment of the economic effects of renewable energy and energy efficiency is building a full economic model which helps to estimate feedback loops and second round effects. Again, numerous examples are included in the literature. IRENA runs a full model on a global scale, the EU has run an impact assessment on all member states figuring out the impacts of e.g. reaching the EU's 2020 targets. This approach answers comprehensively the question of the overall economic effects induced by the transition towards a renewable energy based efficient energy system. It is the most data intensive, but the tool, once established, can be used for further analyses in other economic sectors, such as tourism, health or different industries. The calculation in this report focuses direct and indirect effects from renewable energy and energy efficiency.

3.2 IO Tables and IO Analysis

Following the Interagency[2] Workshop on Employment and Social Inclusion in a Green Economy (ITC 2013) suggestion, input-output (IO) analysis (together with SAM based modelling) can be "*used to estimate the effects on employment resulting from the increase in final demand for the product or service in a given green industry by estimating direct, indirect and induced jobs. Thus, the model can be used to answer questions such as "How*

[1] (**http://www.ilo.org/global/topics/green-jobs/lang--en/index.htm**)

[2] The Partnership for Action on Green Economy, or PAGE, is a response to the outcome document of the United Nations Conference on Sustainable Development (Rio+20), entitled *The Future We Want*, which recognizes the green economy as a vehicle for sustainable development and poverty eradication. Four UN agencies (the United Nations Environment Programme (UNEP), the International Labour Organization (ILO), the United Nations Industrial Development Organization (UNIDO) and the United Nations Institute for Training and Research (UNITAR)) participate.

many jobs may result from a given program of investment in sustainable economic areas?" or "For a given level of investment, which sector or sectors would yield the greatest number of jobs?" "(ITC 2013).

Economic sectors produce goods and services for other sectors and for final consumption and, at the same time, use other goods and services to be able to produce goods and services. The idea of grouping these kinds of input-output flows in a systematic and symmetric table goes back to Wassily Leontief who was awarded with the Nobel Prize in economics in 1923. Input-output tables provide information about the production and consumption of intermediate and final goods and disclose the cost structure of each economic sector. Input-output tables capture the circulation of products within an economy for a given period. They condense the complexity of economic action with all its effects, counter-effects, actions and re-actions. They also allow distinguishing between direct and indirect dependences of and between economic agents. Figure 4 illustrates the basic Input-Output-Table.

	Demand	Intermediate Demand				Final demand				
Supply		Agriculture	Manufacturing	Services	Total	Household consumption	Fixed capital formation	Increase in stocks	Exports	Production
Intermediate Input	Agriculture									
	Manifacturing		IO matrix							
	Services									
	Total									
Value added	Wages									
	Profit									
	Depreciation									
	Indirect taxes									
	Subsidies									
	Sum									
Production										

Figure 4: Schematic presentation of an IO table

Source: own design, following Eurostat EU 27 IO.

The rows show the demand for product i, which is needed for the production process of another product j, and as a final product for consumption. For instance, agriculture supplies agriculture goods to agriculture, in terms of seeds, fodder, or fertilizer. It further supplies agricultural products to the food industry or to the energy sector in terms of inputs to bio-energy. Agricultural products are also directly used by private households or are produced for being exported. The sum of demand for intermediary inputs plus final demand equals final production.

The columns represent the cost structures of production and services: each production sector j needs a different combination of inputs to be able to produce. Again, taking agriculture as an example, the column denotes the inputs from different sectors such as energy, chemical industry (fertilizers), automotive (trucks and tractors), agriculture (seeds and manure) which are necessary for agricultural production. Adding primary inputs such as cost of depreciation, labour compensation or taxes, results in total production by sectors. One important feature of this table is that the sums along the rows equal the sums along the columns. This feature has to be maintained no matter how the table is manipulated.

3.3 Matrix calculation with IO Tables

The IO tables represent a matrix and a system of equations. The Leontief production function condenses this system. The Leontief-multiplier matrix or Leontief inverse $(I-A)^{-1}$ is calculated from the matrix of input coefficients A that puts the intermediate demand by sectors in relation to the total production by sectors. The Leontief inverse implicitly includes all inter-industrial production interdependencies. Given domestic final demand (y-m), total production (x) by sectors can be calculated. The index t denotes time and is relevant for time series analysis or IO projections. Hence, sectoral production is the outcome of both, final domestic demand and inter-industrial production processes:

[1] $$x_t = (I - A_t)^{-1} \cdot (y_t - m_t)$$

Based on this equation, production-induced employment effects can be computed using standard input-output analysis (Holub & Schnabl 1994). To this end, the Leontief inverse needs to be left-multiplied with a diagonal matrix of employment coefficients (*b*) that the resulting matrix can be interpreted as a labor input matrix W.

[2] $$e_t = \hat{b}_t (I - A_t)^{-1} (y_t - m_t) = W (y_t - m_t)$$

The labor input matrix reveals the number of persons employed in sector i that is needed in order to produce an additional unit in sector j. The column sum of that matrix represents the employment multipliers of the 23 industrial sectors. The multiplier subsumes all direct and indirect employment effects initiated in sector j induced by an additional unit of final demand in the corresponding sector. The diagonal of the matrix shows the direct effects of an additional investment. The sum of the non-diagonal elements of sector j indicates the leverage on indirect employment. The relation of total employment multiplier to direct employment multiplier represents the factor, which has to be multiplied with the direct employment in order to obtain the additional employment initiated by an additional unit in final demand. If the factor is greater than one, indirect employment is initiated in this sector. In general, service sectors have an employment factor close to one, whereas manufacturing industries often show a higher employment factor.

Input-output (IO) modeling revolves around the flows of goods and services among different branches of an economy—in this case specifically the relationship between the renewable energy sector and the energy efficiency sectors and their supplier industries. For example, manufacturing a wind turbine (which consists of more than 8,000 components) requires a wide variety of inputs, including steel, fiberglass, gearboxes, electrical equipment, and many others. Insulation of buildings requires insulation material, scaffolding material, paint, architects etc.

IO tables map the supply of goods from each economic branch to all other industries. They contain input structures of every industry as well as information on gross value added and employment.

3.4 Application to Egypt

One of the first publications on Input-Output-Tables (IOT) for Egypt stems from Proceedings of an International Conference on Input-Output Techniques, Geneva, in September 1961. The Egyptian IOT go back to the year 1954. The original table contains 83 productive sectors. The Australia based group around the researcher Manfred Lenzen in the EORA project has developed time series of IO tables for :

- 187 individual countries represented by a total of 15,909 sectors
- continuous coverage for the period 1990-2012
- 35 types of environmental indicators covering air pollution, energy use, greenhouse gas emissions, water use, land occupation, emissions (nitrogen and phosphor), 172 crops, Human Appropriation of Net Primary Productivity
- high-resolution heterogeneous classification, or 26-sector harmonized classification
- raw data drawn from the UN's System of National Accounts and COMTRADE databases, Eurostat, IDE/JETRO, and numerous national agencies
- Distinction between basic prices and purchasers' prices through 5 mark-ups, and reliability statistics (estimates of standard deviation) for all results (Lenzen et al. 2012; Lenzen et al. 2013). The data are in dollar. The EORA tables hold information on economic structures in the manufacturing sector. The projection then uses projections of GDP growth in the near future.

4 Available Tools Used for the Estimation of RE&EE Jobs

The different methods have been translated into tools. Online calculation tools, such as the JEDI model, databases and information material e.g. by IRENA, as well as databases with case studies such ILO Green Jobs website have been developed for the estimation of job impacts from renewables and energy efficiency.

4.1 The IRENA data bases and dashboards

IRENA provides information on renewable energy on a country level. The employment estimates in the employment dashboard are based on the employment data that IRENA is publishing annually. The data are methodologically not homogenous. They are collected from a wide variety of sources. The sources cover either only direct jobs or they cover gross employment (=direct and indirect jobs). For Egypt, the dashboard gives 4,170 jobs in renewable energy.

4.2 The JEDI model

The National Renewable Energy Lab in the US has developed a modeling tool called JEDI (Jobs and Economic Development Impact Models) which "estimate the economic impacts of constructing and operating power generation and biofuel plants at the local and state levels" (JEDI Homepage 2017). They are tailored to the US States, but the method has found applications and tool development also e.g. for Morocco (see the overview of results in the literature below). The tool is based upon the Input-Output-logic and includes information and assumption on the local part of the respective RE project. Each technology has its own tool. The models distinguish local value creation or direct jobs from value creation through industrial interlinkages of indirect jobs and value creation from additional incomes, which refers to induced jobs. The methodology is very similar to the method which will be developed for Egypt and which will be explained later in this report.

4.3 The ILO Green Jobs database

The ILO has on the Green Jobs homepage an overview of assessment models and assessment reports. The reports cover many regions such as Africa, Asia, Americas, and Europe and on the country level Namibia, Malaysia, Zambia, Mauritius, Serbia, United States, Nigeria, India, Bangladesh, Mexico, Philippines, Lebanon, Kenya, South Africa, Spain, Thailand, Brazil, Bolivia, Ghana, Turkey, Albania, Indonesia, Uganda, Chile, Tanzania, Costa Rica, Bolivia, Sweden and China.

The ILO database can be searched for different aspects of green jobs (energy, water and waste) as well as countries and/or regions. It comprises of full studies, trainings and workshops. For Egypt, it contains a report and a documentary on "skills for green jobs" from the year 2012. In Tunisia, a study was finished in 2014 and the respective workshop is also documented. Other examples from the region are from Palestine (Gaza) and Lebanon.

The assessments offer methodological plurality. In the training courses on the measurement of green jobs, however, ILO is promoting an Input-Output-theory based approach and offers the support to develop necessary tables in the respective countries if their own statistics are outdated or not available.

5 Comparison of Selected Results

On a global scale, renewable energy has experienced unprecedented growth and deployment, with dramatic price declines. International studies on the effects on employment now cover more countries and become increasingly refined. Similarly, impacts on employment along the value chain are much better understood.

Among the ex-post analyses, IRENA's series on "Renewable Energy and Jobs" has set a benchmark ((Lehr et al. 2016). It started out as a chapter contributed to the annual REN21 Global Status Report and turned into an own publication by 2013. For the EU, a similar comprehensive – and eclectic approach is found in the EUR'Observer publications.

According to these publications, jobs from renewables increased over the last years, most strongly between 2013 and 2014. Note that the database for these numbers is a study pool, which is not the same each year.

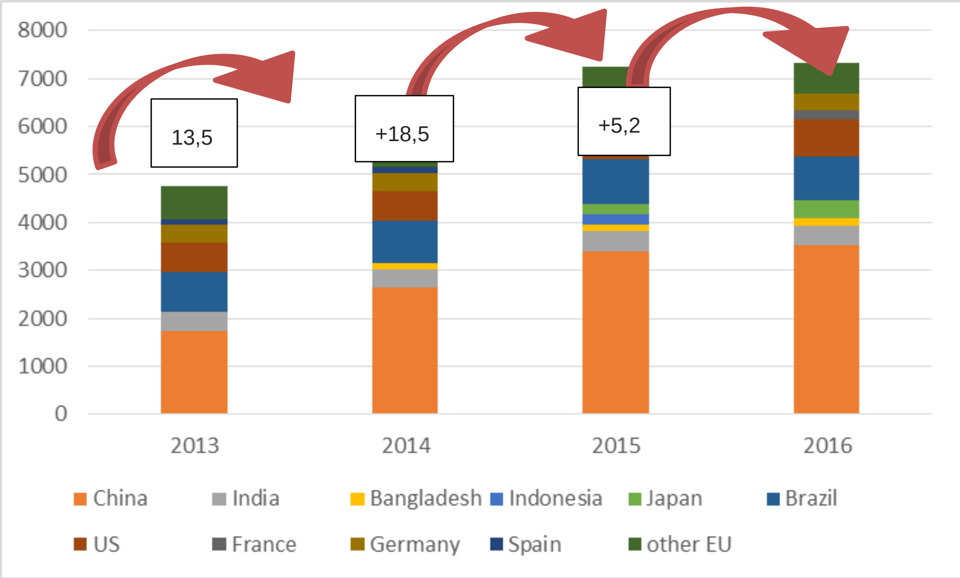

Figure 5: Renewable Energy and Jobs (2013-2016) in selected countries (note: dates equal publication date, data are from the preceding year)

Source: REN21

MENA and GCC share next to region and language the vast potential for RE, in particular the solar potential and the need to crank up efficiency. The resourced based economies in GCC understand that energy saving also makes sense in a situation of abundant energy resources in a country. In addition, job opportunities for the indigenous population is becoming more and more of an issue. UAE support renewables and energy efficiency with a variety of activities, starting with Abu Dhabi being the host country of IRENA, the renewable energy agency and hosting the World Future Energy Summits. The largest project in UAE, however, is Masdar, the 100 percent renewable energy city. Dubai on the other hand support green energy generation and energy efficiency projects, with the governmental company Dubai Carbon working on ways to reduce carbon emissions.

Morocco is maybe the most studied country for RE in the region, because it has excellent potentials and the geographical proximity to Europe makes exports of electricity still feasible. Morocco has targets for 2020 for renewable energy and energy efficiency. The share of renewable energy in electricity production to 2020 is set at about 27 percent of electricity production and energy efficiency shall be increased by 12 percent. Solar, wind and hydropower have to grow. Morocco has developed several institutions concerned with renewable energy and energy efficiency.

According to an analytical study "clean technology transfer mechanisms in Egypt," performed by the African Development Bank (ADB) in late 2013, Egypt is likely to benefit from significant investments in renewable energy with strong potential for job creation and economic growth. This study indicates that nearly four to six green jobs per megawatt of capacity installed newly could be created just in the local manufacturing industry. Specifically, all planned investments in 2014-2018 years in renewable energy in Egypt would lead to the creation of green jobs - with up to 100,000 jobs expected. However, to achieve this it will require action on several levels. Thus, the only injection of capital into the construction of production plants for renewable energy, which is not getting any particular attention in particular to the training of workers or in the longer term while research and development, is not sufficient to maximize benefits of the renewable energy sector (Elkahari 2013).

5.1 Employment from renewable energy in Morocco (de Arce et al. 2012)

This study is an implementation of the JEDI model (see above) to the Moroccan Renewable Energy Plan. Given the rapid cost of development in the recent five years, the study is almost a bit outdated. However, most comprehensive work on employment from renewables and energy efficiency has been carried out in the last five years because the rapid cost development gave rise to new plans and expansion paths.

De Arce et al. used a dynamic IO model. They take different scenarios for RE expansion and industrial integration and find additional employment from renewables under these different scenarios of up to 230 thousand people. Even though the expansion is significant, the employment factor used in the study and the degree of integration applied seems a bit enthusiastic. Calculating the employment factors from this study, they started at 40 people per MW CSP and decreased to 15 people /MW for this technology. The time series for wind obtained from the data shows also more than 30 people per MW, which seems high for wind energy. Comparing it to the table from Rutovitz and Harris (see above), the factors seem high, although they include direct and indirect jobs as opposed to Rutovitz and Harris.

5.2 Desert Power 2050: regional and sectoral impacts of renewable electricity production in Europe, the Middle East and North Africa (Alvaro et al. 2014)

The approach pursued in this study differs from the approaches suggested in this paper. Alvaro et al. (2014) use a computable general equilibrium model. They find 400-600 jobs during the installation phase created in Europe and MENA countries from a program called Desert Power 2050, which at that point was part of the Desertec Industry Initiative. During the operation phase, they find 160,000 to 380,000 jobs, which are permanent as opposed to the installation phase jobs. Most jobs – and most investment – go to Egypt. Saudi Arabia also receives a large share of the investment, but the production infrastructure is much weaker and the technologies are assumed to be largely imported. Jobs created per billion $ investment differ largely across the region. Egypt has 17-42 jobs per million in the PV sector, with 59 percent indirect jobs. Wind energy creates up to 82 jobs per million Euro with 34 percent being indirect. The share of indirect jobs increases with increasing integration during the time span between 2030 and 2050 to 36 percent.

5.3 Economic effects from renewable energy and energy efficiency in Tunisia – an update (Lehr et al. 2016)

The economic effects of the Tunisian Solar Plan have been thoroughly analyzed in a study published in 2012. The National Agency for Energy Management (ANME) then commissioned a series of studies on the future of the energy sector, to map the strategic direction and set ambitious targets for the development of renewable energy and the reduction of energy demand. These studies, which were the subject of extensive consultation, focused on the rational use of energy, development of renewable energy, the energy mix for power generation and possibly the update of the Tunisian solar Plan. This process led to the development of a national action plan for the period 2015-2020, to provide a short-term outlook for the energy transition, because quite often the prospects long term tend to be deferred to a more distant future.

On the economic side, the recovery in Tunisia has taken longer than anticipated and the growth projections are less certain than in 2011. This affects the situation of the labor market, and not for the better. More than ever, job creation is a relevant topic in the political debate in Tunisia.

The study firstly assesses the current job market in the renewable energy sector and of energy efficiency in Tunisia and the prospects of development under the new energy vision of the country. The assessment of the current employment market is based on the information by key industry players and economic agents. Future effects are evaluated based on a macroeconomic approach based on the data of the Tunisian Input Output Tables and the Tunisian economic structure. The study finds more than 25,000 additional jobs in Tunisia. The employment effect is initially rather small since large portions of the new systems will be imported. Only small inputs are locally produced.

Employment figures differ from earlier results mainly driven by the large investment in efficiency. Additional employment could be even larger, if efficiency measures were subsidized and energy saving could be spent. Currently, the scenario does not include these so-called induced effect.

5.4 Employment impacts of solar energy in Turkey (Cetin and Egrican 2011)

The study on solar jobs in Turkey also distinguishes between direct and indirect jobs and tries a simplified multiplier analysis. The authors find 346 jobs per MW newly installed in the installation phase of solar PV and 2.7 jobs/MW each year in the operation phase. These factors go back to a German study which is authored by the authors of the current Egyptian study. They stem from the earlier days of PV where Germany had the entire value chain of production in the country.

For CSP they find 400 jobs/MW in production from Spanish data and 600 jobs/MW during the installation phase, 30 jobs are taken from the literature in O&M.

All these number seem very high and the delineation of the different sectors and does not seem too clear. The final estimate of more than 200,000 jobs from the Turkish roadmap seems rather high. Given that Turkey had no own production of neither PV nor CSP, the figures should be reduced by far. Instead, the authors apply a multiplier of two to come to indirect jobs. This study is included as an example for a very carefree combination of different values found in the literature which lead to not very credible results.

5.5 Towards sustainable construction and green jobs in the Gaza Strip, (Muhaisen and Ahlbäck, 2012)

This publication belongs to the green jobs series of publications by the ILO. It is more of a capacity estimate and does not contain quantitative estimates. However, we include it in this explorative list of publications, because it shows what often comprises the first step in a series of steps aiming at quantitative results and own tools. At first, the range of possibilities in a country or a region has to be explored and the opportunities for job creation need to be listed and named. The study on Gaza is focusing on sustainable construction, and it shows the particular role of small and medium enterprises in this field of green jobs. The study claims in its conclusions: “Promoting sustainable construction in Gaza could be a sustainable pathway for alleviating several challenges and needs currently experienced in Gaza. A number of sustainable construction solutions to improve the efficiency of materials, energy and water use in construction and buildings are feasible in Gaza, despite the current blockade and conflict with Israel. Such solutions include using local and recycled construction materials in buildings where possible, applying energy-efficient designs and adopting renewable energy sources in residential buildings, as well as increasing water efficiency through the use of rainwater, desalination and greywater reuse. Sustainable construction can also facilitate the creation of new job opportunities and the improvement of working standards in the construction sector in Gaza. New opportunities for architects, engineers, electricians, plumbers and construction workers with different specializations can be gained in the construction sector as well as in other related sectors.”(Muhaisen and Ahlbäck 2012).

Part 2: RE and EE in Egypt

1 Economics and Energy in Egypt – Status and Targets

1.1 Current situation

Egypt has the highest population in the Arab world and is the third largest country in Africa. The Central Agency for Public Mobility and Statistics (CAPMAS) provides a population count on their homepage, which read 95,835,491 on October 10, 2017[3].

Compared to many societies in the industrialized countries, the population of Egypt is very young; more than half of the population in the year 2016 was under 24 years old (cf. Figure 6). For comparison, in Germany 23 percent fall into this age group.

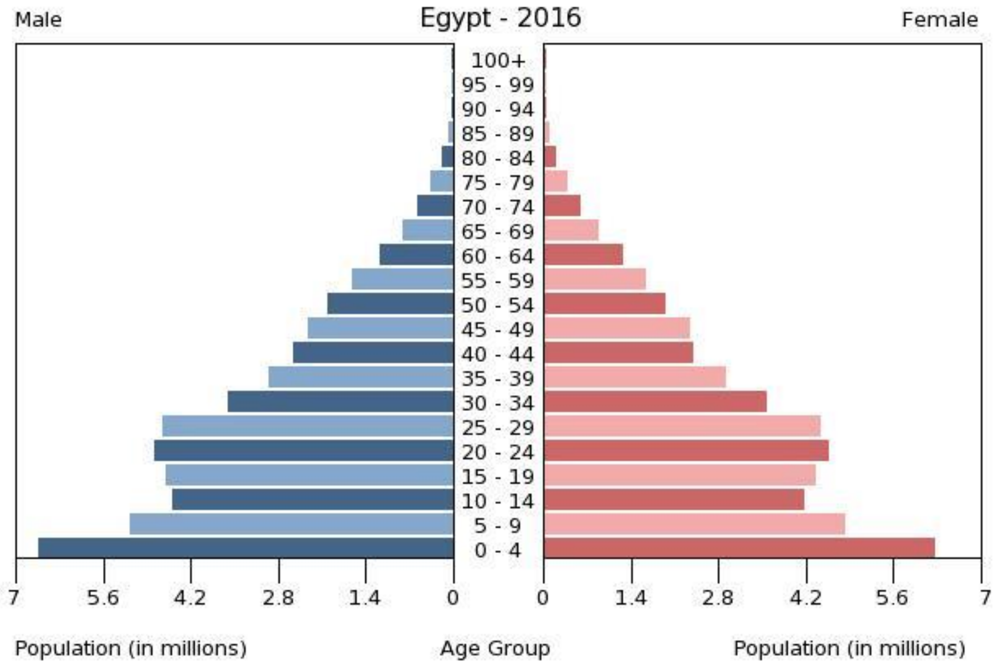

Figure 6: Age pyramid in Egypt
Source: CIA Worldfactbook

In terms of economic development, Egypt seems to be at a turning point. Egypt's real GDP is given by CAPMAS (2017) as 1,905,200.0 million L.E. in 2016/2015 and 1,863,168.7 million L.E. in 2015/2014. The most recent growth rate was 2.3 percent, lower than in the period between 2015/14 and 2014/13 with 3.4 percent. Political changes in the aftermath of the January 25th 2011 revolution have slowed growth in the last years, but plenty of economic measures have come into force since 2015 and led to an improvement of the

[3]Link: **http://www.capmas.gov.eg/HomePage.aspx**

economic outlook (World Bank 2017). According to the World Bank “Egypt has embarked on a major economic reform program, including the liberalization of the exchange rate regime, fiscal consolidation measures and reforms to the business environment. The liberalization of the exchange rate regime is a key step towards restoring the competitiveness of the economy and boosting private sector activity, which had been severely impeded by shortages of foreign currency. Yet, the reforms are exacerbating social pressures in the short term, with inflation reaching some of the highest recorded rates.”

The exchange rate towards the dollar jumped from 6 Pounds per Dollar in 2012 to 9.71 Pounds per Dollar in 2016 and to almost 18 pounds per Dollar as of today (October 2017). Figure 7 shows the development over the last three years of the exchange rate towards the Euro. The percentage change is given with respect to the rate 3 years ago. The date of the chart is July 25, 2017.

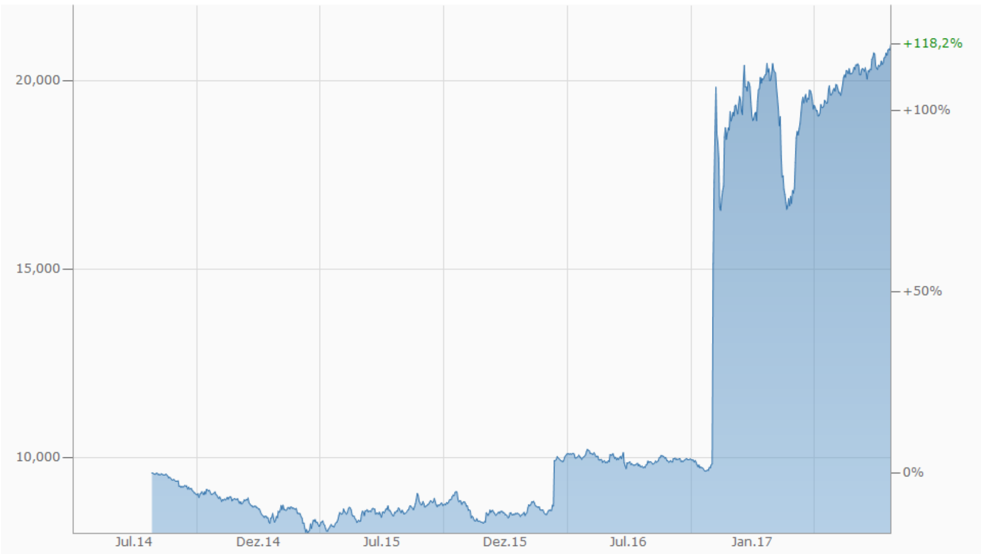

Figure 7: Exchange rate Egyptian Pounds /Euro

Source: Finanzen.net

The currency development makes imports more expensive and investment in the country attractive and inexpensive. The German Trade Support Platform (GTAI: Germany trade and invest) draws an optimistic picture for the development in Egypt’s industrial sectors and the necessities of investment and import of machinery goods. They point at several industrial expansions with high investment, such as the Sidi Krir Petrochemicals company planning Propylen production in Alexandria for $2 billion, an extension of PVC production for $1 Billion in in Port Said, another Propylen production site in Suez (Carbon Holdings 900 Mio. US$).

Food production has to expand, because food demand will rise to $60 billion. The largest project foreseen by GTAI 2017 is sugar production in Minya (Al Canal, 920 Mio. US$) Yeast, juice and other food stuff are also planned currently. The German machinery industry association (VDMA) considers the Egyptian construction sector as continuing dynamic, also regarding the plans for the new capital, necessary infrastructure measures, the renewing of the railways and other projects.

The energy sector is a key sector for development in Egypt. It contributes with 20 percent to GDP and provides employment for more than 300,000 people. Since 2007, however, Egypt experiences an energy supply deficit. The Egyptian energy sector is subject to several pressures and challenges.

Electricity consumption per capita almost doubled from 0.98 MWh/capita in the year 2000 to 1.70 MWh/capita in the year 2014 (IEA Statistics) and to 1.94 MWh/capita in 2016 (AUPTDE 2017). For comparison Germany has electricity consumption per capita in the year 2014 of 7.1 MWh/capita, but this consumption has only grown by 6 percent in the same time span. While steady growth is desirable for the utility companies, a too high growth rate is hard to cope with and leads to power outs, and dissatisfied customers. Energy dependence rose and the oil price fell, which influences governmental budgets. Increasing consumption empties governmental budgets even more, since energy consumption has been subsidized and lead to increasing deficits in the respective budgets.

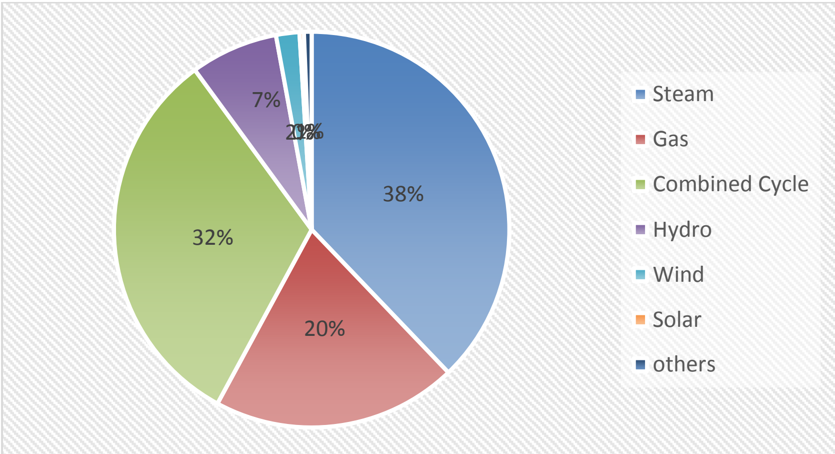

Figure 8: Structure of power generation in Egypt, 2016. (Source: AUPTDE 2017, own graph)

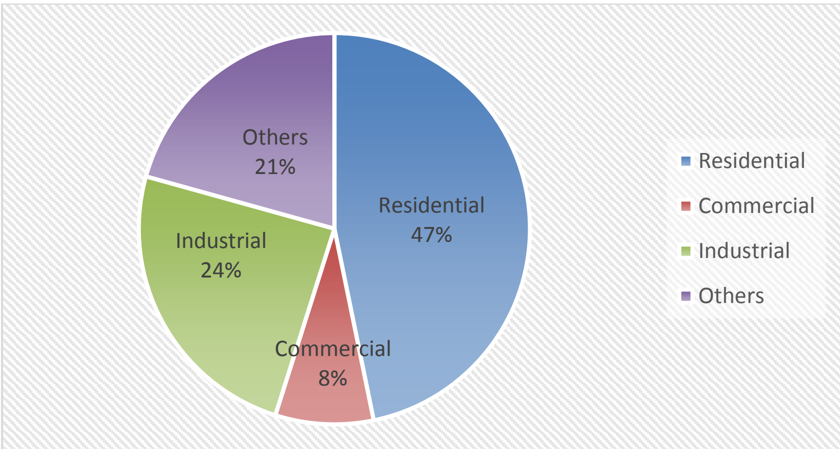

Figure 9: Structure of electricity consumption by sector in Egypt, 2016. (Source: AUPTDE 2017, own graph)

Total electricity supply in 2016 was 186,278 GWh (AUPTDE 2017). Currently, electricity generation in Egypt is dominated by (combined cycle) gas and steam. Wind and solar energy contribute less than 1 percent. Since the year 2008 the support for renewable energy in Egypt became visible specially with the adoption of the new national renewable energy strategy, followed by the Egyptian Solar Plan, the announcement of the Feed-in tariff for wind and solar PV projects as well as the renewable energy custom tax reduction for renewable equipment in 2014 and the Egypt renewable energy tax incentives (Presidential Decree No 17/2015), the Egypt Renewable Energy Law (Decree No 203/2014) and Egypt Renewable Energy Tenders (build-own-operate BOO contracts) in 2015. Hydro energy is still the dominant source for non-fossil electricity generation.

On the demand side, electricity consumption is dominated by residential use. Industrial consumption ranges second, followed by commercial consumption. A total of 156,828 GWh is consumed.

1.2 Future development compared to today

1.2.1 Primary Energy Supply (PES)

Table 2 shows the evolution of primary energy supply by type of resource in thousand (toe/year), while (Figure 8) shows the percentage contribution of such resources for the short term 2020/2021 and the long term 2034/2035. It is noted that the average growth rate for the primary energy demand to year 2035 is projected to be 3.0 percent with clear change in the relative contributions of different resource. Nuclear and coal will have the highest growth rates reaching 21.5 percent and 16.2 respectively , while oil and gas will be reduced remarkably to only 1.2 percent and 1.5 percent and renewable will have a growth rate of 7.3 percent.

Table **2**: Development of PES by type of Resource Thousand T.O.E/year

Energy Resources	2009/2010	2019/2020	2029/2030	2034/2035
Petroleum Products	34070	46968	47630	49275
Natural Gas	40611	59067	51616	54277
Coal	723	5841	20693	31082
Nuclear	00	0.0	9090	9090
Renewable	3879	8380	17521	22767
Total	79284	120257	146550	166491

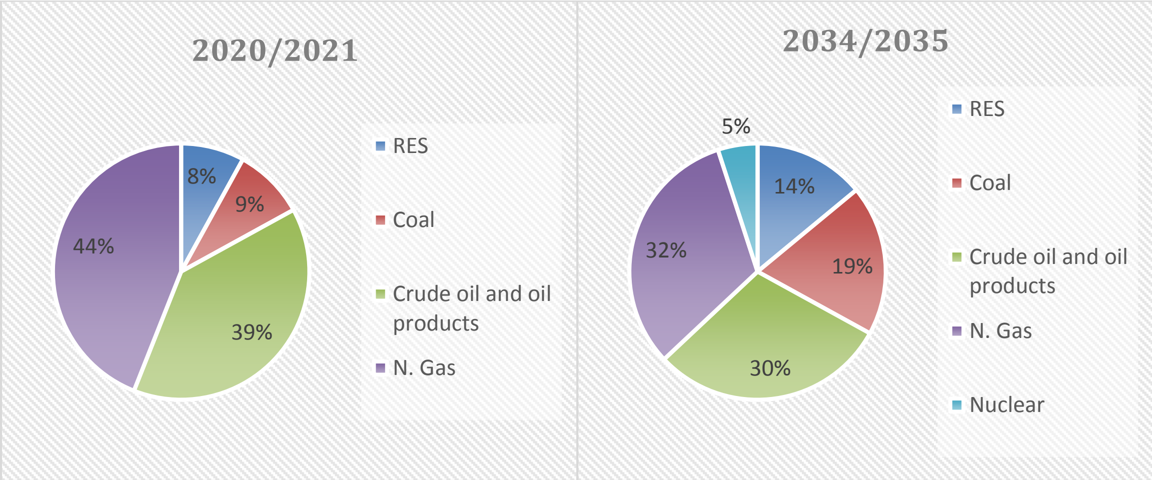

Figure 10: Contribution of energy resources in PES 2020/2021 and 2034/2035

1.2.2 Power Plants Installed

Total installed power plant capacity in the reference year 2009/2010 was 24.6 GW and according to the selected scenario it is expected to reach 77.6 GW in 2019/2020, 125 GW in 2029/2030 and 146.7 in 2034/2035. Table 3 shows the Evolution of the installed power plant capacity to year 2034/2035 and the contribution of the different energy resources to it.

Table **3** : Evolution of Installed Power Plant Capacity (GW)

Type of Fuel	2009/2010	2019/2020	2029/2030	2034/2035
Natural Gas	20.4	55.9	55.0	54.8
Petroleum Products	1.4	0.9	1.3	1.3
Coal	0.0	1.6	13.6	23.2
Nuclear	0.0	0.0	4.8	4.8
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	31.0
CSP	0.0	(0.1)	(4.1)	(8.1)
Total	24.6	77.6	125.1	146.7

* CSP subject to changes in plans.

1.2.3 Generated Electricity

In 2009/2010, the total produced electricity reached (136) TWh, fossil resources have contributed almost 90 percent, while renewable contributed (10 percent) mainly hydro (9 percent) and only 1.0 percent from wind. According to the approved scenario the generated electricity is expected to reach (271) TWh in 2019/2020 and (418) TWh in 2034/2035 with gradual more diversified resource use as shown in (Figure 11).

By 2034/2035 the highest contributions will be from renewable resources counting for (37.2 percent), followed by coal (34 percent), while fossil resources will be sharply reduced to (20.0 percent) and (8.8 percent) from nuclear power plants. Renewable will mainly from wind (14.6 percent), Solar PV (11.8 percent), CSP (7.6 percent0) and hydro (3.2 percent)

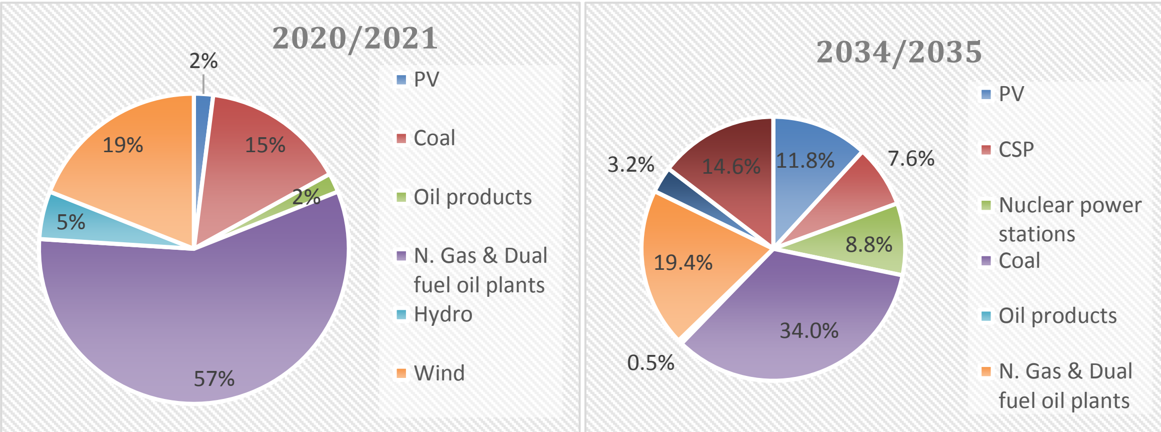

Figure 11: Evolution of the contribution of different resources in power generation

1.2.4 Final Energy Consumption

The total final energy consumption reached (49.6 Mtoe) in 2009/2010, (80.0Mtoe) in 2019/2020 and (114.0Mtoe) in 2034/2035. (Figure 12) shows the evolution of the contributions of different fuel resources to the final energy consumption in 2019/2020 and 2034/2035. By the targeted year 2034/2035, the oil products will contribute (41.0 percent), generated electricity (28 percent), natural gas (19 percent, renewable (8 percent) and (4 percent) from coal.

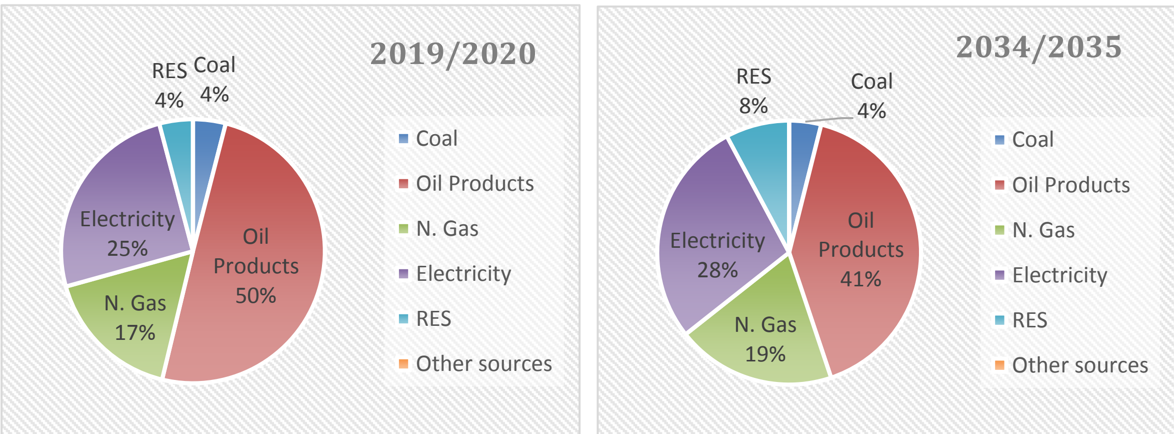

Figure 12: Contribution of energy resources to the final Energy Consumption in 2019/2020 and 2034/2035

In January 2013, the Government of Egypt has started an effort towards developing a new 20 year ***Energy Strategy "2015 to 2035"*** through a project funded by the EU and implemented in cooperation among all national concerned partners. Part 2.7 of this report summarizes the goals of the strategy and the outcome of the strategy scenario that has been adopted by the SEC in October 2016. In addition the following is a brief focused on the renewable energy contributions to the energy mix as identified by the selected scenario for the coming 20 years and given by tables and figures in part 2.7.

1.2.5 Renewable contribution to primary energy supply

The contribution of renewable energy resources was 5.0 percent in 2009/2010 mainly from hydro (4 percent) and wind (1 percent). It is expected to reach a total of (8 percent) by 2019/2020 and (14 percent) in 2034/2035 counting for 22.8 million toe in that year .the average growth rate for renewable contribution in primary energy supply will reach 7.3 percent annually.

1.2.6 Renewable contribution to the installed power capacity

The total installed capacity of renewable energy systems will be (19.3 GW) by 2019/2020 and increase to (49.5 GW) and (62 GW) in years 2029/2030 and 2034/2035 respectively. Table 4 shows the development of the installed capacity for the different renewable technologies.

Table **4**: Evolution of installed power plant capacity (GW)

Type of Fuel	20092010	2019/2020	2029/2030	2034/2035
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	31.0
CSP	0.0	(0.1)	(4.1)	(8.1)
Total	3.3	19.1	49.5	62.6

1.2.7 Renewable contribution to the generated electricity

In 2019/2020 renewable technologies will contribute (21 percent) of the generated electricity and will be increased to reach (34 percent) in 2034/2035, where the contribution by wind will be (14.6 percent), solar PV (11.8 percent) and (7.6 percent) from CSP with storage.

1.3 Egypt vision 2030 for the economy and energy

The pathway to sustainable development for Egypt's future is described in the Sustainable Development Strategy: Egypt Vision 2030 (Ministry of Planning, Monitoring and Administrative Reform, MoPMAR 2015). It rests on 10 pillars, which are connected to the United Nation's 17 sustainable development goals (SDG) for 2030. The pillars are grouped around the dimensions of sustainability: the economic dimension, the social dimension and the environmental dimension. In the economic dimension, pillar one is about the economic development and pillar two about energy, i.e. the two issues considered most relevant are the issues this report is about.

The section about the first pillar, economic development, claims that "*Economic development is one of the most important pillars of the Sustainable Development Strategy: Egypt Vision 2030 as it is one of the main engines of sustainable development. Such growth would contribute to employment and income generation, which enhances the infrastructure necessary to attract local and foreign investment, increase the levels of education, health and cultural services, achieve social justice, and increase the basic service levels necessary for the citizens to improve their standard of living, enabling them to continue to support the economic development process, generating a sustainable prosperity for all individuals*." (MoPMAR 2015).

For the development until 2030, Egypt Vision 2030 aims at the improvement of a set of indicators (Figure 13)

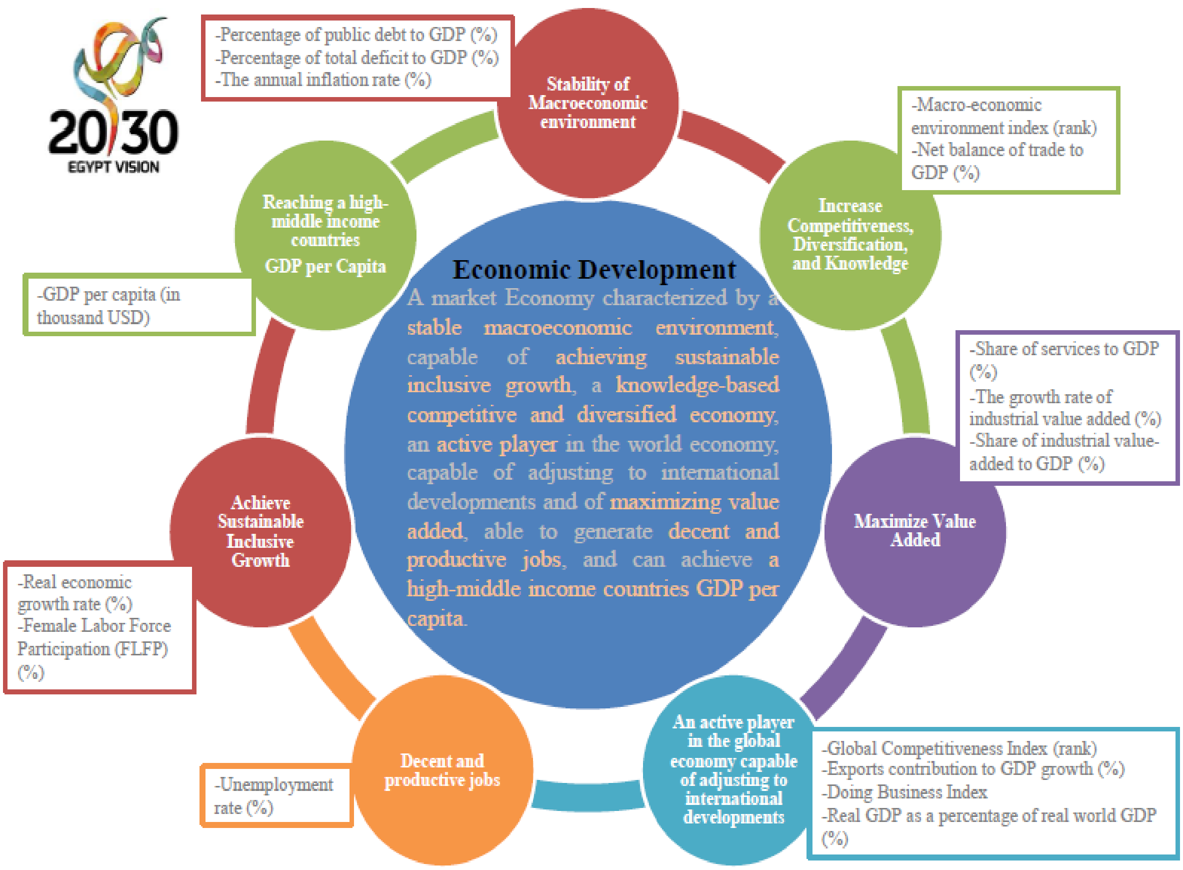

Figure 13: Indicators for Economic Development (Megharbel 2015)

The GDP growth rate targets 10 percent for 2020 and 12 percent for 2030. GDP per capita (in current prices) should rise to 10,000 US$ by 2030, which is almost triple its current volume. Egypt's contribution to world GDP will rise accordingly from 0.21 percent to one percent. Since Egypt's population may reach 117 million people (Euromonitor 2016), in a projected world population of 8.5 billion people by 2030, Egypt's share will be 1.4 percent.

The economic development further target an inflation rate of 3-5 percent and an unemployment rate of 5 percent by 2030. In terms of competitiveness, ease of doing business shall be increased as well as overall competitiveness. This will also be reflected in the share of high-tech goods in exports which shall rise up to 6 percent from currently one percent.

Renewable energy and energy efficiency can contribute positively to some of these goals. Jobs from RE and EE will help to mitigate unemployment, the increase of local content in renewable energy and energy efficiency systems will contribute to competitiveness and own production of some of the technologies needed may be exported to international markets and increase the high-tech share in the respective exports.

An important supporting factor for the economic development is Egypt's endowment with resources. Among others, Egypt vision 2030 points to the availability of renewable energy resources: Egypt has large RE potential due to its climate and geographical location. Regarding wind energy, the Suez Canal area shows high wind speeds up to 10m/sec, and also the desert areas and the Red Sea coast along the Gulf of Aqaba show potential. Solar energy can benefit from direct radiation ranging from 2000 to 2600 kilowatt hour/m2.

This leads directly to the second pillar, the strategy for the development of the energy sector. It is related to the 7th goal of the SDGs, which is under the headline "affordable and clean energy". As outlined above, the current energy mix in Egypt is dominated by fossil fuels. Moreover, energy consumption is heavily subsidized and cuts into the public budgets, in particular since oil prices are down. The budget for the fiscal year 2012-2013 included subsidies of LE 120 billion for petroleum products. Lately, (2014/2015), due to serious attempts towards phase out subsidies, the amount sank.

A switch to renewable energy can be beneficial regarding subsidies, because financial support of RE is an investment support, for instance supporting a switch from diesel generator driven to solar pumping in agriculture. Such an investment support enhances competiveness, gives an opportunities to small domestic companies and replaces the subsidy for diesel.

For 2034/35, the sustainability strategies aims at a more balanced mix, with 14 percent RE, 5 percent nuclear, 29 percent oil products, 19 percent coal and 33 percent gas. Total energy consumption by 2034/35 is projected to be almost twice as high as today.

For renewable energy, NREA, the New and Renewable Energy Authority, foresees the following development, based on the announcement of the Supreme Council of Energy in Egypt. The strategy was approved in 2008 and in its updated version aims at a 20 percent contribution of renewable energy to electricity generation by 2021/22. Among this, the largest share (12 percent) will come from wind energy. In terms of capacity installed this translates into 7200 MW. Wind energy will be installed by the public and the private sector NREA will contribute 2375 MW and the private sector is expected to contribute 4825 MW.

A more detailed description of the paths of different RE technologies to reach these goals and beyond is found in the scenario description in section 3.

Egypt vision 2030 also suggests targets and indicators regarding energy efficiency. Overall economic energy intensity shall decline by 14 percent until 2030. This will mean a massive increase in energy efficiency. The challenges to increase energy efficiency can be found according to the strategy in

- Insufficient expenditure on research and development and the limitation of research systems' effectiveness. This challenge leads to the slow pace of efficiency in improving technology in exploration and using available solutions and to import foreign technology
- Low efficiency of local companies. Poor technical capacity and the limited ability of human and financial resources cause a decrease in the productivity of companies and their ability to meet the needs of citizens.

Among the major challenges addressed in the strategy regarding the development of the energy system, one is addressed in this report, i.e. the lack of required accurate data and information. Following the data collection process outlined below and started in the framework of this study can contribute to addressing this challenge.

2 Employment from Renewable Energy and Energy Efficiency in Egypt until Today

2.1 Our approach

The basic methodological pillar, as has been outlined in Chapter 2 and 3, Part 1 of this report, is the economic Input-Output-Analysis. This has the advantage that direct and indirect effects in all phase of the value chain are included. Although renewable energy systems and energy efficiency equipment today is mostly imported, future scenarios include the domestic production and the possibility of a domestic RE and EE industry, which serves as a hub for the region. However, indirect effects also matter today: if the system itself is imported, parts or components might as well be fabricated in Egypt and create job opportunities for the Egyptian population.

The methodology follows the below logic:

Investment in renewable energy and energy efficiency equals additional demand for wind turbines, towers, PV modules, solar water heaters, efficient motors, air-conditioners etc. Employment is created from planning and design of a wind farm or a solar field, installation of the wind farm, and operation and maintenance of the systems. Direct employment can be thought of as people who work in planning and design services, who manufacture the tank of a solar water heater, who work in the bulb factory and who operate a biogas facility.

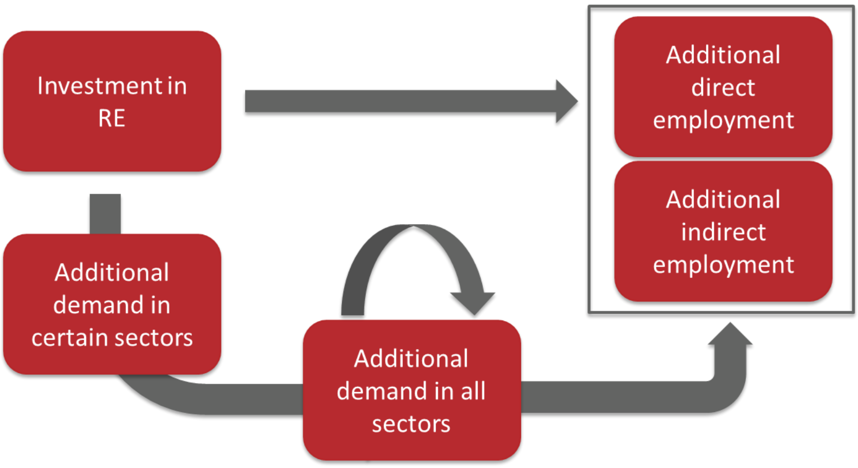

Figure 14: Basis chain of effects
Source: Own graph.

All these activities require inputs, such as printer ink, screws, transport, legal advice etc. Employment coming from the additional demand in these input sectors is often called indirect employment. The characteristic of direct employment is that the workers know they work for renewables or energy efficiency, employees in indirect jobs usually do not.

The connection between capacities or equipment installed, investment, and jobs is given by matrix multiplications as outlined below. To keep track of effects, we have developed an

Excel based tool, which allows for the integration of different data, scenarios and assumptions on future development. Most assumptions can be influenced by the user: costs of RE and EE can vary over time, the industrial integration of Egypt can be assumed higher (or lower), future RE mixes can be entered into the model. Overall GDP growth is currently reflected in the labor productivities, which are taken from statistical data.

The data are a mix of national statistical data, available from the statistical office, international statistics on Egypt, data collected in interviews in Egypt (see chapter on data collection and the Appendix on method, experts interviewed and templates) and international data on renewable energy.

2.2 The tool

Part of the assigned task was the development of a tool, which can be used by the client to project employment from renewable energy and energy efficiency based upon current and future data. The tool was suggested to be Excel based, for it to be easy to handle, easy to update and easy to install.

The tool further helps to structure the data collection process. It has files for data collection, files where data are prepared and sorted, calculation files and results outputs. At the heart of the tool lies the Dashboard, which is one central information point for the user. Here, the user has overview over the data, the scenarios, corrections factors and the results.

The dashboard is connected to data input files, to keep the IO model and the data processing separate. In the input files, the main data inputs are:

- New capacity installed
- Additional energy efficiency implemented

From these inputs, capacity installed is calculated by cumulating the additions over time, investment in new capacities is calculated by multiplication of prices and quantities and costs for operation and maintenance are derived as annually cumulated shares of these investments. The specific costs for RE&EE technologies are taken from a survey (see below) if available, and from the literature otherwise. Shares for O&M are taken from the survey as well, or from international data, if currently unavailable for Egypt.

The tool builds on the basic idea elaborated above. Each phase in the value chain of renewable energy production leads to a direct employment effect. The resulting employment is calculated by multiplication of employment factors with the respective physical quantities. Furthermore, the increased production in certain sectors triggers indirect employment effects due to a risen demand of intermediary input factors. The calculation of indirect employment in the tool is shifted into separate calculation files (*Calculations_Installation* and *Calculations_OM, Calculations_Manufacturing* for renewable energy, and *Calculations_Efficiency* for energy efficiency). This enhances the traceability of steps and improves comprehensibility.

The data base of the tool is also split into several files to make navigation easier and improve clarity. The results are calculated for each year and then copied to a results sheet with the help of a visual basic macro. Each file contains thematically related data on information used in different sections of the tool.

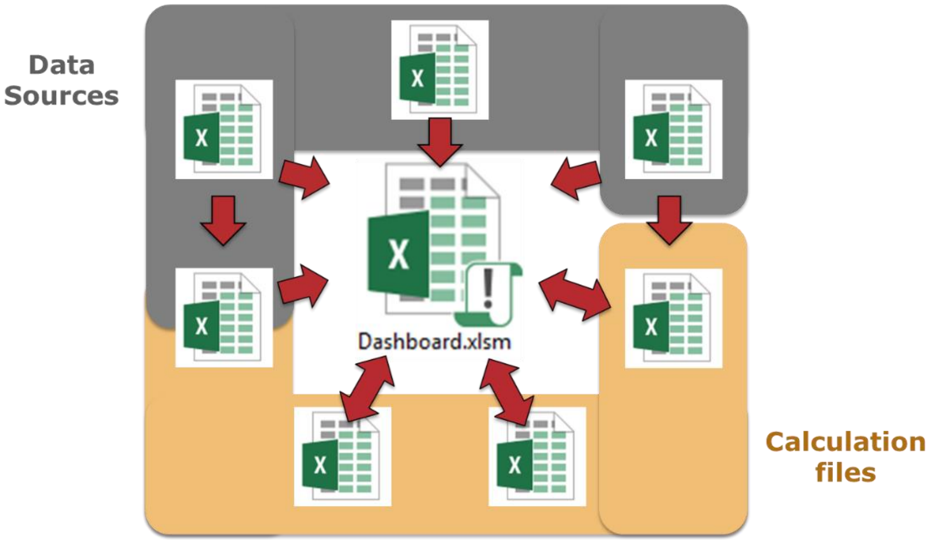

Figure 15: General structure of the tool

Source: own graph.

Input_Data offers a collection of historic data on capacities added of RE in the past by energy source. The unit is MW, m2 or m^3, depending on energy source. The values were taken from the literature as a first step. As data collection proceeded, the values were gradually replaced by data collected in the field. To make this procedure available for future users, *Input_Data* is connected to the data collection files through hard links. All data processing should be taking place in the data collection files. The results are gathered there and then filled in *Input_Data* through Excel links.

Data forwarded to the Dashboard is not limited to past and present information, changes in future installments and investments are also passed on. This means *Input_Data* is the primary instrument to specify scenarios. Values of capacities planned for the future can simply be added to the current development, as can existing values be adjusted.

Input_Data also contains information on capacity costs, costs of O&M and total capacity installed for RE and similar information for EE (measures taken and costs).

Technologies currently covered by the tool are as follows.

- Hydropower
- Wind power
- PV off-grid
- PV on-grid
- CSP
- Biomass, electricity
- Biogas
- SWH

- Solar pumping
- Waste to energy
- Efficient motors
- LED production
- Power Factor Correction Panel
- Efficient Lighting
- Efficient heat and steam use

The addition of five more RE technologies and five more EE technologies can be added in the tool. It includes wildcards for these ten additional entries. If, for instance, Egypt goes into hydrogen production, power to gas or heat technologies or heat pumps, the tool allows for the inclusion of these new technologies.

What else drives employment from RE and EE? Indirect effects matter. They are obtained by deriving additional demand from the installation and construction of RE and EE systems through the respective cost structures. Input vectors contains information specific to the structure of intermediate inputs in the renewable energy industry and is therefore essential for the calculation of indirect employment effects from an investment in RE. The structure determines additional demand in certain sectors resulting from a higher demand for RE. An international data base is used under the assumption that RE industries have similar input structures globally.

Figure 16 shows the respective structure for wind energy. The main domestic inputs here are from the financial and the business service sector, followed by activities in wholesale trade. Construction as such and electrical products such as cables etc. follow. Note that the graph represents cost shares, not employment shares. Employment hinges on the labor intensities in the respective sectors.

The input structures differ by phase of the value chain, i.e. installation, operation and maintenance and are implemented for renewable energy and energy efficiency.

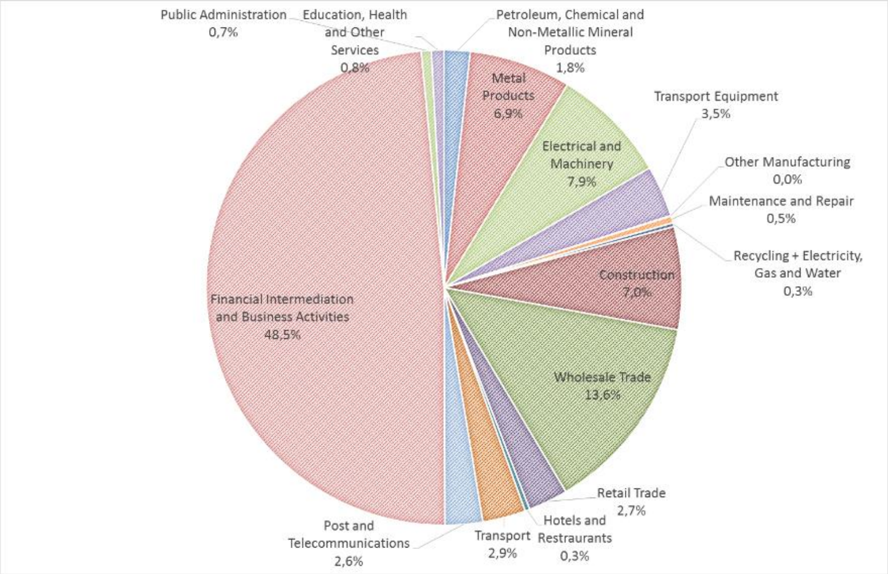

Figure 16: Input structure for wind energy systems

Source: Own graph with data from Lehr et al. 2015

Additional demand leads to additional production which again leads to demand for inputs to this production and multiplier effects. The Egyptian Input-Output Tables are used to estimate the multiplier effects.

The file *IOT_2013_Leontiefinverse* contains the Input-Output Table (IOT) of Egypt. It further contains a stepwise derivation of the Leontief inverse, following the procedure as outlined in chapter 3. The coefficient matrix A is obtained by dividing each cell of the IOT by the respective sector's total output. With the help of the Identity Matrix a new matrix (I-A) is calculated and finally the Leontief-Inverse can be created by inversion ((I-A)^-1). Where the classic IOT table provides information about the production structure of industries in absolute values, the coefficients matrix A shows the relative input structure. Finally, the Leontief-Inverse also takes indirect effects, i.e. multiplier effects, from an increase in production into account. In the next step, the resulting additional demand from all multiplier effects is turned into additional employment by multiplication with sector specific Egyptian labor intensities.

Calculations_Installation (and *Calculations_OM* analogously for operation and maintenance) receives the specified values of investment per year from the Dashboard. Using the production structure of RE from *Input vectors*, the initial impulse from an increase in RE production for each sector of the economy for a given year is calculated on sheet *delta y_inst*. The result is an increased production in all sectors, which deliver intermediate inputs to the sectors directly involved in the installation of RE. The sectors themselves then again require intermediate inputs, thus leading to the multiplier effects mentioned earlier. These effects are mapped by and calculated with help of the Leontief-Inverse-Matrix from *IOT_2013_Leontiefinverse*. The final result – a vector of changes in production (in US-$) for each technology – is reported to the Dashboard and can be found on *RESULTS_indirect_empl_installation*. The indirect employment effect follows from multiplication with the corresponding employment factors.

Employment_Compensation contains information about employment and wages in different sectors of the industry. The data is needed to benchmark employment per output ratio for each sector. The resulting quotas are referred to as employment factors. Multiplication with the additional demands yields indirect employment effects from an investment in renewable energy and energy efficiency, as exemplified above.

What else matters?

As any other economic sector, RE and EE sectors are feeling the effects of economic development of Egypt. If exchange rates are unfavorable, imports become more expensive which may put some projects on hold. It also may lead to imported inputs be replaced by domestic production, which may even result in larger domestic employment. Economic growth, on the other hand will have an effect on economic efficiency and thus on productivity and wages. Further intensified industrialization efforts in Egypt will have spill-over effects on RE and EE sectors, even though these are not directly targeted. Increasing integration of the industrial production will lead to higher employment from the respective RE and EE activities.

How do these facts enter the tool? It depends. There are no direct linkages between the tool and an overarching economic model, although this would be a rewarding exercise, too. However, the several quantities implemented in the tool allow for adjustments, which can be interpreted as effects from economic growth, industrial integration and other economic drivers. One way to implement less imports, for instance, in the tool is to increase domestic production.

Employment factors, for instance, reflect the Egyptian part of activities connected with the installation, manufacturing and operation and maintenance of the respective RE and EE technologies and services. If more local value is contained in these activities, the respective employment factor can be adjusted. Examples are given in the sensitivity analyses at the end of this report. A GDP projection is included in the tool, it can be found in the file *EF* and can be used to model increased productivity from overall economic growth. As a default, it is included in the employment factors given in the dashboard. Domestic filters are also given in the dashboard and serve as a means to include more integration or an opening up of the Egyptian economy.

The tool serves a) for ex post data analysis and b) as a projection tool for scenario of "what-if" analysis. Typical questions are: What will be the employment effect of the doubling of investment in a certain technology? What happens in terms of jobs, if we include a new technology, e.g. waste to energy?

The user can enter new data or adjust data according to the needs of a new scenario. From the added capacity, the installed capacity of each technology per year is derived automatically, decommissioning is not currently implemented. Indirect employment is driven by monetary expenditures, while future cost assumptions can be adjusted if new data are available. Recurring expenditures for operation and maintenance are computed by multiplying the average cost per installed MW, m2 or m^3 with a specific cost factor. Data on this stems from international sources as well as Egyptian ones where available.

The user specifies scenarios, which not only include different paths for RE and EE, but also different assumptions on costs, industrial development and technology choice. The overall computing process is illustrated by the following example of investment in Solar Water Heaters in the years 2010 till 2017. Results from different scenarios are then given in section 4.

Box 1: The Example of SWH

First of all, data on capacity added over the years is needed which yields the starting point for the calculation of direct employment. *Input Data* shows newly installed amount of SHW per year, given in m^2. With 1,800 m^2 added in 2010 the additional capacity increases each year up until 2015 where it reaches its maximum with 2,300 m^2, followed by a decrease down to 2,400 m^2 in 2016. Direct employment from construction is then derived by multiplying the capacity added each year with the specific employment factor of SWH in a given year. This factor is about 33.33 jobs per 1000 m^2 installed in 2010 and continuously decreases over time until 2016 where it takes on a value of 22.08. The course accounts for the improvement in productivity over the considered time span. As a consequence direct employment from construction is about 60 jobs in the years 2010 till 2013 – where increase in capacity installed is effectively cancelled out by an increase in productivity – 47, 62 and 53 from 2014 to 2016 respectively. Since the installed amount does not necessarily equal the manufactured amount in Egypt (exports as well as imports of considered technology is possible), there is additional data required to calculate direct employment from manufacturing of SWH, which can also be found in *Input data*. One can see that Egypt produces the major share of SWH itself. However, the local share decreases over the examined time span. While 1,600 m^2 where manufactured in 2010 the value decreases continuously down to 1,300 m^2 in 2016 – while the amount installed actually increases over the years, as elaborated above. The employment factor for manufacturing is about 3.75 jobs per 1,000 m^2 in 2010 and increases to 4.62 in 2016. Jobs created from manufacturing of SWH are thus varying between 6 and 7 for all years considered

For jobs in operation and maintenance, total capacity is the relevant quantity. Therefor capacity added each year is cumulated. The total amount of SWH installed rises from 1,800 m^2 at the end of 2010 to 16,000 m^2 at the end of 2017, reflecting the development depicted above. Jobs from O&M of SWH increase from 0.38 per 1 000 m^2 in 2010 to 0.46 in 2016, resulting in a rise from just one 1 job in 2010 to 7 in 2016.

Direct employment from investing in SWH narrowly fluctuates around 70 each year with one outlier being 2014 where it accounts for only 58 jobs.

To calculate indirect employment information on monetary expenditures is needed – which again can be found in the *Input Data* file. The values, however, are not given directly in this case but instead are derived from the newly added capacity and total amount of renewable energy installed for costs of installation and O&M respectively. Average costs of installation are assumed constant over the considered time span and take on a value of about 0.4 $/$m^2$. This results in an effective investment of over 700,000 US-$ (1,800 m^2 * 0.4 $/$m^2$) in 2010, increasing steadily to nearly one million in 2015, followed by a minor decrease to about 950,000 US-$ at the end of the period. This investment induces increased production in several different sectors that are delivering intermediary products for the installation of SWH. Which sectors are affected to which degree can be seen in the corresponding vector of SWH in *Input vectors*, also shown below.

Input vectors Egypt, installation		SWH
3	Mining and Quarrying	0,0000
6	Wood and Paper	0,0002
7	Petroleum, Chemical and Non-	0,0023
8	Metal Products	0,0051
9	Electrical and Machinery	0,0182
10	Transport Equipment	0,0003
11	Other Manufacturing	0,0000
12	Maintenance and Repair	0,0004
13	Recycling + Electricity, Gas and	0,0003
14	Construction	0,0200
15	Wholesale Trade	0,0138
16	Retail Trade	0,0029
17	Hotels and Restraurants	0,0004
18	Transport	0,0033
19	Post and Telecommunications	0,0025
20	Financial Intermediation and B	0,0228
21	Public Administration	0,0009
22	Education, Health and Other Se	0,0008
23	Private Households	0,0000
24	Others	0,0000

Figure 17: Input vector, Installation of SWH

The industries affected most are Financial Intermediation and Business activities, Construction, and Electrical and Machinery. All of the sectors themselves again require intermediary input factors. The precise production structure is given by the Leontief inverse matrix, which is derived from the IOT found inside file *IOT_2013_Leontiefinverse*. Due to the fact that not all products are produced locally the final value of induced investment per sector is adjusted by a domestic factor, which indicates the amount manufactured inside the country.

		Δy SWH
1	Agriculture	0
2	Fishing	0
3	Mining and Quarrying	2
4	Food & Beverages	0
5	Textiles and Wearing	12
6	Wood and Paper	140
7	Petroleum, Chemical	1.854
8	Metal Products	4.178
9	Electrical and Machin	14.842
10	Transport Equipment	276
11	Other Manufacturing	32
12	Maintenance and Re	351
13	Recycling + Electricity	237
14	Construction	16.311
15	Wholesale Trade	11.264
16	Retail Trade	2.332
17	Hotels and Restraura	329
18	Transport	2.674
19	Post and Telecommu	2.049
20	Financial Intermedia	18.556
21	Public Administration	739
22	Education, Health an	685
23	Private Households	0
24	Others	0

Figure 18: Vector of directly induced demand

In 2012 for example the amount of money invested in the installation of SWH is 814,847 US-$. This is multiplied by the above described vector, resulting in a vector indicating the intermediary input factors used in the process, which is shown below (Figure 18). Multiplication with the Leontief-Inverse yields the vector of resulting demand when taking indirect effects (multiplier effects) into account. The vector is also shown below (Figure 19, A). The vector adjusted by the domestic filter (B) is shown as (C).

The initial 814,847 US-$ raise the production of the industries producing intermediate input factors by 76,863 US-$ (see sum of Figure 18). Due to multiplier effects the resulting demand in all sectors amounts to 121,452 US-$ (the sum of vector A in Figure 19). Taking the share of domestic production into account the total intermediary input factors produced by all sectors equals 109,140 US-$ (see vector C).

	Installation: Δx SWH
Agriculture	304
Fishing	16
Mining and Quarrying	619
Food & Beverages	282
Textiles and Wearing Apparel	78
Wood and Paper	1.881
Petroleum, Chemical and Non-Metallic Mineral Products	5.327
Metal Products	8.830
Electrical and Machinery	20.810
Transport Equipment	1.265
Other Manufacturing	422
Maintenance and Repair	1.873
Recycling + Electricity, Gas and Water	1.471
Construction	16.366
Wholesale Trade	14.508
Retail Trade	2.618
Hotels and Restraurants	646
Transport	5.021
Post and Telecommunications	4.554
Financial Intermediation and Business Activities	32.248
Public Administration	806
Education, Health and Other Services	1.231
Private Households	0
Others	276

A

	SWH(1000 m2)
Mining and Quarryin	*0,85652202*
Food & Beverages	*0,89757277*
Textiles and Wearing	*0,89680059*
Wood and Paper	*0,78984151*
Petroleum, Chemica	*0,70304708*
Metal Products	*0,77238125*
Electrical and Machir	*0,74056129*
Transport Equipmen	*0,77162025*
Other Manufacturing	*0,80226981*
Maintenance and Re	*0,80226981*
Recycling + Electricit	*0,75842135*
Construction	*0,89599009*

B

Installation: Δx	Installation: Δx SWH(1000 m2)
Agriculture	304
Fishing	16
Mining and Quarrying	530
Food & Beverages	253
Textiles and Wearing Apparel	70
Wood and Paper	1.486
Petroleum, Chemical and Non-I	3.745
Metal Products	6.820
Electrical and Machinery	15.411
Transport Equipment	976
Other Manufacturing	338
Maintenance and Repair	1.503
Recycling + Electricity, Gas and \	1.115
Construction	14.664
Wholesale Trade	14.508
Retail Trade	2.618
Hotels and Restraurants	646
Transport	5.021
Post and Telecommunications	4.554
Financial Intermediation and Bu	32.248
Public Administration	806
Education, Health and Other Se	1.231
Private Households	0
Others	276
Sum	**109.140**

C

Figure 19: SWH installation vectors

To answer the question what that means for employment in the corresponding sectors once again employment factors are used. In *Employment_Compensation* data on production and wages is used to calculate the average number of jobs per output depending on industry. These factors are then used in the *Dashboard* to calculate the total indirect employment from installation SWH on the sheet *RESULTS_indirect_empl_instal*. In 2012 about 5.4 jobs are created as a consequence. Repeating the process for all years from 2010 to 2016 returns values between 5 and 7.

To calculate indirect employment from operation and maintenance of RE systems the same scheme is applied. Annual expenditure is derived as a factor of installed capacity in this case. The data on average costs stems from Lehr et al. 2015. Total costs for O&M of SWH are growing over the considered time period, nevertheless they sustain a very low level, reaching 30,000 US-$ in 2016. The corresponding number of jobs is about 0.3 with accordingly smaller values in the years before. For 2012 there are about 11,000 US-$ spent on O&M which a corresponding number of jobs of about 0.1.

A complete overview of expenditure and corresponding jobs with regards to investment in SWH technology is depicted below.

	2010	2011	2012	2013	2014	2015	2016
Total expenditure (installation + O&M)	719.053	742.604	826.175	850.223	934.291	1.018.757	983.778
Number of jobs	71,4	72,5	73,9	75,9	64,0	80,3	73,9

Figure 20: Final results from investing in SWH

Source: Own results.

Expenditure is rising steadily up until 2015, with a small decrease following in 2016. Installation accounts for the vast majority of costs during the complete time period with operation and maintenance only being responsible for a minor share. Employment is increasing during the first years up until 2013. In 2014 there is a significant drop in jobs which is caused by a sharp decrease of the employment factor for installation of SWH. The available data clearly shows a stark increase in productivity in the year in question. While 60 people were needed for the installment of 2 100 m^2 SWH in 2013, 57 were responsible for the installment of 2400 m^2 in the year after. In 2015 productivity is more in line with its average growth path. In combination with the ongoing increase in investment an employment maximum is the consequence. While expenditure in 2016 is still higher compared to the years before 2014 the number of jobs are about on the same level, causal is yet again the employment factor that has decreased due to changes in productivity.

2.3 Data sources

2.3.1 Explorative data collection

Most data on capacities installed, costs of past installations and employment from past installations have been collected between April 2017 and August 2017.

A brief disclaimer to start with: All data collected on EE stem from 150 Energy Efficiency projects applied in around 146 entity of different sectors by either itself, service provider, international program, or national program; so the collected data represent available samples only are by no means comprehensive of all projects. The data collection procedure for energy efficiency proceeded as follows.

Step 1: Data collection planning

- Contacting the most active EE service providers and some large companies to have an idea about the available data.
- Data collection team brain storms to find the main key indicators expected from the data collection analysis and select the main criteria of data collection and develop data collection forms and templates from the initially suggested templates.

Results:

- 1- Data will cover FY 2010 to FY 2017
- 2- Collected data covers the following technologies only:
    - Motors System Optimization (MSO),
    - Lighting System Optimization (LSO),
    - Steam System Optimization (SSO), and
    - Power Quality Optimization (PQO).

Step 2: Evaluation of reports

Companies and service providers were contacted and project reports were collected for each EE project.

- 1- Egypt National Cleaner Production Center (ENCPC)
    - Collected reports: (57 reports)
    - Sectors: Industrial
- 2- European Energy Manager Program (EUREM) under the umbrella of the German Arab Chamber for Industry and Commerce (GACIC)
    - Collected reports: (77 reports)
    - Sectors: (Industrial, Tourism, Commercial, Residential, Governmental, Non-Governmental, and Public)
- 3- "Low Carbon and Climate Resilient Industrial Development Egypt" under the umbrella of the United Nations Industrial Development Organization (UNIDO)
    - Collected reports: (12 reports)
    - Sectors: Industrial (Agro-Food)

Results:

- 146 full reports and samples from the following sectors were collected: Industrial including many sub-sectors (large and SMEs), tourism including hotels and resorts in (Cairo, Sharm El-Sheikh, Hurghada, and Dahab), commercial (large and SMEs), residential including traditional houses, villas, and residential compounds, governmental offices, non-governmental offices, and streets and mosques.

Step 3: Data extraction

The following format proved feasible

- Title of the project

- Investment in L.E., US$, or Euro (according to the costs of the same year of implementation)
- Energy saved in kWh/year or MMBTU/year for thermal EE projects (Unifying conversion developed in step 5)
- Energy costs reduction in L.E./year (according to Energy tariffs and demand charge of the same year of implementation)

Step 4: Data filtration

The extracted data were filtered and 131 EE projects passed the reliability tests.

Step 5: Data elicitation

Data was converted using the norm standards of the EUREM materials to facilitate data analysis.

Step 6: Data completion

Results:

- Representative indicators:
  - Motors System Optimization (MSO): *no. of jobs per 1 improved motor*
  - Lighting System Optimization (LSO): *no. of jobs per 1 square meter of improved system.*
  - Steam System Optimization (SSO):
  - Insulation: *no. of jobs per 1 square meter of installed insulation material.*
  - Steam generator improvement: *no. of jobs per 1 boiler.*
  - Power Quality Optimization (PQO): *no. of jobs per 1 installed panel.*

Table 5 : Example of data collection: Efficient lighting

Year	Egyptian Jobs												
	L.E.	Level of Effort E** in days						Number of permanent jobs created					
		A	B	C	D	E	**Total**	A	B	C	D	E	**Total**
2008	88	28	97,55	14,0	390,20	682,85	**1212,60**	0,11	0,37	0,05	1,48	2,59	**4,6**
2009	63	12	87,68	6,00	350,74	613,79	**1070,22**	0,05	0,33	0,02	1,33	2,32	**4,1**
2010	38	10	29,56	5,00	118,25	206,95	**369,76**	0,04	0,11	0,02	0,45	0,78	**1,5**
2011	42	6	42,64	3,00	170,57	298,50	**520,71**	0,02	0,16	0,01	0,65	1,13	**2,0**
2012	33	6	4,01	3,00	16,04	28,06	**57,11**	0,02	0,02	0,01	0,06	0,11	**0,3**
2013	98	8	58,95	4,00	235,78	412,62	**719,35**	0,03	0,22	0,02	0,89	1,56	**2,8**
2014	904	6	234,9	3,00	939,88	1644,8	**2828,64**	0,02	0,89	0,01	3,56	6,23	**10,8**

2015	2.78	10	88,39	5,00	353,55	618,72	**1075,65**	0,04	0,33	0,02	1,34	2,34	**4,1**
2016	189	14	428,9	7,00	1715,6	3002,4	**5167,91**	0,05	1,62	0,03	6,50	11,4	**19,6**
2017	0	0	0,00	0,00	6,79	11,88	**18,67**	0,00	0,00	0,00	0,03	0,04	**0,1**

Source: Results from survey 2017.

A: Planning and Management, B: Design, Specifications and Offers,
C: Manufacturing operation, D: Project Implementation
E: Operation and Maintenance

The data collection process for RE employed a similar template (Table 6). A list of the contacted institutions is available in annex 5. It turned out during the data collection process in the field of renewable energy that the issue of employment has not been researched up to now. Although of acknowledged importance for Egypt, data on RE projects have been collected in physical unit thus far. The definition of job equivalent and of level of effort had to be provided to the persons who filled out the questionnaire. For future data collection processes, these definitions have to be provided together with the data collection sheets and templates.

2.4 Data collection plan

Future data collection and data input is crucial for the maintenance and the guarantee of the future usability of the tool.

Phase 1: 2017/2018 – Refine existing results

In phase 1, the current data set shall be refined.

Step 1: Employment factors – Renewable Energy

Data on employment in existing projects have been collected thoroughly for wind energy, hydro power, solar water heaters (installation and manufacturing), PV assembling and installation and biogas.

Hydro energy data and wind energy data seem complete. The hydro power plants and the wind farms are rather large units, they are maintained by a known authority and data can be easily obtained. The same holds true for large PV installations. The small scale units are less easily monitored.

The structure of the template has been tested and improved from feedback in the field. The recommendation is to continue with the templates (see Table 8 and Table 6)

Table 6: Data collection template for renewable energy

Concerned organization/source						
Technology*						
Year	Installed Capacity	Investments		Egyptian Direct Jobs		
		Local Share	Foreign share	Total No.	Permeant	Part-time
2010						
2011						
2012						
2013						
2014						
2015						
2016						
2017						
* a separate table should be developed for each of the technologies that your organization is working with from the following technologies						
Wind, PV, CSP, SWH, Biomass, and Biogas						

These data are the base for the estimation of employment factors. The employment factors are derived dividing Jobs in Egypt by the respective unit. Comparison with results from international studies and the most recent study show, that employment in wind energy and large solar seems to have rather low participation from Egyptian workers.

Table 7 : Comparison of employment factors

	Energy Source	Wind power, onshore	Photo-voltaics	Solar water heater	Hy-dropower	Biogas
International Employment factors (Jobs/MW)	**Construction**	3,2	13	8,4	7,4	14
	Manufacturing	4,7	6,5	8,4	3,5	2,9
	Operation & maintenance	0,3	0,7	0	0,2	1,5
Employment factors Egypt (Jobs/phys. unit), SWH (m2); Biogas (m3)	**Construction**	0,8	1	11,03	1	0,07
	Manufacturing			6/1400 m2		
	Operation & maintenance	0,3	0,1	0,8	1,28	0,01
Employment factors Tunisia (Jobs/phys. unit), SWH (m2); Biogas (m3)	**Construction**	2,9	6,833	14		
	Manufacturing			5.2/1000 m2		
	Operation & maintenance	0,4		0,8		

In this phase, the data should be completed for solar pumping installation, CSP installation, and most manufacturing sectors.

To do so, the following steps are necessary:

a) Develop a RE company data base. It should be structured as follows:
    a. Companies involved in planning and design of RE facilities
    b. Companies manufacturing RE systems or parts thereof
    c. Companies importing and trading with RE systems or parts thereof.
b) Try to obtain data on turnover of these companies for the last years since either their activity in the field or since 2010. This can be obtained by direct survey or by analysis of the companies' annual reports, homepage, etc.
c) Complete data collection sheets for manufacturing and fill the gaps

Step 2: Employment factors – Energy Efficiency

The data on energy efficiency have been collected into a similar template (see Table 8). Employment factors could be easily obtained from the data.

Table 8: Data collection template for energy efficiency

Concerned organization/source															
Technology*															
Year	Number of Projects	Saved Energy (kWh/a)	Investments		Egyptian Jobs										
			Local Share EGP	Foreign share EGP	LOE** in days					Number of Equivalent Permanent Jobs created					
					A	C	D	E	**Total**	A	B	C	D	E	**Total**
2008															
2009															
2010															
2011															
2012															
2013															
2014															
2015															
2016															
2017															
Total															
* Separate table should be developed for each of the technologies that your organization is working with from the following technologies:															

Motors Optimization, Lighting Optimization, Burners Optimization, and Power Quality Optimization
** Level of Efforts in days/year
A: Studies and Planning.
B: Design, Specification, and Tendering.
C: Contracting, Contract management, and Supplying.
D: Project implementation.
E: Operation and Maintenance.

However, the question is if the list of efficiency technologies is complete. In a similar exercise for Tunisia, efficiency measures in the building sector were included as well as diagnostic test centers for the automotive sector. Therefore, the next step here should be to expand the list of technologies. The tool has been programmed to accommodate 5 more technologies.

Step 3: Capacities installed in renewable energy and existing project of energy efficiency

To be sure of employment from RE and EE, comprehensive data on all installations are necessary. They can be collected in the 6_Input_Data.xls table in the tool.

Table 9: Capacities added - Renewable Energy

	Unit	2010	2011	2012	2013	2014	2015	2016
Hydropower	MW						0	0
Wind power	MW	120	0	0	70	70	70	220
PV off-grid	MW	0	0	0	0	0	1	1
PV on-grid	MW	0	0	0	0	0	16	16,1
CSP	MW	10	10	0	0	0	0	0
Biomass, electricity	MW							
Biogas	1000 m3	0	0	180	758	1313	1725	900
SWH	1000 m2	55	68	85	106	133	166	208
Solar pumping	MW	100	100	100	100	100	100	100
Waste to energy	MW							
V	y							
W	y							
X	y							
Y	y							
Z	y							

To control the results, the sheet on capacities installed (Table 10) can be used.

Table 10 : Capacities installed - RE

	Unit	2010	2011	2012	2013	2014	2015	2016
Hydropower	MW	2800	2800	2800	2800	2800	2800	2800
Wind power	MW	430	430	430	500	570	640	860
PV off-grid	MW	0	0	0	0	0	2	3
PV on-grid	MW	0	0	0	0	0	16	32
CSP	MW	10	20	20	20	20	20	20
Biomass, electricity	MW	0	0	0	0	0	0	0
Biogas	1000 m3	0	0	180	938	2250	3975	4875
SWH	1000 m2	55	123	208	314	447	614	822
Solar pumping	MW	100	200	300	400	500	600	700

Step 4: Energy efficiency

This step will be difficult for energy efficiency. Data on ALL existing projects should be collected, after the decision in step 2, which technologies should be covered. Data shall be collected from the respective authorities (e.g. on the building sector or the transport sector) and/or from relevant energy efficiency support programs. A tentative list for the latter is given in step 2 chapter 2.3.1.

Phase 2: Next 3-5 years

In the mid-term perspective, data collection should become more and more automatized. In this study it was a research effort, in the suggested first year plan it will be an institutional effort, in the mid-term it should take less and less resources.

1. Make an institution (NREA with RCREEE support for instance) responsible for the data so that there is an acknowledged data hub. For instance, Germany created an Agency for Renewable Energy Statistics (AGEE-Stat), as the official hub.
2. Make data reporting part of the approval procedures of projects. This might be the most relevant point for future data collection. If projects are approved, they should sign, that they will provide data, timely and in a certain format.

AGEE-Stat, Germany

Established in 2004, the agency is in charge of providing reliable and consistent data on RE. The quantities reported are:

Capacities installed, heat, electricity (by support mechanism) generated, fuels consumed, by source. Further, data on investment in new RE installations is reported as well as CO2

The second point is very important but will require legislation support.

Only if any program, any new RE or EE project is required to give data within a certain timespan after approval to the data collecting authority, the whole process will be automated. From the German example (see box) it can be learned that the quality of data increases tremendously, if it collected in an automated fashion. For PV, a registry exists since 2009, into which anybody who has a new PV system, be it on the roof, or large on the ground has to report to the respective authority and register. The data include: address, size of the system, ownership. All other RE technologies have to register since 2014. Any other power plant larger than 10 MW has to register with its address, owner and capacity installed, too.

Regarding the tool, the IO data core has to be updated within the next three years. Check the homepage of the database (**www.eora.org**) for the most recent available data set.

General structure of data collection

The following aspects hold true, no matter of the time frame:

- Provide a budget. Filling in forms and collecting data requires effort. There should be a small budget for the collection of data. Unfortunately, due to circumstances, this could not be provided by this study and data collection hinged on favors. Although it was extremely successful, for future purposes a small budget should be considered.
- Develop the templates through usage further. Although the templates already have been developed into a usable format during the course of this project, future usage will help to identify future data needs and suggestions for elicitation. Data collection is a dynamic process and develops along with the data needs for evaluation. However, one has to be careful not to become too detail oriented.
- Collect data during the course of the year, but do set a deadline. Although data can be collected continuously, there should be a deadline for the finalization of the status quo of the respective year. This deadline should be announced and be included in the data collection obligations of the firms (see point 3).

2.5 Limitations – what the tool currently does not cover

The tool has been developed according to recommendations from several international organization (ILO, IEA-RETD) on the use of Input-Output-Tables for the calculation of green jobs. Based upon statistical data from Egypt and international databases, as well as a survey carried out in Egypt, it provides the best available estimate of jobs created from renewable energy and energy efficiency. It calculates direct impacts and indirect impacts. In its current form, it does not calculate induced impacts, from energy saved or from having an additional job.

The results can serve as an important information for planning processes in different policy areas. Regarding economics, the results show under different scenarios a sector specific impact of RE and EE deployment. The decision maker can decide, which sectors could benefit, if for instance supported by the respective measures, such as tax reductions, speeded approvals etc.

Further, the results can be used for reflections on future qualification needs. Given, that renewable energy technologies and energy efficiency equipment need a well-qualified labor force, the results can be interpreted as the qualification challenge in the years to come. If, for instance, 40,000 people will work in installation, operation and maintenance and the manufacturing of RE and EE equipment, there will be a need for additional qualification. Typical for nascent markets is the on the job training by the companies themselves. However, if more industrial integration is targeted, the future labor force should be ready for working in increasingly high-tech work places.

The model is not currently providing estimates on qualifications necessary. This can be carried out in a separate exercise or will be included at a later point in time.

Economic effects hinge on policy instruments. The tool, however, only considers that deployment takes place, and does not suggest or compare alternative measures and policy instruments.

Last but not least exports are only considered based on assumptions and are not a direct result of the tool.

2.6 Preliminary results on employment from RE and EE until today

Based on the data collected during the framework of the project and seeing the data and time limitations, the results and the figures presented here can only be considered as a very conservative estimate that can be of course developed and ameliorated based on the data collection plan mentioned earlier.

The results of the tool showed that more than 8,800 people in Egypt had their job in the year 2016 due to activities related to renewable energy and energy efficiency. Renewable energy dominates this number, but in energy efficiency, also more than 560 people are working to produce energy efficient lamps, consult companies or install efficient air-conditioning. Figure 21 shows the development of the total effect from RE and EE. Total employment comprises direct and indirect effects as described in the earlier chapters of this report. It also includes employment in administration, in particular NREA employees, unless they are working in operation and maintenance of wind farms or the CSP plant. These employees are accounted for under the rubric of RE-O&M.

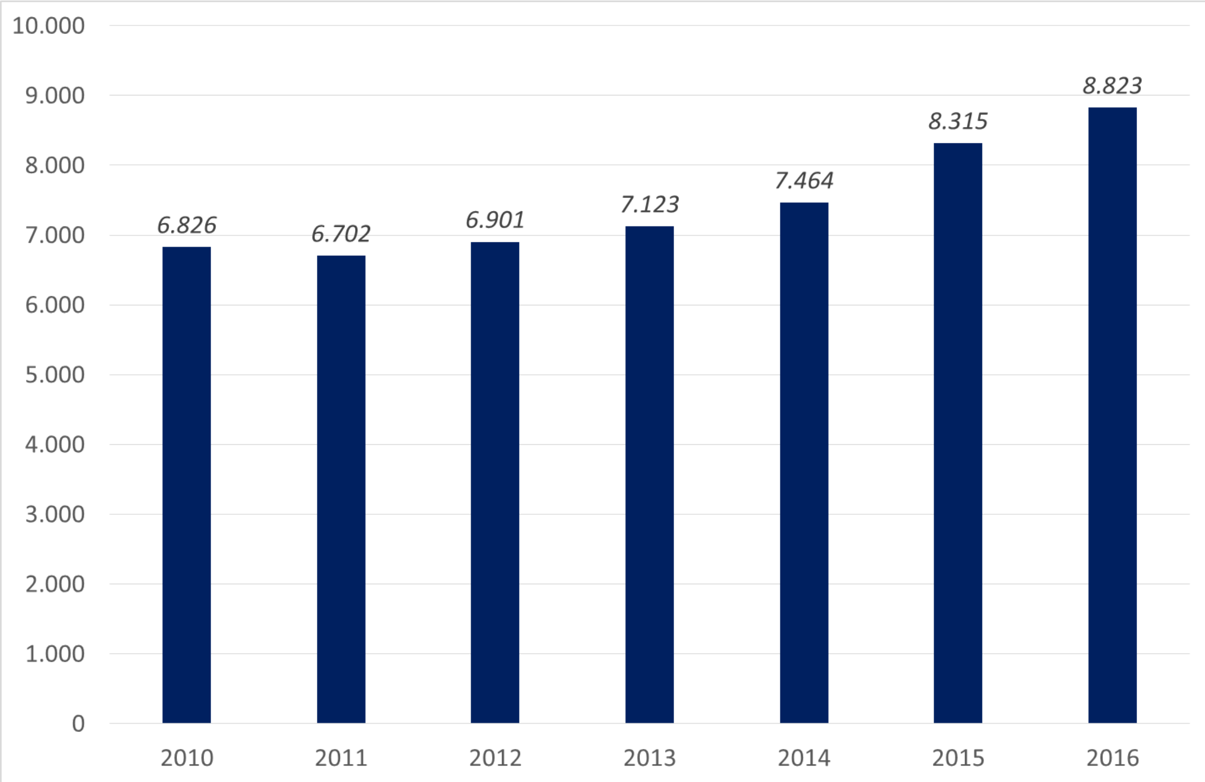

Figure 21: Total employment from RE and EE (Full-time employment, FTE)

Source: Own results.

If we look further into the above figure, we can notice that EE and RE jobs have grown the most during the latest years of this decade. The early years of the decade show lower results which is similar to other economic sectors as well as the country's GDP. Employment from renewable energy and energy efficiency, however, not only follows the economic development but is mainly driven by deployment activities in the respective fields. We see employment from renewables and energy efficiency grow steadily since 2012.

Breaking these number down into its segments, sheds further light on the structure of today's employment from renewables and energy efficiency in Egypt. This is relevant, because it also elucidates future niches and opportunities for growth, assuming that the targets of Egypt's renewable energy plans will be met (see next chapter on scenarios).

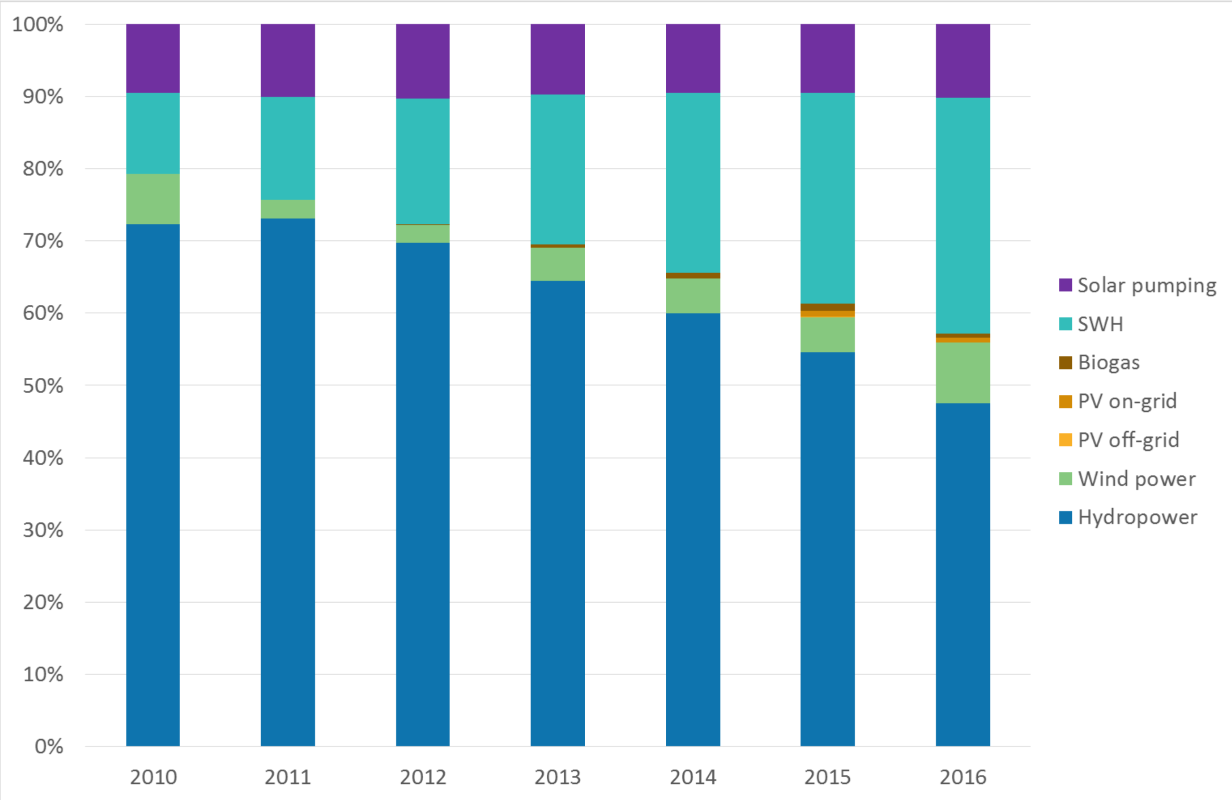

Figure 22: Relative employment shares – RE (in percent)

Source: Own results.

Figure 22 shows the past and ongoing dominance of operation and maintenance of hydro power of up to 90 percent in the years 2011 and 2012. However, wind is growing in importance, and by 2016 all other renewable energy sources apart from hydro almost hold 50 percent of the total employment. Solar energy is gaining more weight in terms of employment especially due to new PV installations and the assemblage of PV modules in Egypt. The numbers also shows that rooftop and off-grid installations are more labor intensive and require more effort per kW installed capacity, therefore PV-employment shares are larger than shares in capacity installed.

Employment from energy efficiency is dominated on the other hand by the production of efficient bulbs (Figure 23). Other areas of efficiency are still rather underdeveloped. Note that the data situation for efficiency was even more difficult than RE data collection and the figures presented here can be considered as a very conservative estimate (for more on the data used, see the chapter on data collection (2.3.1).

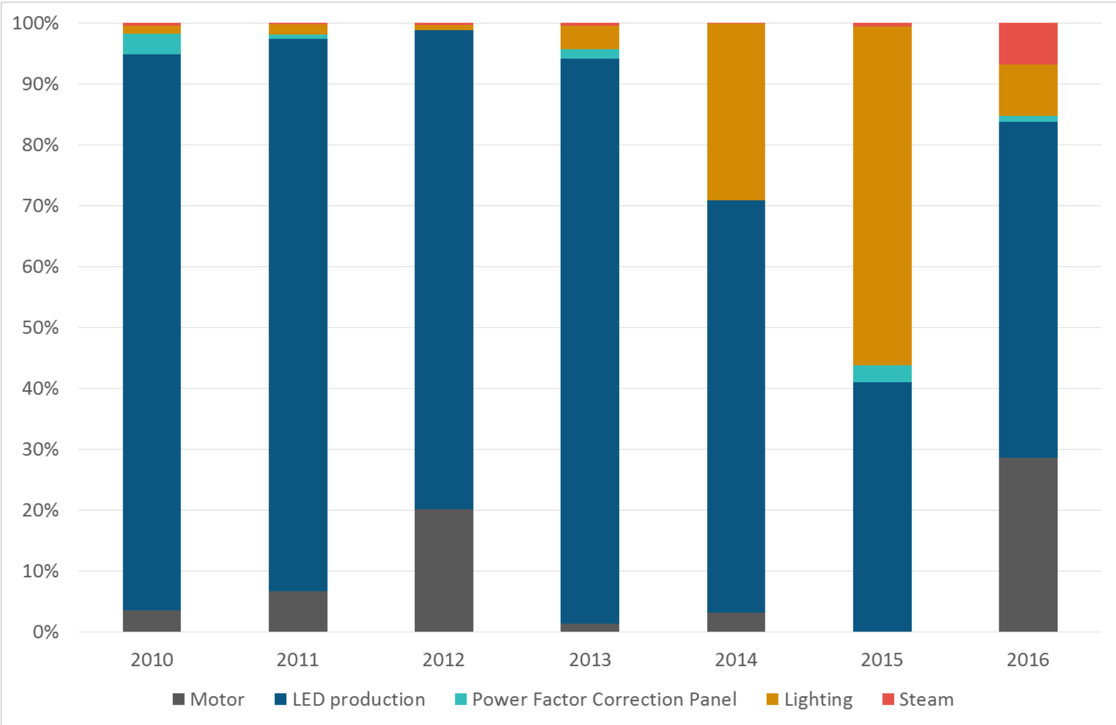

Figure 23 : Relative employment shares - EE (in percent)

Source: Own results.

Regarding indirect effects a more detailed analysis shows the already high relevance for total employment effects. Indirect effects from wind energy range between almost 1000 and close to 2000 jobs. The largest indirect contributions are found in administration, legal services, whole sale and retail distribution and in the metal and electronics industry. Examples for the metal industries are the companies in cable production, among them rather large players such as Giza cable industries.

Figure 24 gives however an overview of the total investment in new capacities and expenditure for O&M in the renewable energy sectors. While hydro power requires only expenditures for O&M, wind energy and solar energy require both, investment and O&M expenditures. Biogas and solar water heater do as well, but are still of very small size until today.

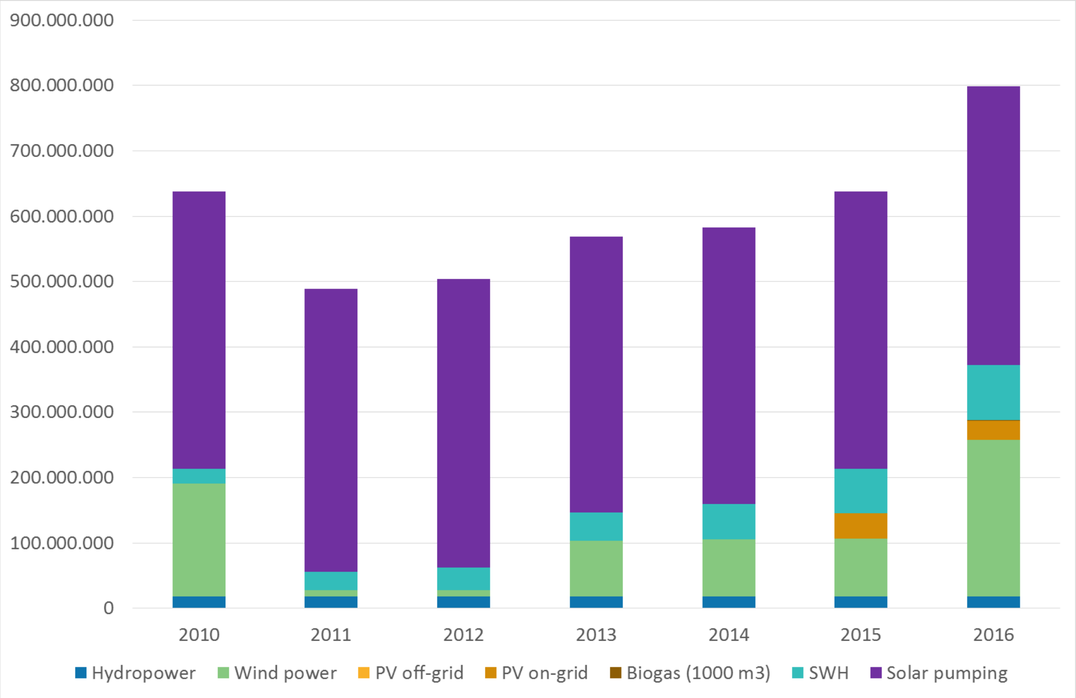

Figure 24: Total investment plus O&M expenditures for RE (in US$)

Source: Own results.

It is worth mentioning that two solar technologies, PV and solar water heaters already exhibit some domestic employment in manufacturing e.g. in the Egyptian Solar Systems Company. It exists since 1989, and is specialized on the design, manufacturing and installation of solar hot water systems and solar heating systems. The assemblage and installation of PV systems (off-grid) is also part of the company's portfolio[4]. Comparing the results to other studies by the authors or others in the region, shows that they compare well. In comparison to Tunisia, employment from wind energy per MW installed is a little bit lower, which shows, that wind energy installations have slightly higher domestic production in Tunisia. The details will vary by project and given its industrial structure, Egypt can easily approach employment factors similar to Tunisia or in the later future. A sensitivity analysis in the next chapter shows the impact from more domestic production. The optimistic outlook on CSP as described above (Desert Power 2050) seems unrealistic from today's point of view. However, that outlook goes beyond the time horizon of our study (and tool). The results from Arcen et al. (2012) for Morocco also show, how much employment could be generated for wind energy, if the industry was located to a larger extent in Egypt. Overall, 8000 people as of today are a conservative estimate of the jobs from RE and EE. This number will now provide the starting point for future scenarios and sensitivity analysis.

[4] All information are extracted from **http://egyptsolar.net/**.

3 Scenarios for Future Development

Scenarios for future development are characterized by different assumptions on:

- Future installations of RE systems
- Future costs of development
- Future capacities of the domestic industry and assumptions on local content
- Future productivity increases.

3.1 Benchmark scenario

In order to be able to compare different scenarios and assumptions in the future steps, as a first step, the benchmark scenario should be defined.

The scenario chosen by the project contains an installation path of RE systems which reaches the targets of Egypt's strategy as outlined above. In particular, for wind energy, the target of 5000 MW in 2022 is reached, PV reaches 1500 MW from FiT and 300 MW small scale.

Biogas is projected using past trends leading to an additional installation of 5000 m3 per year, solar water heaters uses a projection by Hegazi (2017), projecting additional installations of 2000 m2 each until 2020, 3000 m2/a until 2025 and 4000 m2/a for the remaining 5 years of the calculation period. The path for solar pumping refers to Abou-Khodier and Mahmoud (2017). Data on energy efficiency are much sparser and no detailed strategy exists. Therefore, EE is projected to follow its past path.

Results of the benchmark scenario

Figure 25 gives an overview of the projections used in the benchmark scenario. In total, all efforts in the benchmark scenario amount to investment in new capacities and energy efficiency of $2.25 billion by 2020 and $2.57 billion in 2030. Expenditures on operation and maintenance amounts to $250 million per year in 2020 and to $485 million in 2030.

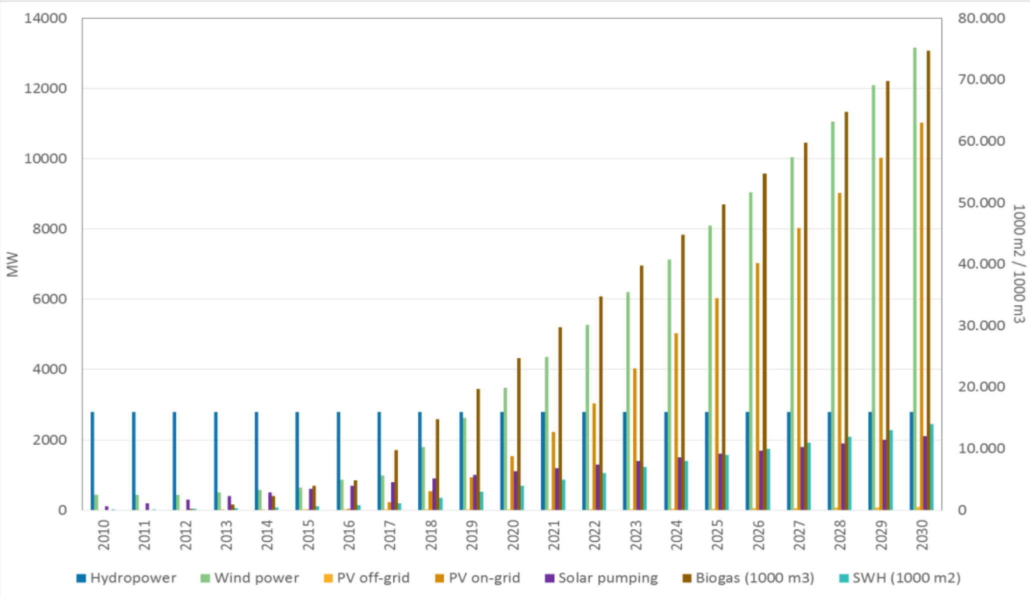

Figure 25: Capacity installed, left axis in MW, right axis in $1000m^2$, and 1000 m^3 for solar water heaters.

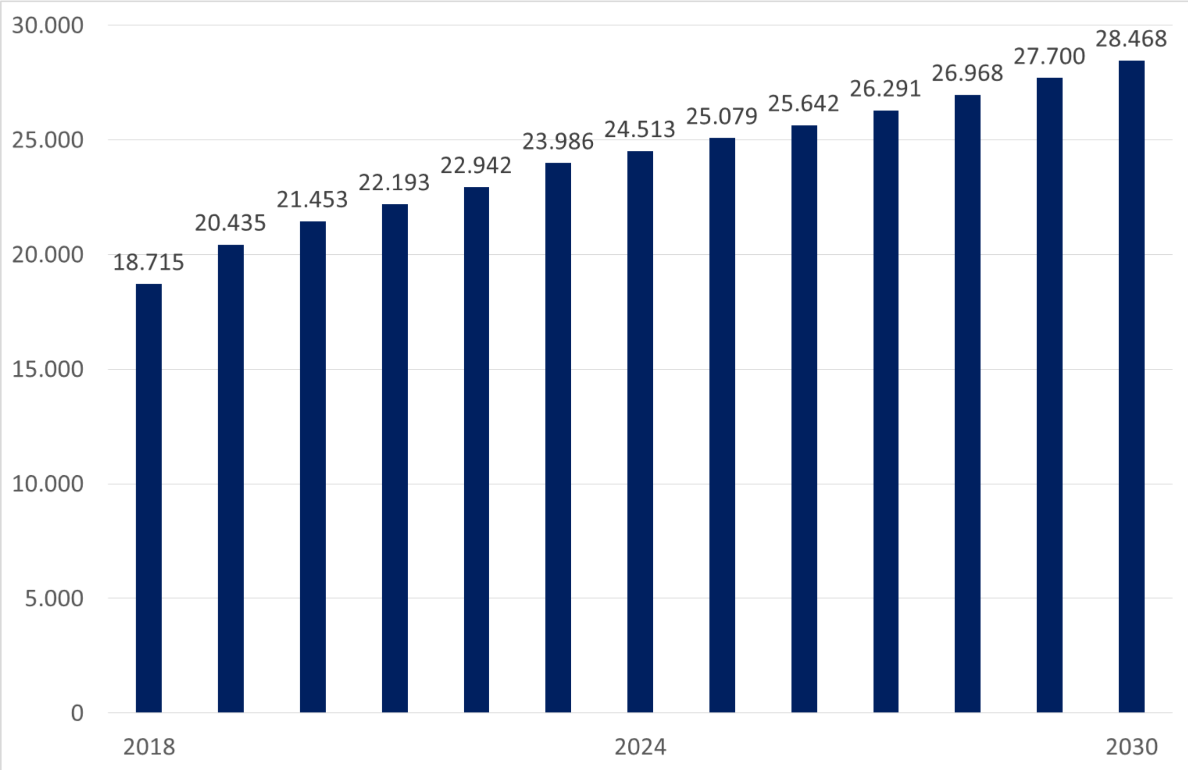

Figure 26: Employment from RE and EE in the benchmark scenario

Source: Own results.

How many Egyptian jobs are created in the benchmark scenario?

In the benchmark scenario, employment from RE and EE increases significantly and reaches 28.468 by the year 2030 as shown in Figure 26.

The main drivers are the expansion of wind energy and solar energy (SWH and PV). Wind energy will be reaching a conservative target of 5000 MW by 2022, PV of 3000 MW, SWH sees 5 million square meters installed. The number of energy efficiency projects is assumed to increase by 10 percent/a.

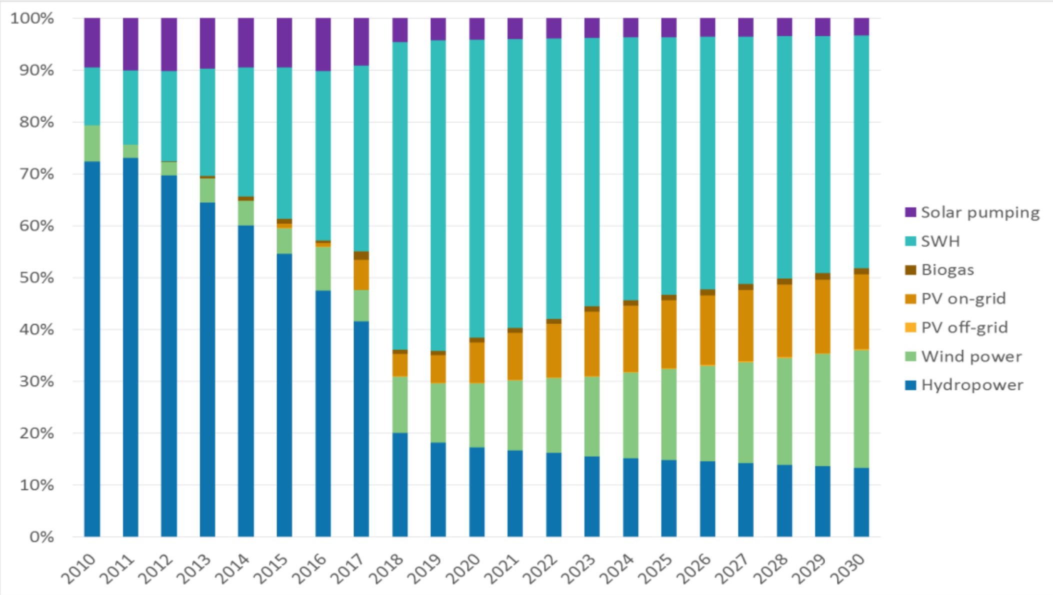

Figure 27: Employment shares in percent of total employment from renewables

While jobs in operating maintaining hydro energy held the largest share of total employment from renewable energy at the beginning of the observation period, the new installations of wind energy, PV (small and large) became increasingly relevant towards the end of the simulation period. In terms of money spent, investment in new installations and expenditures on operation and maintenance amounted to a total of more than $2.5 billion in 2030. While this is a massive investment program, it fits the goals of Egypt vision 2030, where investment in clean energy and investment in future oriented green technologies feature as economic strategy (see chapter 1 in part 2).

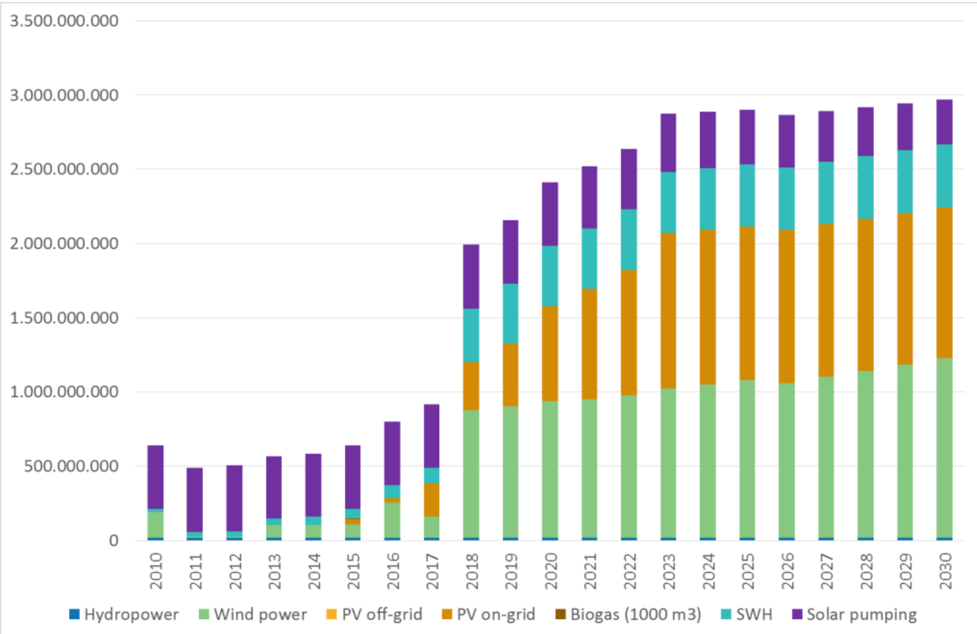

Figure 28: Total expenditures for RE

Investment on EE is smaller by comparison. As shown in Figure 29, it amounts to $100 million per year. Energy efficiency technologies, however, do not have operation and maintenance costs. All investment considered is in new systems and devices.

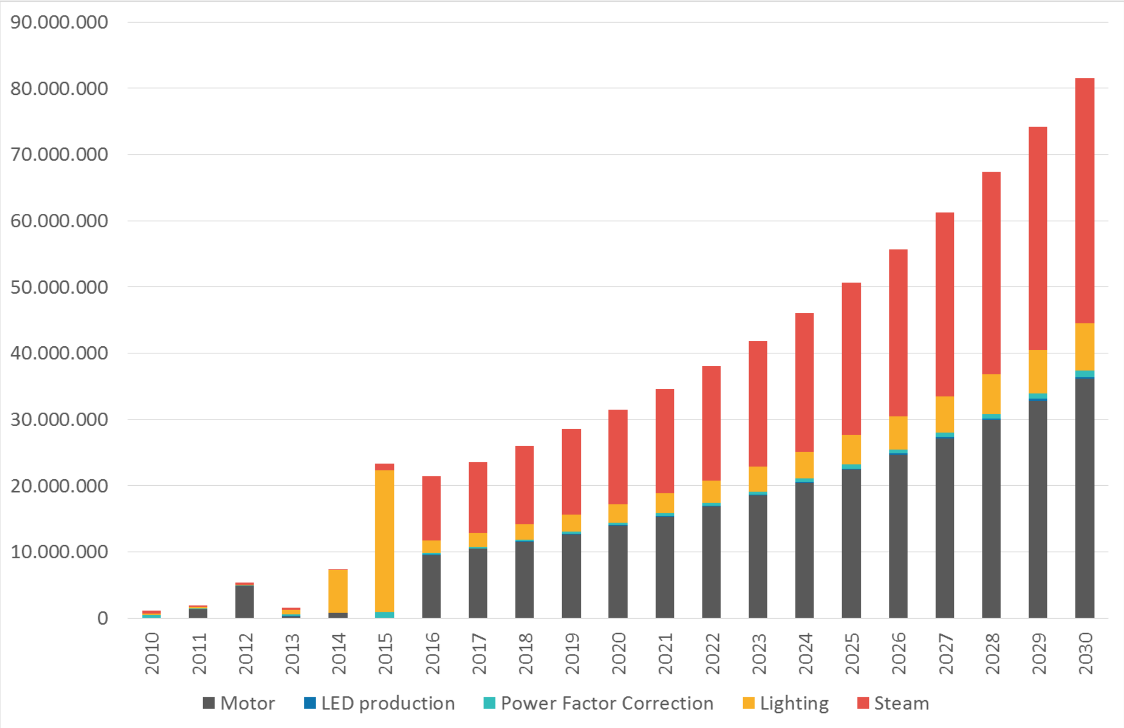

Figure 29: Investment in energy efficiency.

In the benchmark scenario, most jobs are from direct employment, because the scenario perpetuates today's local content and does have particular assumptions on the development of the domestic industry.

In the following we will compare this benchmark scenario to two different developments and assumptions.

3.2 Scenario 1: More ambitious deployment

In this scenario we aimed for a more ambitious scenario for the shares of renewable energy in the energy system in Egypt.

It specifically aims at 21 GW Wind in 2030, 23 GW PV and 4.1 GW CSP. To reach this ambitious set of goals, massive additional investment is assumed from 2020 on. The new investment path and resulting employment are given in Figure 30.The figure shows the higher annual investment path and the higher job creation in the ambitious scenario. The largest differences can be seen regarding the solar electricity generating technologies. CSP figures largely in the scenario as well as PV. Together, they contribute more than 8,400 people in direct employment.

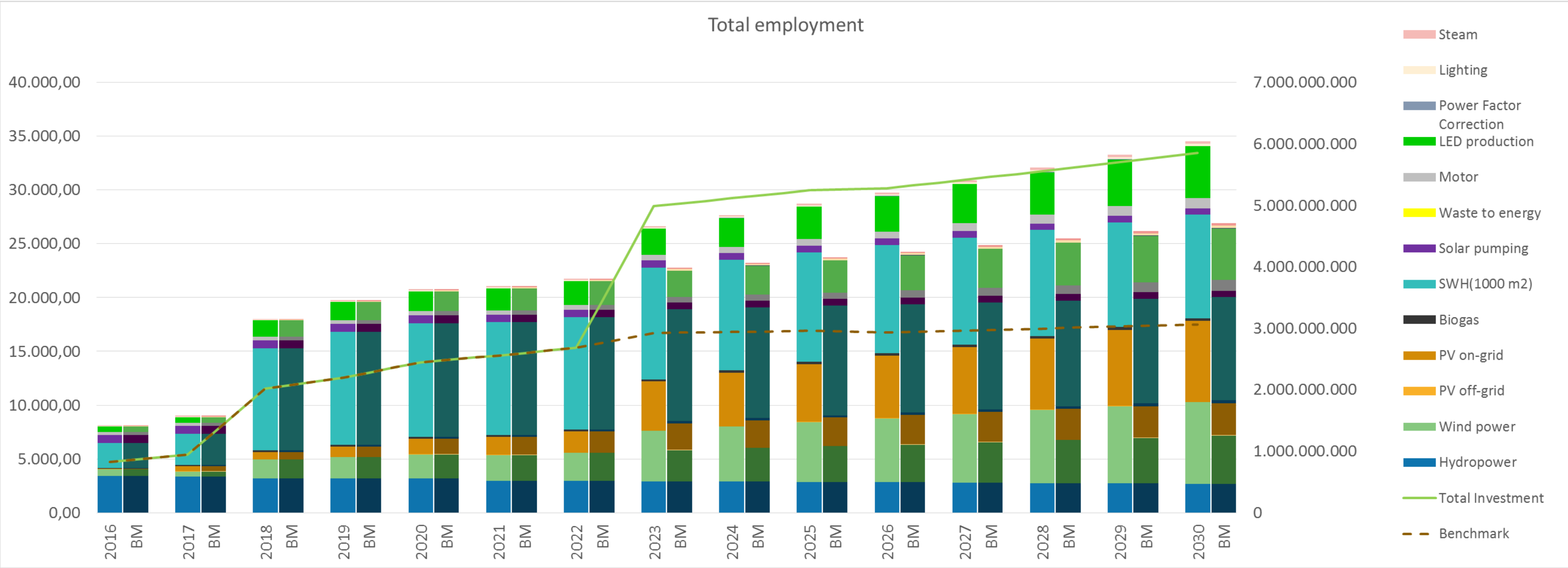

Figure 30: Comparison of benchmark scenario and ambitious scenario, employment (left axis) and investment in $ (right axis)

3.3 Scenario 2: Focus on small installations

The next sensitivity analysis analyzes what happens if installations focus on small installations such as rooftop PV, solar pumps and solar water heaters. Seeing that these installations are more labor intensive and more spatially distributed, they therefore require more logistics in distribution and installation.

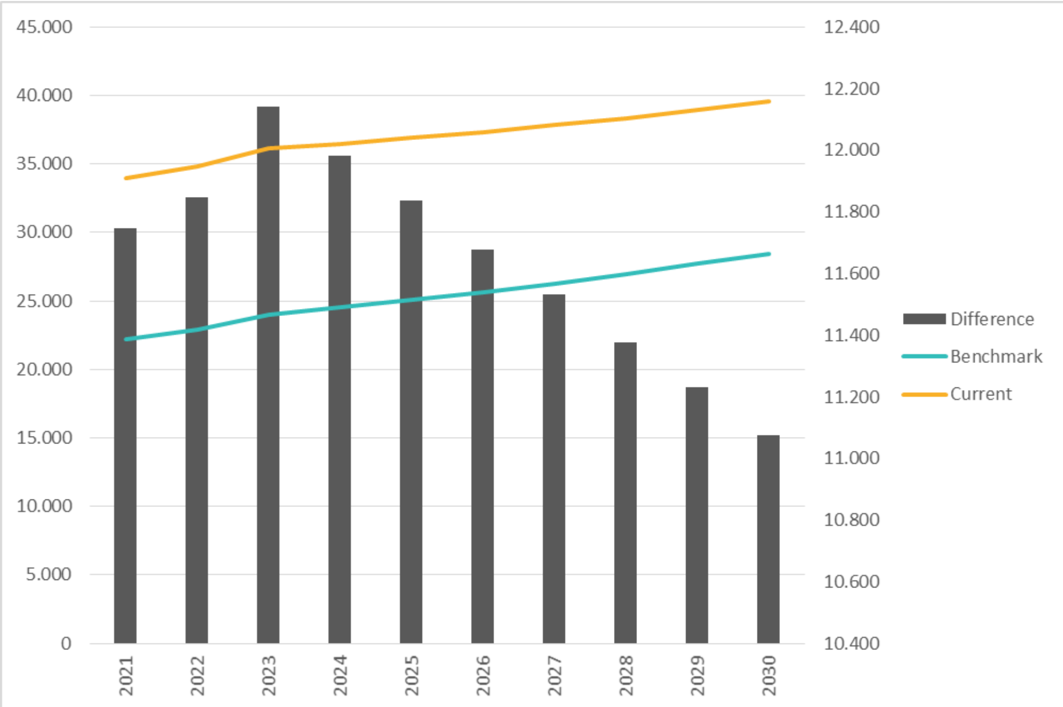

Figure 31: Employment from RE and EE, comparison of Benchmark and focus on small installations.

In order to obtain accurate results, we run a simulation where PV installation is gradually shifted from large to small installations and solar water heaters are increased significantly. Up to 12.000 jobs more are created in this scenario. The difference between this and the benchmark scenario decreases towards the end of the observation period due to increased productivity.

Figure 32 shows the difference between employment from renewables in the benchmark scenario and the different investment paths. The additional investment necessary is much smaller than in the ambitious scenario, but the employment effect is significant.

Although the model does not currently include skill levels needed, one could argue that distributed generation and installation contributes to a more wide spread distribution of the required skills. This will be a challenge to the realization of such a scenario with a focus on distributed generation, because the training efforts have to be more regionally dispersed to guarantee the quality of works in installation in all regions.

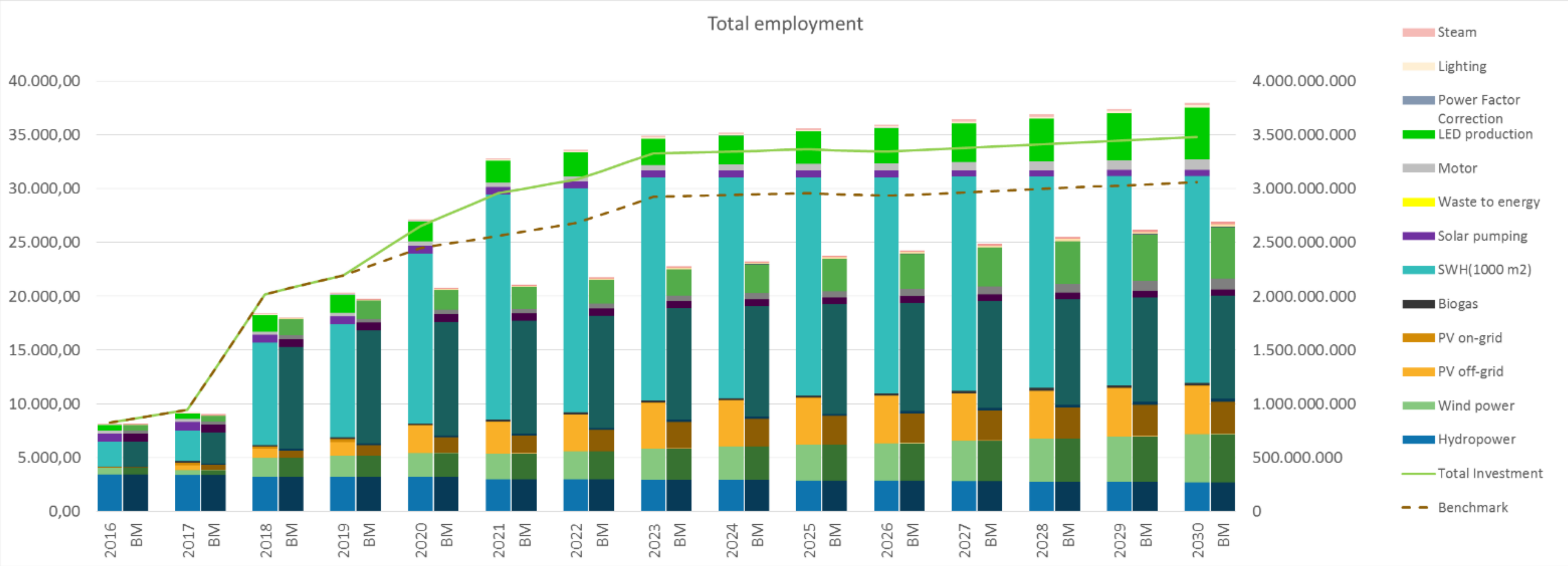

Figure 32: Comparison of benchmark scenario and focus on small scenario, employment (left axis) and investment in $ (right axis)

3.4 Scenario 3: More local content in installation and the rise of domestic production

For the generation of clean energy, additional deployment is a relevant solution. However, to exploit the full scope of benefits from renewable energy expansion and increased efficiency, the respective technologies should be largely produced in the country and installers should be Egyptian.

To model the possible effect of this, scenario 2 increases local content in the wind industry, triples the production of solar water heaters and increases local content in installation to 50 percent. Also, along the value chain, inputs will be produced to 50 percent in Egypt.

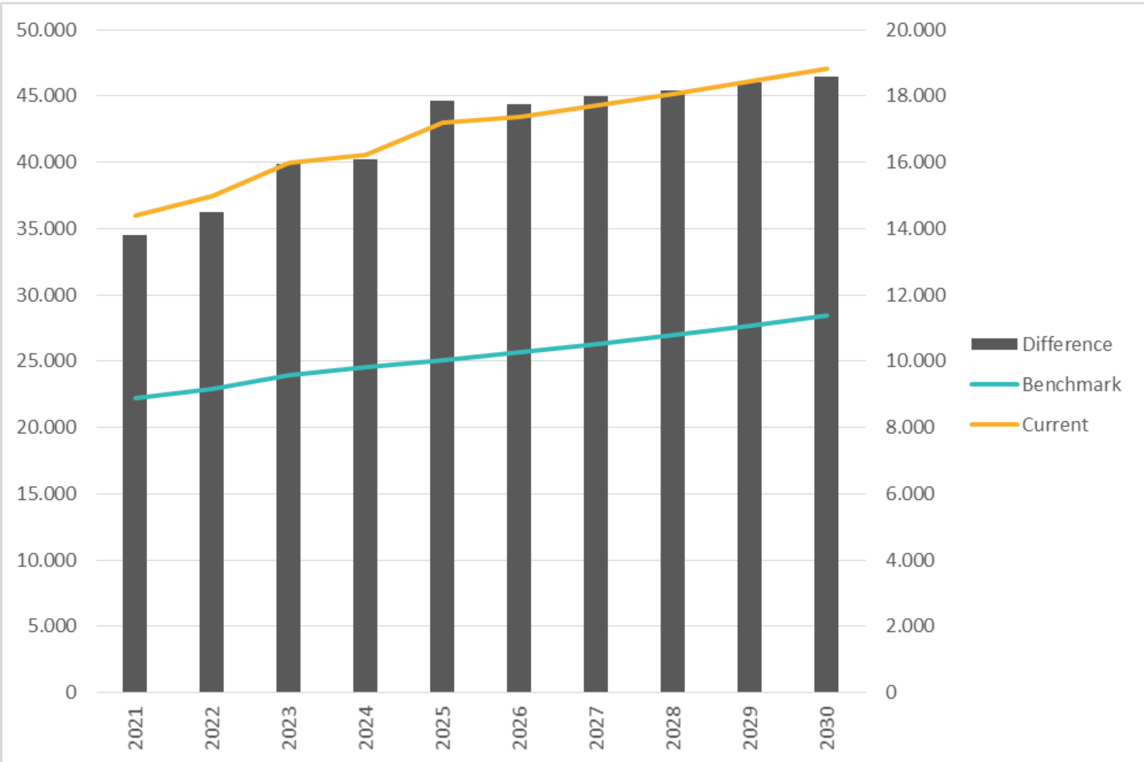

Figure 33: Employment in Benchmark Scenario, More domestic production scenario and difference in employment (right axis)

Source: Own results

More domestic participation makes a difference of more than 18,000 jobs in 2030 in the final results. That means it provides much more employment from the same amount of investment by just increasing the local value.

Figure 34: Total employment by technology (lhs) and investment 8rhs). Variant 3 and benchmark.

Source: Own calculation.

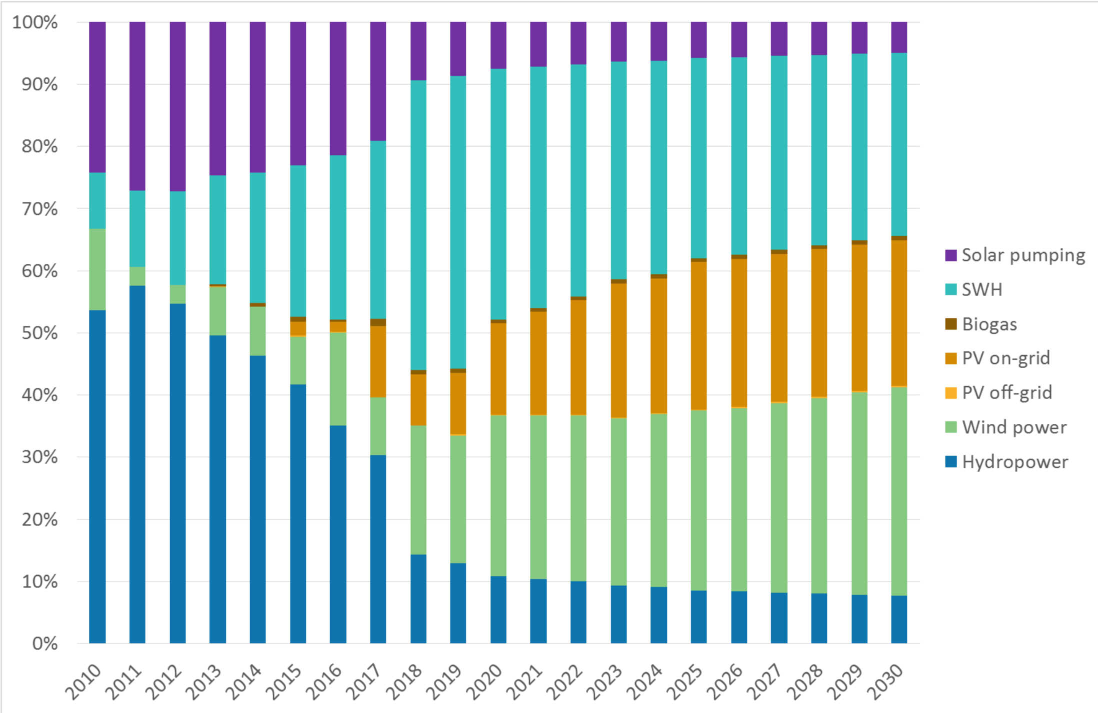

Figure 35: Employment shares in percent of total employment from renewables

Figure 35 is the corresponding diagram for this scenario (Scenario 3) to Figure 23 for the benchmark scenario. It shows the respective shares of employment in percent in the scenario and its development over time. In this scenario, there is a noticeable shift towards PV, SWH and wind, because we have assumed more domestic production in all three of them and more domestic content also in the installation of wind farms.

The relation between direct jobs and indirect jobs also becomes more balanced in this scenario.

4 Summary and Outlook

Renewable energy (RE) expansion and energy efficiency (EE) increases exhibit several benefits, be it regarding environmental quality, climate change mitigation or economic impacts in terms of savings, value creation and domestic employment. Taking advantage of these benefits comes with several prerequisites. The main pillars are a reliable expansion path and plan, an implementation strategy and a reliable mechanism to put the strategy to work.

To control what has been achieved and will be achievable along the expansion path, however, a monitoring tool and process should be implemented. The reason is to see where the country stands at any given point in time, is to fine-tune incentives or adjust and strengthen the instruments if necessary. Monitoring also serves the detection of successes, which will support the development along the paths by encouraging the continuity of the successful strategies and incentives.

On a global scale, renewable energy has experienced unprecedented growth and deployment, with dramatic price declines. International studies on the effects on employment now cover more countries and become increasingly refined. Similarly, impacts on employment along the value chain are much better understood.

Investment in renewable energy and energy efficiency equals additional demand for wind turbines, towers, PV modules, solar water heaters, efficient motors, air-conditioners etc. Employment is created from planning and design of a wind farm or a solar field, installation of the wind farm, and operation and maintenance of the systems. Direct employment can be thought of as people who work in planning and design services, who manufacture the tank of a solar water heater, who work in the bulb factory and who operate a biogas facility.

Part of the assigned task was the development of a tool, which can be used by the client to project employment from renewable energy and energy efficiency based upon current and future data. The tool was suggested to be Excel based, for it to be easy to handle, easy to update and easy to install.

The tool further helps to structure the data collection process. It has files for data collection, files where data are prepared and sorted, calculation files and results outputs. At the heart of the tool lies the Dashboard, which is one central information point for the user. Here, the user has overview over the data, the scenarios, corrections factors and the results.

But the task comprised more than the development of the tool. It was applied to past developments and different scenarios for the future. It yields a first, conservative, estimate of employment from renewable energy and energy efficiency today in Egypt.

The results showed that more than 8,800 people had their income from renewable energy and energy efficiency in the year 2016 in Egypt. This number can increase in the future to more than 65,000 people by 2030, under the right framework conditions.

Seeing the current conditions and results obtained by the project and based on the set of scenarios that were suggested and their results, it is highly recommended for the public Institutions, the regional and international organization as well as the policy maker to work hand in hand in the near future trying to achieve the renewable energy targets that has been already decided by the Egyptian Government.

Furthermore, and as proved by running different scenarios, more economic impacts from the same investment can be obtained if the domestic industry becomes more involved. Hence, we need to focus in the future in developing more labor intensive production, such as blade production for wind turbines because they show to be advantageous in the scenario. If this industry is expanded, there might be room for exports and becoming a regional hub.

On the issue of knowledge increase and capacity building, systematic data collection should be pursued. First suggestions for the oncoming years have been made in the data collection plan.

5 Annex

5.1 Persons contacted for the survey

#	Organizations	Relevant technologies	Focal point
1	New & Renewable Energy Authority (NREA)	• Photovoltaic (PV) • Concentrated Solar Power (CSP) • Wind Energy	- Eng. Ehab Ismael - Eng. Mohamed Abdelaziz
2	Ministry of Petroleum and Mineral Resources-Egypt	• Photovoltaic (PV) • Energy Efficiency (EE)	- Eng. Ahmed Abd Rabo
3	Ministry of Planning and Follow-up and administrative reform-Egypt	• Employments • Energy sector Job Opportunities	- Dr. Ahmed Soliman
4	New Urban Communities Authority	• Photovoltaic (PV) • Solar Water Heaters (SWH) • LED	- Dr. Hend Farouh
5	Ministry of Environment-Egypt	• Biomass (BM)	- Eng. Ahmed Medhat
6	UNIDO- Industrial Energy Efficiency (IEE)	• Energy Efficiency (EE)	- Dr. Gihan Bayoumi
7	Lighting factory	• LED lamps Manufacturing	- Eng. Bahaa Aladly
8	ORIGIN ENERGY SOLUTIONS Company	• Photovoltaic (PV)	- Eng. Sherif Abdelmonem
9	Tec-Merge Company	• Photovoltaic (PV) • Solar Water Heaters (SWH)	- Dr. Hassan Hassaballah - Eng. Mohamed Hassan
10	Egyptian Solar Energy Systems Company	• Solar Water Heaters (SWH)	- Dr. Samir Ayad - Eng. Samual Fanous
11	3brothers for lighting Company	• LED	- Eng. Odette Maichle

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