GWS SPECIALISTS IN EMPIRICAL ECONOMIC RESEARCH

RE&EE VALUE AND JOBS – LESSONS LEARNED IN 15 YEARS

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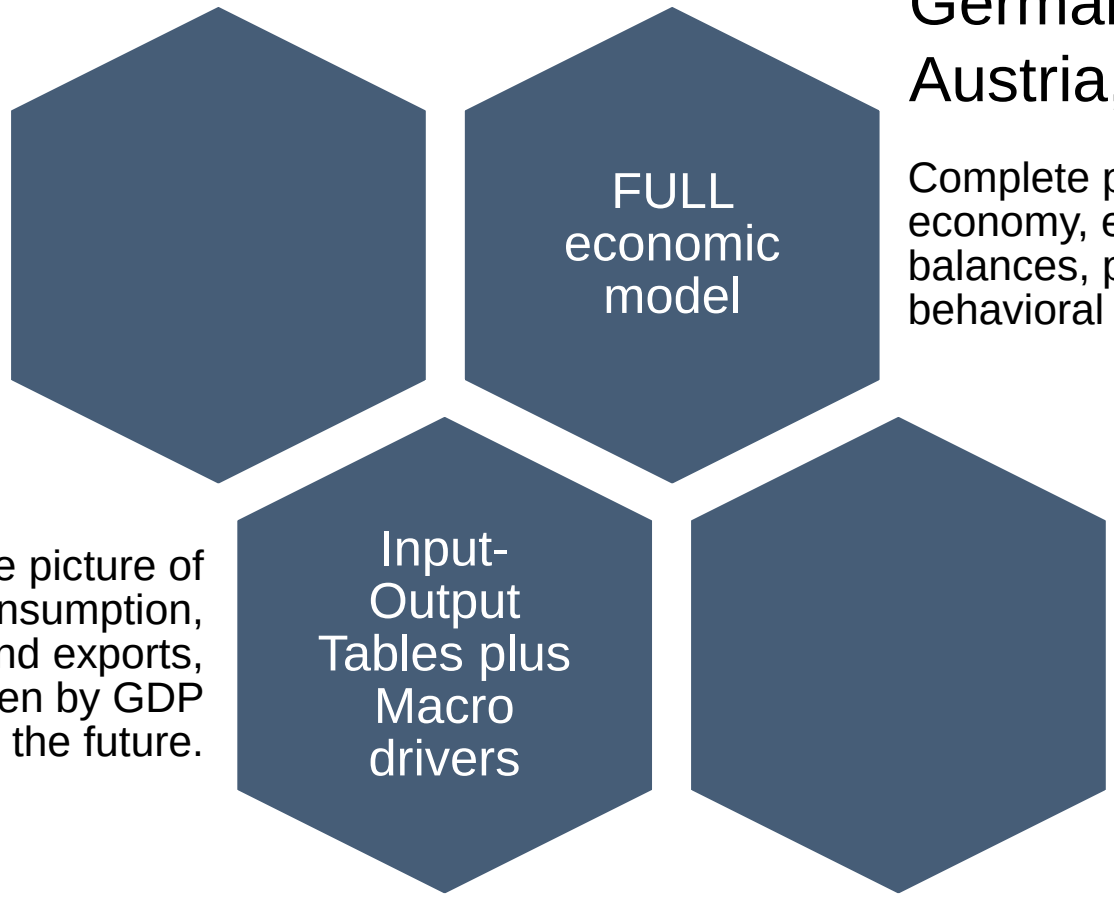
Different models – tailor-made to different countries



Algeria, Germany, Austria, Russia

Complete picture of the economy, energy balances, prices, behavioral equations

Complete picture of production, consumption, imports and exports, driven by GDP development in the future.

Tunisia, Lebanon, Egypt, Dubai

Germany – how it all began

- 2004: Ministry of the Environment commissions the first study explicitly on employment effects of renewable energy with a special focus on international trade
- Why?
  - ⇨ Low growth (1.2 in 2001, 0.0 in 2002, -0.3 in 2003)
  - ⇨ High unemployment (~10%)
  - ⇨ Several studies showed negative effects: either looking at electricity prices only (neglecting installation, manufacturing and O&M) or used on the effects of electricity only, or focus on the development until 2010.

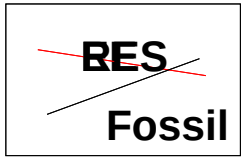
- W. Pfaffenberger, K. Nguyen, J. Gabriel: Ermittlung der Arbeitsplätze und Beschäftigungswirkungen im Bereich erneuerbarer Energien. Studie des bremer energie instituts im Auftrag der Hans-Böckler-Stiftung, 2003.
- Pfaffenberger, W., Wertschöpfung und Beschäftigung durch grüne Energieproduktion?, Energiewirtschaftliche tagesfragen, 9/2006, 22-26
- Hillebrand, B., Buttermann, H. G., Behringer, J. M., Bleuel M., The expansion of renewable energies and employment effects in Germany, Energy Policy 34/18, p. 3484-3494
- Fahl, U., Küster, R, Ellersdorfer, I., 2005: Jobmotor Ökostrom? Beschäftigungseffekte der Förderung von erneuerbaren Energien in Deutschland. Energiewirtschaftliche Tagesfragen 55 (7), 2005, S. 476-481.

First comprehensive analysis considering all effects

Increase RES

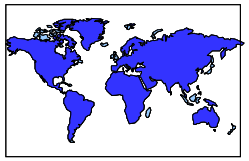
Investment and O&M + +

Prices



„Substitution“
„Budget“ - +

Trade



Exports/Imports - +

Gross employment

- Neg. effects

Net

? ?

Time
(2004-2030)

But how?

- Development of the methodology together with colleagues from German Aerospace Center (DLR), German Economic Institute (DIW), the Center of Research on Solar and Hydrogen Energy (ZSW) and the Institute of Economic Structures Research (GWS)
- Decision to use and apply the Input-Output framework for the domestic effects
  - ⇨ Goes back to Wassily Leontief (Nobel prize 1973)
  - ⇨ Measures economic effects in all industrial and service sectors in a consistent framework
  - ⇨ Input output analysis was reanimated by the Green Growth, Green Jobs, RE and EE discussion
  - ⇨ At the core of most full models
- Trade model for the trade effects

RE not an explicit economic sector in official statistics

Data requirements to implement the new sector „Production of facilities using renewable sources“

Survey

Information concerning the structure

- Important inputs
- Information on sub-suppliers
- Production plan
- Imports of inputs
- Exports

Technology data/ Economic data

Technical details of facilities

- Components and modules
- Engineering data

Production in I-O-T

- “unimportant” inputs
- Structure of similar productions

Additional Information from I-O-Tables

To get the data, a survey was needed

- 2005, 2012, 2015
- Approx. 1,100 telephone interviews

Questions on:

- ⇨ Employment (qualification, M/F, FT/PT)
- ⇨ Turnover (national/international input, end product, regional aspects), Origin of inputs (type, region)
- ⇨ Expectations on future development

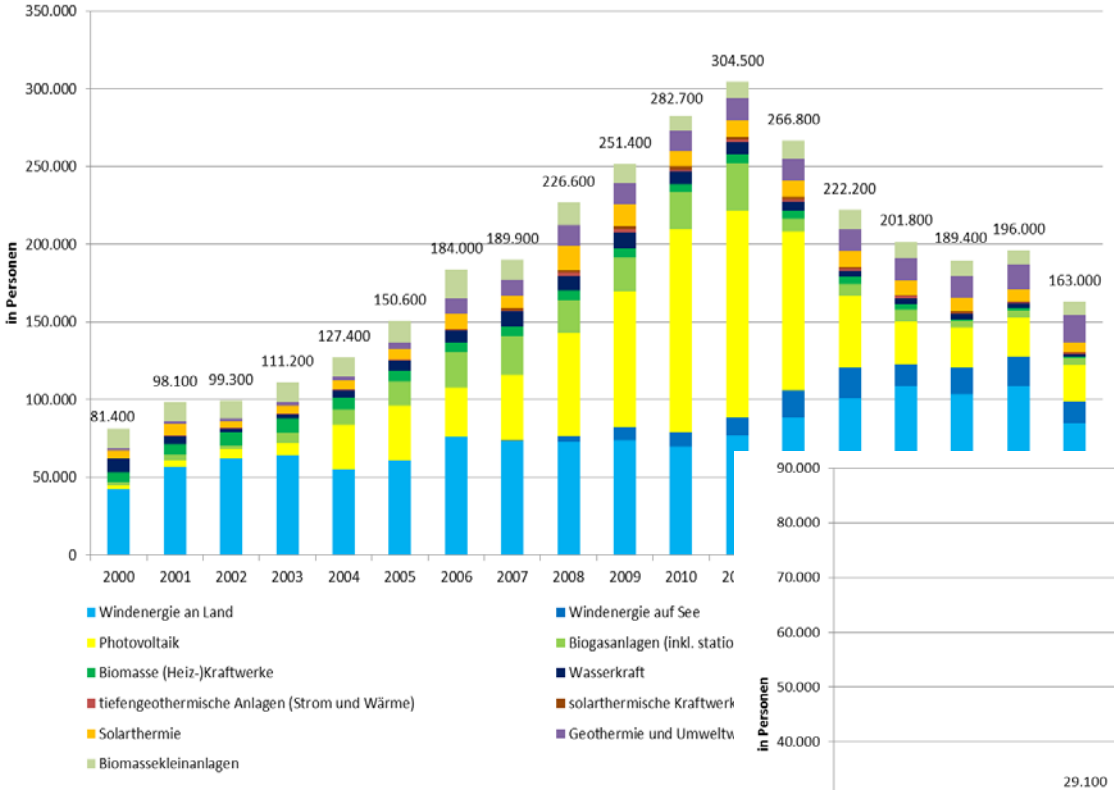
- Result: Input-Output Vectors for 13 technologies and 2 value phases

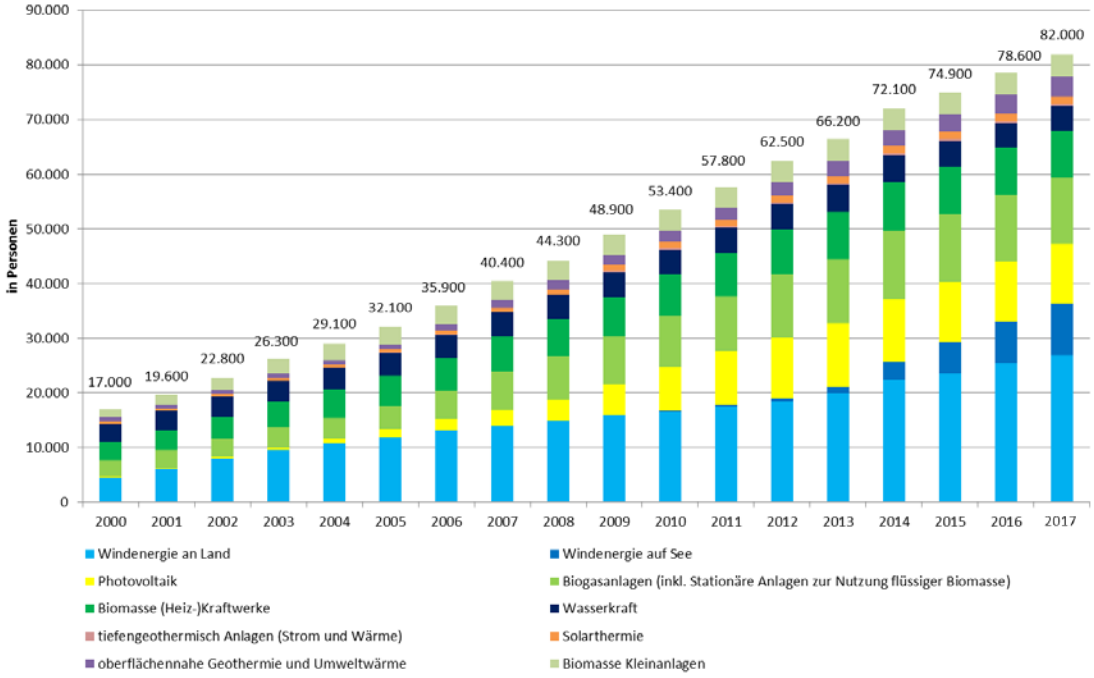
Trade model

- Determine most relevant export sectors
- Determine target countries of exports; countries of origine for imports
- Analyse RE development in target countries
- Project trade

Annual analysis for Germany since 2004

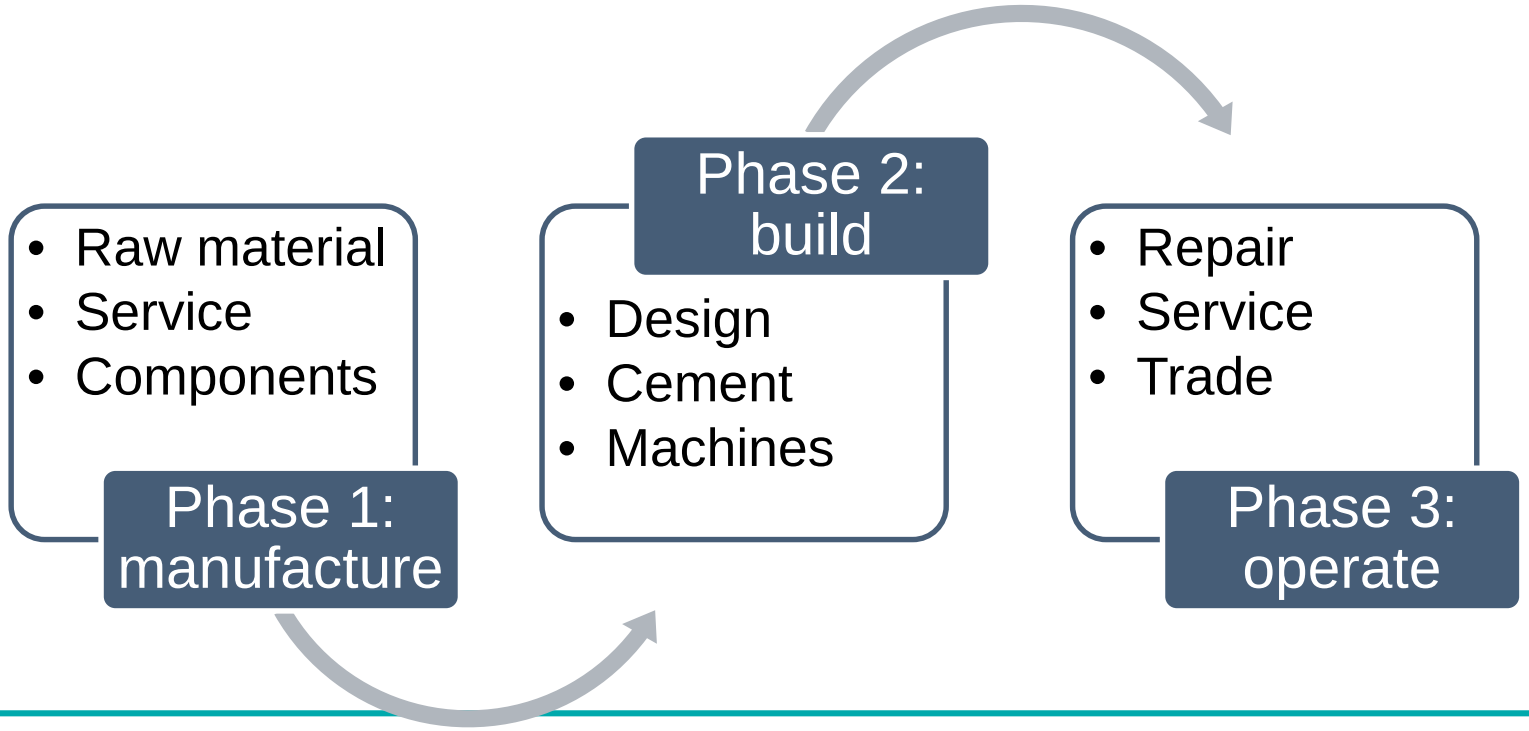
- Latest result: time series of employment from RE (2019)





Next stop: Tunisia

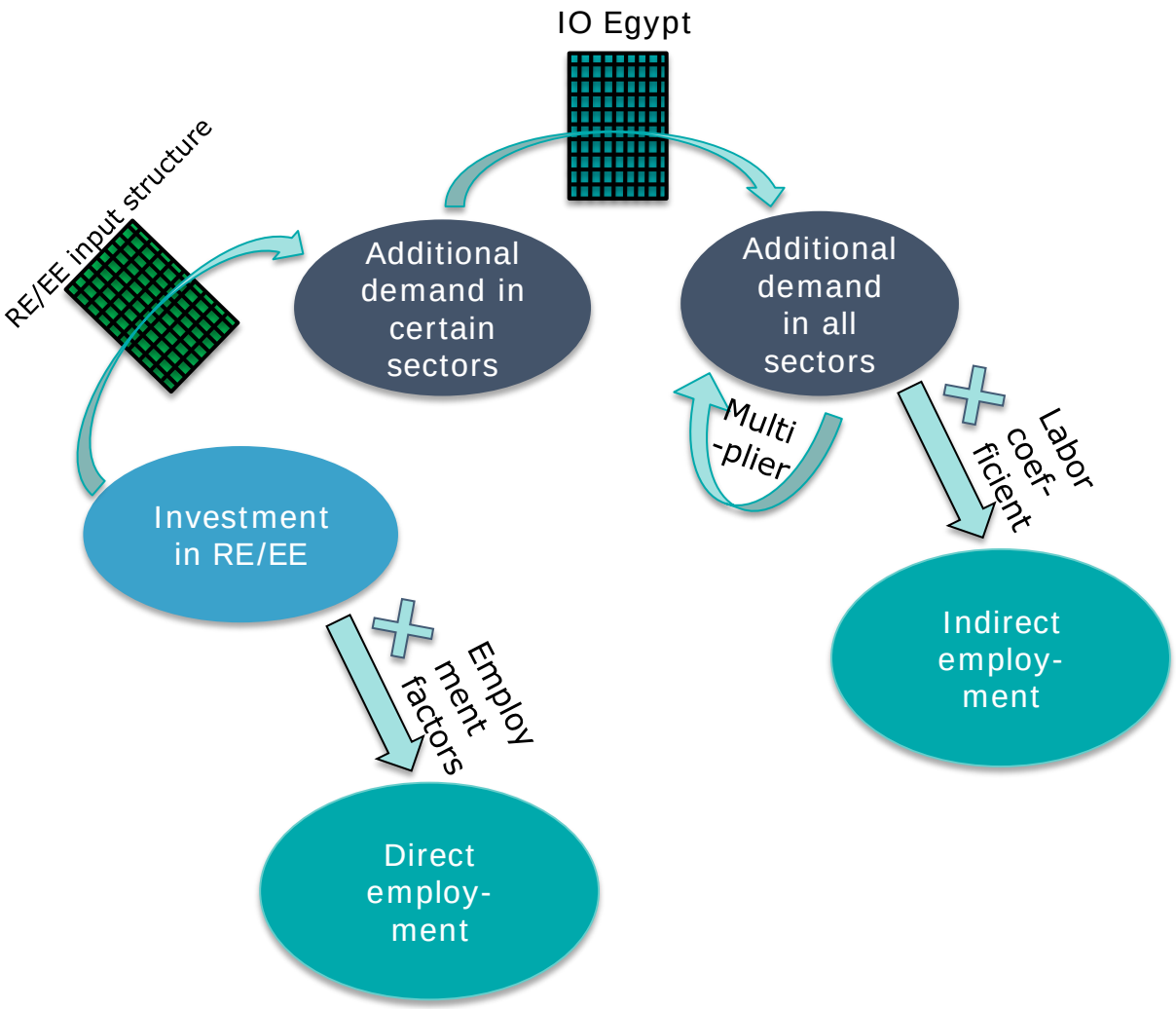
- First application in a developing country/ emerging economy
- Three phases of the value chain matter
- Local experts matter a lot
- Decision to use local, country specific data
- Program the tool in c++ and own software



Next stop: Egypt

- Input output table difficult, use World MRIO database
  - ⇨ Plenty of additional information on wages, labor etc.
- Include energy efficiency and renewable energy
- Switch to Excel based tool
- Develop the tool with and for the client
- Capacity building and training
- New technologies: solar pumping – develop approach.

The Model – our tool



Based upon

- Input Output Tables for Egypt to include the Egyptian industrial structure
- Input vectors for renewable energy (RE) and energy efficiency (EE) to include the respective demand structure
- Labor coefficients for sectors and employment factors by technologies

For each phase of the value chain

Next stop: Lebanon

- Few country data
- Adjustment of international data with local experts.
- Prioritization: which technology will add the most value

Table 9. Table of indicators and recommendations for PV

Ind. #	Indicator	Evaluation	
A	**Technical Potential**		
A.1	Natural Resource		Very high
A.2	Relevance		High, in particular in combination with storage.
B	**Economic potential**		
B.1	Short term potential		Few assemblers, enough installers for the few installations currently.
B.2	Long term potential		Cells and modules should be imported. Installation (roof, large, off-grid) should aim at %100 domestic, with a focus on regional local. Some components, BOS domestic. Services: Forecast, engineering, testing.
B.3	Value and employment		Local content in installation, value from trade, importation, system design.
B.4	Market development		Needs support
C	**Institutional potential**		
C.1	Complexity of deployment		Easy
C.2	Alignment with government vision		In complete alignment.
RECOMMENDATION:		Solar PV is selected for the in-depth analysis	

Algeria – from tool to model

- Use of the tool to analyze employment from renewables under two different pathways to reach the targets
- Development of a full model
- Excel based
  - ⇨ free of licensing, easy data storage, most people are familiar with it.
  - ⇨ Comparison with other languages showed that VBA is the fastest not compiled language
- Close cooperation with expert group in Algeria, mutual visits
- Energy efficiency included

Conclusions

- Local expertise matters!
  - ⇨ Without Sami, Anhar, Jad and Abdelmalek and all other colleagues the models would have been useless
- New technologies – hydrogen and storage
  - ⇨ Europe looks increasingly at hydrogen
  - ⇨ New economic structures have to be thought out
  - ⇨ Often similar to existing sectors: refineries, LNG terminals
  - ⇨ Storage is interesting for
    - Remote areas
    - Large RE shares in electricity generation
    - Back up

Conclusions

- Full model or tool?
  - ⇨ Tool gives a good impression of direct and indirect jobs from renewables and energy efficiency
  - ⇨ Easily adjusted, because it can use national data or international data
  - ⇨ Full model contains feedback loops
    - Useful if monetary instruments are used, e.g. tax breaks, subsidies, feed in tariff
    - Useful if RE and EE are expected to have large economic feedbacks, such as freeing gas/oil for exports
    - Useful if fossil generation is crowded out
  - ⇨ Regional model will be useful to show effects of:
    - Larger markets
    - Joint efforts in the region
    - Regional hubs

Thank you for your attention.

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Table 68: Processing time for array element processing (10k x 10k elements) in selected programming languages

Language	Time (s)	First Index	Language type
Eviews 9	93	1	Interpreter
Octave 5.1	435	1	Interpreter
R 3.6.1	2628	0	Interpreter
Python 3.6	54	0	Interpreter
Julia 1.0	4.5	1	Interpreter
VBA 2016	5	1	Interpreter
VBScript 5.812	19	0	Interpreter
C# Interactive 3.1	0.5	0	JIT Compiler
Java JDK 1.8	0.2	0	JIT Compiler
C# .NET 4.7	0.6	0	JIT Compiler
MinGW C++ 7.3	0.3	0	Compiler

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Data collection – template for RE

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						

Data collection – templates – Example PV

NREA						
PV Power plants						
Year	Installed Capacity	Investments		Egyptian Direct Jobs		
		Local Share	Foreign share $	Total No.	Permanent	Part-time
2015	10 MWp in Siwa		22.750 mio.	18	3*	15**
2015	5 MWp in El Farafra		13.135 mio.	17	2*	15**
2015	0.5 MWp in Darb El Arbeen		1.313,5 mio.	17	2*	15**
2015	0.5 MWp in Abo Monkhar		1.313,5 mio.	17	2*	15**
2016	6 MWp in Marsa Alam		12.747,512 mio.	17	2*	15**
2016	5 MWp in Shalateen		10.622,926 mio.	17	2*	15**
2016	2 MWp in Abo ramad		4.249,170 mio.	17	2*	15**
2016	1 MWp in Halayeb		2.214,586 mio.	17	2*	15**
2016	2.1 MWp off grid in Aswan, Qena, Souhag, Matrouh and Louxer		16.870 mio.	22	2*	20**

Literature

1. Lenzen M, Kanemoto K; Moran D, and Geschke A (2012) Mapping the structure of the world economy. *Environmental Science & Technology* 46(15) pp 8374–8381. DOI: 10.1021/es300171x. Supplementary Information
2. Lenzen, M., Moran, D., Kanemoto, K., Geschke, A. (2013) Building Eora: A Global Multi-regional Input-Output Database at High Country and Sector Resolution. *Economic Systems Research*, 25:1, 20-49, DOI:10.1080/09535314.2013.769938