Building Domestic Capabilities in Renewable Energy (RE)

A case study of Egypt

Georgeta Vidican

ILO/GIZ “Skills for green jobs workshop in Egypt: The case of composting and renewable energy”

19 November 2012, Cairo
The context for RE in the MENA region
Assessing domestic technological capabilities in RE in Egypt
Expectations for job creation
The wind power sector:
  - Capabilities for production and project execution
  - Job profiles
Concentrated solar thermal power (CSP) sector
  - Capabilities for production and project execution
  - Job profiles
Policy guidelines
The context for RE in the MENA region

Growing electricity demand around the Mediterranean region

- In Egypt energy demand is expected to **double by 2020 and triple by 2030**

Source: DLR (2005)
The context for RE in the MENA region

- Climate change concerns:
  - Water scarcity

\[\text{Deficit } \sim 2 \times \text{Nile}\]

- Hence, need for water desalination
- But energy intensive

Source: H. Nokraschy (2011)
The context for RE in the MENA region

- High dependence on fossil fuels in the energy mix

**Total Energy Consumption in Egypt, by Type (2008)**

- Natural Gas: 49%
- Oil: 45%
- Coal: 1%
- Hydro: 5%
- Other Renewables: 0.3%

Source: EIA
The context for RE in the MENA region

- Climate change concerns:
  - 85% of GHG emissions in the MENA region come from energy production, transformation and use (WB 2012)

Source: WB (2008)

Source: the IEA database

Egypt - 10% of total MENA GHG emissions

5% of total GHG emissions
The context for RE in the MENA region

- Renewable energy is abundant

Economic potential (TWh/yr)

- CSP = 632,099
- PV = 447
- Wind = 218

Source: DLR (2005, 2006); DESERTEC Foundation
The context for RE in the MENA region

Renewable energy targets

- 42% by 2030
- 10% by 2030
- 20% by 2020
- 20% by 2030

But, only 0.1% of total energy supply comes from renewables (RECREEE, 2009)
Domestic technological capabilities in RE

Driving questions:

- Which parts of the wind and solar value chains offer prospects for generating local benefits in terms of private sector development and building technological capabilities?

- How can the required capabilities built up? What institutional and political obstacles need to be overcome?

- What policy recommendations could be offered to national policy-makers and international cooperation agencies?
Figure 1–1: A simple depiction of an integrated development approach

Source: Adapted from Amsden’s (2001) conceptualization of technological capabilities
## Domestic technological capabilities in RE

### Types of technological capabilities

<table>
<thead>
<tr>
<th>Production capabilities</th>
<th>Project execution capabilities</th>
<th>Innovation capabilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Production management</td>
<td>Personnel training</td>
<td>Pure science</td>
</tr>
<tr>
<td>Production engineering</td>
<td>Pre-investment feasibility studies</td>
<td>Basic science</td>
</tr>
<tr>
<td></td>
<td>Project execution</td>
<td>Applied research</td>
</tr>
<tr>
<td></td>
<td>- Project management</td>
<td>Exploratory research</td>
</tr>
<tr>
<td></td>
<td>- Project engineering</td>
<td>Advanced development</td>
</tr>
<tr>
<td></td>
<td>- Procurement</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Construction, machinery production, plant erection</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Start-up of operations</td>
<td></td>
</tr>
</tbody>
</table>

Source: Vidican (2012)
Expectations for job creation

Average Direct Job Years Per GWH

- Solar PV: 0.87
- Geothermal: 0.25
- CSP: 0.23
- Wind: 0.17
- Nuclear: 0.14
- Coal: 0.11
- Natural Gas: 0.11

There are many comparisons of jobs per unit of energy – this one was chosen because it appeared to be the most robust:

- Only PV and CSP shows a range of average jobs years/GWh: For PV, this reflects a different mix of distributed versus utility scale applications (according to the authors)
- It includes direct CIM and O&M jobs averaged over the life of the equipment (plant)
- And for Coal and Natural Gas, it includes Fuel Extraction and Processing per GWh
- The unit of energy produced is measured in GW-hour, adjusted for capacity utilization (i.e. does not use peak output)
- The authors aggregated a number of studies for each energy type

Expectations for job creation

**Photovoltaics**

<table>
<thead>
<tr>
<th>Jobs/MW (FTE-Year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comm'l &amp; Utility</td>
</tr>
<tr>
<td>Manufacturing total: 14.0 (75%)</td>
</tr>
<tr>
<td>Constr/Inst tot: 4.8 (25%)</td>
</tr>
<tr>
<td>TOTAL: 18.8 jobs/MW + O&amp;M: 0.5 FTE/MW*</td>
</tr>
<tr>
<td>Residential</td>
</tr>
<tr>
<td>Manufacturing total: 14.0 (46%)</td>
</tr>
<tr>
<td>Construction/Installation total: 16.8 (54%)</td>
</tr>
<tr>
<td>TOTAL: 30.8 jobs/MW + O&amp;M: 0.3 FTE/MW*</td>
</tr>
</tbody>
</table>

- **Wafer&Cell**
- **Module**
- **BOS components**
- **System Integration**
- **Installation**

- Manufacturing job-years/MW is the same for residential, commercial, and utility (14 FTE-year/MW)
- But system integration/install per MW is much greater for residential PV because residential systems are much smaller

*Source: Navigant Consulting; 2010 scenario

* FTE/MW are ongoing positions; FTE/MW X lifetime years of the plant = FTE-yr/MW
Expectations for job creation

- **Construction/Install/Manufacturing**
  - CSP: 4.0 6.0
  - PV: 9.1 31.9

- **Operations & Maintenance**
  - CSP: 0.30
  - PV: 0.40

- Using one source reduces definitional or methodological differences
- Direct jobs only:
  - Note: Source does not indicate, for PV, what mix of distributed vs. utility scale is being assumed. Based on Navigant Consulting information, nearly 40 jobs/MW reflects residential (roof-top) installations.

Expectations for job creation

**Wind energy**

**FIGURE 01:** Direct employment by type of company, according to the results of the EWEA survey

Source: EWEA (2009) – Wind at Work
## Expectations for job creation

### Wind energy

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>WT Manufacturing – Direct</td>
<td>64,074</td>
<td>7.5</td>
<td></td>
<td>Annual</td>
</tr>
<tr>
<td>Wt manufacturing – Indirect</td>
<td>42,716</td>
<td>5.0</td>
<td></td>
<td>Annual</td>
</tr>
<tr>
<td>Installation</td>
<td>10,665</td>
<td>1.2</td>
<td></td>
<td>Annual</td>
</tr>
<tr>
<td>Operations and maintenance</td>
<td>18,657</td>
<td>0.33</td>
<td></td>
<td>Cumulative</td>
</tr>
<tr>
<td>Other direct employment*</td>
<td>15,204</td>
<td>1.3</td>
<td>0.07</td>
<td>75% annual/25% cumulative</td>
</tr>
<tr>
<td>Total employment</td>
<td>151,316</td>
<td>15.1</td>
<td>0.40</td>
<td></td>
</tr>
</tbody>
</table>

*IPP/utilities, consultants, research institutions, universities, financial services and other.

Source: EWEA (2009) – Wind at Work
## The wind power sector in Egypt

<table>
<thead>
<tr>
<th>Stage of the project</th>
<th>Capacity (MW)</th>
<th>Foreign partner</th>
</tr>
</thead>
<tbody>
<tr>
<td>Completed</td>
<td>545</td>
<td>Various partners</td>
</tr>
<tr>
<td>Under implementation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- By the NREA</td>
<td>200</td>
<td></td>
</tr>
<tr>
<td>- With the private sector</td>
<td>200</td>
<td>Germany &amp; EU</td>
</tr>
<tr>
<td></td>
<td>120</td>
<td>Italcementi (Italy)</td>
</tr>
<tr>
<td></td>
<td>250</td>
<td>(Build-Operate-Own, or BOO, in the Gulf of Suez, by 2014)</td>
</tr>
<tr>
<td></td>
<td>1,000</td>
<td>(BOO, pre-qualification documents)</td>
</tr>
<tr>
<td>In the pipeline</td>
<td>220</td>
<td>Japan</td>
</tr>
<tr>
<td>(Land has been allocated; permits have been obtained; financing has largely been secured)</td>
<td>120</td>
<td>Spain</td>
</tr>
<tr>
<td></td>
<td>200</td>
<td>UAE (Masdar)</td>
</tr>
<tr>
<td>In preparation</td>
<td>180</td>
<td>Spain</td>
</tr>
<tr>
<td>(Projects have been announced; necessary documents and financing are being obtained)</td>
<td>200</td>
<td>Germany &amp; EU</td>
</tr>
<tr>
<td></td>
<td>200</td>
<td>Japan</td>
</tr>
<tr>
<td>Total</td>
<td><strong>3,235 MW</strong></td>
<td></td>
</tr>
</tbody>
</table>

Source: Presentation by the New and Renewable Energy Authority (NREA) at the 10th World Wind Energy Congress, Cairo, 30 November 2011, and the NREA (2010)
# The wind power sector in Egypt

<table>
<thead>
<tr>
<th>Value chain stage</th>
<th>Local production and project execution capabilities</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Existing</td>
</tr>
<tr>
<td>Component design</td>
<td>Towers</td>
</tr>
<tr>
<td>and manufacturing</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Blades</td>
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<tr>
<td></td>
<td>Bearings</td>
</tr>
<tr>
<td></td>
<td>Nacelles</td>
</tr>
<tr>
<td></td>
<td>Gearboxes</td>
</tr>
<tr>
<td></td>
<td>Controls systems</td>
</tr>
<tr>
<td></td>
<td>Power converters</td>
</tr>
</tbody>
</table>

<table>
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</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Existing</td>
</tr>
<tr>
<td>Turbine design</td>
<td>Research, design and engineering</td>
</tr>
<tr>
<td>Turbine manufacturing</td>
<td>Wind turbine, generator assembly</td>
</tr>
<tr>
<td>Pre-deployment</td>
<td>Site assessment, planning, finance</td>
</tr>
<tr>
<td>Deployment</td>
<td>Site construction, transport, distribution of electricity</td>
</tr>
<tr>
<td>Post-deployment</td>
<td>Operation and maintenance (O&amp;M), output monitoring, sales</td>
</tr>
</tbody>
</table>

Source: Based on literature and field interviews in Cairo in 2011
The wind power sector in Egypt

Type of skills that are currently AVAILABLE in Egypt

- Programmers and meteorologists for wind energy forecasts and prediction models
- Supporting staff (administrative, sales managers, marketing and accounting)
- Electrical and civil engineers for coordination of construction works
- Technical staff for O&M
- Health and safety experts
- Specialists in transport of heavy goods
- Electricians
- Semi-skilled and non-skilled construction workers
- Experts in social-surveys, training and communication
- Financiers and economists
- Marketing personnel and event organisers
The wind power sector in Egypt

Type of skills that are currently LIMITED in Egypt

- *Project managers* (engineers and economists) to coordinate the process
- *Environmental engineers* and other specialists to analyse environmental impacts of wind farms
- *Lawyers and economists* to deal with legal, financial, environmental aspects of project development
- *Technical staff for O&M and repair* of wind turbines
- *Technical staff specialized in wind turbine installation*, including activities in cranes, fitters and nacelles
- *Electrical, environmental and civil engineers* for plant management
- *Financiers, sales and marketing staff* to deal with the sale of electricity
- *Programmers and meteorologists* for the analysis of wind regimes and output forecasts
- *Engineers* specialized in aerodynamics, computational fluid dynamics and other R&D areas
- *Environmental engineers*
- *Energy policy experts*
# The CSP sector in Egypt

<table>
<thead>
<tr>
<th>Value chain stage</th>
<th>Local production and project execution capabilities</th>
<th>Existing</th>
<th>Developing</th>
<th>Not currently present</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Materials</strong></td>
<td>Concretes, steels, cements, sands, glasses, silvers, copper, salts and other chemicals</td>
<td>Local companies such as Al-Ezz Dekheila Steel Co., and Sphinx Glass</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Component design and manufacturing</td>
<td>Mirrors</td>
<td>Several glass and mirrors for local manufacturers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mounting structures</td>
<td>Companies such as NSF and El-Sewedy</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Receiver</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>HTF</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Connection piping and insulation</td>
<td>Companies such as Alkamac and El Nasr Steel</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Steam generator/heat exchanger</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Storage system</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Power block</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CSP manufacturing</td>
<td>CSP collectors</td>
<td>Dr. Greiche Glass has invested in developing CSP collectors.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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<thead>
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</tr>
</thead>
<tbody>
<tr>
<td><strong>CSP manufacturing (cont.)</strong></td>
<td>Plant assembly</td>
<td>OCI and other subcontractors</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Project design</strong></td>
<td>Research</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Design and concept engineering</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Procurement</td>
<td>OCI</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre-deployment</td>
<td>Site assessment</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Determination of general requirements</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deployment</td>
<td>Site construction</td>
<td>OCI</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Transport and distribution of electricity</td>
<td>Egyptian Electricity Transmission Company</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Post-deployment</td>
<td>Operation and maintenance (O&amp;M), output monitoring and sales</td>
<td>OCI with know-how transfer from international partners</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Source:** Based on literature and field interviews in Cairo in 2011

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The CSP sector

- Less widely available as compared to those for wind energy
  - EPC and O&M activities have been performed by OCI (in partnership with foreign companies) for the Kuraymat plant
  - Several less technology intensive components could also be supplied locally (e.g. Cables, steel structures) – but local market is too small

- Opportunities for research on technological adaptation (e.g. Dry cooling, energy storage, solar dissallination, cleaning techniques)
Policy guidelines

- Developing local technological capabilities requires a steady stock of scientists and engineers involved in assimilating and adapting foreign technology.

- **Education programs** are necessary but not sufficient - “know-how” / “learning by doing” is what matter most.
  - Acquire know-how to operate new types of organizations and technologies.
  - Access to laboratory equipment and experimentation –creates value for universities-private sector collaboration.
  - Mechanisms (i.e. technology incubators) to enhance the “third mission” of universities and increase students’ participation in R&D.
  - Technology transfer and know-how development through long-term research programs.
Policy guidelines

Skills development programs are also necessary:

- Integrate a RE component in vocational education and training programs. Involve companies at all levels of training (eg. Germany, Malaysia)

- Include the Ministry of State for Environmental Affairs and NREA in the coordination mechanisms for skills development (currently shared between different ministries)

- Designate an entity to systematically collect data on the skills and knowledge base of workforce (the Danish and German experience would be instructive)

- Open communication and collaboration channels between various organisations concerned with the environment and RE and in education and training (ILO 2011, 277)
Policy guidelines

- Align training and education program to private sector development
- A sizable and diversified **local market** is critical:
  - Enabling both large and small scale renewable energy installations
  - Technological diversity should be encouraged
    - Such that competitiveness for local products is ensured & job creation potential is maximized
Policy guidelines

- Align training and education program to private sector development
- A sizable and diversified **local market** is critical:
  - Enabling both large and small scale renewable energy installations
  - Technological diversity should be encouraged
- **Government intervention** is necessary:
  - Use a range of policy tools to increase profitability in selected sectors
  - Facilitate linkages between foreign firms and local companies
  - Effectiveness to be enhanced by **performance standards**
Policy guidelines

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  - Enabling both large and small scale renewable energy installations
  - Technological diversity should be encouraged

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  - Use a range of policy tools to increase profitability in selected sectors
  - Facilitate linkages between foreign firms and local companies
  - Effectiveness to be enhanced by performance standards

- Political and institutional capabilities are important:
  - Governance capabilities to discipline and manage development rents
  - Supporting investments in areas where new capabilities can be developed and withdrawing conditional rents if competitiveness failed to emerge in time
“… fears that environmental regulations will lead to massive job losses or loss of competitiveness are probably as unfounded as the hope that green jobs will single-handedly solve countries’ employment problems.”

Thank you for your attention!

Georgeta Vidican  
German Development Institute / Deutsches Institut für Entwicklungspolitik (DIE)  
Tulpenfeld 6  
D-53113 Bonn  
Telephone: +49 (0)228-949 25-3  
E-Mail: Georgeta.Vidican@die-gdi.de  
www.die-gdi.de
Figure 3-1: The wind energy industry value chain (simplified)

Source: Lema et al. (2011). Arrows indicate flows of goods and services between functions in the chain.
Figure 3–2: The CSP industry value chain (simplified)

Source: Adapted from Lema et al. (2011) and the World Bank (2011). Arrows indicate flows of goods and services between functions in the chain.