CHAPTER 2

Review of Manufacturing Capabilities and Potential in MENA Countries

2.1 Review of the Main CSP-Related Industrial Sectors and Companies in the MENA Region

This study targets the industries in MENA that have the profile to become potential contributors to the CSP value chain in the short or medium term. This work is based on the consultants' experience, on bibliography reviews and on interviews which were carried out during field trips in Morocco, Algeria, Tunisia, Egypt, and Jordan. The list of contacts interviewed is provided in annex C of this document.[1]

In a first step, the potential manufacturers of CSP components and second rank suppliers were identified. The most relevant industry sectors were analyzed to understand which companies are positioned on value chain segments where entry barriers do not prevent newcomers. Industry sectors analyzed include:

- glass industry
- steel metallic structure/steel piping
- electrical and electronic equipment industry

A brief summary of the strengths and weaknesses of each of these sectors is also presented in the annexes.

[1] Note that, despite ongoing CSP projects considered in Jordan, the Hashemite Kingdom does not appear as a primary target for international companies related to CSP. This is particularly due to the small size of the local market and to high energy prices. There are also a very limited number of mainstream industrial sectors that could step into CSP components manufacturing in Jordan. As a consequence, the present study displays limited information on this country, especially dealing with its manufacturing capabilities and potential.

In a second step the potential players in terms of construction works and EPC contractors were covered. In particular the following sectors were screened:

- Construction companies or contractors
- Energy operators and operations & maintenance firms
- Engineering firms and technical consultants

The analysis includes subsidiaries of international corporations that are have a strong presence in the MENA markets, especially as regards building materials, construction, infrastructure development, and operations. It is aimed at understanding the perception of these players about potential industrial partnerships with local corporations.

2.1.1 MENA Glass and Mirror Industry

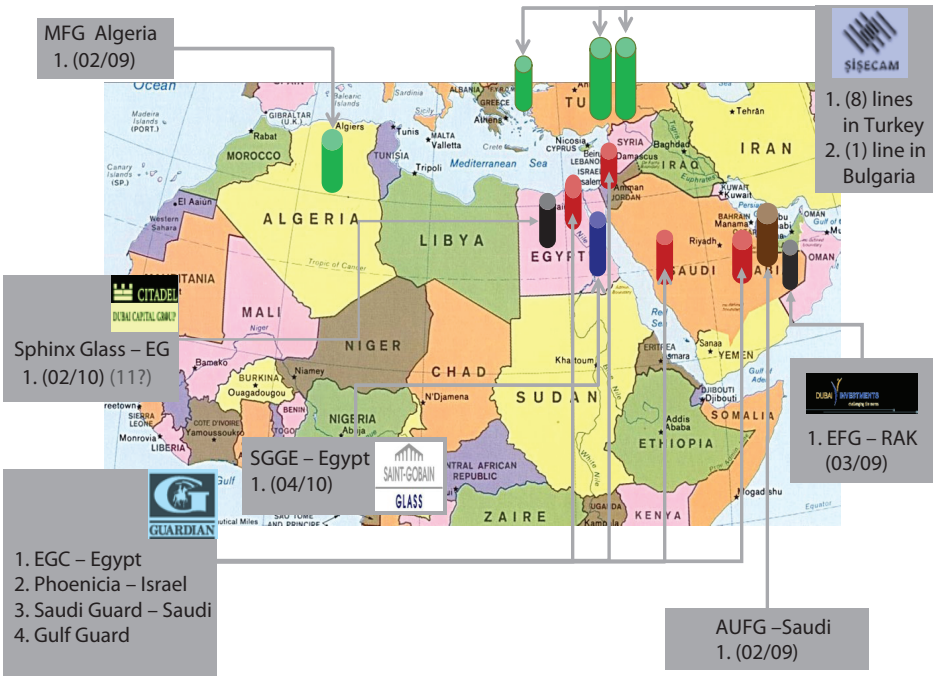
The main output of the MENA glass and mirror industry is food and beverage glass, glassware, building, and automotive glass. The glass product that is of direct interest to CSP is float glass as, given appropriate quality, it can be transformed into flat mirrors (solar tower or linear Fresnel) and bent into parabolic mirrors. Float glass currently produced in MENA countries is used for building, and automotive and household mirrors. No flat or parabolic CSP mirror production has been identified in the countries covered by our study

Float glass production capacities were scarce until recent years but are currently increasing in Algeria and Egypt. However, most of the regional demand is still supplied through imports. Figure 2.1 gives an overview of the companies that are active in the MENA market and the float glass lines that are currently in service or under construction (starting date in brackets when available). Out of the five countries covered by the CTF ("CTF MENA countries"), only Algeria and Egypt have float glass production capacities (Table 2.1).

The four float glass producers of CTF MENA countries are the Egyptian Glass Company, Sphinx Glass, Saint-Gobain and Cevital. Note that there are no float glass producers in Tunisia, Morocco and Jordan. In these countries, high energy price combined with low local demand for float glass are strong drawbacks for installing production units. As an example, the local demand in Tunisia is around 25 percent of the production of a profitable float glass plant (for which the minimum output can be estimated at approximately 150,000 tons/year).

Production of float glass in CTF MENA countries has been generally very low (around 2 tons/1,000 persons, compared to over 7 tons/1,000 persons in Saudi Arabia for example). Despite this historically low production level, Egypt and Algeria are currently experiencing a serious ramp up in float glass production which is catalyzed by the fact that they are natural gas producers. Egypt's production capacity of float glass was around 160,000 tons per year in 2003, which is at least 40,000 tons short of domestic demand. Egypt had weak export performance across most flat glass products, which was partly due to the shortage of domestic

Figure 2.1 ■ Float Glass Lines Implemented in the MENA Region



Source: Sphinx Glass.

Table 2.1 ■ Float Glass Production Capacities in CTF MENA Countries

Name of company	Country	Current output	Shareholders	Production capacities
Egyptian Glass Company	Egypt	Clear glass only Quality grades: Building, Silvering & Auto	JV: 55% Khalafi/45% Guardian	1 oven of 160 000 tons/year
Sphinx glass co.	Egypt	Glass with thickness varying between 2 mm and up to 19mm in varied sheet sizes up to jumbo size glass panes as large as 6000mm x 3660mm. products	Citadel Group + Dubai Capital Technology transfer agreement with PPG	1 oven of 200 000 tons/year (starting date: Q1 2011)
Saint-Gobain	Egypt	Float glass	In partnership with MM-ID & Ali Moussa	1 oven of 160 000 tons/year to be commissioned in sept. 2010
Mediterranean Float glass/ CEVITAL	Algeria	Float glass	JV with the Chinese CLFG	3 lines of 600, 700 and 900 tons/day

Source: EY, based on interview

production capacity in basic float glass. Yet, two to three plants of around 200,000 tons/year were under construction in 2010 according to the Egyptian Chamber of Building Materials industries. This adds to the two current float glass production

lines with a capacity of around 150,000–200,000 tons each. As a consequence, while all CTF MENA countries are net importers of float glass, recent investments in production lines will make Egypt and Algeria net exporters of float glass. As shown in Table 2.2, the production of the Egyptian and Algerian glass industry will help meet the increasing local demand while developing exports. Further data on import and export figures and the level of specialization of the glass sector in the CTF MENA countries is provided in the annexes.

Large-scale modern glass manufacturing facilities require either developed domestic markets with large customer bases for their products or access to export markets. For a developing economy, such as Egypt and Algeria, the glass sector is developing to match growing demand from industrial sectors that are significant users of glass, such as: food processing, automotive, pharmaceuticals, electric lighting, and construction. The sector is also export-oriented to supply customers in regional and international markets. In terms of employment, approximately 2,000 people are currently employed by the float glass production industry in Egypt and Algeria. In these markets, despite favorable conditions (local availability of natural gas, materials quality), the emergence of significant float glass production projects has been a lengthy process, partly due to the fact that these projects are very capital-intensive (US$180–200 million) of investment for a float glass plant of 600 tons/day, integrating a high level of automation).

Demand for float glass in Morocco, Tunisia, and Jordan is expected to increase in the next years. This rise of domestic demand might still reach levels required to justify a local float glass production capacity, unless there is a clear business case for exports.

However, it must be stressed that most of the MENA capacities listed above are producing glass with iron content that would not yet be compliant with CSP requirement. Green glass is less expensive than white glass, but green glass mirrors are 5 percent less efficient than white glass. Cost savings would hence need to be about 6 percent for green glass to be cost efficient (because optical effects have a slightly over-proportional effect on performance), which would be about €33/m². Since this represents the cost for the entire mirror, including bending, silvering, and additional coatings, it is unlikely that the EPC would not take the option of using green glass mirrors.

Table 2.2 ■ Annual Float Glass Production in CTF MENA Countries, Tons/year

Country	2003 production levels	Current demand	Current production	5-year forecast demand	5-year forecast production
Egypt	180,000	250,000	340,000	350,000	> 700,000
Morocco	0	60,000	0	80,000	0
Tunisia	0	40,000	0	60,000	0
Jordan	0	20,000	0	30,000	0
Algeria	Na	70,000	200,000	100,000	400,000

Source: EY, based on interviews

Presentation of the glass transformation industry

Not all CTF MENA countries host float glass production capacities, however glass transformation activities exist in all countries; between 10 and 20 mirror lines are currently in operation in CTF MENA countries. The output of most of these production lines is mirrors with an average thickness of ~ 3 mm and with building quality. The main suppliers of these mirror producers are Sphinx Glass, EGC, SGG, and Chinese producers according to Sphinx Glass.

The mirror production capacities identified in CTF MENA countries are presented in Table 2.3.

Some of these companies, for example, SIALA or Dr Greiche, are producing high quality mirrors. In the case of Tunisian-based SIALA, glass used for transformation is imported mainly from Algeria, and to a lesser extent from Egypt and Europe. Transport from Algeria to Tunisia is obviously much easier than from Egypt or Europe as there is no need for heavy packaging (required for maritime transportation).

Even if local MENA glass players have skills in transforming glass and producing high tech mirrors some doubts remain about their capability of producing and coating CSP mirrors with the specifications to endure harsh Saharan conditions like sand storms. At the Solar Paces Conference 2010 in France, it was stressed that blowing sand and sand damage to mirrors is going to be a major concern of operations in the MENA region. DLR has tested monolithic mirrors with paint on the back in a lab simulating Saharan conditions. It was found that in an environment like the Sahara, a monolithic mirror would only last three years.

Manufacturing mirrors that could resist these kinds of conditions, like laminated mirrors where the coating is completely encapsulated between two panes of glass, is more complex than manufacturing conventional CSP mirrors. Few CSP mirrors have patents for the laminated mirror process and product; this adds to

Table 2.3 ■ Companies with Mirror Production Lines in CTF MENA Countries and Production Capacities

Name of company	Country	Production capacities
Dr. Greiche (1,500 employees)	Egypt	5 kt/year
Khattab Mirrors	Egypt	4 kt/year
United Mirrors	Egypt	3.5 kt/year
Universal Mirrors	Egypt	2.5 kt/year
Hawala Mirrors	Egypt	2.5 kt/year
Loaloa Mirrors	Egypt	2.5 kt/year
El Gammal Mirrors	Egypt	2.5 kt/year
El Sadaawi Mirrors	Egypt	2.5 kt/year
Nabil Salah Mirrors	Egypt	2.5 kt/year
SIALA	Tunisia	6 kt/year
STEMIR, SOVEP, SAVEMI	Tunisia	Not available

Source: EY, Sphinx Glass

the uncertainty for local industries starting production of CSP mirrors for the local stringent market.

Furthermore, mirror bending with CSP specifications would be a challenge for local industries; it remains a difficult process to learn and would need a joint venture, requiring extensive technical assistance and knowledge transfer to be implemented.

As an example, Guardian Industries managed to convert their automotive glass bending assets into CSP bending assets. But they had significant experience in bending glass and even with that experience, development to reach current quality levels required over three years. According to the Guardian Industries an investment of $50 million would be enough to commission the necessary bending equipment. Running that equipment, however, would be difficult without the appropriate knowledge and licenses.

Competitive advantages

The key asset of Egypt and Algeria's glass industry is the combination of:

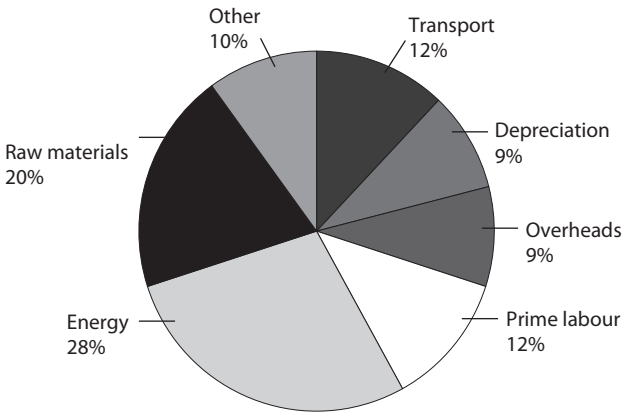
- Access to raw materials
- Natural gas available locally
- Strategic market location,
- Access to technology and new products that meet the requirements of domestic and international customers.

The availability of raw materials is not a decisive competitive advantage for Egypt's and Algeria's glass industry. All the input materials available in Egypt and Algeria are international commodities that are readily available to CTF MENA countries' competitors. In the past, Egypt and Algeria have lacked access to technology and new products, but with the development of joint ventures (JVs), know-how and technology are being progressively transferred.

Joint ventures are a key strategic tool, promoting market development, business growth, and risk sharing. There are several examples in CTF MENA countries of glass manufacturers (PPG, CLFG, Guardian, etc.) sharing the risk of large investments in float glass production lines, either with other manufacturers (Cevital for example) or with financial partners (Citadel for example). The development of these partnerships demonstrates the current attractiveness of MENA countries for float glass production. However, low cost producers continue to operate in the region, where a combination of limited regulatory requirements (or no control over their implementation), shortage of reasonably priced quality products, and an emphasis on keeping costs to a minimum maintains demand for low-cost products.

Energy and raw material costs are each as significant as labor in the overall delivered cost. Glass is heavy and comparatively cheap, making distribution costs significant. These typically represent around 15 percent of total costs (Figure 2.2).

Figure 2.2 ■ Conventional Float Glass Nominal Cost



Source: Pilkington, 2009.

In most cases, transport costs limit the transport of float glass for long distances overland. Typically, 200 km is seen as the average range, and 600 km as the economic limit for most products (which is not a long distance in comparison with the sizes of Algeria and Egypt), although this varies between markets. Potentially it is possible to achieve a very cost-effective transport of float glass, even over long distances, provided that transportation by sea is possible and no long road transport is involved at both ends. This tends to favor float glass production lines with local port access unless a local market is available for the line's output.

Industry outlook

The development of the MENA glass production and transformation industry faces several barriers:

- Limited R&D activity: links between research centers and industry are weak and need to be strengthened through collaborative research and/or clustering approaches.
- Shortage of trained personnel: there is a lack of suitably trained engineers and technicians to operate the existing production lines. For higher quality products, engineering and technological know-how need to be transferred (through knowledge transfer agreements, partnerships, etc.).
- The MENA float glass and mirror industry does not integrate the full value chain. For instance, float glass line equipment is coming from other countries (Europe or Asia mostly). In a number of countries, activities cover only the downstream items; this is typically the case of countries that import float glass in order to transform it locally into mirrors, tainted glass, etc. (Jordan, Morocco and Tunisia).

However, Algeria and Egypt present favorable conditions:

- Natural gas available locally
- Virtually all input materials required to produce glass are available domestically. High quality sand and also high quality limestone are available. Float glass with very low iron content and high solar energy transmittance is available, which is paramount for the production of ultra-clear float glass which is needed for CSP applications.
- Strategic location on the crossroads of three regional markets: Europe, Middle East and Africa.
- Financial strength of players in the MENA market place due to joint ventures and backing by local private equity (Citadel Group for example). Using close strategic partnerships with the main international players allows for example to produce under license high performance glass.
- The well understood opportunity to develop their glass industry (especially float glass), which is proving to be successful.

Glass industry players in MENA could be interested in CSP if the size of the demand is sufficient. According to the stakeholders interviewed, float glass plant implementation is profitable only if its capacity is at least 150,000 tons per year. The size of the regional CSP market has to reach a threshold volume to justify the installation of CSP mirror manufacturing plants, although the size of the export potential is also critical. As an indication, it is estimated that the minimum output for CSP mirror plants would correspond approximately to a year's supply of the equivalent of 400 MW of solar capacity for flat mirrors and 250 MW for parabolic mirrors. Such annual volumes will not be generated by any of the MENA countries in the short to medium term. These aspects are currently under analysis by industry players to establish their investment priorities. In any case, local manufacturing facilities in this sector will not be limited to supplying a national market but will aim at serving a wider regional (MENA) and possibly worldwide CSP market.

The technological gap between conventional float glass produced by MENA players and quality requirements for CSP mirrors remains significant; options to foster technology transfer and to train the local workforce will need to be investigated, possibly in the framework of donor-funded technical assistance.

Despite the lack of float glass production in the other CTF MENA countries (Jordan, Tunisia and Morocco), local industries could position themselves on glass transformation activities in order to manufacture high quality mirrors. For example, SIALA (Tunisia) and Dr Greiche (Egypt) would be ready to consider adjusting their new production capacities to enable CSP mirror production provided a market with a sufficient size. However, they would need technical assistance to identify specifically what adjustment would be needed (coating techniques for example) and the associated costs.

In addition, new entrants seeking to position themselves on CSP-related opportunities in the glass sectors will face the following entry barriers:

- Despite low prices, access to gas needed by float glass plants faces some limitations. In some cases, natural gas produced in Egypt is dedicated in priority to exports rather than to Egyptian industries.

- CTF MENA countries will compete for outside investments in this field and will seek to maintain their first-mover advantage.
- Competition is emerging at regional level either to take new positions (e.g., EUA, Saudi Arabia) or to maintain the competitiveness of existing CSP mirror production facilities (e.g., Saint-Gobain Solar in Portugal, Guardian Industries in Israel).

2.1.2 MENA Electronic and Electrical Industry

The electrical equipment industry covers a wide range of components (cables, electric motors, transformers, etc.). This section focuses on the cable industry as well as the other electronic and electrical component industry.

Presentation of the cable industry

One of the main industrial developments in the CTF MENA countries regarding electrical equipment has been cable production for the European automotive and aeronautics sectors. A strong industrial capacity has emerged in Tunisia and Morocco, consisting of both small export-oriented players and a few major cable groups such as Nexans, Leoni or Corning Cable Systems. The Egyptian production capacity is also developing. Today, the MENA region accounts for 6.5 percent of the world's total cable production and Tunisia alone supplies half the European demand for automotive cables, benefitting from local regulations that encourage export-oriented investments by foreign companies. Trade balances and information on the level of specialization of the MENA countries' economies in this sector are given in the annexes.

Although a few cross-border interests have been developed in the region (e.g. the Egyptian group El-Sewedy invests in Sudan and Saudi Arabia), the cable industry in MENA remains fragmented; no large groups have yet emerged with a regional presence comparable with European leaders such as Nexans, Prysmian, or Draka. Another weakness that the industry is not integrated upstream and most raw materials need to be imported.

The cable industry is both highly capital intensive and highly dependent on the price of raw materials whereas labor and energy do not account for a significant share of the total end product cost. As a consequence, there are little cost reduction margins to be obtained by manufacturing cables locally (as opposed to labor intensive assembly activities). However, high transportation cost contributes to the rationale of local production. Quality standards achieved by MENA companies are competitive with European standards.

Presentation of the other electric and electronic components industry

Many international firms have chosen to outsource in the region, in particular in Tunisia where large international companies employ over 45,000 people or in Morocco where manufacturing of electronic components is carried out by

approximately 10 firms (e.g., STMicroelectronics) employing over 7,000 people (see examples in box below).

In Algeria, the sector shows high annual growth (from 6 to 10 percent), and export to Europe is expected starting in 2012. Currently, 16 local companies are active in the sector. The region around Sétif (Bordj Bou Arreridj) has become an important industrial pole in the electronic sector. Several international firms have also established their production plants in Algeria.

Engineering, design and R&D activities are still limited but are progressively emerging. Local companies have understood the need to develop small product series, with higher added value and technology content, in order to compete with imports from low cost countries (mainly China and South East Asia). Some international European companies have chosen to keep the production of their most technological products (such as specialized cables for the solar industry) in Europe.

This is also reflected by the status of intellectual property rights in this sector. The number of filed patents in MENA in the field of electronics is considerably higher than in all other industrial sectors that have been analyzed. Information on the number of patents held by the CTF countries is provided in the annexes.

Figure 2.3 shows a specialization pattern for the electronics industry for several of MENA and non-MENA countries. The specialization pattern combines information from patent analysis (cf. annexes) and foreign trade analysis (cf. annexes). The 'Revealed Competitive Advantage' (RCA) is plotted against the 'Relative Patent Share' (RPA). The export volume is displayed by the size of the data points of the individual countries. Positive values for both indicators indicate that a country is notably active in terms of export and R&D in this sector, compared to other industrial sectors of the economy. Negative values indicate that the respective sector performs below average, considering trade balance and intellectual property. For the electronics industry, however, positive RPA values occur and a relatively high export volume is reached by Morocco and Tunisia, compared to other MENA countries.

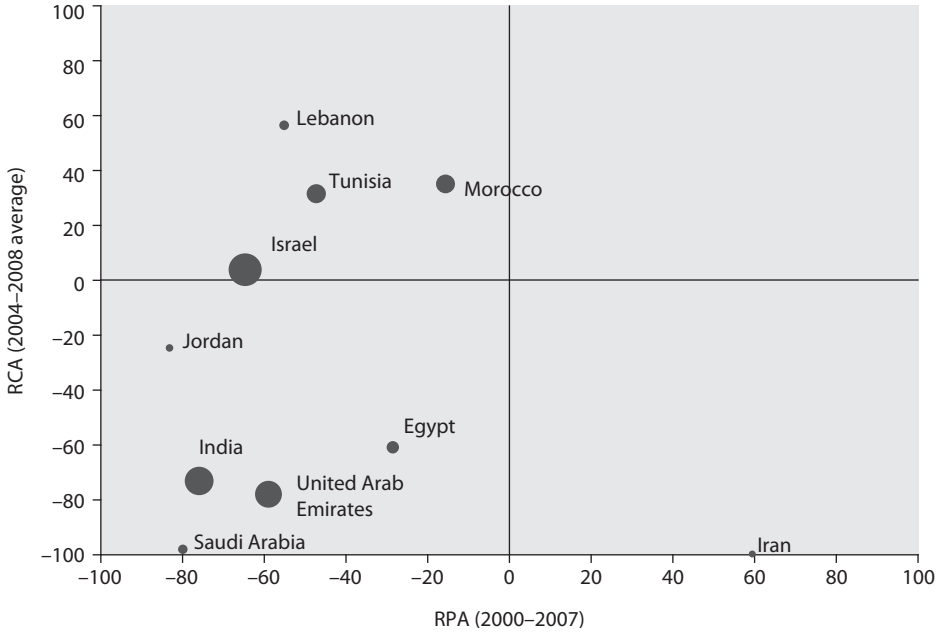
Industry outlook

The electronic and electrical components industry is developed and dynamic in most of the CTF MENA countries, driven by both increasing local demand and

International electric players producing in the CTF MENA region:
Bosch, Casco, Cegelec, Doncaster Cables, Dräxlmaier, Delphi, Fritz Driescher, Haier,, Heinrich Kopp, Kaschke, Kbe Elektrotechnik, Kromberg & Schubert, Latécoère, Lear Corporation, Leoni, Optelec, Philips, Radiall, Socomec, Somfy, Sumitomo, Sylvania, Valeo, Vossloh Schwabe, Yazaki, Yura Corporation, Zodiac, Etc.

International electronic players producing in the CTF MENA region:
Anjou Électronique, Asteel, Fitelec, Fuba Printed Circuits, Groupe Actia, Groupe, Cofidur, Isophon Vertrieb, Johnson Controls, Kaschke, Lacroix Électronique, Mentor, Philips, Phoenix, Safran, Siemens, St Microelectronics, Thomson, Multimedia, Weco Wester Ebbinghaus, Yamaichi Electronics, Zolner, Etc.

Figure 2.3 ■ Specialization Pattern for Electronic Equipment in MENA Countries, Relative Patent Share (RPA) vs. Relative Competitive Advantage (RCA). Sizes of the Circles Indicate Export Volumes



Source: Authors.

large exports to Europe. According to most people contacted, local industries could probably supply CSP plants with electric and electronic components in the short term, especially cables, tracking systems, balance of the plant and monitoring systems. Most of these components are not specific to CSP or could be rather easily adapted to CSP. Electronic and electrical industry entering the CSP value chain would significantly contribute to an increase of the local share as these components represent over 10 percent of the total value of a CSP plant.

Although local players have mainly acted as subcontractors in the past, they are progressively investing in R&D and starting to develop new products, and the added value of this industry's output is increasing. Added value of the Tunisian electric and electronic industry is increasing by 18 percent a year.[2] The remaining gap between the components currently produced and the electric and electronic components needed for a CSP plant could be easily bridged by current efforts to develop R&D activities. Seizing this opportunity will require strengthening the links between research and industry (for example, by supporting the creation of other industrial poles) and strengthening the business case for the local manufacturing of products that will compete with European and Asian production.

[2] Source: Invest in Tunisia, 2009 (http://www.investintunisia.tn/document/488.pdf).

2.1.3 MENA Steel Industry

Presentation of the steel production industry

The main liquid steel production capacities of the region are located in Egypt (9.6 MTPY in 2010), Algeria (2.4 MTPY in 2010), and Morocco (1.25 MTPY in 2010). Only limited capacities are installed in Tunisia (285 KTPY in 2007) and in Jordan (75 KTPY in 2007). In the entire region, local production capacities are much lower than crude steel local demand (as an indication, in 2008 Africa and the Middle East produced 2.6 percent of the world production while using 5.8 percent). All MENA countries rely on imports, mainly from Turkey and Spain.

Large investments have been committed during the past few years in order to reduce the supply-demand gap. As a result, CTF MENA countries are now one of the fastest growing regions in terms of steel production. Some steel producers (for example ArcelorMittal with SONASID in Morocco) have invested in several former public companies in CTF MENA countries to upgrade the actual plants and invest in new facilities. Barriers to new entrants in the sector are mainly:

- Capital-intensity of the industry,
- Skilled-labor intensity of the industry. Although several companies benefit from high-tech production lines, there is a lack of sufficiently trained engineers to operate them;
- Uncertainty on price due to monopolistic situations. As an example, the Egyptian market is dominated by Ezz-Dekhela which holds a 61 percent share of the market.

Presentation of the steel structure manufacturing industry

The main output of the MENA structure manufacturing industry is conventional steel products such as reinforcement bars, wire rods, and billets. The industry employs approximately 25 to 30,000 people, and regroups a wide variety of companies, mostly small and medium enterprises. A significant number of companies manufacture high quality metallic structures including National Steel Fabrication (NSF), Al Zamil and El Sewedy in Egypt; Charcomem, Espace Metal, Menasteel,

Table 2.4 ■ Steel Demand and Production in CTF MENA Countries

Country	2008 demand* ktons/year	2007 production levels ktons/year	2009 production ktons/year
Egypt	8,253	6,224	5,508
Morocco	2,441	512	479
Tunisia	1,301	160	—
Jordan	1,776	150	—
Algeria	5,546	1,278	458

Source: IISI
*Apparent Steel Use, ktons/year=crude steel equivalent

Polymetal and DLM in Morocco; MSGI in Tunisia and several others in Jordan and Algeria. Most of these companies have automated production, quality certification, and high-tech tools and could reportedly supply CSP plants with support structures. Still R&D activities and the status of intellectual property rights in this sector are generally low in the region (cf. patent data in annexes).

However, as for crude steel, all CTF MENA countries are net importers of steel products. The increase of the local production capacity does not yet cover the growing demand from the construction sector, which requires significant imports. Further information on trade balances and the level of specialization of the steel transformation industry on the export of steel structures is provided in the annexes.

Industry outlook

In some MENA countries, the steel industry benefits from the local availability of natural gas and low labor costs, however in return it faces high levels of raw materials imports, as well as monopolistic situations. This leads to uncertainty on prices and presents barriers for new entrants. However, the availability and price of steel would not put at risk the potential of steel structure manufacturing companies to enter the CSP market. Indeed, the volumes of steel needed for CSP plants are not significant compared to volumes needed for building and other applications.

Some local industries already operate high tech production lines and have the skilled workers available that are needed to build CSP metallic structures. A good example is the involvement of NSF in the steel structure supply to Orascom Industries for the Kuraymat project. Generally, CTF MENA countries are currently expanding their industrial sector and are entering a new phase of industrial development. Demand for flat steel is expected to boost industry performance. However, local players will face competition with foreign companies (mainly Turkish and Spanish).

2.1.4 Other Industrial Sectors

Piping and insulation

Pipes and insulation systems needed for a CSP plant are not specific and the main companies providing the international market are generally not specialized in CSP pipe manufacturing.

In the MENA region, in addition to Babcock Wanson (an international boiler specialist which has set up one of its three production sites in Morocco) several local producers seem to have the know-how to supply a CSP plant:

- El Nasr Steel which is one of the largest manufacturers and exporters of steel pipes in the Middle East.
- United Company for Manufacture Metal Pipes which has a factory in Cairo.
- Alkarnac which is another manufacturer of metals pipe in Egypt

Figure 2.4 ■ Composite Wing for Small Airplanes Produced by Avionav

- The Jordan Pipes Manufacturing Co. which produces water, gas and central heating pipes.

Composite materials

Composite materials are widely used for wind turbines and masts as well as in the aeronautic, automotive, and leisure industries, because of their resilient properties, such as mechanical, weight, and temperature resistance. They could be used to form support structures for CSP plants.

Although the big international players (Toray, Teijin, Owens Corning) are not present in the CTF MENA region, a few locally established enterprises seem to have the necessary know-how to produce such CSP structures:

- Solutions Composites is the leader in the Tunisian and North African market and has a large production site. Its customers come from several sectors: shipyards (they are a major sub-contractor of Zodiac), railway industry, and leisure industry.
- Avionav, established in Tunisia, is a subsidiary of Stormcraft (Italia) producing small planes and helicopters with composites, designed for exportation.
- Aircelle, established in Morocco, one of the leading players in the nacelle and aerostructure market, is developing its expertise in composite materials. The company pursues a policy of innovation by implementing new composite technologies with the design and production of large lightweight structures. It possesses the technical know-how to widen the range of products.

2.2 Analysis of MENA Capabilities and Potential for CSP Components

2.2.1 Analysis of Value- and Supply Chains for CSP and Identification of Potential Players

In this section an assessment of the current output capacities and capabilities of the local MENA industries is carried out from which a general potential for local manufacturing of CSP components can be derived. Examples of the project development of ongoing CSP projects in MENA are then analyzed and potential players for a future CSP industry in MENA are identified to evaluate the overall potential of CSP manufacturing in MENA.

Potential of local industries to integrate the CSP value chain

The quality of the steel and glass industries' output is variable. On the one hand some companies are producing very basic hand welded steel structures or green glass with high iron content. This kind of float glass is used for automotive or building industries but would not be suitable for CSP mirrors. On the other hand, several companies, operating automated production lines and benefiting from international certification and knowledge transfer agreements, would be in a position to meet the quality requirements of CSP industry.

Table 2.5 MENA Industries Gaps and Competitive Advantages Regarding CSP Requirements

MENA industry/ capacity	Investment potential and financial strength	Current output quality	R&D potential	Cost reduction/ international competitors
Glass and mirror industry	++ JV and international partnerships already developed	–/+ Conventional glass and mirrors (most of output is green glass)	–/+ Low local R&D but possible technology transfer	++ Availability of natural gas
Importance of criteria regarding CSP requirements	Important as it requires large and capital intensive production facilities	Need for low fraction iron dioxide, precision of bending and quality of coating	Not much R&D needed if technology transfer takes place Further R&D needed for "Sahara conditions" resistant mirrors	Important as energy is a large share of the total CSP mirror cost
Electronic and Electrical industry	++ Large local and international firms present in MENA	+ Supplying international clients	+ Already in place to comply with international new requirements	+ Impact of lower transport cost on total cost
Importance of criteria regarding CSP requirements	Not much investment needed to provide CSP compliant electronic and electric components	Na	Needed to meet potentially specific CSP requirements	Needed as not many other opportunities to differentiate from competitors
Raw material and structure manufacturing	+ Large companies in value chain	––/++ Large discrepancies between stakeholders	+ Some companies used to develop new structures for particular needs	+ Low labor cost
Importance of criteria regarding CSP requirements	Investments needed to develop new designs and production line	High resistance and stiffness as well as accuracy needed	R&D needed to design mounting structure at the beginning and then need for mass industrialization	Importance of labor cost in total cost (if not highly automated)

As discussed in the previous section and highlighted in Table 2.5, many local industries already benefit from strong partnerships with international stakeholders. Some of these are looking into developing new activities, and CSP is considered as a potential opportunity. However, the awareness of CSP technologies is low among local industries and mainly relies on the curiosity of some individuals. Furthermore, some companies are focusing on other technologies such as wind and PV and do not see CSP as a priority for diversifying their businesses.

Local availability of natural gas and low labor costs are competitive advantages for some industries like glass production and transformation and steel structure manufacturing, and could reduce costs for a CSP system. The lower transport costs of local suppliers could also contribute to the business case for local production of some low added value components like cables, pipes or raw materials (cement, concrete, etc.). However, transport costs remain a small share of the total CSP plant costs and will not be a main driver for cost reduction.

Other local industries have developed due to a skilled workforce and regulatory frameworks that incentivize foreign investments, as in Tunisia which has developed flourishing cable, electric, and electronic industries. These industries have managed to expand thanks to the development of partnerships and international clients with specific needs and high quality standards.

The current R&D capacities of local industries are limited, and depend on the company's business model. For instance, a complex structure manufacturer is used to dealing with "one shot" orders, which need a phase of design and development. On the other hand, the glass industry produces mostly standard types of float glass. This is also the case for glass processing companies, like Dr Greiche, the R&D of which relies only on five people (out of hundreds of employees). For the moment very few collaborative research projects with public bodies have emerged, although the establishment of technology platforms in most CTF MENA countries should encourage more collaboration. Most stakeholders interviewed consider that the availability of a skilled workforce is not a problem. Skilled workers can be acquired, and generally on-the-job and cross-training is done within the company.

The gaps identified in this study might be addressed through various measures, including private or public international cooperation, investment in R&D, and the development of centers of excellence. One short term action that would increase interest from the industrial sector would be to provide more visibility of the CSP projects pipeline and more precision about the potential of the CSP market. This could be partly addressed by the decision of MENA countries to better communicate about CSP development road maps, including calls for tender. Other measures, such as including requirements for a target level of local content in calls for tenders will be critical.

If the incentives and capacity building detailed in the following sections are put in place, CTF MENA stakeholders consider that cables/electronics could potentially be supplied by local industries. The steel structure could be manufactured locally as is already done for the Kuraymat project. The mirrors could be manufactured in the mid-term, however the bending process requires new production lines and additional know-how, which currently does not exist in CTF

MENA industries (e.g., the coating process for bended mirrors, which needs a special spray technique). Conventional CSP mirrors might not be suitable for harsh Saharan weather conditions (sand storms, very high temperatures, etc.); R&D that can only be carried out through joint ventures with extensive background in mirrors bending and coating will be needed.

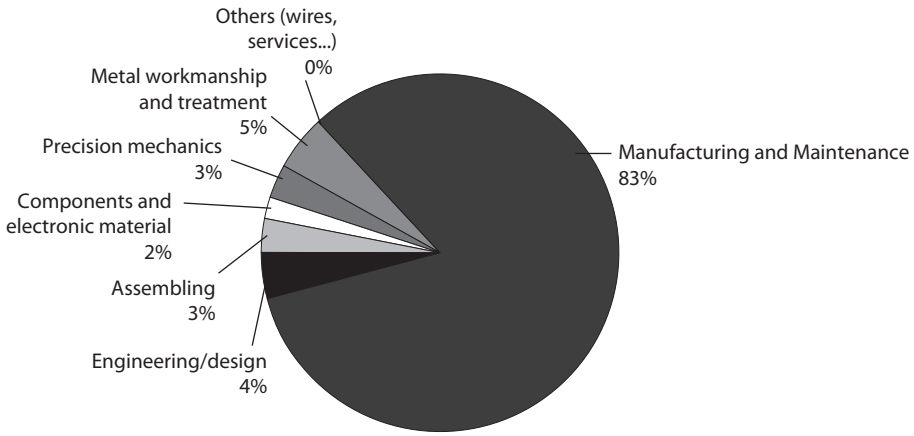
2.2.2 Illustrative Industrial Development in the MENA Region: Aeronautics Industry in Morocco

The potential of industries to develop CSP activities is confirmed by some success stories in the MENA region; the development of the aeronautical industry in Morocco is one example.

Historical background

The aviation industry in Morocco can be dated to 1994 with the inauguration of the "Aéropôle" located next to the Casablanca airport. It was the first Moroccan cluster in aeronautics and was created through a state initiative. This area of 85 ha—which became operational in 1996—is dedicated to innovation, incubation, and outsourcing of material and components related to aeronautics. In 1999, one of the first actors was created by a joint venture between Royal Air Maroc and Snecma Services (SAFRAN). Snecma Morocco Engine Services (SMES) specializes in the maintenance and repair of civil airplane engines. In 2000, a school located in the "Aéropôle" called "Académie Internationale Mohammed VI de l'Aviation Civile" was created to help provide the sector with qualified workers. In the early 2000s, several equipment manufacturers and their suppliers set up business in Morocco, which led to the creation of Matis (JV Ram, Safran and Boeing), Sermp (Le Piston Français), Sefcam, Asi, Assystem. These companies,

Figure 2.5 ■ Breakdown of Activity Types for Aeronautics Industry in Morocco



Source: Sectoral study by the FIMME, 2005.

mostly French subsidiaries, helped Morocco turn its aeronautic industry from maintenance toward production.

In 2005, aeronautics is designated in the national "Plan d' Emergence" among the eight strategic sectors for the economic development of Morocco. At the beginning of Emergence, 17 companies settled in the "Aéropôle." A sectoral federation called the GIMAS (Le Groupement des Industries Marocaines Aéronautiques et Spatiales) was created in 2004.

Although the industry developed in Casablanca, cities such as Tangiers (in the "Tanger Free Zone"), Rabat and Marrakech recently began to enter into this field.

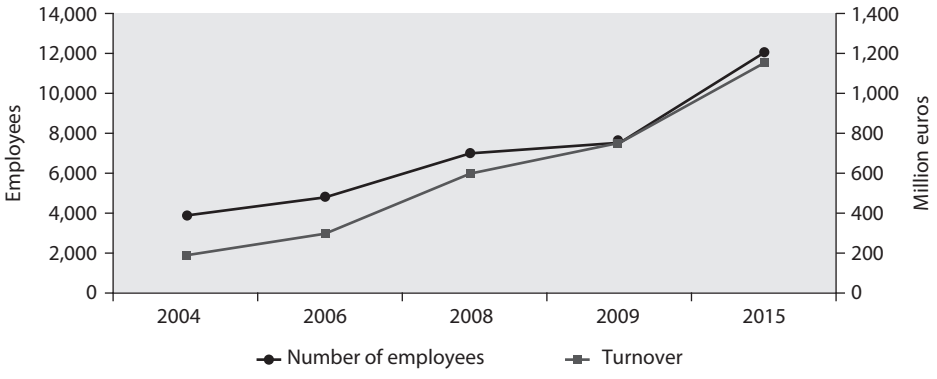
General description

Most of the companies operating in this sector are foreign capital enterprises. Many are subsidiaries of foreign groups, such as EADS, SAFRAN and DAHER, whose only client is their parent company. These companies tend to be small and there is little competition or commercial relationship between them. They operate in the outsourcing of elementary operations that can be classified under seven types of activities.

Nevertheless, with more than 90 players today,[3] the industry is making its way toward greater technological content and more added value. This results in the increase of services and engineering/design activities as well as R&D. The industry's clients are mostly airlines but also aircraft and engine manufacturers as well as subsystems designers and manufacturers mainly located in France and Morocco.

In 2009, the industry reached a turnover of €750 million (more than 70 percent of which comes from exports) with an average growth of 25 percent during the last five years and employing about 7,500 workers. Most of these are factory

Figure 2.6 Evolution and Projection of Employment and Turnover in Aeronautics Industry in Morocco



Source: Sectoral study by the FIMME, 2005.

[3] According to GIMAS (Groupement des Industries Marocaines Aéronautiques et Spatiales).

workers or technicians. The proportion of engineers is usually low (about 5%)[4] with the exception of companies, such as Teuchos, that are focused on engineering and design, and where up to 60 percent of the workforce are engineers (see Figure 2.5).[4] Currently, the sector benefited from €350 million of investment. By 2015, the sector is expected to create up to 15,000 new jobs and reach an additional €400 million turnover (see Figure 2.6).[5]

Key success factors and strategic issues

In addition to the general trend of low costs and outsourcing of non strategic activities, Morocco benefited from several key factors that contributed to the success of its aeronautics sector. These include the country's geographical and cultural proximity to Europe, its economic and political stability, and its economic position in Africa with the second largest air fleet after South Africa. Free trade agreements with Europe and the United States were also important.

The Aéropôle and the Emergence plan were important state-sponsored initiatives for the development of this sector. They resulted in significant tax relief with total exemption during the first five years, with subsequent deductions of 17.5 percent as well as financial aids for land cost, construction, and equipment. The Aéropôle is located in an area of Casablanca that is at the heart of an important labor pool, offering a workforce at lower costs and more flexible work legislation, as well as specialized engineers from top schools in Morocco (EMI, RAM Academy) or in France (Supaéro, ENAC). Moreover, the Aérôpole was designed to allow quick and easy set up of operational units: companies can rent parcels at a low price for building their own factories or rent "ready to produce" modular industrial spaces equipped with utilities (electricity, water, compressed air and computer network) allowing them to install their machines in 24 hours. There are also "ready for services" buildings offering modular and cabled offices for service companies. The Aéropôle also offers general services such as cleaning, security, training rooms, meeting rooms, and copy centers. The strategic location next to Casablanca's airport also allows quick delivery by plane.

Finally, the presence of major foreign groups' subsidiaries such as EADS, Boeing and SAFRAN and the success of the first actors and joint ventures acted as a virtuous circle by attracting other companies.

Some of the factors that contributed to the success of the Aeronautics industry in Morocco took time to develop. The first and most important gap to address at the start was the training of professionals. The training of technicians and workers is usually provided by external companies, but when the process is complex, they can be trained directly by the parent company or the client. In 2000, the

[4] Estimation made by ESCAE MBA students in their research paper conducted in 2007 under the title "Dynamique des relations verticales et clustering: Quelle strategie pour une sous-traitance aeronautique marocaine competitive ?"
[5] Forecasts from the Moroccan daily Newspaper 'Le matin': http://www.lematin.ma/Actualite/Supplement/Article.asp?origine=sej&idr=639&id=116183.

"Académie Internationale Mohammed VI de l'Aviation Civile" was created by the ONDA (a state institution for the management of Morocco's airports), joined in 2009 by the "Institut des Métiers de l'Aéronautique" created by the GIMAS (sectoral federation). Nevertheless, companies still play a large role in the training of their own workers. For example, Nexans created its third industrial site dedicated to aeronautics wires in Morocco by signing a technology transfer contract with Nexans Maroc, that allowed the subsidiary's. experience in the manufacture of car wires to be converted to the aeronautics industry.

The lack of relationship and communication between the different companies acting in this industry created another barrier to growth. In the past, most companies were addressing their parent companies' needs instead of serving as a supply source for other local companies, which impeded vertical integration in the industry. This was partially addressed through the creation of the GIMAS in 2004 which is in charge of creating a federation for these companies. Institutional communication was improved with the participation of Morocco since 2007 in the French air show "Le Bourget" and the creation of the Moroccan air show "AeroExpo" in 2008. The industry is also promoted by the CRI ("Centres Régionaux d'Investissement") and the CFCIM ("Chambre Française de Commerce et d'Industrie du Maroc"). There are still some challenges to tackle, however, including the development of R&D, the further development of support services (supply, logistics and quality support), the structuring of commercial actions, and the development of local supply sources for materials and components. Other supporting activities such as bank financing, administration, public transportation, and reliable electricity supply could help this further.

Learning from the aeronautics experience for the development of CSP manufacturing in Morocco

To make the link with the development of a CSP industry in Morocco, Table 2.6 and Table 2.7 show an analysis of the key factors and challenges for Aeronautics that are relevant for CSP:

2.2.3 Illustrative Business Cases of Current CSP Projects

ISCCS power plant in Kuraymat (Egypt)

Project Overview

The Integrated Solar Combined Cycle Power Plant (ISCC) Kuraymat is a hybrid power plant with a total capacity of 150 MW that uses both solar energy and natural gas to generate electricity. It is located about 90 kilometers south of Cairo, Egypt on the eastern side of the Nile River. In 1999 the World Bank decided to sponsor four ISCC projects (in Egypt, Morocco, India and Mexico) by a grant of US$50 million each. In 2001 Fichtner Solar started with the first layouts of the plant in Kuraymat, and construction has been underway since January 2008. The plant was divided into two lots: the Solar Island, for which Orascom is the

Table 2.6 ■ Comparative Analysis of Key Success Factors

	Importance of the factors for the successful industrial development		
Challenges	**Aeronautics**	**CSP**	**Comments**
Geographical and cultural proximity to Europe			Market for CSP components is mainly in MENA region, Africa and USA whereas market for aeronautics components manufactured in Morocco is mainly European.
Economic and political stability			This is a factor of major importance for any investment decision.
Proximity to regional MENA/Africa markets			CSP market is MENA whereas aeronautics market is Europe.
Free trade agreement with Europe and the US			See comments above
The state's support (political support, tax reliefs, grants, etc.)			The state's support has been determinant in the case of aeronautics' industrial development. Considering the high level of investments needed for development of CSP, state's support might be as determinant.
Cheap labor costs and flexible work legislation			CSP is less labor intensive than aeronautics and should rely on more skilled staff.
Strategic location (next to an airport or in a logistics zone)			CSP will need good logistics infrastructure (ports, roads…) in order to reach MENA and world market. Nevertheless, it should be less critical than aeronautics that requires quick delivery from subsidiaries to parent companies.
Network development			CSP makes the junction between several industries that are not used to cooperate. Then, the creation and development of a network between these companies and the integration of their technical skills is critical. Moreover, CSP needs to leverage its network in order to get known.
Trained workforce			For both industries, there were/are no competencies before the first training from foreign companies/experts.

Source: EY.

Table 2.7 ■ Comparative Analysis of Key Challenges

	Importance of the remaining challenges		
Challenges	**Aeronautics**	**CSP**	**Comments**
Lack of bank financing/fund raising			CSP development might be more capital intensive than aeronautics. Therefore, state's funding might not be sufficient.
Administration burden			Aeronautics experience showed that administrative constraints are not insurmountable
Reliable energy supply for industries			CSP industry is energy intensive
R&D and engineering			R&D is an important challenge for aeronautics to continue going toward a high-tech industry. It should be at least as critical for CSP suppliers that will have to produce CSP-quality components.
	 Neutral → Decisive		

Source: EY.

EPC contractor (together with Fichtner Solar and Flagsol as subcontractors) and the Combined Cycle Island, for which Iberdrola was chosen as EPC contractor. The BOOT (Build-Own-Operate-Transfer) project is likely to reach integrated

Table 2.8 ■ Technical Data of Kuraymat ISCC Plant

Technical Data	Value	Unit
Solar Field total Area (mirror surface) (Source: Flabeg)	148169	m^2
Number of mirrors (Source: Flabeg)	55502	N°
Total length of the rows	23600	m
Number of Collector-units (~ 12 m long, 6 m wide) (Source: Solar Millennium)	2000	N°
Receivers	5900	N°
Number of Loops	40	N°
Hot Leg HFT Temperature	393	°C
Cold Leg HFT Temperature	293	°C
Gas Turbine Generator	74,4	MWe
Steam Turbine Generator	59,5	MWe
Solar Field Design Thermal Power at Reference Conditions	50	MJ/s
Output solar field (electric power) (Source: Flabeg)	20–25	MWe
Installed power specific investment costs	4.935	US$/kW

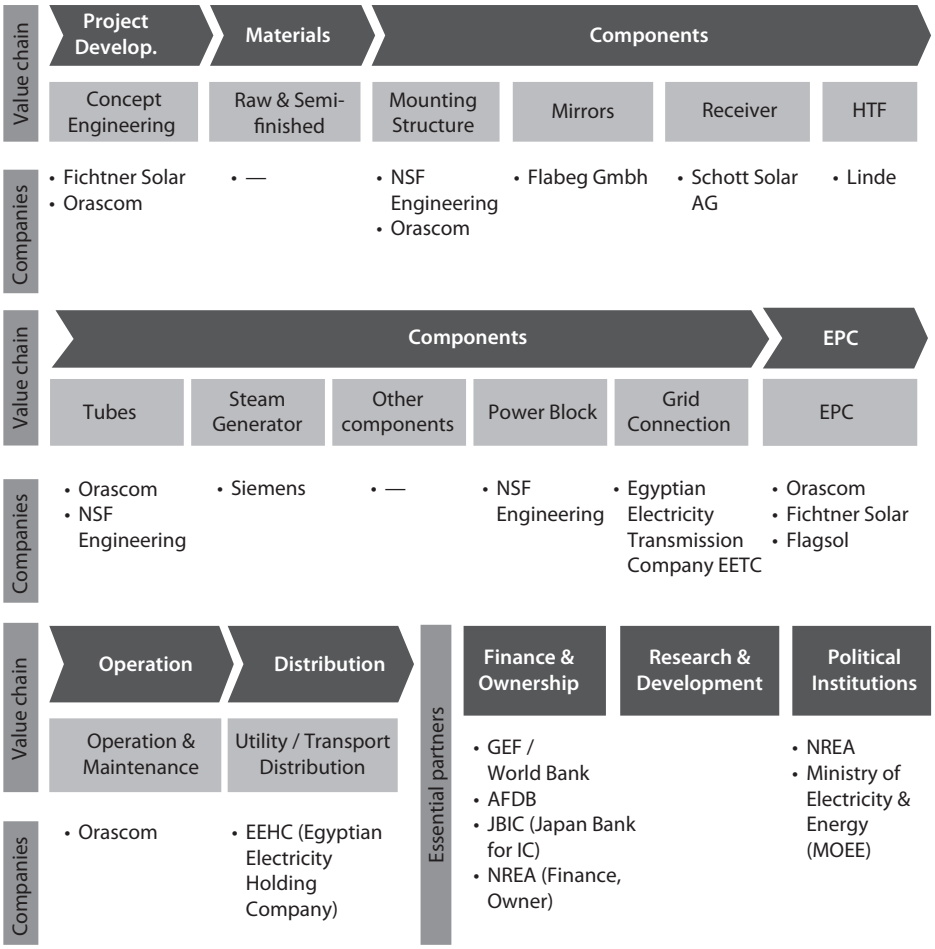
Sources: Fichtner Solar, Flabeg, Solar Millennium, Fraunhofer ISE

commercial operation by April 2011. The ISCC Kuraymat is the first of its kind with the projects in Algeria and Morocco. The solar field thermal power output is estimated at 50 MJ/s which corresponds to estimated electric power of 20 to 25 MWe at reference conditions.

Value chain for Kuraymat

The Kuraymat project is financed by the Egyptian New and Renewable Energy Authority (NREA), the Global Environmental Facility (GEF) and the Japan Bank for International Cooperation (JBIC). The GEF has provided a US$49.8 million grant for the solar field due to the project's exemplary status. The remaining foreign currency portion is financed by JBIC and the local currency portion of the investment by NREA. About 60 percent of the value for the solar field is generated locally. Civil works, the mounting structure, the tubes, electrical cables,

Figure 2.7 ■ Value Chain for the ISCC Plant in Kuraymat, Egypt with Involved Companies



grid connection, the engineering, procurement, and construction responsibility (engineering strongly supported by Fichtner Solar and Flagsol), the operation is by local industry. However some of the key components are still provided by international industry (e.g., the mirrors, receiver, heat transfer fluid, and steam generator).

Key Findings from interviews and project experience

The Kuraymat ISCC plant might become a reference project for pure CSP plants in the region. Despite unfavorable conditions for CSP approximately 60 percent local value generation for the solar field shows that local industry is already capable of realizing CSP projects. The project development for the solar field was undertaken by international companies. But this is one of the first CSP projects in North Africa and international industry already has experience with the development of CSP plants; it is likely that local engineering offices and EPC contractors will be able to transfer their experiences to future projects. In Kuraymat the EPC contractor Orascom was strongly supported by Fichtner Solar and Flagsol with the conceptual design, engineering, and technical advisory of the assembly. However, materials were purchased partly from local sides: the windbreakers were constructed from locally manufactured bricks; the cables, steel for the mounting structure, and tubes (performed by NSF) were also locally produced; the SKAL-ET collector was assembled by Orascom close to the site from a pre-fabricated low cost steel structure; and local sub suppliers delivered the pre-fabricated welded steel parts of torque box frames and plates, cantilever arms, and HCE supports.

The site conditions at the Kuraymat plant are not ideal for a solar field. The chosen field area is rocky so the civil works became much more complicated and expensive than expected. Because of high wind loads, windbreakers had to be built and the collectors reinforced. Strongly varying temperatures made it necessary to add a freeze protection unit with a natural gas fired freeze protection heater and freeze protection pumps for the HTF.

Figure 2.8 ■ Installation of Mirror Collector at Kuraymat Site

Source: Solar Millennium.

The project suffered from different cost and scheduling issues. Since two different tenders for the solar field and power block of the combined cycle were contracted, coordination problems occurred. Also a relatively low solar share does not increase the efficiency significantly: a large solar field with smaller gas back-up would raise the economical parameters of

the plant. Furthermore the final price that was tendered for the solar field was comparatively high.

Conclusion for future CSP plants in Egypt

The Kuraymat ISCC plant proves that international know-how and technical support in project engineering combined with local know-how, raw material supply, and locally manufactured components is feasible and serves as a model for future projects. With a value generation of about 60 percent for the solar field already in 2010, the local economy will see significant benefits from this investment in renewable technology. Currently, local industries confirm that they suffer from a lack of engineering experts. For these projects to be successful, local industries and the country as a whole will need to invest further in R&D and education. But because CSP is not a highly specific technology and Egypt already has industries that produce some of the necessary components, actions to support CSP industries will have synergies with other industry sectors (steel, glass, cables, and engineering in general).

The critical aspects of the tender procedure and design of ISCCS plants should be assessed further. A larger solar share would be a good alternative to provide pure solar power to the Egyptian electricity consumer in the future.

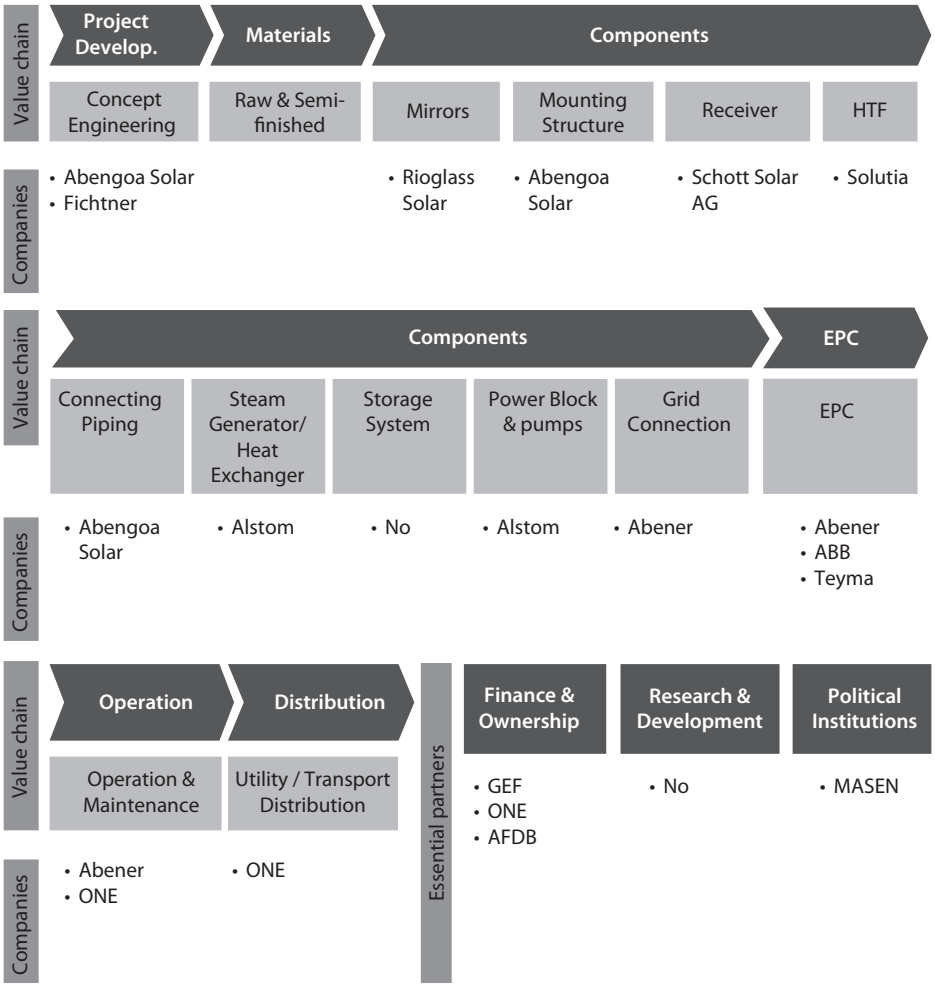
ISCCS power plant in Aïn Beni Mathar, Morocco

The ISCCS plant in Ain Beni Mathar, Morocco, was constructed by Abener in cooperation with Abengoa Solar. It has a total capacity of 470 MW of which 20 MW will use thermal energy from a solar field. The largest share will be generated by a conventional combined cycle system. The solar field counts on a reflecting surface of more than 180,000 m² and has a capacity to generate a power of 20 megawatts. Abener Energia won the bidding of ONE and GEF for the EPC contract for the construction. Abener provides global, innovative, and sustainable solutions, which have been applied to the design, construction and operation for energy and industrial plants. The equipment and components are mainly imported from European countries like Spain, France, and Turkey. The civil works and construction are undertaken by international firms that use a few subcontractors to provide basic and elementary ground breaking with local work force and their own machines. Figure 2.9 shows the main companies involved in the production of components and equipment and the construction of the plant at the site which lies 80 kilometers outside the city of Oujda in East-Morocco.

Main lessons from this project

An examination of the first CSP project as an Integrated Combined Cycle System in Morocco reveals some important lessons learned. Future CSP projects will not have completely the same project structure and an EPC contractor will be

Figure 2.9 ■ Value Chain for ISCCS Power Plant in Ain Beni Mathar



Source: Authors.

involved. But some aspects of this project reflect the general situation of manufacturing, construction, and project finance in Morocco:

- All main components and equipment are imported for the Aïn Beni Mathar project from international market players.
- International EPC contractor Abener commissioned the project successfully by the end of 2016 (duration of construction will be 3 years)
- Abengoa and Abener observed small cost differences for metal mounting structures in Morocco because of the small margin between imports and local manufacturers (no advantage for local components)
- Abengoa and Abener lacked significant international experience in CSP, which made contracting with local companies more complex

- There were doubts about the ability of local industry to supply in quantity and in a timely fashion and it was considered a lower risk to buy from large international suppliers)
- Problems of finding well trained and highly skilled workers
- Problems of local products and steel construction: mainly quality and price
- Issues related to intra-Morocco logistics: importing components from abroad seemed easier than shipping by road from economic hubs (Casablanca for example) to Ain Beni Mathar.
- Available in Morocco: Large machines (all types)
- Administration and bureaucracy: Lower speed of implementation of project
- Reasons for imports: No import taxes (price advantages to local products/ price difference 6–10 percent)
- O&M has to be undertaken by internationally experienced company to sustain the performance of plant

Conclusion for future CSP plants in Morocco:

Strongly supported by international donors, the first CSP project in Morocco will produce electricity for the Moroccan market by the end of 2010. This pilot project will increase knowledge, experience with operation and maintenance, and acceptance for CSP projects in Morocco. But local manufacturing outcomes have not proved positive:

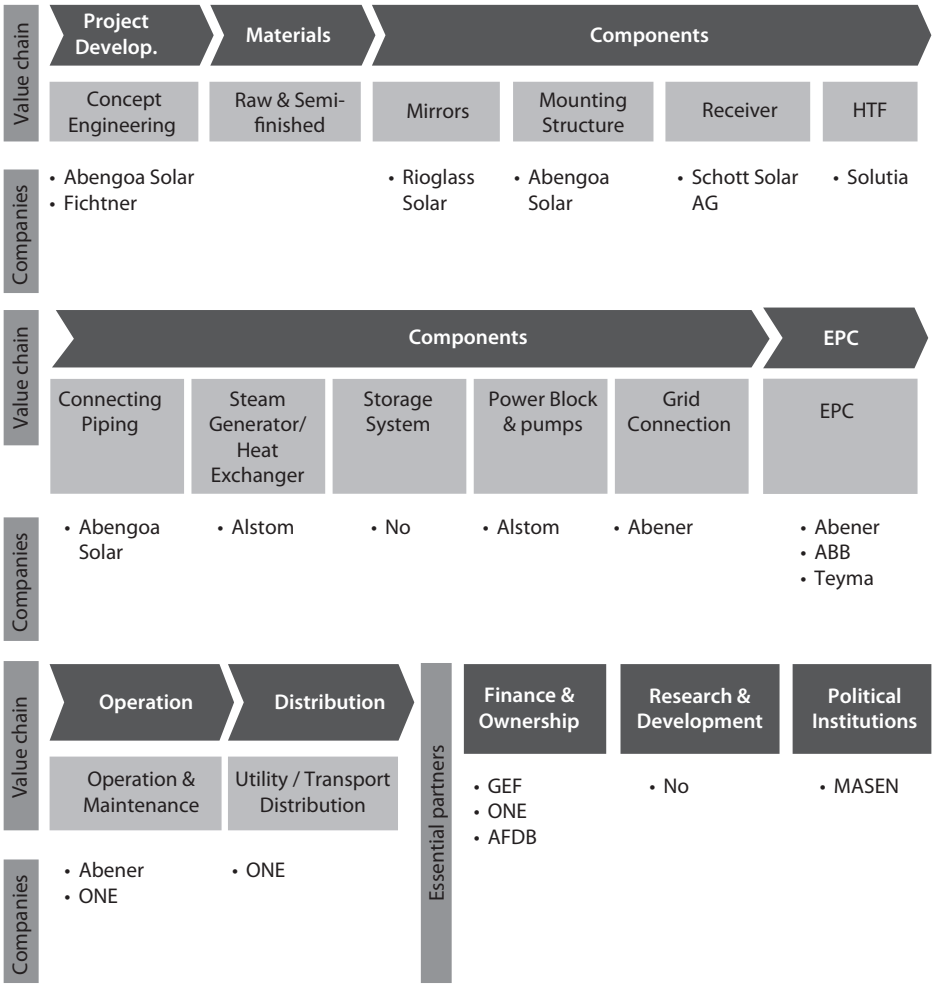
- Low participation of local industry in this initial project may lead to low levels of technology transfer and little learning
- Many international component suppliers have made first steps into the MENA market by selling their components in Morocco, but cost advantages for local components and services could not be identified

ISCCS power plant in Hassi R'mel (Algeria)

This project is being promoted by Solar Power Plant One (SPP1), an Abener and NEAL joint venture formed for this purpose, which will operate and exploit the plant for a period of 25 years. The Algerian state society, Sonatrach, will buy all the power produced under a Build own operate (BOO) contract with Abener. The project company is owned by four shareholders: Abener (51 percent), Neal (20 percent), Sonatrach (14 percent) and Cofides (15 percent). The lead bank for this project was the Algerian bank BEA, Banque Extérieure d'Algérie. The total investment was issued for 315 Mio Euro to Abener.

The plant will be composed of a 25 MW (183,860 m²) solar field of parabolic trough technology that will provide complementary thermal energy to a 150 MW combined cycle. The concept includes a dry cooling system that uses only 10 percent of a water-cooled system. The leading role of Abener as EPC-contractor and Abengoa Solar as central for the solar field development is shown in Figure 2.10.

Figure 2.10 ■ Value Chain for the ISCCS Power Plant in Hassi R`mel



Source: Authors.

Main lessons from this project:

The first project in Algeria was built because there was strong political will for a CSP plant in Hassi R´mel to be built in a total project time of 33 months. The next series of three solar thermal plants in Algeria can profit from the technological experience gained in this first project.

- Engineering company Abener is responsible for the EPC of the total ISCCS plant; Abengoa´s subsidiary is the main supplier for the components and engineering of the solar field
- Ninety percent of equipment and components are imported
- Solar field is 30–40% of total project cost, engineering 10–15% of total project cost

- No local manufacturing was used for the solar field
- Civil work at Algerian site ranges up to 30 percent higher than in Spain
- Abener expects to use locally produced steel mounting system for future projects
- Limited know-how for project development of (conventional) power plants exists in Algeria; EPC contractor always international company
- Local company Sarpi provides electronic equipment for the plant
- The main O&M is done by Abener but an Algerian engineering company (Algesco) will provide turbine maintenance during operation

Conclusion for future CSP plants in Algeria:

- Low developed private industrial sector reduces the capabilities of Algerian industry to react efficiently and quickly to market demand and project needs
- Turnkey projects preferred in Algeria because of limited experience with power technologies

The share of local involvement in the project is very low. The Algerian industry could play a limited role in local manufacturing, but even components and services with a lower technology level have been provided by international companies.

Conclusion on feedback from MENA ISCCS

The local share has been very limited for Hassi R'Mel and Aïn Beni Mathar as most components have been imported by the EPC contractors. This can be explained by the fact that the first aim was not to develop the local CSP related industry but to deliver a functional ISCCS within tight deadlines. On the other hand, the Kuraymat ISCCS achieved 60 percent local production. The key to that success was the involvement of a local EPC contractor, Orascom Industries, and the support of Fichtner Solar and Flagsol for the conceptual design, engineering, and the technical advisory of the assembly. As Orascom is an Egyptian company, it was easier to involve local subcontractors, like NSF for the steel structure. The local companies involved in the Kuraymat project gained know-how and should be able to use it for future projects.

A promising approach to develop local CSP components production would be to combine the following elements:

- International cooperation to facilitate knowledge transfer
- Involvement of a local EPC contractor to facilitate the involvement of local companies
- The provision of incentives to companies for making the effort to involve local companies and components.

Within such a framework, the Mediterranean Solar Plan is one of the key programs under the union for the Mediterranean (UfM) that provides political

momentum for initiatives such as Desertec at a bilateral level. MENA CSP could make solar energy trade a fundamental pillar of MENA-EU economic integration, and it therefore presents a major opportunity for MENA to earn export revenue. MENA CSP could be key to realizing the EU's GHG emissions reduction and energy security objectives. The April 2009 EU Renewable Energy Directive, with its provisions for the import of renewable energy to achieve the mandatory renewable energy targets of EU member states, is a first step in that process, as are the Desertec Industry Initiative and the Transgreen/Medgrid Initiative.

2.2.4 Potential Involvement of International Players in Local Production

International companies and partners are already involved in recent CSP projects in the MENA region. In the future, local manufacturing capacities by international companies will be a key to increasing manufacturing at the local level. Several expert interviews with international European market leaders in Spain, France, and Germany were conducted to identify the position of industry with regards to the MENA market. Strategies to enter the market or to build up local production factories were discussed. This section is divided into four topics: expectations on market development, experts' experiences in MENA, the potential for local manufacturing by international industry, and reasonable support mechanisms.

Expectations of CSP market development worldwide and in North Africa

In the short and medium term, the largest markets will be in the United States and Spain. While Asia (China and India) will increase their solar markets significantly in the near future, expectations for the MENA region are limited to a slow growth but could increase later if support mechanisms are installed. One important factor will be the cost disadvantages of CSP compared to fossil fuels in countries where local resources like gas or oil are available (Algeria, Egypt). Morocco is seen as the most important and fast growing CSP market in the region.

Experiences in the region

The CSP regional market is subject to economic, political, and legal factors. Positive and negative experiences strongly influence further business decisions on the part of international companies. Almost all the companies interviewed have conducted business in the region. EPC companies like Acciona, ACS Cobra or Ferrostaal have extended experience working in MENA from previous business activities. For future projects, engineering companies like Fichtner and Flagsol can make use of the experience gained at the ISCCS plants in Morocco and Egypt. The problems associated with doing business in the region are perceived in different ways by different companies working in different regions. Companies with longer experience in MENA describe fewer problems because they have found stable local partners for their activities; local partners and

political support are important factors to success in these markets. In terms of regional variation, Egypt is seen as highly attractive due to its technical expertise and qualified work force.

Political risks are critical for international industry. The industry ranks them among the most severe problems in North Africa. Political risks lead to several barriers to productivity: direct investments are limited and very expensive because of countries' high risk ratings, and the full potential for local value generation is not tapped. The CSP market can only reach its potential with a foreseeable market development and lower debt costs. Companies are seeking long-term guaranties and long-term investment in the solar market. One company also recommended the creation of an arbitration court with international standards to secure payments for supplied components and long-term contracts.

Security concerns are important for international firms. Companies often incur extra expenses for on-site security staff, if they send their employees into the countries of North Africa.

Customs duties hinder business activities in the CSP market. For an integrated MENA market, intra-MENA countries' logistics might be a relevant aspect if barriers of international trade come into the focus.

Education and qualifications of the workforce are lower in North Africa, but this is not seen as a primary problem for international companies because training on the job is possible. Wages for local staff are 1/3 to 1/4 lower than in Europe, which helps offset lower education and efficiency. However for expert tasks the international companies still use their regular employees from Europe.

In summary, the interviews indicated a different rating of risk and problems in different countries. Stable frameworks in combination with strong local business partners could facilitate growth. Further regulatory and legal support would help international companies build up local subsidies and joint ventures and consequently new factories and production capabilities.

Potential for local subsidies and local manufacturing by international companies

EPC companies and project developers already active in the region have local offices close to CSP projects and their customers. The companies employ local and international workers for projects. As with conventional power plants, CSP companies expect a large share of project development, management, and engineering will come from international companies with knowledge and experience in these kinds of projects.

Table 2.9 ■ Barriers and Problems Expressed by the CSP Industry

Often mentioned problems in countries of North Africa	
Payment of bills	Security concerns
Political risks	Qualification and education of work force
Corruption	Problem of time scheduling

Table 2.10 ■ Industry View on Potential of Local Manufacturing

Component	Local manufacturing possible?	Services and power block	Local manufacturing possible?
Mirrors	Yes, large market	Civil works	Yes, up to 100%
Receivers	Yes, long-term	Assembling	Yes, up to 100%
Metal structure	Yes, today	Installation works (solar field)	Partly, up to 80%
Pylons	Yes, today	Power block	No
Trackers	Partly	Grid connection	Yes, up to 100%
Swivel joints	Partly	Project development	Partly, up to 25%
HFT systems	No, except pipes	EPC	Partly, up to 75%
Storage system	Only small share	Financing	Partly

Schott Solar sees some critical issues for high technology receiver production in North Africa. Complex and expensive production facilities require a sophisticated technology framework for operation and maintenance. In Spain a local content clause was the main driver to move a factory to Spain. According to Schott Solar local manufacturing of receivers is problematic, but may be feasible in the long-term.

Mirror production requires a large local market to be economically viable. CSP developers explain that the metal support structure could be easily produced in MENA if licenses for the design and assembling are obtained by local companies in the steel transformation industry. Other installation works could also be done locally in the near future.

As a whole, the CSP industry reiterates that "*if the local market is large and stable enough, we will produce locally.*" As the average factory for mirrors as well as for receivers has an output of 200–400 MW per year this is the absolute minimum market size required to motivate companies to invest in local plants. The industry underlines the importance of a stable and growing market. If the industry is not convinced that a local market will demand a more or less stable amount of components per year, companies will not invest in local factories. Table 2.11 shows the output of a typical factory for core CSP components and corresponding jobs and factory investment costs.

Support actions for a predictable and stable market

In interviews companies were asked which support mechanism would improve the situation of CSP in the MENA region.

Three central answers emerged to this question:

- Long-term security for planning and financing by feed-in tariffs
- Need to improve the legal framework for enforcement of contracts
- Guarantees from European countries or international financial organizations to reduce country specific risk and financial costs

Table 2.11 ■ Component Specific Parameter for Typical Factories

	Components of the value chain	Annual output of a typical factory (MW/year)	Investment per factory (in Million €)	Jobs per factory (Jobs per year	Specific Jobs (Jobs/MW)
Components	Receiver	200–400 MW	€40	140 Jobs	0.3–0.7
	Mirrors	200–400 MW.	€30	300 Jobs	0.7–1.5
	Steel structure	50–200 MW.	€10	70 Jobs	0.3–0.5
	HTF	Very high	—	—	—

A sustainable market is difficult to achieve with grants that are for only a limited number of projects in the region; a feed-in tariff would give the industry a long-term planning scenario. If a long-term perspective is missing, international companies have a limited interest in investing in the region. Some interview partners recommended PPAs with a long-term perspective of tender procedures with a constant annual installation volume over 5 to 10 years. Investment decisions depend more on the existence of a predictable and stable market than on secondary factors like skilled workers or business networks.

2.2.5 Mapping of Potential CSP MENA Players

This section maps the potential CSP industries in the CTF MENA region in regard to the size of the components market and three terms, 2015, 2020 and 2030.

The mapping of players for CSP components other than mirrors, mounting structures, and electric/electronic components should be less dynamic. On the one hand, components that are not specific to CSP (cables, balance of plant, etc.) will be supplied by players that are currently active on conventional markets. Market shares should evolve according to traditional market drivers like MENA industries competitiveness, change rate, availability of low cost materials, etc. On the other hand, high tech components that are specific to CSP (HTF, receivers) will continue to be supplied by a very limited number of international companies; the mapping for these components should not change completely.

2.2.6 Illustrative Business Cases of Current or Potential CSP MENA Players

CSP mirrors

Sphinx Glass

MENA Glass, through its fully-owned subsidiary Sphinx Glass, is a company established by Citadel Capital and a group of leading regional investors to pursue investments in the promising MENA glass industry, with an initial capital of $120 million. Sphinx Glass' greenfield plant is located in Sadat City, 70 km north of Cairo, and has licensed world-class production technologies from PPG Ind. Inc.

Figure 2.11 ■ Mapping of Potential CSP Industries and their Respective Markets

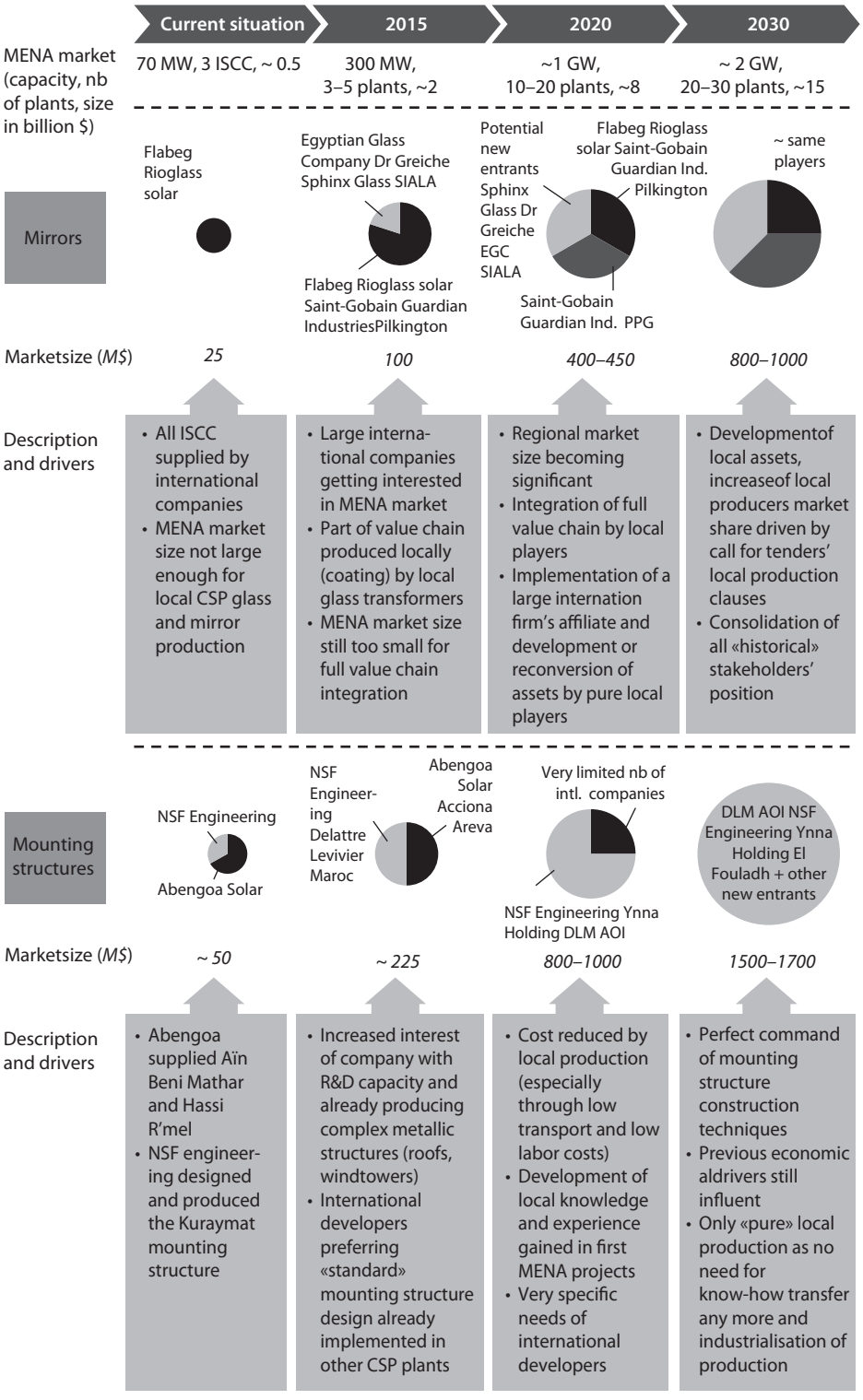
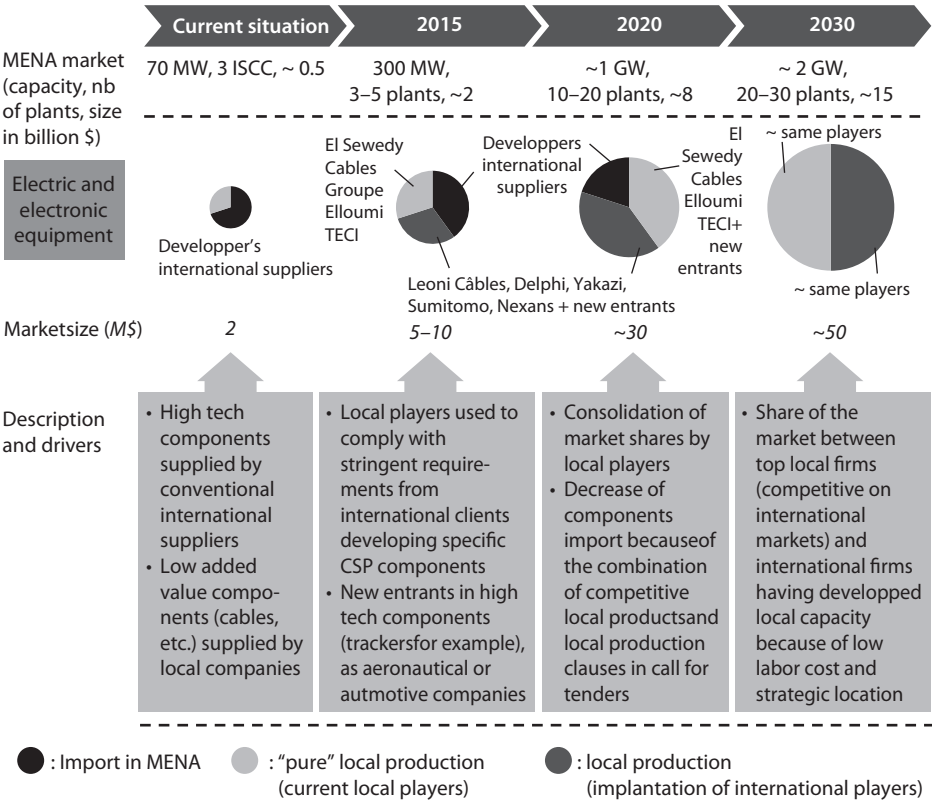


Figure 2.11 ■ Mapping of Potential CSP Industries and their Respective Markets (*continued*)



The new state-of-the-art facility has a production capacity of 600 tons/day and sells to both local and export markets. Two hundred new jobs will be created initially. The construction phase has employed some 2,000 workers.

The new plant is producing high quality clear, colored, and reflective float glass for use in both the automotive and construction industries. Glass sizes vary in thickness between 2–19 mm.

Hisham El-Khazindar, Managing Director and Co-Founder of Citadel Capital, sees strong competitive advantages in Egypt in the global glass industry with a large supply of high-quality raw materials, local availability of natural gas, low labor costs and a geographic location that easily supports exports. The country is perfectly suited to become an important manufacturer and exporter of both float and container glass.

Saint-Gobain

The Saint-Gobain and Şişecam groups have agreed to jointly develop their flat glass (float) activities in Egypt and Russia, by carrying out two projects together. Şişecam will take a minority stake in Saint-Gobain Glass's investment project to build its first float glass production line in Egypt, alongside Saint-Gobain's local partner, MMID.

In addition, a joint venture will be set up between Saint-Gobain and Şişecam for the construction of a float line in Russia, in the Republic of Tatarstan. A feasibility study for this investment was recently announced by Trakya Cam, a company of the Şişecam Group. Output from this plant will be sold in the building and automotive markets.

Guardian industries

Guardian Industries (GI) operates four float glass plants in Egypt, Saudi Arabia, EUA, and Israel. The plants are "high tech and modern". The group has taken over 62 percent of the stakes of the Egyptian Glass Company (EGC), a former state-owned company, from the Egypt Kuwait Holding Co. With the same infrastructure, the company managed to increase the daily output from 400 to 500 tons. Float glass in Egypt is much cheaper than in the US (US: US$350–400/ton, Egypt: US$200/ton). However, GI has expressed concerns in interviews for the poor condition of infrastructure in the country and in the region as a whole.

In the context of CSP, Guardian Industry is producing flat monolithic, bent monolithic, flat laminated and bent laminated mirrors in the United States and in Israel. Laminated mirrors have been developed for higher reflectivity and increased durability. Guardian industry is already experienced in CSP mirror manufacturing with annual production figures of 7.4 million square meters bent, 9.2 million square meters laminated, 20.4 million square meters mirrored

Among other projects, Guardian Industries has already supplied the following solar fields:

- Acciona (Parabolic) La Riska
- Acciona (Parabolic) Palma Del Rio
- Acciona (Parabolic) Majadas
- Novatec Biosol (Flat Linear Fresnel) Puerto Erado 2

GI has altered the bending furnaces used for automotive glass dramatically in order to step into the CSP industry. The conversion took over four years as bending parabolas requires a high degree of accuracy.

GI considers that there are different ways to develop local integration for CSP mirror construction. For example, mirrors that are already bent could be sent to CTF MENA countries. Local industries could then undertake the high added value step of silvering and treating the glass.

Guardian Industries would be ready to manufacture CSP mirrors in CTF MENA countries if the market was there. At the beginning, local MENA companies could take on only some steps of the manufacturing process and then eventually integrate the full CSP mirror value chain. The local production of CSP components could be initiated by the development of JVs with public authorities.

CEVITAL

An industrial glass complex that will be among the largest in the world is being developed by Cevital. Three production lines will be implemented as follows: the first line of 600 tons/day will come into production by the end of 2010, a second line of 700 tons/day and a third line of 900 tons/day will then be added. According to Cevital's chairman, the total cost of the project investment is US$181 million funded by 75 percent equity and 25 percent bank credits. The complex will create over 2,500 direct jobs on the site of Larbaa. The first line will employ 375 staff including 15 expatriates, the 2nd and 3rd lines will add 300 jobs each.

Sand and feldspar necessary for production will be supplied to the site from two large quarries, in Algeria.

According to Cevital's chairman, the plant will be highly competitive on world markets due to low Algerian energy costs.

Cevital has built a partnership with the Chinese company CLFG. CLFG is a major player in the float glass Industry in the world with 10 production centers in China. In this contract, CLFG operates in four areas: engineering, technology (licensed and know how), and assistance in the acquisition of production equipment and production management.

SIALA (Tunisia)

SIALA is producing 6,000 tons/year of mirrors, its activity is limited to glass transformation. SIALA could be interested in CSP mirrors as a way to diversify their industry.

An oven for toughened/tempered glass will be built in the next months. It will produce mirrors of a thickness of 4 millimeters. This is too thick for CSP, but SIALA might reconsider their position and assess the additional cost needed to produce thinner mirrors that would be compliant with CSP specifications.

Dr Greiche Glass

Products of the company are mostly flat glass for buildings, automotive glass, and mirrors. The company has a clear interest in manufacturing mirrors for CSP and is currently involved in providing mirrors for a pilot/demo plant with Cairo University (~60 square meters of slightly bended mirrors). The company is interested in extending its current business into CSP.

The main condition for becoming more heavily involved in CSP technology is growth of the market. Suppliers of glass manufacturing machines are the same for CSP glass as for ordinary glass. The minimum market size to develop a new factory to locally manufacture CSP mirrors in Egypt is one million square meters per year. White glass as the main input material is currently not produced in Egypt. The minimum market size to open a factory for white glass is 20,000 tons/year.

The main barrier for local manufacturing at the moment is that the market does not exist. Dr. Greiche Glass is willing to take some risk, but before making

investments in CSP they want to see a clear government policy and projected trajectory on CSP's role in energy production for the country.

Raw material suppliers and mounting structure manufacturers

SONASID

Created by the Moroccan state in 1974 to develop a fully-integrated steel company, in 1996 SONASID introduced 35 percent of its capital in the Casablanca stock exchange. In 1997, the state sold 62 percent of the capital to a consortium of investors and industrials including Arcelor.

SONASID controls 75 percent of the Moroccan market. Some subsidiaries are specialized in downstream activities (for example, Longometal Armatures, specialized in the construction and installation of metal armatures). SONASID was an active founder of the professional association, the ASM (Association des Sidérurgistes Marocains"), and employs 930 people.

A broad estimate of the need for steel for the Plan Solaire Marocain shows that this demand could easily be satisfied by local steel production:

- With a projected estimate of 10,000 to 15,000 tons of steel for a 50 MW CSP plant, by 2020 the demand could reach 40,000 to 60,000 tons in 10 years.
- The actual long product production capacity in Morocco reaches 2.2 million tons per year.

EzzSteel

After being a leading importer and distributor of steel products from the 1970s to the 1990s, the Ezz family launched its long steel production in 1996. Today, Ezzsteel is the largest independent producer of steel in the MENA region and the market leader in Egypt.

Its four plants (Alexandria, Suez, Sadat City, 10th of Ramadan City) produce long products, principally rebars and wire rods, and also flat products, which consist of hot roll coil, for use in a wide range of applications.

Ezzsteel's total production capacity is 5.8 million tons per year (3.5 MTPY of long products and 2.3 MTPY of flat products). It employs 6,300 workers and the turnover reached $2 billion in 2009 ($288 million of which was export sales). The EU is Ezzsteel's largest export market accounting for 59 percent of total exports. The MENA region countries account for 15 percent.

Today, Ezzsteel exclusively produces reinforcement bars and wire rods. Diversification is not in the agenda, which implies that the region's largest producer would not be directly involved in the CSP value chain.

DLM (Delattre Levivier Maroc)

Delattre Levivier Maroc (DLM), the leading heavy steel construction company, and boiler making and pipe work specialists, has been a presence for 50 years on

Morocco's national market and on international markets and has 1,300 employees. Thanks to its long experience, technical expertise, cutting-edge industrial tool, and the expertise of its teams, DLM has won the trust of the largest operators and engineering offices in a wide range of sectors (Mines and Chemicals, Oil and Gas, Infrastructures, Cement and Energy).

DLM is currently concentrating on three new axes of development: export, with increasing presence in Africa and the Middle East; wind power, with construction of a new production line; and offshore oil. DLM has shown ability to adapt to new markets (e.g., wind masts, offshore platforms).

NSF (National Steel Fabrication)

NSF was established in 1995, with a single production facility in Egypt and a total annual production capacity of 36,000 tons. They now own and operate four major facilities in Egypt and Algeria with a total combined production capacity of 120,000 tons annually. NSF's plants cover a total area of 1 million square meters.

NSF is involved in the production of specialist pressure vessels and boilers, as well as steel structure components for projects including bridges and military airports. They supplied and erected the steel structure for the Kuraymat ISCCS project (around 3,200 tons of steel). The scope of their work included:

- Preparation of shop drawings as per specifications and data sheets
- Supply of carbon steel materials
- Pre-fabrication of steel work at NSF for site assembly
- Hot dipped galvanization for all steel parts
- Supply of Huck bolts
- Erection of steel elements

NSF's production facilities include the latest CNC machines, laser cutting equipment and highly automated robots. In addition, NSF production is executed in line with ASME, AISC, BS, DIN and Euro norm quality certificates.

Electric and electronic components manufacturers

Chakira cables (Elloumi group)

Chakira is one of the main cable manufacturers in Tunisia and in the MENA region. Chakira does not see any issue in supplying CSP plant with cables produced locally.

Chakira is looking forward to diversifying its production and is already producing PV cables. The company would be ready to invest inr CSP cable production as they know that they would get financial and technical support from the Ministry of Industry since a public fund aimed at supporting innovation in Tunisia has already been established. The Elloumi Group also includes an entity which is specialized in electric installations. This entity constructed the electric network of the first wind farm in Tunisia. Furthermore a subsidiary

of Elloumi group is involved in R&D for electric vehicles (cables enabling high speed charge of vehicles).

Arab British Dynamics, affiliate of the Arab Organization of Industrialization (AOI)

Arab British Dynamics is state-owned and was established in 1978 as a joint venture of AOI and British Aerospace for design of defense systems. Since 1998 it is completely owned by the AOI.

Their main products are defense products (wireless communication systems, rocket systems), aircraft harnesses and cables for navigation systems, gas- and oil burners, gas taps, medical equipment (e.g. hospital beds). Production lines are Computer Numerically Controlled (CNC) and are certified ISO standard 9000 & 14001 and awarded by national standard certificates. AOI believes a production of CSP mounting structures is possible but is not yet well informed about it.

AOI might have the capabilities to enter into manufacturing of CSP components but currently the awareness about the technology is low and the focus is on other technologies (mainly PV).

AOI-Electronics Factory

AOI-Electronics Factory is also an affiliate of AOI and produces communication systems (military) and consumer electronics (LCD television screens, speakers, etc.). The company is interested in renewable energies and already did the design of a wind turbine control unit (but manufactured only 2 pieces in total).

El Sewedy Power

El Sewedy's companies are active in a large variety of sectors: cables, electrical products, communications, transformers, meters, steel structures, wind turbines, EPC. El Sewedy exports to over 100 countries and operates 30 manufacturing plants in 16 countries. It is the 4th largest cable manufacturer worldwide. El Sewedy Power owns the biggest galvanization factory in the world.

El Sewedy Power holds a 90 percent share in Spanish wind manufacturer M Torres and manufactures wind turbines and blades. Currently the company is negotiating with the government for the erection and support of a 300 MW wind park in Egypt. The agreement would state that El Sewedy Power would be given the contract but that the turbines would be produced locally.

2.2.7 Competitive Advantages and Weaknesses of CSP Value Chains in MENA

The readiness of economies to adopt new technologies and to implement innovation activities in the future is a crucial factor for sustainable development. To allow for the design of a suitable action plan for the promotion of CSP component manufacturing within the MENA Region it is important to assess the

innovative capability and the competitiveness of country economies. A general SWOT analysis of the CSP value chains in the MENA market can help point out the competitive market positioning of company players in the value chain (see Table 2.13). It is based mainly on the findings from expert interviews during the field study. By analyzing the strengths and weaknesses this assessment focuses on the barriers that must be faced by MENA market players in order to penetrate the CSP value chain, and on first directions for addressing these difficulties. The analysis is supplemented by information on the general conditions of the research system, the technological capability, the conditions for technology diffusion, and the general investment climate in the countries.

Information on aspects of general competitiveness and investment friendliness of 133 countries is aggregated in the Global Competitiveness Report (GCR) by the World Economic Forum (World Competitiveness Report 2009). The Report compiles data on 113 variables and provides a ranking based on the Global Competitiveness Index (GCI). The GCI is split into three categories: basic requirements, efficiency enhancers, and innovation and sophistication factors, which are split into several sub-categories. A selection of data in these sub-categories is used in this report to conduct a cross-country comparison of the CTF countries (Table 2.12). The CTF MENA countries are related to the remaining MENA countries (non-CTF countries[6]) and a relative comparison to other countries is provided by the international ranking in the GCR. To allow for a simplified overview, an average value for the non-CTF MENA countries is calculated (Table 2.12, right column).

In average terms, the non-CTF MENA countries show slightly higher scores in all presented sub-categories compared to the CTF countries, but as the MENA economies are heterogeneous in their development and represent a wide range in an international comparison, a more differentiated outline for the remaining MENA countries, regarding single sub-indicators of special interest, is necessary.

The basic requirements for the development of an economy are, efficiently functioning institutions, a well developed and maintained infrastructure, and macroeconomic stability. These characteristics manifest themselves in a precise definition and strong protection of property rights and intellectual property, righteousness and independence of the political and legal system, and the existence of overall corporate ethics. The infrastructure encompasses not only the development and quality of roads, railroads, air- and waterways but also electricity and telephone lines.

Concerning these fundamentals of economic development, the five CTF MENA countries mostly lie in the middle of the scale, indicating that they meet the basic requirements relatively well in most fields. However, some countries, Tunisia and Jordan in particular, have above-average rankings, and Algeria surpasses all examined MENA countries in macroeconomic stability, achieving the

[6] This group consists of ten countries: Bahrain, Israel, Kuwait, Libya, Mauritania, Oman, Qatar, Saudi Arabia, Syria, United Arab. Emirates. Data for Djibouti, Iraq, Iran, Lebanon, Sudan and Yemen is not provided in the GCR.

Table 2.12 ■ Selection of Scores in GCR-Sub-Categories Illustrating the General Competitiveness of the 5 MENA Countries

	Algeria		Egypt		Jordan		Morocco		Tunisia			
	Eval.	Int. Rank	Eval.	Int. Rank	Eval.	Int. Rank	Eval.	Int. Rank	Eval.	Int. Rank	CTF Average	Non-CTF Average
Basic Requirements												
Public Institutions	3.12	109	3.98	57	4.94	23	3.85	61	5.02	22	**4.18**	**4.36**
Infrastructure	2.91	99	4.07	55	4.45	42	3.62	70	4.62	37	**3.93**	**4.24**
Macroeconomic Stability	6.39	2	3.46	120	3.97	105	5.24	32	4.77	55	**4.77**	**5.41**
Efficiency Enhancers												
Higher Education and Training	3.30	102	3.62	88	4.45	42	3.40	99	4.70	32	**3.89**	**4.01**
Labor Market Efficiency	3.45	127	3.46	126	3.97	106	3.42	129	4.07	98	**3.67**	**4.36**
Financial Market Sophistication	2.79	132	4.01	84	4.45	52	3.81	96	3.97	87	**3.80**	**4.19**
Technological Readiness	2.56	123	3.35	82	3.75	61	3.41	76	3.82	55	**3.38**	**4.02**
Innovation and Sophistication Factors												
Business Sophistication	3.13	128	3.98	72	4.30	49	3.83	78	4.24	54	**3.90**	**4.16**
Innovation	2.64	114	3.03	74	3.27	59	2.88	96	3.64	38	**3.09**	**3.37**
GCI (total score)	**3.95**	**83**	**4.04**	**70**	**4.30**	**50**	**4.03**	**73**	**4.50**	**40**	4.16	4.39

Note: Indicators range between 1 (= weak position) and 7 (=strong position). Light orange: below CTF country average; light blue: above CTF country average; blue: above remaining MENA countries average. International rank ranges from 1 to 133 (source: GCR homepage. Column 7 and 8: own calculation).

second highest ranking worldwide.[7] Nevertheless, the rankings for infrastructure and public institutions in Algeria reflect some deficits in these fields.

On a more advanced stage of economic development, the efficiency of economic processes gains importance. At this point, decisive factors for the competitiveness of economies are the status of higher education (measured by the number of graduates, overall quality of the educational system, availability of specialized research services and extent of staff training in companies), the development and size of goods, labor and financial markets,[8] as well as the ability to access and to adapt to new technological advancements. This can be expressed by the level of availability of modern communication systems (e.g. number of broadband internet

[7] Due to revenues from oil and gas exports.

[8] Status of financial markets is characterized e.g. by the development of local equity markets, access to loans and venture capital, state of investor protection, soundness of banks and restrictions on capital flows.

Table 2.13 ■ SWOT Analysis of Local Manufacturing of CSP Components in MENA Region*

Strengths	Weaknesses
• Low labor cost (especially for low-skilled workers) • One of the highest solar potentials in the world (desert areas) • Strong GDP growth over the 5 past years in all MENA countries • High growth in the electricity demand will require large investments in new capacities • Strong industrial sector in Egypt • Particular proximity of Spain and Morocco • Existing float glass sector in Algeria • Large export industry in Tunisia and Morocco with long experience with Europe (e.g. automotive industry and aeronautics to a lesser extent) • First CSP/ISCCS plants in three MENA countries constructed by 2010	• Insufficient market size for creation of local manufacturing • Administrational and legal barriers • Lack of financial markets for new financing • Higher wages for international experts/ engineers • Higher capital costs • Energy highly subsidized at 75% (although subsidies are decreasing)/Egypt is a net exporter of crude oil and natural gas. • No fiscal, institutional and legislative framework for RE development (laws for renewable energies under development for long periods) • Despite numerous regulations, implementation and enforcement of environmental regulation is often deficient • Need for strong network, business and political connections • Lack of specialized training programs for RE • Partly insufficiently developed infrastructure
Opportunities	**Threats**
• Further cost reduction of all components • Attractiveness to external investors by large market demand • Solar energy: premises of an Egyptian Solar Plan or Morocco with 2 GW • Wind energy: 400 MW of wind capacity/year until 2020 to be developed by the private sector (bid-procedure) • Political will to develop a local renewable energy technologies industry • Possibility of technology transfer/spillover effects from foreign stakeholders in MENA • Export potential (priority given to export industries by GoE)	• Training of workforce and availability of skilled workers not sufficient • Technical capacities of local engineering firms • Lack of informational awareness of management on opportunities in the CSP sector, etc. • Access to financing for new production capacities, etc. • Presence of public actors in clean-techs value chain (ex.: Arab Organization for Industrialization (AOI) in turbine blades manufacturing) • Competition with foreign stakeholders: e.g. historical presence of German players and strong interest of USA in the Egyptian market • Higher manufacturing costs compared to international players • Higher transport losses/costs due to insufficient infrastructure • Competition with other emerging countries

* An analysis of the strengths and weaknesses on a country basis is provided in the annex (cf. page 170 onwards).

& mobile telephone subscribers), the general disposability of latest technologies, or the legislation related to information technologies (e.g. consumer protection, use of digital signatures).

Here the MENA countries again appear mostly in the medium range of the scale as well as the international ranking with strengths indicated in the fields of higher education (in particular in Jordan and Tunisia) and financial market sophistication (in particular in Jordan and Egypt). Deficits are indicated concerning

the development of technological readiness and the financial markets in Algeria, which might be of particular relevance with regard to financing of CSP projects and potential industrial investments in the area of CSP manufacturing.

Finally, to be internationally competitive, economies must develop a sophisticated, innovation-driven approach which allows for the enlargement of intellectual property rights and the design of their own, unique products. This is expressed, by a large number and a high diversity of local suppliers, well developed industrial clusters and networks, and the application of precise and efficient production technologies. The innovative capacity is reflected in the quality of research institutions, the extent of collaboration between industry and research facilities, the number of recorded utility patents, and the general availability of scientists and engineers.

On this high level of economic development the CSP MENA countries rank mostly in the lower range of the scale. Nevertheless, Tunisia, Jordan and Egypt achieve above-average scores with regard to business sophistication, indicating significant potential for the development of business in these countries. The innovative potential of MENA countries could be improved through the promotion of research facilities and the development of intellectual property rights.

2.3 Conclusion of Chapter 2

Industry capabilities for CSP components and services

Several industrial sectors that have the potential to integrate the CSP value chain in the MENA region are dynamic and competitive at regional and sometimes international scales. The glass industry, particularly in Egypt and Algeria, has been a regional leader for a long time and continues to increase its production capacity. The cable, electrical and electronic industry can also claim the same position, especially in Tunisia and in Morocco. The success of these industries is facilitated by the development of joint ventures between large international companies and local firms but also by the local implementation of subsidiaries of international players.

Inititally, the development of MENA CTF industries was driven by the low cost for labor and energy (in particular for Algeria and Egypt) and also by the geographic proximity to Europe; a delivery to Europe within 48 to 72 hours is possible. This is a key factor for short production cycles with variable specifications, for example components, cables and wiring for the automotive sector. In order to position themselves on the CSP market, MENA CTF industries face several challenges, mainly adapting their industrial capacity to a higher technology content. The landscape is already changing; the situation of pure subcontracting is now shifting toward more local R&D and the production of high tech components. MENA CTF countries are aiming to be considered as "centers of excellence" instead of low-cost and low-skilled workshops. The shift toward higher technology will require increased international cooperation. For example, Guardian Industries has taken over the Egyptian Glass Company, while a technology transfer agreement has been signed between PPG and Sphinx Glass.

Although cooperation between western countries and CTF MENA is thriving, cooperation between industries in MENA countries is relatively low. Initiatives have been undertaken to develop intra MENA cooperation (for example in the aeronautics industry) but have never been very successful. Shared research and technology development between public bodies (universities, etc.) and corporations could be strongly enhanced, for instance, by developing technology platforms and clusters. Horizontal cooperation could be better utilized to support regional centers of excellence.

Many companies discussed in this study still have a limited understanding of the market potential offered by CSP. Raising the awareness and interest of these potential players will require a clarification of the market for CSP in the MENA region and beyond; the identification of future demand volumes will be critical in the investment decision process. Specifying the market shares achievable for local industries will also be useful for regional corporate strategies. Furthermore, an investigation of the possibilities of flexible production lines might contribute to mitigating the risks related to entry into the CSP market; for example, steel structure manufacturers can adapt their production tools to different products with little effort.

In spite of the obstacles to participation of local MENA industries, expert interviews with MENA companies and with the existing CSP industry revealed potential for the local manufacturing of CSP components. The participation of local firms in the provision of construction and engineering services for new CSP plants in the MENA region were identified as an activity with promising growth in the future.

Key findings of this chapter are:

- Successfully constructed ISCCS projects have increased CSP experience and expertise in MENA (Algeria, Egypt, and Morocco).
- Some components and parts for the collector steel structure have been supplied by the local steel manufacturing industry (Algeria, Egypt, and Morocco).
- Workforce has been trained on the job; engineering capacities have also experienced some progress.
- Specialization in each country would be beneficial, because local demand will probably be relatively low in the short to medium term.
- Several parts of the piping system in the solar field—for the (inter)connection of collectors and power block—can already be produced locally by regional suppliers.
- The development of a CSP mirror industry in MENA is a promising direction for future local involvement.
- The involvement of international companies will play an important role in the mid-term development of a CSP industry in MENA countries because it will facilitate the creation of local production.
- Minimum factory outputs have to be taken into consideration when local manufacturing of special components is envisaged (parabolic mirrors, receivers, salt, thermal oil).

The main drivers for a development local manufacturing of CSP components in the MENA Region are similar to markets in Spain or the United States and include the following issues:

- attractiveness of local markets
- technology transfer for capacity building
- technological expertise, including precision of processes and lifetime stability
- training and education of workforce, including structure and skills of the workforce
- large financial investments in production capacities
- competitive location factors including attractive costs for local manufacturing, availability of required raw materials, and infrastructure and logistic networks
- improvement of quality standards
- improvement of regulatory framework with financial and legal issues

Depending on the specific component under consideration the importance of each of these conditions may vary (Table 2.14).

It has to be stressed that the increase in CSP performance with stepped-up MENA investment could also translate into a boost for strong competitors in

Table 2.14 ■ Required Conditions for Enhancing Local Manufacturing of CSP Components

Component	Attractiveness of local markets, local demand	Technological Know-how	Training Education	Financial investment	Competitive location factors	Improvement of quality and assurances standards	Investment regulatory framework
Civil Work					x	x	
Installations			X			x	
EPC Engineers		x	X			x	
Assembling		x				x	
Receiver	x	x	X	x	x	x	x
Mirrors Flat & Parabolic	x	x	X	x	x	x	x
Mounting structure				x	x	x	
HTF	x	x			x		
Connection piping	x	x	X	x	x	x	
Storage system		x	X			x	
Electronic equipment	x	x	X		x	x	

technology supply, China or India for example, as has occurred with Chinese PV modules or, to a lesser extent, with Turkish Solar Water Heaters. This could then jeopardize the emergence of local CSP related industries in the MENA region.

To face international competition, particularly with China or India, MENA countries would need to strengthen and develop their competitive advantages:

- Rapid delivery and low transport costs, would be strong assets as shipping from India or China would take several days. However, although rapid delivery has been a decisive asset for the MENA automotive industry, it might be less crucial for CSP as logistics are less tight.
- Enhanced R&D would help to improve CSP components, drive their cost down, and increase their quality, compared to the competition.
- MENA industries could tailor their CSP component production to local environmental conditions (desertic conditions) whereas non MENA countries would lack this specialization.

Eventually, the development of local production clauses in CSP call for tenders that are compliant with international free trade agreements would help to limit competition with international low-cost competitors, but this will require careful consideration of possible negative impacts on learning curves due to a lack of competition.

Summary of outlook on local component manufacturing

First step: Construction and Civil works

In the short-term, all construction work at the plant site including basic infrastructure, installation of the solar field, and construction of the power block and storage system could be accomplished by local companies. These activities account for roughly 17 percent of the total CSP investment or approximately US$1 million per MW (cf. Table 1.7). Large companies from the construction sector play the most important role in this area of basic construction. In Spain and the United States, on-site construction and assembly is contracted by the local construction and infrastructure industry, and basic construction (civil and infrastructure works, plant engineering) is the first step in which local firms are involved in building the plant. Experience from the ongoing CSP projects in Egypt and Morocco support this finding.

Engineering and EPC companies in the CSP industry are limited. In the world market, only a few companies already have the expertise to construct large CSP projects. New firms are now entering this market, but the demand for these services is concentrated in Spain and the United States. In the MENA Region companies in the CSP engineering and project managing sector still need to be established. The Egyptian company Orascom is a good example of a successful venture in this sector; its activities go beyond the provision of labor and it has

even become the EPC contractor for a CSP project. Orascom uses a large number of local staff for construction on the plant site. For the initial CSP projects some of the EPC and labor tasks were carried out by external (international) companies and workforce.

The ability of local industry to provide EPC services in MENA varies by country. Egypt now leads in this area, but Egypt required the expertise and management support of an international company to reach this position. In other MENA countries the short-time focus should be set on developing EPC capabilities to reach the same level.

Second step: Mounting structure

The mounting structure can be supplied locally if the local companies can adapt manufacturing processes to produce steel or aluminum components with the required high accuracy. Generally it has been found that companies in MENA are very competitive in the field of steel structures on a global scale. Required quality levels require the adoption of automatic production lines with typical machines and equipment.

Third step: CSP-specific components with higher complexity

In the short to medium term, the local industry is generally capable of adapting production capacities to produce high quality mirrors (glass bending, glass coating and possibly float glass process) to a high technical standard as required for parabolic trough plants. This might require international co-operation for specific manufacturing steps in the short term. Later, local manufacturing of components could include, in addition to high-quality mirrors, receivers, electronic equipment, insulation and skills for project engineering and project management (see assessment of ongoing ISCCS construction).

The success of this process will be dependent on the attraction and integration of international firms. As it might be difficult for local firms to enter the CSP manufacturing market of specific components immediately, it will be economically beneficial for international CSP companies to increase their manufacturing and production capacities in the MENA region to supply new CSP plants with locally produced equipment and components. In that case, international companies invest in the region with a long-term objective and strategy, creating jobs and wealth locally.

Particularly for receiver (absorber) production, the most promising option will be for international companies to move closer to a strongly increasing market. This happened in the Spanish market where international firms (Solel and Schott Solar), which had previously shipped components from plants in Israel and Germany, formed new production capacities in Spain to be closer to the CSP market.

Components with potential in the MENA region

Based on the complexity level and the potential for local manufacturing (cf. section 1.3) as well as the share of added value in the CSP value chain (cf. section 1.2), a number of key components and services can be identified which are most promising to foster for local manufacture in the MENA region (figure 2.12). Key components are mounting structures, mirrors, and receivers, and key services range from assembling and EPC to O&M.

Secondary components can also be identified, for which some MENA countries have already developed production capabilities and which might thus contribute to an enhanced local supply of future CSP projects, although their share in the overall value chain might be of minor importance (see Figure 2.12). Electronics, cables and piping belong to this group.

For these key components and services in the CSP value chain, roadmaps and an action plan are developed in the next chapter.

Figure 2.12 ■ Key Components and Services for CSP