Report Summary

The Need for a Concentrated Solar Power (CSP) Home Base in MENA Countries

Concentrated Solar Power (CSP) is a renewable energy technology which, after a period of stagnation, has started to penetrate the energy market, particularly in Spain and the United States, but also in the Middle East and North Africa Region (MENA) as well as other regions of the world. To implement CSP projects in MENA competitively in the short and medium term, a portfolio of different support schemes is necessary, including climate finance and other concessional loans, revenues of solar electricity exports to Europe, and national incentives (including long-term power purchase agreements (PPA), feed-in tariffs or tax rebates).

As a concrete step toward realizing these strategies, a "MENA CSP scale-up Investment Plan" (MENA CSP IP) was prepared by the World Bank and the African Development Bank (AfDB), and was endorsed by the Clean Technology Fund (CTF) Trust Fund Committee on December 2, 2009. It is a landmark climate change mitigation program aiming to co-finance nine commercial-scale power plants (totaling around 1.2 GW) and two strategic transmission projects in five countries of the MENA region (Algeria, Egypt, Jordan, Morocco and Tunisia, called the "MENA CTF" countries in the rest of this report). The total cost of the MENA CSP IP is estimated at US$5.6 billion, of which the CTF will provide co-financing of US$750 million. The vision is for the Mediterranean MENA countries ultimately to become major suppliers and consumers of CSP-generated electricity. The MENA CSP IP is conceived as a transformational program, aimed at overcoming market and technical barriers, in order to offer the CSP industry a credible commitment that allows them to develop a large scale, multi-country portfolio of projects. It is intended to stimulate the installation of at least 5 GW of CSP capacity in MENA by 2020 based on the 1.2 GW triggered by the MENA CSP IP. The first projects are expected to start commercial operations by 2014, and initially to supply domestic markets in MENA countries.

MENA could become home to a new industry with great potential in a region with considerable solar energy resources. If the CSP market increases rapidly in the next few years, the region could benefit from significant job and wealth creation as well as from sufficient power supply to satisfy the growing demand, while the world's renewable energy sector would benefit from increased competition and lower costs in CSP equipment manufacturing.

There are several transformational opportunities for local manufacturing in MENA countries:

- MENA CSP is well placed to benefit from the massive scale-up of concessional climate financing envisaged under the United Nations Framework Convention on Climate Change (UNFCCC), and recently reaffirmed at the Copenhagen and Cancun conferences. The CTF allocation for MENA CSP could be the seed money for financing a more ambitious scale-up. CSP in MENA and other regions could benefit from the recent Cancun agreements in 2010 which have opened the way for a much larger funding framework. The Cancun climate conference agreed on a Green Climate Fund of $100 billion a year of climate funding from 2020 onwards that will be generated from a "wide variety of sources, public and private, bilateral and multilateral, including alternative sources." This could include a range of mechanisms such as auctioning carbon credits and levies on international aviation and shipping.
- MENA CSP is central to the high-level political agreement between MENA and the European Union to 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. The political initiative of the Mediterranean Solar Plan may act as an umbrella for initiatives such as Desertec at a bilateral level.
- MENA's oil-producing countries are embarking on CSP investment programs to liberate oil and gas from the power sector for higher value-added uses and exports, and in the longer term for CSP energy export.

These factors could uniquely advantage MENA as a global location of choice for CSP production and could strongly drive local manufacturing while creating demand for installed capacity.[1]

[1] The term "local manufacturing" comprises both local industries and subsidiaries of international players established in a country to produce locally.

Figure RS.1 ■ Main Objectives of the Study

1. Provide an overview of manufacturing processes, cost reduction potential for key CSP components
2. Assess the potential for a CSP manufacturing industry in the MENA region
3. Establish roadmaps and an action plan for the development of local CSP manufacturing in MENA
4. Analyze potential economic benefits of a CSP component manufacturing industry in MENA

The main objectives of this study are:

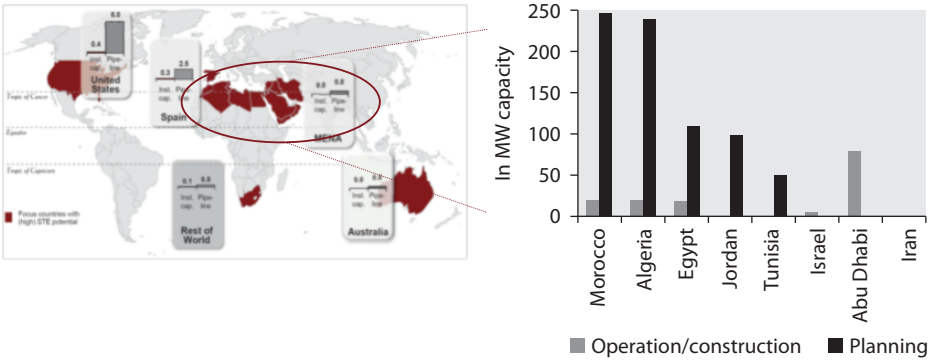
- to provide an overview of *manufacturing processes* for key CSP components as well as a *cost analysis* for CSP components and systems, and for CSP plants as a whole, including the potential for cost reduction
- to further assess the *potential in the MENA region* for building and developing a CSP component and equipment manufacturing industry, focusing on the five MENA CTF countries, but with a broader view to the MENA region
- to propose roadmaps and an *action plan* to help develop the potential of locally manufactured CSP components in the existing industry and for new market entrants
- to analyze potential *economic benefits* of developing a CSP component manufacturing industry and CSP manufacturing at the construction site of new CSP plants

The CSP Market Environment: Positive Trend

After twenty years of operation in the Solar Electric Generating System (SEGS) plants in California, the worldwide market growth of renewable energies gave CSP technology a new outlook in countries with high direct radiation. Beginning with the Spanish and US electricity markets, many projects are now under development. Electricity-producing CSP plants doubled their capacity with new installations since 2007; by the middle of 2010, a total of over 800 MW of CSP plants were in operation. Although the United States and Spain strongly dominate the CSP market, national support incentives for CSP has caused the market to boom over the past few years. Australia and countries in MENA and Asia are developing their first projects.

The MENA CSP IP and its co-financing by the CTF play a vital role in stimulating CSP plans in the MENA region. Table RS.1 shows the CSP projects in the MENA CSP IP pipeline as of October 2010. In total, for the five MENA CTF countries considered in this study, nearly 1.2 GW of CSP power plants are expected to be developed in the coming years.

Figure RS.2 ■ a) Global CSP Capacity Existing by Mid-2010 and Projected through 2015 b) MENA CSP Capacity: Projects under Operation*/construction and in Planning Phase**



Source: Estela, 2010
* The CSP operational power tends to change quite rapidly, especially in Spain and the US: Protermosolar provided in December 2010 the following figures: Spain Total operational 674 MW (Tower: 21 MW, Parabolic Trough 13x50 MW=650 MW, Fresnel+Stirling 3 MW), USA 505 MW(Parabolic Trough 354 + 64 + 75 MW = 493 MW, Fresnel + Stirling 7 MW, Tower 5 MW).
** Higher figures have been forwarded in some MENA countries, e.g. 2000 MW in Morocco. This figure only includes planned plants which are sufficiently well documented, e.g. through calls for tender. Also, frequently it is not clear how large the CSP share in those plans could be.

Status of CSP Technology: Diverse Solutions, Significant Cost Reduction Potential

Since parabolic trough plants have become commercially bankable, the highest share of announced new projects worldwide (up to 9,000 MW) uses this technology. The focus throughout this study is therefore on parabolic trough plants. Some

Table RS.1 ■ Planned Projects for MENA CSP IP

Country	Project (Name)	Capacity (MW)	CTF financing (US$ million)
Algeria	Megahir	80	
	Naama	70	
	Hassi R'mel II	70	
Egypt	Kom Ombo	100	
Jordan	Ma'an	100	
	Mashreq CSP transmission	-	
Morocco	Ouarzazate	500	
Tunisia	IPP-CSP	100	
	ELMED-CSP	100+	
	STEG-CSP	50	
	Tunisia-Italy transmission	-	
Total		**~ 1,170**	**750**

Source: The World Bank

projects using central receivers with high solar towers are also under development, mainly in the United States. Dish engines still have some cost disadvantages, but US developers hope to overcome this by mass production and thousands of single installations in a large area (total capacity 800–1,000 MW). Although Fresnel technology has the same solar field design, but its mirrors have lower production costs, this technology still lags in volumes of announced projects (the first 30 MW plant in the south of Spain will create commercial experience). Due to considerable advances in all four types of CSP technologies, calls for tenders should promote all technologies that match minimum requirements (including experience with the technology). This will allow innovative and cost-efficient technologies to prove their potential, will bring down the cost of CSP, and will help to materialize more CSP capacity with a given amount of financing. Most findings are also applicable to all CSP technologies, because the working principles, the materials, and the production processes do not vary significantly. Most trough, Fresnel, tower (and partially dish) technologies consist of steel structures, glass mirrors, and absorber tubes using a sputtered selective coating. All systems track the sun, have high optical/geometric accuracy requirements, use relatively high-temperature materials and processes, and have electric generators that need to be coupled to the electric grid. Hence:

- **processes and components serving different technologies will be most relevant to local manufacturing concerns;**
- **and newer technologies such as Fresnel may offer opportunities for local innovators to enter the market where international players are still less well positioned.**

A recent study carried out by the European CSP industry association Estela and by AT Kearney (Estela, 2010) analyzed the latest cost reduction potential by interviewing the existing CSP industries regarding technology improvements and effects of economies of scale. The results are shown in table RS.3. Overall the levelized cost of electricity (LCOE) could decrease by 45–60 percent by 2025 according to AT Kearney. Economies of scale, efficiency increases, and technology improvements are the main drivers for this development. Many factors will

Table RS.2 ■ Current CSP Projects in the World Market

[MW]	Operational	Under construction	Planning phase*	Total
Tower	44	17	1,603	1,664
Parabolic	778	1,400	8,144	10,322
Fresnel	9	30	134	173
Dish & Stirling	2	1	2,247	2,250
Total	**833**	**1,448**	**12,128**	**14,409**

Source: Sun & Wind Energy 2010.
* Planning phase: Projects are announced by project developers or owners. Pre-engineering is taking place, but real construction and all administrational authorizations have not been finalized yet.

Table RS.3 ■ Potential Reductions in Levelized Cost of Electricity to 2025

	Reduction in total plant Levelized Cost of Electricity LCOE (2025)				45–60%	
	Economies of scale				21–33%	
	Efficiency increase				10–15%	
	Technology improvements				18–22%	
Technology improvements	Mirrors parabolic	Mirrors flat	Receivers	Steel structure	Storage tank	Molten salt
2020	25%	25%	25%	30%	20%	15%

Source: Estela 2010

contribute to these total technology and cost improvements by values of 15 to 25 percent including:

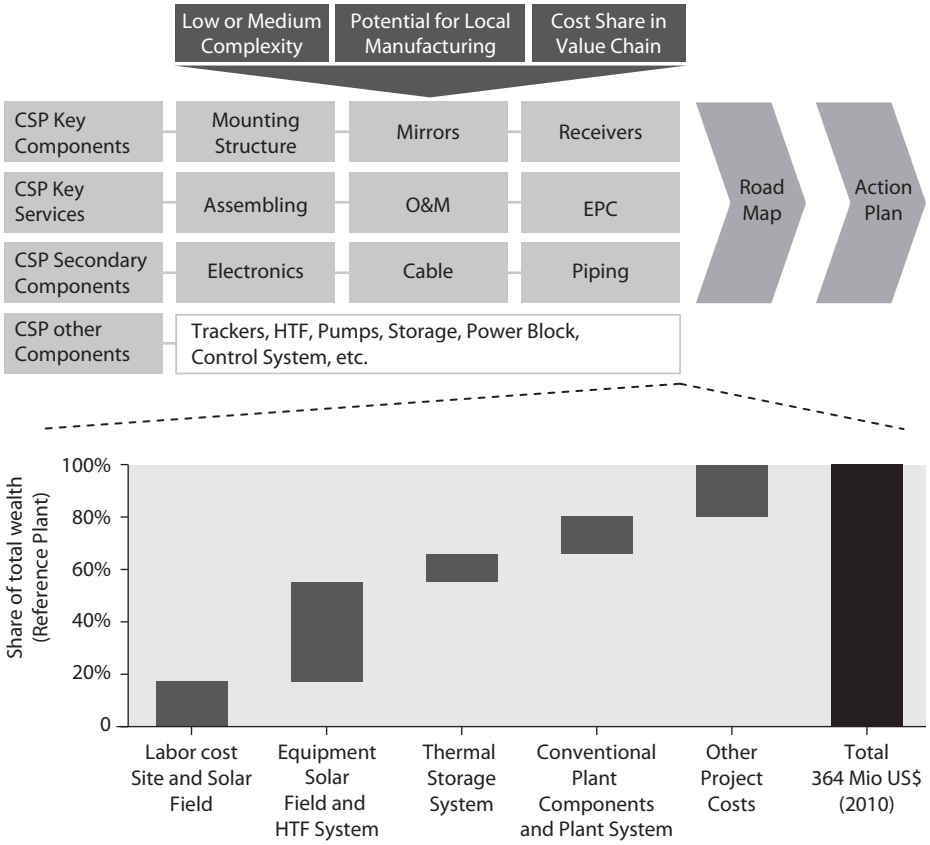
- **an increasing number of plants being built in sustainable and reliable markets,**
- **competitive market mechanisms, including established and innovative CSP technologies**
- **further research and development.**
- **On average, the expected annual cost decrease is about 3–4 percent—placing CSP between wind energy (with expected cost decreases of about 2 percent a year) and photovoltaic (PV) (with a cost reduction path exceeding 10 percent annually).**

The CSP Value Chain

An evaluation of the MENA region's potential for developing a domestic industry for CSP requires a detailed analysis of the CSP value chain: the technologies and services, the production processes, and the main industrial players. It is further important to review the cost of CSP and the contributions from individual components of the CSP value chain. Based on the complexity level and the potential for local manufacturing, as well as the share of added value in the CSP value chain, a number of key components and services can be identified that are most promising: key components include mounting structures, mirrors, and receivers, and key services range from assembling and engineering, procurement and construction (EPC) to operation and maintenance (O&M). Single countries of the MENA region have already developed some production capabilities of secondary components—including electronics, cables and piping—which might contribute to the local supply of future CSP projects, although their share in the overall value chain might be of minor importance. Figure RS.3 shows the different components and services linked to the production and use of CSP, and their shares in the value chain.

The components of the solar field are the most capital-intensive and constitute the largest part of the value chain (38.5%). The price of a collector is mainly

Figure RS.3 ■ Main CSP Components and Services and their Share in the Value Chain



Source: Kistner 2009, Nava 2009, Schnatbaum 2009,VoteSolar 2009.
Note: Investment cost data based on estimated investment cost of an Andasol-like power plant with a rated power of 50 MWel, a thermal storage capacity of 7.5 hours and a solar field size of 510 thousand m^2.

determined by the cost of the receiver (7.1%), the reflector (6.4%) and the metal support structure (10.7%), but solar field piping (5.4%) and HTF (2.1%) also involve considerable investment. To install these components and build the whole power plant, it is necessary to employ a staff of about 500 people, based on Andasol 1, while more advanced technologies rely on fewer workers. The majority of the workforce is blue collar workers who assemble the collectors and perform construction work of building infrastructure. Further, logistic experts need to provide the whole transport system, which must be resistant to bottlenecks which are a cost multiplier in the work flow. Overall management is provided by experienced specialists, to ensure on-time and cost-efficient planning. Labor constitutes about 17 percent of costs. If storage is included, 10 percent of total investment is due to this system. The relative contribution of other costs is also affected by storage because a storage plant is usually equipped with a much larger solar field. Other costs include project development (2.9%), project management (7.7%), financing

(6%) and risk allowances (3%). This cost block is strongly project-related and can change due to project characteristics.

- **Although the components of the solar field are the most capital-intensive and largest part in the value chain, there are opportunities for local manufacturing and services all along the value chain.**

The International Players in the CSP Value Chain

The value chain analysis gives an overview of international companies currently active in CSP. These companies show a high potential to participate in future MENA CSP markets. Some players are already involved in the ongoing CSP projects in Morocco, Algeria and Egypt.

- **Local manufacturing can take place if technical and economic requirements for local and international companies are met. Most important is a sustainable CSP market, which will have to be facilitated by a supportive policy environment. Local manufacturing is related to market size as the output of a single component factory is often high.**

Opportunities for MENA Industries of Manufacturing CSP Components in the Value Chain

The report analyzes in depth the complexity and investment intensity of a selection of production processes to give a broad overview of which CSP components can be most easily adapted for local manufacturing by local or international industry, and would consequently have the highest potential for manufacture in MENA countries in the short- and mid-term. For each manufacturing process or service, barriers and bottlenecks can be identified that could impede local MENA industries' entry to the CSP market in MENA. Table RS.5 provides an overview of technical and economic barriers to manufacturing CSP components that will need to be minimized with special roadmaps and action plans if the greatest potential of MENA in CSP is to be realized.

The analysis of the value chain leads to the following conclusions:

- A growing market has been identified for all groups in the value chain (raw materials, components, engineering, engineering, procurement and construction contractors, operator, owner, investors, and research institutions).
- High technological know-how and advanced manufacturing processes are necessary for some key components, like parabolic mirrors or receivers, which nevertheless offer the highest reward in terms of value added.
- Some sectors and companies, like receiver suppliers, strongly depend on CSP market demand and growth. Other firms have built their production and manufacturing capacities to respond to the demand of other markets (CSP is only one market segment for these companies).

Table RS.4 ■ Value Chain Analysis

	Industry structure	Economics and costs
Project development	• Small group of companies with technological know-how • International actors have fully integrated activities of concept engineering; often with project development, engineering, financing.	• Mainly labor-intensive engineering activities and activities to obtain permits.
EPC contractors	• Strong market position for construction, energy, transport and infrastructure projects.	• Large infrastructure companies (high turnover)
Parabolic mirrors	• Few, large companies, often from the automotive sector • Large factory output	• Large turnover for a variety of mirror and glass products
Receivers	• Two large players • Factories also in CSP markets in Spain and US	• Large investment in know-how and machines required
Metal support structure	• Steel supply can be provided locally • Local and international suppliers can produce the parts	• High share of costs for raw material, steel or aluminum

	Market structure and trends	Key competiveness factor
Project development	• Strongly depending on growth/expectations of individual markets • Activities world-wide	• Central role for CSP projects • Technology know-how • Access to finance
EPC contractors	• Maximum 20 companies • Most of the companies active on markets in Spain and the US	• Existing supplier network
Parabolic mirrors	• A few companies share market, all have increased capacities • High mirror price might decline	• Bending glass • Manufacturing of long-term stable mirrors with high reflectance • Inclusion of up-stream float glass process
Receivers	• Strongly depending on market growth • Low competition today; new players about to enter the market	• High-tech component with specialized production and manufacturing process
Metal support structure	• Increase on the international scale expected • Subcontractors for assembling and materials	• Price competition • Mass production/ Automation

	Strengths	Weaknesses	Opportunities	Threats
Project development	• Reference projects • Technology know-how	• Dependency on political support	• Projects in pipeline	• Price competition with other renewables
EPC contractors	• Reference projects • Well-trained staff • Network of suppliers	• High cost	• Projects in pipeline • Achieve high cost reduction	• Price competition with other renewables
Parabolic mirrors	• Strong position of few players • High margins (high cost reduction potential)	• Cost of factory • Continuous demand required	• New CSP markets • Barriers for market enrty	• Unstable CSP market • Flat mirror technology (Fresnel/ Tower)

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Table RS.4 ■ Value Chain Analysis (*continued*)

	Strengths	Weaknesses	Opportunities	Threats
Receivers	• High margins (high cost reduction potential)	• Dependency on CSP market • High entry barrier for new players (know-how/ invest)	• High cost reduction potential through competition	• Unstable CSP market • Low market demand • Strong market position of few players; new players to become commercial
Metal support structure	• Experience • New business opportunities for structural steel • Low entry barriers	• High cost competition	• Increase of efficiency and size	• Volatile CSP market

- Some components (piping, HTF, electronics, power block) are produced by companies without extensive CSP know-how or background because this equipment is used for many other applications (chemical, electronic, and electric industries).
- The potential of MENA CSP may be achieved by the manufacture of components by local, regional and international companies, and the construction of CSP plants in the MENA region by local construction companies and subsidiaries of the international CSP industry.
- Production capabilities for some key components (mirrors and receivers) moved to the current CSP markets in Spain and the United States as soon as the market (or the prospects for the market) had attained a sufficient size. They could move to MENA when the CSP market takes off in the region.

Evidence from the CSP Value Chain of Local Manufacturing in MENA and other CSP Markets

Three CSP plants (all integrated with gas-fired combined cycle turbines) are under construction or in the commissioning phase in Kuraymat (Egypt), Ain Beni Mathar (Morocco) and Hassi R'mel (Algeria). As these are the first plants of their type in the region, examining their use of local manufacturing provides insights about the share of local content that can be achieved and could diminish the learning curve of future plants. For comparative purposes, the local component of plants in Spain, the United States and China are also evaluated:

- ***Kuraymat (Egypt):*** About 60 percent of the value for the solar field is generated locally. Civil works, the mounting structure, the tubes, electrical cables, grid connection, the engineering, procurement and construction responsibility (engineering strongly supported by Fichtner Solar and

Table RS.5 ■ Technical and Economic Barriers to Manufacturing CSP Components

Components	Technical barriers	Financial barriers	Quality	Market	Suppliers	Level of barriers
Civil work	Low technical skills required	Investment in large shovels and trucks	Standard quality of civil works, exact works	Successful market players will provide these tasks	Existing supplier structure can be used for materials	**Low**
EPC engineers and project managers	Very highly skilled professionals: engineers and project managers with university degrees		Quality management of total site has to be done	Limited market of experienced engineers	Need to build up an own network	**Medium**
Assembly	Logistic and management skills necessary Lean manufacturing, automation	Investment in assembly-building for each site, investment in training of work force	Accuracy of process, low fault production during continuous large output Low skilled workers	Collector assembly has to be located close to site	Steel parts transported over longer distance Competitive suppliers often also local firms	**Low**
Receiver	Highly specialized coating process with high accuracy Technology-intensive sputtering step	High specific investment for manufacturing process	High process know-how for continuous high quality	Low market opportunities to sell this product to other industries and sectors	Supplier network not strongly required	**High**
Float glass production (for flat and curved mirrors)	Float glass process is the state-of-the-art technology but large quantities and highly energy intensive Complex manufacturing line Highly skilled workforce to run a line	Very capital-intensive	Purity of white glass (raw products)	Large demand is required to build production lines	Supplier network not strongly required	**High**
Mirror *flat* (float glass)	Complex manufacturing line Highly skilled workforce to run a line	Capital-intensive	Long-term stability of mirror coatings	High quality flat mirrors have limited further markets Large demand is required to build production lines	Supplier network not strongly required	**High**

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Table RS.5 ■ Technical and Economic Barriers to Manufacturing CSP Components (*continued*)

Mirror *parabolic*	*See flat mirrors* Plus: Bending: highly automated production	*See flat mirrors* + bending devices	*See flat mirrors* High geometric precision of bending process	Large demand is required to build production lines Parabolic mirrors can only be used for CSP market	Supplier network not strongly required	**High**
Mounting structure	Structure and assembly are usually proprietary know-how of companies Standardization/automation by robots or stamping reduces low skilled workers, but increases process know-how	Automation is capital-intensive Cheap steel is competitive advantage	For tracking and mounting: stiffness of system required	Markets with large and cheap steel Transformation industries are highly competitive	Raw steel market important	**Low**
HTF	Chemical industry with large productions. However, the oil is not highly specific	Very capital- intensive	Standard product, heat resistant	Large chemical companies produce thermal oil	Not identified	**High**
Connection piping	Large and intensive industrial steel transformation processes Process know-how	Capital-intensive production line	High precision and heat resistance	Large quantities	Not identified	**Medium**
Storage system	Civil works and construction is done locally Design and architecture Salt is provided by large suppliers	Not identified	Not identified	Low developed market, few project developers in Spain	Not identified	**Medium**
Electronic equipment	Standard cabling not difficult Many electrical components specialized, but not CSP specific equipment Equipment not produced for CSP only	Not identified	Not identified	Market demand of other industries necessary	Often supplier networks because of division	**Low**

Flagsol), the operation and utility is all done by local industry. However, some of the key components are still provided by international industry (for example, the mirrors, receiver, heat transfer fluid, and steam generator). Egypt is making efforts to achieve more local content in newly established wind parks. In tenders and bidding procedures, projects with a large share of locally produced components are prioritized. This approach could also be introduced for CSP projects.

- ***Aïn Beni Mathar (Morocco):*** All main components and equipment for the project are imported from international market players. Low participation of local industry in the first projects leads to low technology transfer. Many international component suppliers have taken their first steps in the MENA market by selling their components in Morocco. Cost advantages for local components and services could not be identified.
- ***Hassi R'mel (Algeria):*** A very large share (up to 90 percent) of all equipment and components is imported: there is no local share in the manufacturing of the solar field. Civil work at the Algerian site costs up to 30 percent more than in Spain. Abener is expecting that future projects can use a locally produced steel mounting system. Although some know-how for project development of conventional power plants exists in Algeria, the engineering, procurement and construction (EPC) contractor is always an international company. A local company, Sarpi, provides electronic equipment for the plant. An Algerian engineering company (Algesco) will provide turbine maintenance during operation; the main O&M is done by Abener. Although this analysis finds that the Algerian industry could play a role in local manufacturing, the share of local involvement in the current project is very low. Even components and services with a lower technology level have been provided by international companies.
- ***USA:*** The US government recently provided a loan guarantee of US$1.45 billion to Abengoa to build a 260 MW_{el} CSP power plant in Arizona (Solana) with the condition that the project was to utilize a maximum share of American components, leading Abengoa to raise the local share to 70 percent.
- ***Spain***: For the first large commercial plant Andasol 1 in 2006, the share of Spanish suppliers was below 50 percent. Four years later, the new plants had more than 75 percent local suppliers (personal communication Protermosolar).
- ***China:*** Among several other countries, China has successfully used local content requirements to increase the local manufacturing of renewable energy components. In 2005, the Chinese National Development and Reform Commission (NDRC) stipulated that new wind farms must meet a 70 percent local content requirement on value added. Local content clauses are removed once internationally competitive local industries have been established.

These examples show a large range of local manufacturing shares in CSP projects. The local share has been very limited for Hassi R'Mel and Aïn Beni Mathar, as most components were imported by the EPC contractors. This can

be explained by the fact that the first aim of these projects 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 technical advice on 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 that project have gained knowledge and should be able to use it for future projects.

- **The Kuraymat ISCCS plant in Egypt could 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 the local industry is already capable of developing and building CSP projects.**

Although the project development for the solar field was done by international companies because of a lack of local experience with the development of CSP plants, in the future, it is likely that local engineering offices and EPC contractors will be able to transfer the experience gained in this project to future projects.

A promising approach to develop local CSP production would be to combine:

- International cooperation to facilitate know-how transfer.
- Involvement of a local EPC contractor to facilitate local companies stepping into the CSP value chain.
- Providing incentives to companies for making the effort to involve local companies and components so that they can gain experience in the field.

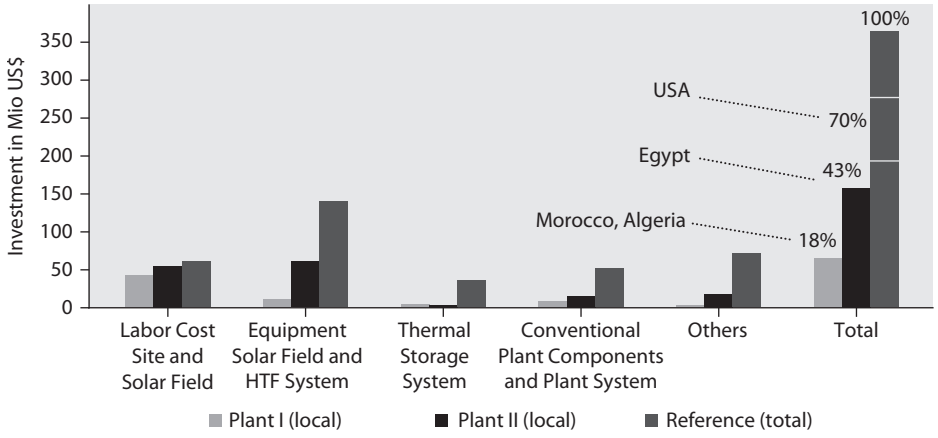
Potential for Local Subsidies and Local Manufacturing of International Companies and Production Thresholds

International companies will have an important role to play in the development of local industries. EPC companies and project developers already active in the region have local offices in MENA countries close to the CSP projects and their customers. The companies employ local and international workers and engineers for projects in the countries. Comparable with conventional power plants, CSP companies also expect a high share of project development, management, and engineering from international companies with extensive technical expertise and project experience. Figure RS.4 provides an overview of the possible local content of different parts in the value chain as seen by international players.

The status quo of local manufacturing for CSP projects in the MENA region and the potential for local manufacturing for the different blocks in the value chain is evident from figure RS.4 above, which shows that overall local content in the value chain ranges from 18–43 percent while examples from the US show

Figure RS.4 ■ Possible Local Content by Component of CSP Power Plants

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



that 70 percent could be reached. The importance of the size of the domestic CSP market is underlined by table RS.6.

- **Below the thresholds listed in table RS.6, it may be difficult to attract core CSP manufacturing unless export markets can be exploited to support market deployment. This also points to the importance of regional specialization and cooperation as long as the domestic markets are still on the rise.**

In interviews, international companies emphasized several support mechanisms that would improve the situation of CSP in the MENA Region:

- Long-term security for planning and financing by feed-in tariffs or comparable mechanisms, including export contracts to Europe
- 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 RS.6 ■ Thresholds for a Typical Factory for core CSP Components

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

Achieving a sustainable market will require more than grants or concessional loans, which are for only a limited number of projects. Instruments like feed-in tariffs or PPAs with a long-term perspective and tender procedures with a constant annual installation volume over at least 5 to 10 years would facilitate long-term planning. Without a long-term perspective, international companies have low interest in investing in the region.

SWOT Analysis of MENA Industries Relevant for Key CSP Components

A SWOT analysis of MENA industries suitable for CSP is summarized in the table RS-7; more details by industry are given in the report.

- **Several industrial sectors that have the potential to integrate the CSP value chain in the MENA Region are dynamic and competitive on a regional, and sometimes international, scale.**

The glass industry, particularly in Egypt and Algeria, has been a regional leader for a long time and is still increasing 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, as well as through the establishment of local subsidiaries of international players. In the past, the development of MENA CSP industries was driven by the low cost for labor and energy (the latter in particular for Algeria and Egypt) and by the geographic proximity to Europe. In order to position themselves for the CSP market, MENA industries face several challenges, mainly in adapting their capacity to higher technology content (for example in the glass industry). 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 "centers of excellence" instead of low-cost and low-skilled manufacturing.centers.

The shift toward higher technology content will require increased international and regional cooperation. Whereas cooperation between western countries and

Table RS.7 ■ A SWOT Analysis of MENA Industries Suitable for CSP

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, to a lesser extent, aeronautics) • 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 subsidized up to 75% in some countries (although subsidies are decreasing) • 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 regulations often deficient • Need for strong network, business and political connections • Lack of specialized training programs for renewable energies • Partly insufficiently developed infrastructure
Opportunities	**Threats**
• Further cost reduction of all components • Attractiveness to external investors by large market demand • Solar energy: Moroccan Solar Plan (2 GW), Tunisian Solar Plan, premises of an Egyptian Solar Plan, etc. • Possibility of technology transfer/spillover effects from foreign stakeholders in MENA • Political will to develop a local renewable energy technologies industry • Export potential (priority given to export industries)	• Training of workforce and availability of skilled workers not sufficient • Technical capacities of local engineering firms • Lack of awareness of management on opportunities in CSP sector • Access to financing for new production capacities • Presence of public actors in clean-tech value chain while private actors more absent • Competition with foreign stakeholders: historical presence of German players and strong interest of USA in the Egyptian market • Higher costs compared to international players • Higher transport losses/costs due to insufficient infrastructure • Competition with other emerging countries

MENA is thriving, cooperation between MENA countries' industries is relatively low. Initiatives have been undertaken to develop intra-MENA cooperation, in aeronautics for example, but have never been very successful. Shared research and technology development between public bodies (e.g., universities) and corporations could be strongly enhanced, for instance, by developing technology platforms and clusters.

Many industrial companies still have a limited understanding of the market potential offered by CSP deployment. Raising the awareness and interest of these potential players will require clarification of the market for CSP in the MENA region and beyond. Furthermore, investigating the possibilities of flexible

production lines might contribute toward mitigating other risks related to the CSP market's evolution. For example, steel structure manufacturers usually adapt their production tools to different products with little effort.

Industry Capabilities for CSP Components and Services

- **Regardless of identified obstacles to participation of local MENA industries, the expert interviews with MENA companies and with the existing CSP industry carried out during this study have shown increasing potential for local manufacturing of components for CSP and the provision of construction and engineering services for new CSP plants, if the CSP market grows steadily in the MENA Region.**

Key findings regarding the status quo and future perspectives of local manufacturing for CSP plants are:

- Successfully constructed ISCCS projects have increased CSP experience and know-how in MENA.
- Some components and parts for the collector steel structure were supplied by the local steel manufacturing industry (Algeria, Egypt, and Morocco).
- The workforce has been trained on the job; engineering capacities have also experienced some progress.
- Specialization of each country would be beneficial because local demand will probably be relatively low in short/medium terms.
- Several parts of the piping system in the solar field—for the interconnection of collectors and power block—can already be produced locally by regional suppliers.
- The development of a CSP mirror industry in MENA countries has significant potential.
- Involvement of international companies will play an important role in the mid-term development of the CSP industry in MENA countries because it will build up local production facilities.
- Minimum factory outputs have to be taken into consideration for local manufacturing of special components (glass, receivers, salt, thermal oil).

The main drivers for development of CSP local manufacturing in the MENA region are similar to markets in Spain or the United States (table RS.8).

The prospects for local manufacturing can be summarized for each component:

- ***Construction and civil works:*** In the short term, all construction at the final plant site with the basic infrastructure, installation of the solar field, and construction of the power block and storage system could be accomplished by local companies (17 percent of total CSP investment for a reference plant or approximately US$1 million per MW).

Table RS.8 ■ Requirements 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 Works					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	

- ***Mounting structure:*** The mounting structure can be supplied locally if local companies can adapt manufacturing processes to produce steel or aluminum components with the required high accuracy.
- ***CSP-specific components with higher complexity:*** In the short to medium term, local industry is generally capable of adapting production capacities and creating the technological knowledge to produce mirrors (glass bending, glass coating and possibly float glass process) of high quality and high technical standard as required for parabolic mirrors in parabolic trough plants. This might require international cooperation for specific manufacturing steps in the short term. Later, local provision of components could include high-quality mirrors, receivers, electronic equipment, insulation, and skills for project engineering and project management. In particular for the receiver (absorber) technology, the most promising option will be for international companies to move closer to the rapidly increasing markets.

Figure RS.5 describes a possible evolution of local CSP industries for the key components (mirrors, mounting structure, electrical and electronic equipment) in the MENA region, taking into account the market size for different components.

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 (e.g., cables, balance of plant) will be supplied by players who are currently active in conventional markets. Market

Figure RS.5 ■ Evolution of Local CSP Industries for Key Components in the MENA Region

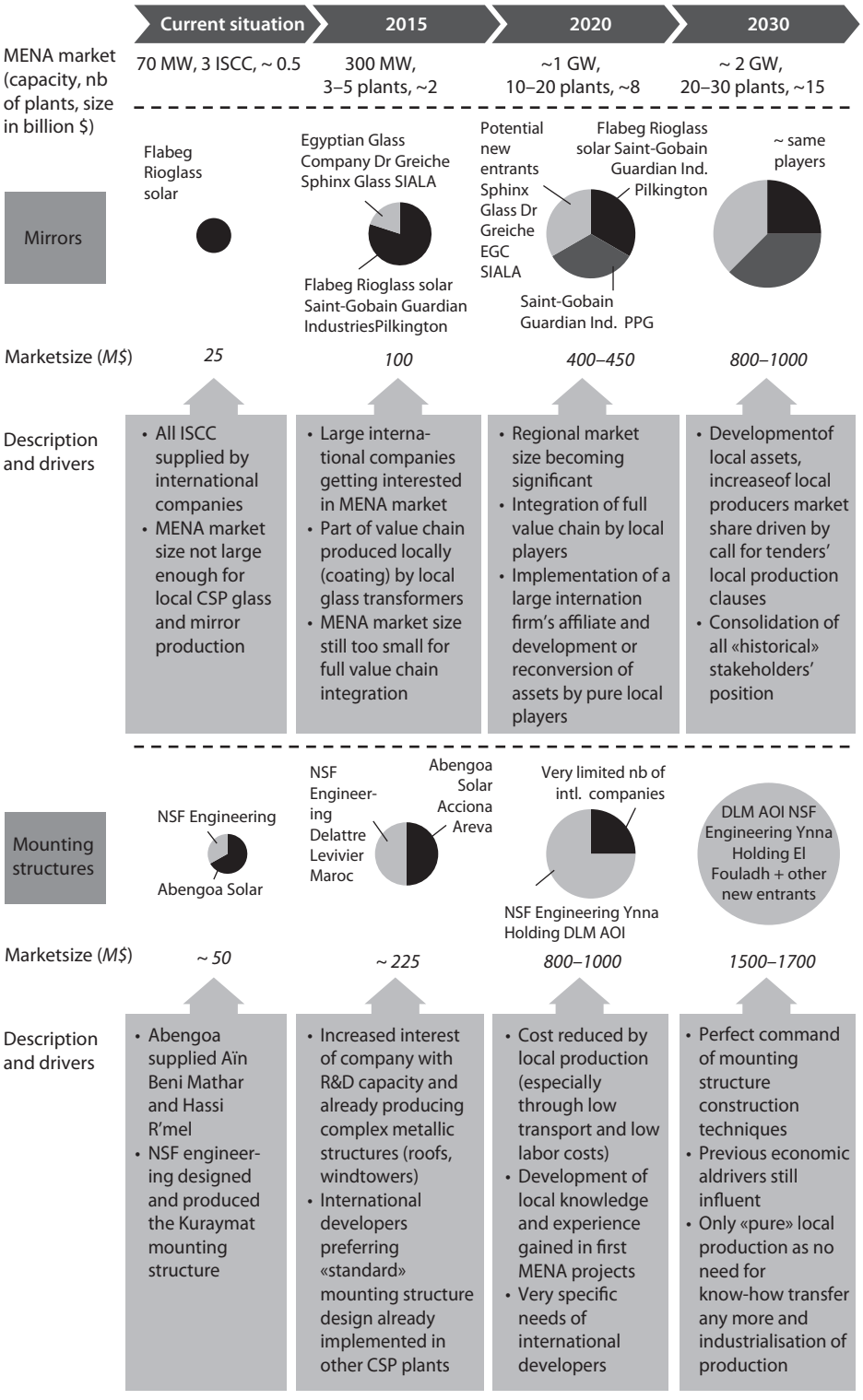
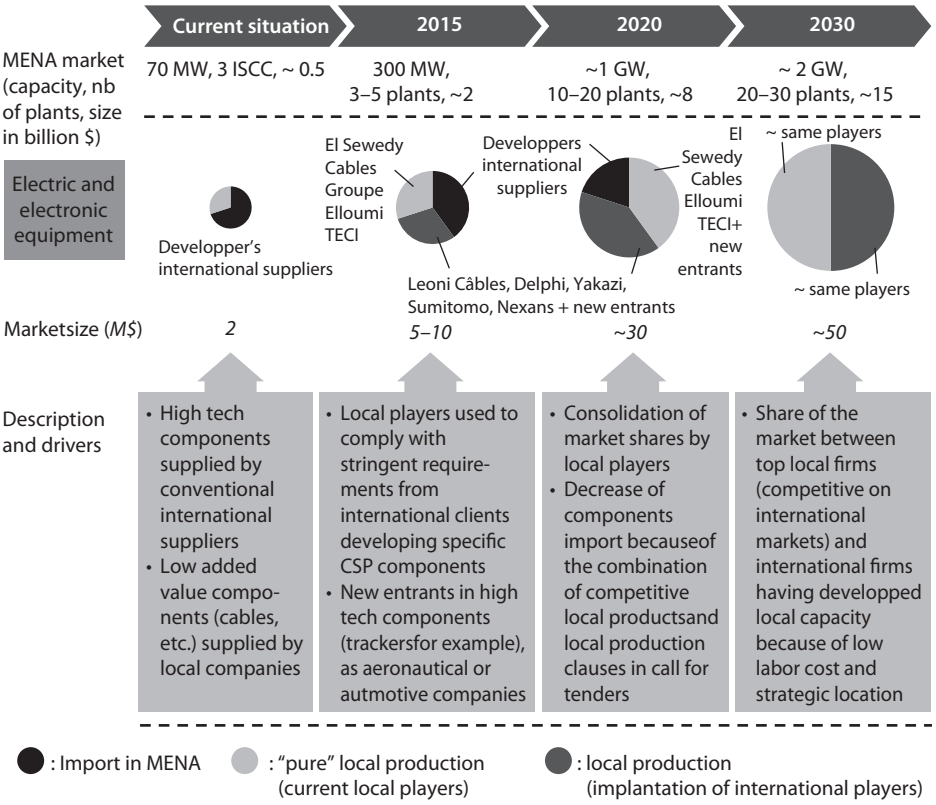


Figure RS.5 ■ Evolution of Local CSP Industries for Key Components in the MENA Region (*continued*)



shares should evolve according to traditional market drivers such as MENA industries' competitiveness, exchange rate, and availability of low cost materials. On the other hand, very 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 significantly.

Scenarios for Local Manufacturing in MENA Countries

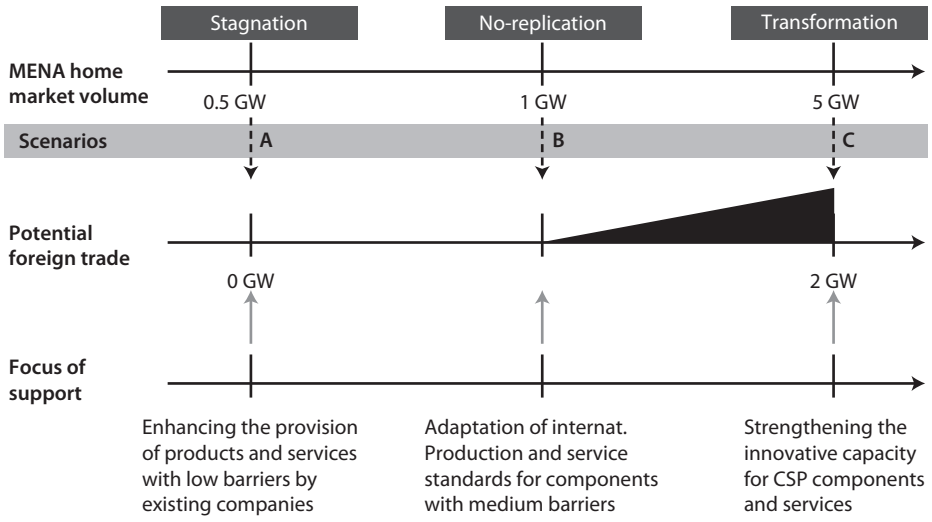
In the report, detailed roadmaps and action plans are developed for the key components and services of the CSP value chain. The action plan, with a time horizon until 2020, is developed based on three scenarios.

- **It is assumed that the volume of the installed CSP capacity within the MENA region (home market volume) is a main precondition for the emergence of local manufacturing, thus the scenarios represent critical levels of market development for local manufacturing. The home market volume and the potential amount of export (external market volume) are regarded as indicators for the development of a successful policy scheme.**

The scenarios chosen here represent critical levels of market development for local manufacturing. The market volume is described for the five countries investigated in detail in this study. For the MENA region as a whole, it can be assumed that the market volume could twice as large as in the MENA CTF countries alone. The three scenarios proposed are:

- **Scenario A – Stagnation:** The domestic market volume of the five MENA CTF countries amounts to 0.5 GW only. Major obstacles to local manufacturing of CSP components remain in the country markets, and most components, particularly those whose production requires high investment costs, are imported from more advanced markets. This scenario implies an incomplete realization of the MENA CSP IP.
- **Scenario B – No-replication:** The home market volume of the five MENA CTF countries amounts to 1 GW in 2020, which is strictly the MENA CSP IP target, without any significant replication effect. In this scenario, the market offers some opportunities for the development of local manufacturing of CSP components and provision of CSP services. This scenario aims at an adaptation of international production standards and techniques in existing industries, and leads to a region-wide supply of suitable CSP components produced locally in the MENA region. The base level of 1 GW, which would mainly be determined by the CTF alone, does not include any additional CSP development triggered beyond the initiative in a narrow sense. This base level would therefore constitute a foundation on which more comprehensive policies can spur a larger CSP development in the region.
- **Scenario C – Transformation:** The domestic market volume of the five countries amounts to 5 GW and the export of components reaches a volume corresponding to 2 GW installed CSP capacity. National CSP promotion

Figure RS.6 ■ Market Scenario Context for the Analysis of Local Manufacturing Opportunities



plans have been developed quickly, international initiatives are strongly represented and/or private investors are notably active in the region. Policy actions should support innovations and the development of intellectual property rights in the field of CSP components. A strong export orientation should be motivated to take advantage of the proximity to other emerging markets.

Assumptions for scenario C are based on past developments for the annual growth rates of total installed capacities for other renewable technologies, such as wind and PV (about 60 percent annual growth rates over a decade in the case of ambitious policies, and about 20–30 percent for countries with less ambitious policies, table RS.9), as well as on world-market projections for CSP.

It is important to compare the scenario settings described above with the production thresholds of typical factories for core CSP components (see section on "Potential for local subsidies and local manufacturing of international companies and production thresholds"). As discussed earlier in this report typical thresholds for key components are in the range of 200–400 MW per year for mirrors or receivers, and 50–200 MW per year for mounting structures. This implies that the total MENA market should reach, in the ten years up to 2020, a level of total installed CSP

Table RS.9 Average Annual Growth in Cumulative Installed Capacities for Wind Energy, PV and CSP

Wind Power	1991/2000	2000/2009	Exact period
Germany	56%	17%	
Spain	90%	27%	
Denmark	22%	4%	
USA	—	63%	2003/2009
China	—	60%	
India	—	28%	
Brazil	—	66%	2003/2009
Egypt	—	36%	2003/2009
Morocco	—	29%	2003/2009
Turkey	—	155%	2005/2009
Solar PV	**2000/1991**	**2009/2000**	
Germany	57%	64%	
USA		28%	
Japan		18%	2004/2009
CSP			
World		41%	2007/mid-2010
World		59%	2007/2015
Scenario A		24%	2010/2020
Scenario B		32%	2010/2020
Scenario C		61%	2010/2020

Source: Fraunhofer ISI based on various sources

capacity of 2–4 GW in the first case and 0.5–2 GW in the second case. Assuming half are installed in the five MENA CTF countries, the thresholds are 1–2 GW up to 2020 if mirrors or receivers are considered for local production, and 0.25–1 GW in the case of mounting structures (i.e., between scenarios B and C).

- **This shows that the "no-replication" scenario is at the lowest level to fulfill those thresholds, and that the CTF effort must at least trigger a doubling of the CSP installations in these five MENA CTF countries.**
- **The "transformation" scenario, on the other hand, may materialize only under favorable conditions and a more conservative level of installed power may lie somewhere between the "no-replication" scenario and the "transformation" scenario. It was, however, the purpose here to estimate a range rather than to come up with a precise view on how many GW out of the 5+2 GW underlying the "transformation" scenario will be constructed by 2020.**

Roadmaps for the Development of Local Manufacturing of CSP Components in the MENA Region

Based on the assessment and identification carried out of existing and potential domestic and foreign players (manufacturing companies, financial investors, etc.), the report identifies potential routes to developing local manufacturing capabilities. The aim of the roadmaps is to show, based on the current situation, possible technological and entrepreneurial developments in the regional manufacturing of each component in the short, medium, and long term and to identify overall, long-term objectives in these fields. The underlying essential preconditions for all components include a reliable CSP market growth and a stable political framework. Detailed roadmaps are developed for:

- **Key components:** The highest value added for the region can be expected from these components which include CSP mirrors (see next page), mounting structures, and receiver tubes.
- **Key services:** EPC and other services.
- **Secondary components:** For components such as piping and cables countries have already developed competitive advantages (e.g. production of electric cables in Tunisia and Egypt). These components do not represent a major share of value added, but can still contribute significantly in absolute terms, particularly due to possible exports.

The roadmaps are separated into technological developments (e.g. changes in production lines, production skills, and production capacities), business developments (e.g, cooperation agreements, R&D activities and other entrepreneurial decisions) and underlying market and policy developments. For each of these levels, the most important critical steps and milestones are presented and interrelations between the different levels are indicated. The measures needed to overcome critical steps and reach the milestones are subsequently discussed in

Figure RS.7a ■ Potential Roadmap for EPC and Services in CSP-Projects in the MENA Region

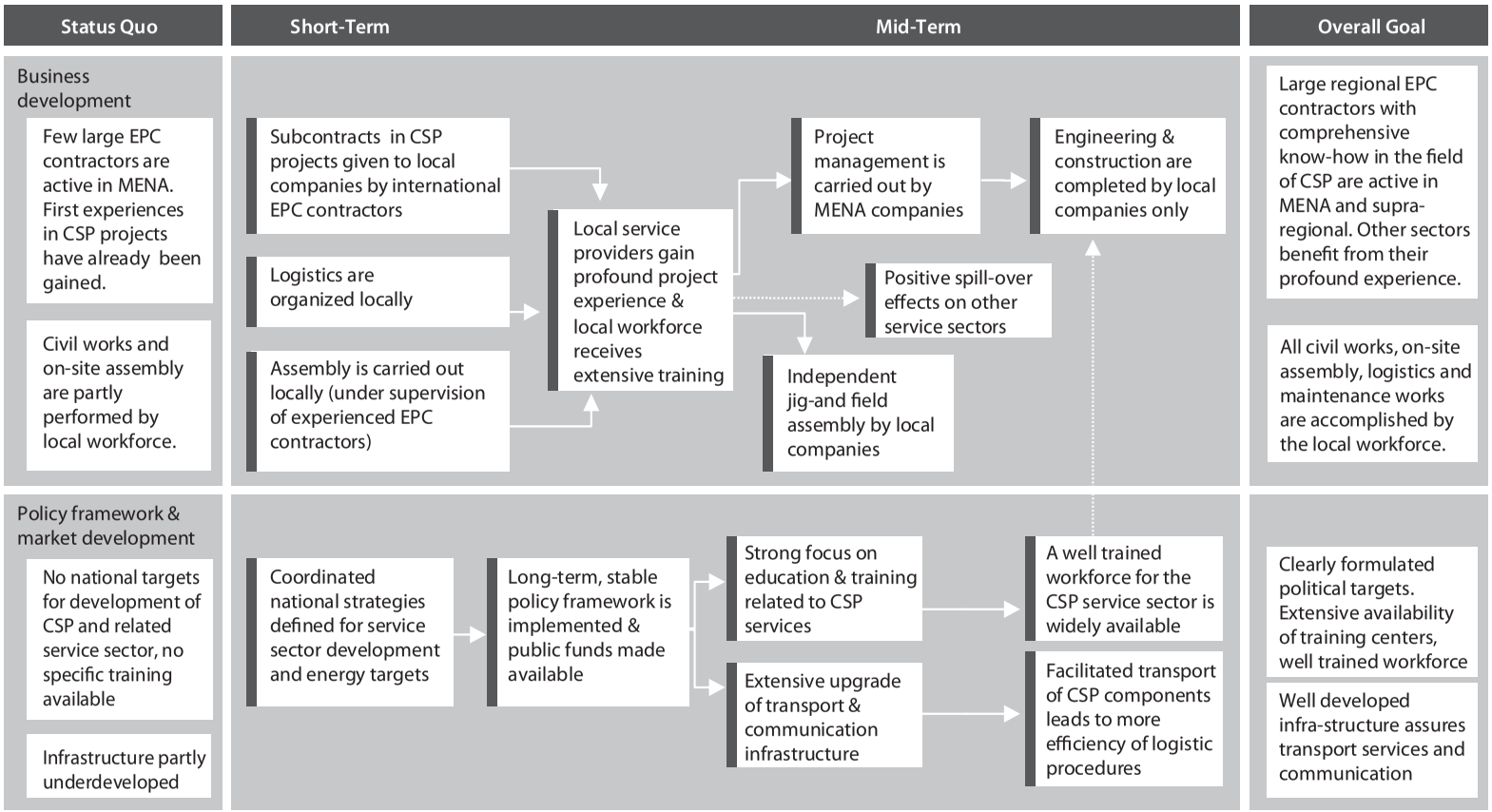


Figure RS.7b ■ Potential Roadmap for the Production of CSP-Mirrors in the MENA Region

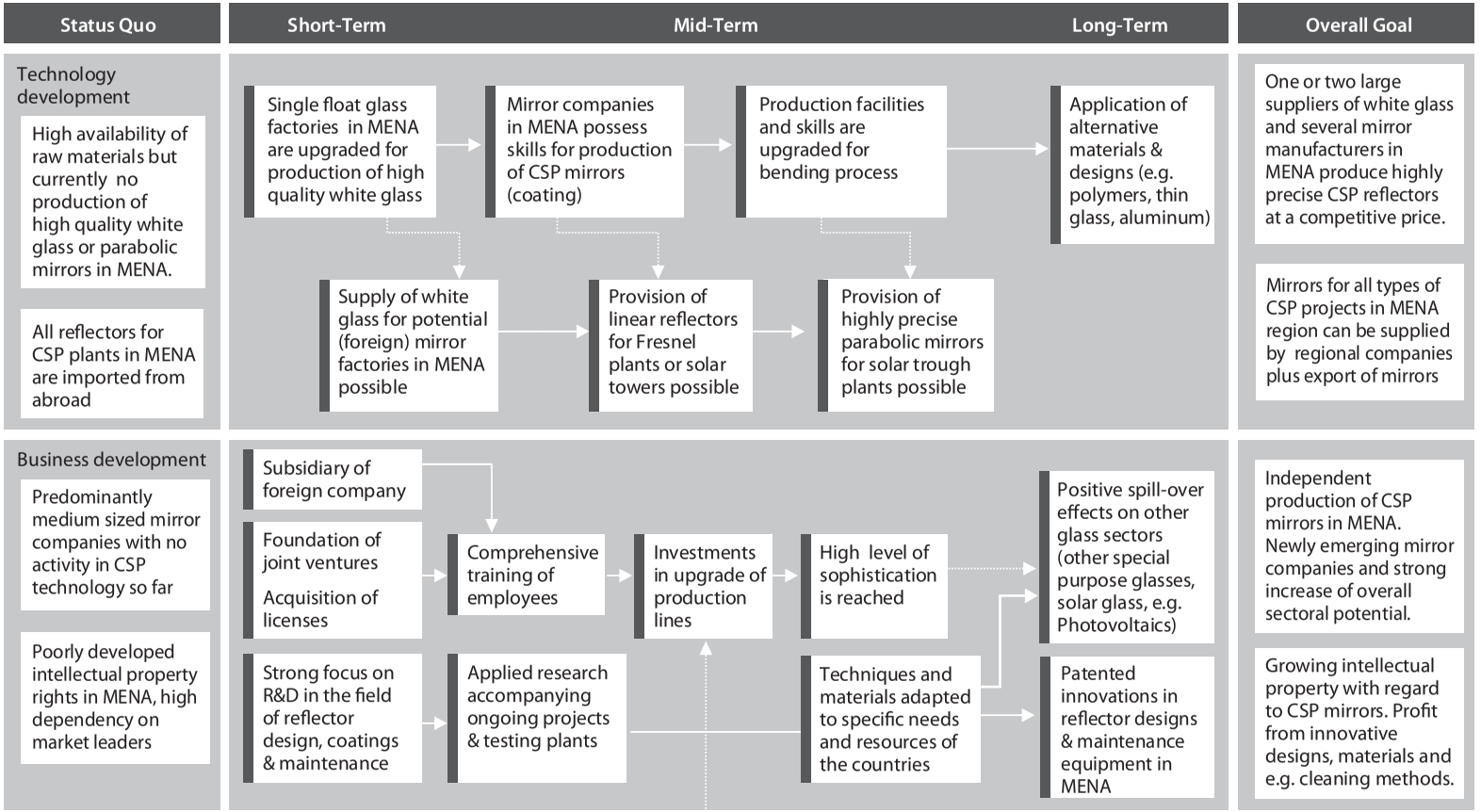


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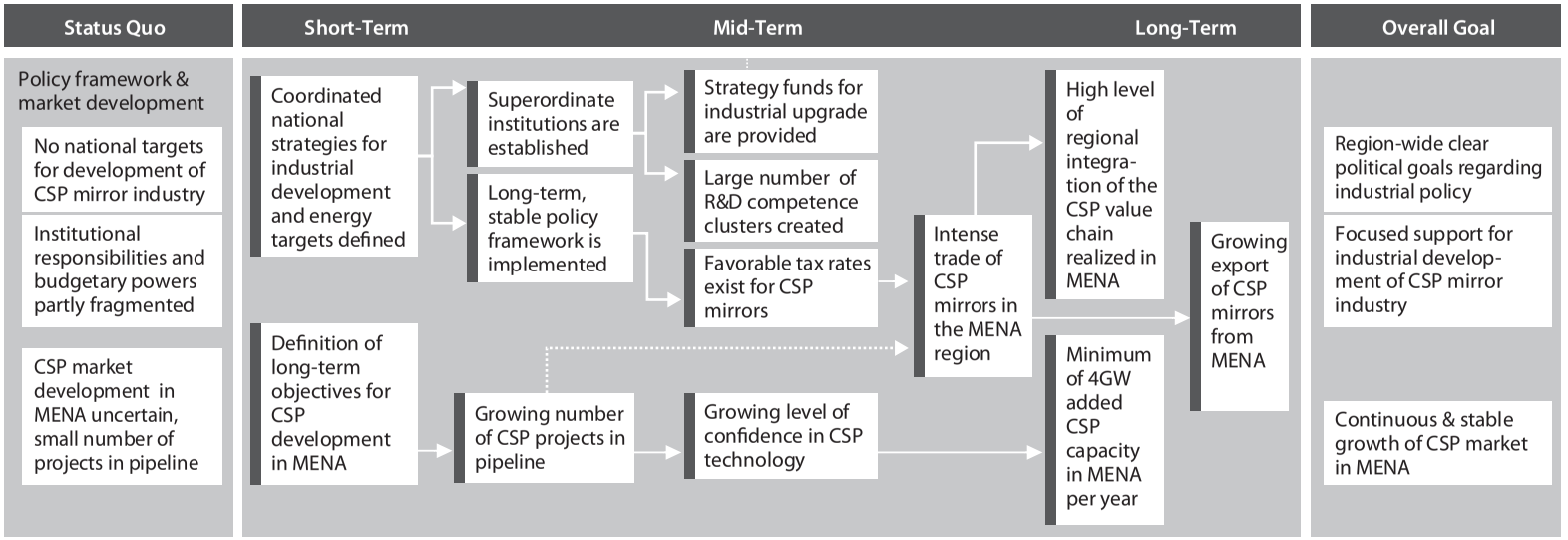
Figure RS.7b ■ Potential Roadmap for the Production of CSP-Mirrors in the MENA Region *(continued)*



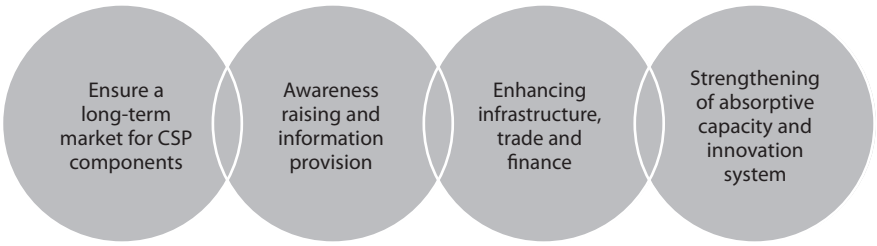
an action plan. The timeframe of the roadmaps covers short-term developments which could be realized within the next 2–5 years, mid-term developments in 6–10 years, and long-term developments which might be realizable after 2020. These targets, particularly in the long-term, depend on the development of a CSP market as described in the previous section. Some technological milestones might only be reached if there is robust growth in the CSP market.

Action Plan for Stimulating CSP Manufacturing and Services in the MENA Region

In this section a detailed action plan for stimulating CSP manufacturing and service provision in the MENA region is developed for all relevant actors.

The creation of a stable policy framework and a sustained domestic market are the major preconditions for the development of a sustainable CSP-industry. In the long run, the annually installed capacity should be on a GW scale to allow for the development of production lines, particularly in the case of mirrors and receivers. The success of the MENA CSP IP is key to achieving this target. Also, a strong regional integration of the CSP value chain, making use of the countries' comparative advantages and including dismantling of trade barriers and coordination of national policies, is crucial to overcome barriers related to critical quantities (threshold values for a profitable production) in the manufacturing of CSP components.

The focus of support depends on the expected market size. In the case of a quasi stagnation of the CSP market in the region (scenario A – stagnation), support should focus on enhancing the manufacturing of low-tech components and basic services for which the market barriers are relatively small and no large investments are required (e.g., mounting structures, civil works, and assembly). Assuming a moderate but stable growth of the CSP MENA market (scenario B – no replication), an adaptation of international production standards and techniques in existing industries should be targeted to achieve a region-wide supply of at least some suitable CSP components produced locally in the MENA region (e.g., mounting structures, piping, cables/electronic equipment and a wide range of related services). Under the more desirable "transformation" scenario (scenario



C), policy actions should strongly support innovation and the development of intellectual property rights in the field of CSP components to profit from first-mover advantages and to develop technologies specifically tailored to MENA conditions. A strong export orientation should be encouraged to benefit from the proximity to other emerging markets. Under this scenario, the production of a wide range of CSP components could be achieved (parabolic mirrors and potentially receivers).

National strategies for industrial development and energy policy must be well coordinated. They should include clearly defined and broadly communicated targets for the market diffusion of CSP, substantial R&D efforts, and the creation of highly specialized strategy funds for industrial development of CSP industry sectors.

- **Financial aid will be necessary**, especially for the technical adjustment of production facilities (including feasibility assessments) and the implementation of training courses for the local workforce. A provision of low interest loans, grants, and tax incentives specifically designed to foster the local manufacturing of renewable energy components would help MENA companies to enter the CSP business.[2] Funds could also be provided to facilitate knowledge transfer (e.g., via purchase of licenses). It is considered unlikely that local companies will enter into the production of CSP receivers due to the high complexity of this component; tax incentives (e.g., in the form of reduced corporate and land registration taxes and facilitated VAT refunds) could help to attract international companies to the MENA region for this specialized production.
- **Market actors will need good access to CSP-related information and certainty about market development.** The creation of a regional CSP or renewable energy association dealing with issues such as the CSP market development, manufacturing options, and the latest technological advances will facilitate access to information.
- **An enhanced innovative capacity will be key.** The creation of a larger number of technology parks/clusters and regional innovation platforms is necessary to grow innovative capacity of industrial sectors and to foster company networking and R&D. This will help small and medium-sized firms in particular to overcome innovation barriers and to gain access to the latest technological advances.
- **Individual business models should build on the comparative advantages of certain sectors in MENA countries and also involve international co-operation agreements**, e.g. in the form of joint ventures and licensing, to

[2] The most critical steps in the upgrade of production facilities for CSP components have been identified as the implementation of automated processes for the production of precisely manufactured mounting structures, the supply of high quality white float glass, and the adaption of techniques for coating and bending of parabolic CSP mirrors.

accelerate the development of comprehensive CSP know-how in the region and to benefit from the broad experience of existing companies. Especially in the case of receivers, subsidiaries of foreign companies will most likely be a relevant business model at the beginning. Governments could assist the private sector in finding appropriate partners for such cooperative ventures.

- **The careful introduction of local (domestic) content clauses within CSP project tenders will foster a long-term demand for CSP components.** This will be particularly useful in encouraging the deployment of local EPC contractors who have better access to local supply chains and service networks, and who might therefore play a key role in raising the share of local value added in future CSP projects. Increased local consent could be built into contracts.
- **Comprehensive education and training programs for the industrial workforce in relevant sectors will be critical for entering into local manufacturing of CSP components.** Universities should be encouraged to teach CSP-technology-based courses to educate the potential workforce, particularly engineers and other technical graduates.
- **Implementing quality assurance standards for CSP components in the medium to long term should be considered** to ensure regional and international quality requirements and to strengthen the competitiveness of future MENA CSP industries.

Table RS.10 summarizes the potential measures addressed to different actors to stimulate the production of CSP components and provide CSP-related services in the MENA region.

Potential Economic Benefits of Developing a CSP Industry in North Africa

The economic benefits of developing a CSP industry were evaluated for the three CSP scenarios (stagnation, no replication, and transformation) for North Africa with the following distribution of CSP plants over time based on the reference plant taking into account cost degression effects (table RS.11).

Local economic benefits by industrial development in the MENA region, in particular with respect to labor and foreign trade impacts are:

- ***Average share of local manufacturing in the CSP value chain in the MENA region:*** Under the conditions of scenario B ("no-replication"), which does not include additional policy impacts triggered by the MENA CSP IP, and even more under the low-level development of scenario A, the impact on local manufacturing is comparatively low; most CSP components would remain imported, and only construction, project management, and basic engineering services might increase. In the more favorable "transformation" scenario, with significant market growth, the total potential of local added value of CSP plants will increase constantly and could reach almost 60

Table RS.10 ■ Action Plan for Stimulation of Production of CSP Products in the MENA Region
Actors/financers: Δ = National Authorities, ▲ = Internat. Donors, ◊ = National CSP Players, ♦ = International CSP Players

Goals	Intermediate Steps	Necessary processes/assistance	Target groups	Potential actors	Implementation timeframe
Upgrade & increase of industrial and service capacities	Provision of information on CSP market size and opportunities of production and service adjustment	Implementation of national and regional CSP associations that foster networking, accelerate business contacts and provide information	Current and potential future producers of intermediate products and CSP components, research organizations	Δ ▲♦◊	Short to medium term
		Establishment of superordinated national institutions responsible for CSP targets to enhance and coordinate policy development in the regional context and to provide assistance	See above	Δ	Short to medium term
		Creation of internet platforms, newsletters on technical issues and market development, information centers and other informational support	See above	Δ ▲	Short to medium term
	Assessment of technical feasibility for firms to upgrade current production to CSP component production and service provision	Foundation of consortia of technical experts that support companies which show interest in CSP manufacture or provision of funds to consult external technical experts	Current producers of intermediate products and CSP components	Δ ▲	Short to medium term
	Implementation of investment support mechanisms for adaptation of production lines	Financial support of a certain share of the necessary investment for implementation of upgrade of production facilities (e.g. "renewable energy innovation fund")	Current local producers of intermediate products	Δ ▲	Short to medium term
		Provision of long-term low-interest loans for companies willing to invest in innovation of production lines	Current local producers of intermediate products and potential future producers	Δ ▲	Short to medium term
		Facilitation of foreign investments by simplification of bureaucracy and assistance	International players	Δ	Short to medium term

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Table RS.10 ■ Action Plan for Stimulation of Production of CSP Products in the MENA Region (*continued*)
Actors/financers: Δ = National Authorities, ▲ = Internat. Donors, ◊ = National CSP Players, ♦ = International CSP Players

	Price incentives	Tax incentives for production/export of CSP components (e.g. reduction or exemption on customs duties for raw materials, parts or spare parts of CSP components, refund of customs duties with export)	Local producers, national and international companies	Δ	Medium term
		Tax credits or deductions for investments in production lines related to CSP and investments in R&D	National and international companies	Δ	Medium term
		Lowered trade barriers for RE/CSP components and intermediate products to accelerate the trade of components	See above	Δ	Medium term
		Tax credits on firm-level training measures	See above	Δ	Short to medium term
	Further incentives	Local and regional content obligations for components and services in CSP projects	See above	Δ	Medium term
		Foster integration of secondary components suppliers in region	See above	Δ	Short term
Activation of further potential market players and service providers	Strong focus in national and regional industrial policy on CSP development	Formulation of clear national targets regarding the development of CSP industries	National and international industrial players in general	Δ	Short to medium term
		Provision of administrative and legislative support for company start-ups and foreign investments, and formation of relevant institutions	National and international industrial players in general	Δ ▲	Short to medium term
		Financial support mechanisms for national company start-ups in the sector of renewable energy manufacturing	National players	Δ ▲	Short to medium term

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Table RS.10 ■ Action Plan for Stimulation of Production of CSP Products in the MENA Region (*continued*)
Actors/financers: Δ = National Authorities, ▲ = Internat. Donors, ◊ = National CSP Players, ♦ = International CSP Players

		Introduction of regional quality assurance standards for CSP products to decrease uncertainty	National and international companies	Δ ▲♦◊	Medium to long term
	Awareness raising	Awareness-raising initiatives (e.g. conferences, workshops, other marketing activities) and formation of relevant institutions	National and international industrial players in general	Δ ▲♦	Medium to long term
Facilitation of skill enhancement and knowledge transfer	Promote creation of joint ventures between existing manufacturers and potential regional newcomers	Facilitation of networking and knowledge transfer by creating networking platforms and organization of business fairs	Regional and international manufacturers	Δ ♦◊	Short to medium term
	Support of training activities for local workforce	Review of existing national training facilities, upgrade/creation of specific institutions if needed		Δ ▲	Short to medium term
		Provision of short basic training courses for civil workers (e.g. involved in assembly activities)	Regional companies, particularly low-skilled workforce	Δ ▲	Short to medium term
		Support the training of regional workforce by financial support if external training facilities are involved	Regional companies, international companies	Δ ▲	Short to medium term
		Promotion of financial incentives for 'train the trainers' programs	Regional companies, international companies	Δ ▲	Short to medium term
	Support of higher education	Establishment of study courses with regard to solar energy techniques/CSP and other required skills related to RE/CSP	Regional students and engineers, O&M workforce	Δ ▲	Short to medium term
		Creation of master programs at foreign universities and student exchange programs with regard to RE/CSP	Regional students	Δ ▲	Short to medium term
		Review of management and project planning capabilities and creation of training courses	Students, potential CSP workforce (e.g. existing EPC contractors)	Δ ▲	Medium to long term

(*continued on next page*)

Table RS.10 ■ Action Plan for Stimulation of Production of CSP Products in the MENA Region (*continued*)
Actors/financers: Δ = National Authorities, ▲ = Internat. Donors, ◊ = National CSP Players, ♦ = International CSP Players

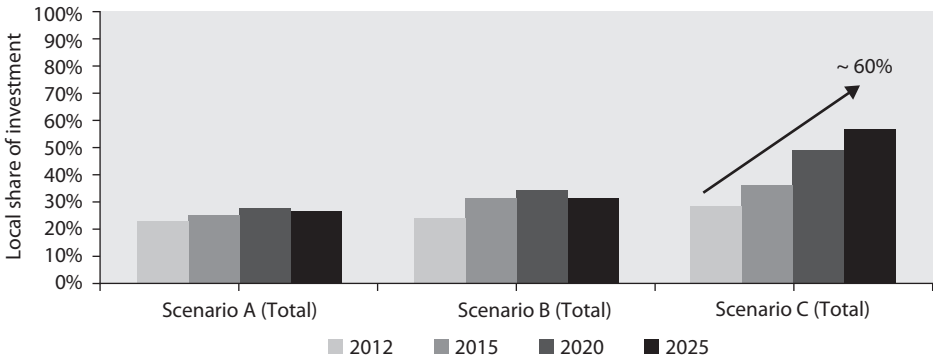
	Support of private and public R&D	Improvement of renewable energy related R&D legislation, and national legislation exchange (e.g. through RCREE)	Manufacturers, private and public research institutions (e.g. universities)	Δ ▲	Short to medium term
		Foundation of research institutions and technology clusters with regard to CSP technologies, to foster regional knowledge distribution and innovation	See above	Δ ▲♦◊	Medium to long term
		Implementation of CSP testing plants and project-parallel research activities at CSP sites	CSP-project developer, national and international CSP component producers, public and private research facilities	Δ ▲♦◊	Short to medium term
		Promotion of international science networks and exchange of scientific experts in the field of CSP component design (particularly important for collectors and receivers)	Scientists at national and international institutions	Δ ▲	Medium to long term
		Enhancement of links between industry and research facilities (universities)	Scientists at national and international institutions, regional companies, international companies	Δ ▲♦◊	Medium to long term

Table RS.11 ■ Newly Installed CSP Plant Capacity in MENA by 2020

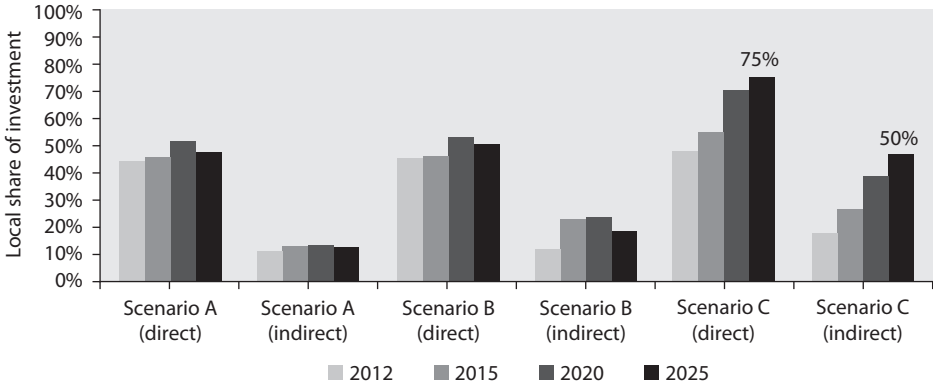
in MW		2011–2014	2015–2017	2018–2020	Total by 2020	Total by 2025
Scenario A	domestic	80	160	260	**500**	1,050
Scenario B	domestic	160	320	520	**1,000**	1,550
Scenario C	domestic	800	1,600	2,600	**5,000**	14,500
	component export (MW equivalent)	250	600	1,150	**2,000**	5,180

Note: The exports refer to components expressed in terms of equivalent CSP plants

Figure RS.8 ■ a) Share of Total Local Manufacturing Potential in Scenario A, B, C
b) Total Local Manufacturing Potential for Construction and Components
c) Direct and Indirect Local Economic Impact in Scenarios A, B and C



Remarks
- Average values for all countries (see different status-quo)
- Some projects with up to 80% local participation possible



Remarks
- Direct = Construction, Installation, Assembling, Engineering, Management
- Indirect = Component manufacturing
- Average values for all countries

(*continued on next page*)

(*continued*)

Figure RS.8 ■ a) Share of Total Local Manufacturing Potential in Scenario A, B, C
b) Total Local Manufacturing Potential for Construction and Components
c) Direct and Indirect Local Economic Impact in Scenarios A, B and C

in Mio US$ (cumulated)	2010	2015	**2020**	2025	Local share by 2025	Cost reduction by 2025
Scenario A	30	193	916	1,498	25.7%	~ 16%
Direct	20	125	571	946		
Indirect	10	68	344	551		
Scenario B	61	465	2,163	3,495	**30.6%**	~ 16%
Direct	39	251	1,167	1,959		
Indirect	22	213	996	1,535		
Scenario C	368	2,803	14,277	45,226	**56.6%**	~ 40%
Direct	206	1,403	6,999	21,675		
Indirect	162	1,401	7,278	23,551		

Note: The exports refer to components expressed in terms of equivalent CSP plants

percent in 2025 as an average value for all CSP projects. This could increase the local share of some projects up to 70 percent of the total value. After 2025, the share of local manufacturing is assumed to increase further due to more technology transfer and learning through the realization of more CSP plants in the region.

- ***The economic impact on GDP:*** The level of local share influences the economic impact and job impact of CSP development in the MENA region. Economic impact is strongly related to the market size of CSP in the MENA region. The "transformation" scenario creates a local economic impact of US$14.3 billion, roughly half of which is from indirect impacts in the CSP value chain (excluding component export), compared to only US$ 2.2 billion in scenario B ("no-replication").
- ***Labor impact:*** In scenario B ("no- replication") a permanent workforce of 4,500 to 6,000 local employees is created by 2020. In contrast, in scenario C ("transformation") in 2025 the number of permanent local jobs could rise to between 65,000 and 79,000 (46,000 to 60,000 jobs in the construction and manufacturing sector plus 19,000 jobs in operation and maintenance). Looking only to the time horizon of the CTF projects (2020), in total 34,000 employees (including employment for component export) might be working in the CSP industry permanently. Table RS.12 shows details for the local employment in scenarios B and C excluding exports of components.
- ***Foreign trade impact:*** Additional impacts for job creation and growth of GDP could come from export opportunities for CSP components. Exporting the same components as are manufactured for local markets to EU, USA or MENA (2 GW by 2020, 5 GW by 2025) could lead to additional revenues

Table RS.12 ■ Local Employement in Scenarios B and C

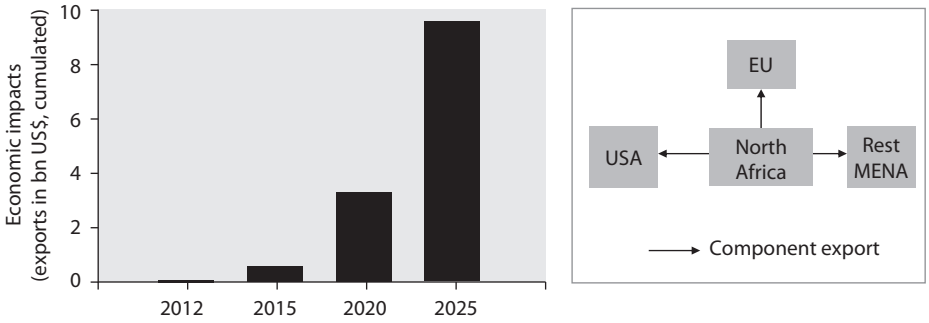
Employment all 5 MENA countries: scenario B	2015	2020	2025
One-year jobs			
Construction and interconnection labour	3,593	14,917	22,727
Construction related services	58	320	485
Equipment and supply chain	471	2,175	3,046
Total Construction and Supply Chain-related	**4,121**	**17,413**	**26,258**
↓			
Permanent employment			
Construction and interconnection labour	1,296	3,093	1,552
Construction related services	20	76	33
Equipment and supply chain	203	456	172
Total Construction and Supply Chain-related	**1,519**	**3,624**	**1,756**
Permanent employment			
Operation & Maintenance (O&M)	315	1,313	2,036
Permanent employment			
Total Construction/Supply Chain/O&M	**1,834**	**4,938**	**3,792**

Employment all 5 MENA countries: scenario C	2015	2020	2025
One-year jobs			
Construction and interconnection labour	16,973	72,345	209,557
Construction related services	463	2,657	8,173
Equipment and supply chain	3,269	15,938	48,687
Total Construction and Supply Chain-related permanent employment	**20,706**	**90,939**	**266,416**
↓			
Construction and interconnection labour	6,170	15,184	35,589
Construction related services	172	634	1,431
Equipment and supply chain	1,308	3,495	8,764
Total Construction and Supply Chain-related	**7,650**	**19,313**	**45,783**
Permanent employment			
Operation & Maintenance (O&M)	1,576	6,567	19,102
Permanent employment			
Total Construction/Supply Chain/O&M	9,226	25,880	64,885

of more than US$3 billion by 2020 and up to US$10 billion by 2025 for local CSP industries.

Other markets for renewable energies, such as the photovoltaic (PV) industry in Germany or the wind industry in Denmark, have contributed to the creation of a local industry. Some emerging countries like China and India have significantly

Figure RS.9 ■ Economic Benefit and Job Effect by Export Outside MENA Region



boosted their own industries for renewable energies. India, for example, is creating a powerful local wind industry—with new jobs and economic benefits for the country—that has supplied the home market as well as the international wind power market in recent years. A similar development in the MENA Region could be promoted by the action plan for CSP projects and their local manufacturing presented in this report. However, the increase in CSP demand with stepped-up MENA investment could also allow strong competitors in technology supply to compete successfully with local MENA products, as has happened 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 competition, particularly with China or India, MENA countries would need to strengthen and develop competitive advantages:

- Rapid delivery and low transport costs are strong assets, as shipping from China or India can take days. Although rapid delivery was decisive 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, by driving down their cost and increasing their quality, thereby making them more competitive with Chinese or Indian production.
- MENA industries could tailor their CSP components production to specific local environmental conditions (i.e., desert conditions) whereas non-MENA countries would lack this knowledge.

The development of local production clauses in CSP calls for tenders that comply with international free trade agreements would help, but this requires careful consideration of possible negative impacts on learning curves due to a lack of competition.

The main precondition for developing the local manufacture of CSP components in the MENA Region will be to develop and grow the CSP market itself. The MENA CSP IP is a first step toward this goal.