CHAPTER 3

Outline of an Action Plan to Develop the Region's Potential in CSP Component Manufacturing

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

Introduction

Based on the assessment and identification of existing and potential domestic and foreign players (manufacturing companies, financial investors, etc.) carried out in the previous steps, this section will focus on the potential routes to develop 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 name 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** and **key services** which have the potentially highest share in the CSP value chain (as identified in section 2.21 of this report, Table 2.5). The highest value added for the region can be expected from these components.

Furthermore, other components will be taken into account for which the countries have already developed competitive advantages, e.g. production of electric cables in Tunisia or Egypt. These **secondary components** may not have a major share of the value added, but can still contribute significantly in absolute terms also due to possible exports.

The roadmaps are separated into technological developments (e.g. changes in production lines, production skills and production capacities), business developments (in terms of cooperation agreements, R&D activities and other entrepreneurial decisions) and the underlying market and policy development, all of which make up the basis for industrial development. For each of these levels, the most important milestones and critical steps are presented and interrelations between the different levels are indicated (dotted arrows). The related measures needed to overcome critical steps and reach the milestones are subsequently discussed in the action plan (cf. section 3.3).

The timeframe of the roadmaps covers possible 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.

However, especially the long-term targets are strongly dependent on the development of the CSP market as described in the different scenarios presented in section 3.2. Some technological milestones might only be reached assuming a strong growth of the CSP market.

Roadmap for the production of CSP mirrors in the MENA region

Figure 3.1 presents potential development paths for producing CSP mirrors in the MENA region. The basic conditions are promising, because the glass industry is already present in this region and raw materials are easily available (cf. section 2.2). A key condition for the production of mirrors for CSP technologies, however, is the availability of production lines for high quality white glass. There are no such production lines at present in MENA countries. Short-term actions on company level could be either the creation of such production lines by international players, or the formation of joint ventures between local players and international companies for such a purpose. The economic viability of creating a white glass production line will strongly depend on the market demand for such glass in MENA countries. As a second step, new production lines for linear or bent mirrors need to be established. Again, this could be accomplished through joint ventures with international companies experienced in mirror production for CSP plants (for companies see section 1.2) or by setting up new mirror production lines of MENA companies (for companies see section 2.1.1) possibly accompanied by acquiring licenses for this technology. From a MENA country's perspective, a joint venture is more favorable than direct investments of international companies since this is usually linked with a more intensive know-how transfer, which may lead to a more independent evolvement of the industry. Depending how the CSP market develops in MENA and globally, this would also facilitate the establishment of independent CSP mirror companies in the MENA region in the medium and long term.

From a technology viewpoint, the first step for existing glass companies in the MENA region which are interested in adapting production to produce glass for CSP applications is to develop new, or enhance their present, capacities of float glass production in the short-term to be able to supply glass for CSP plants. At

Figure 3.1 Potential Roadmap for the Production of CSP-Mirrors in the MENA Region

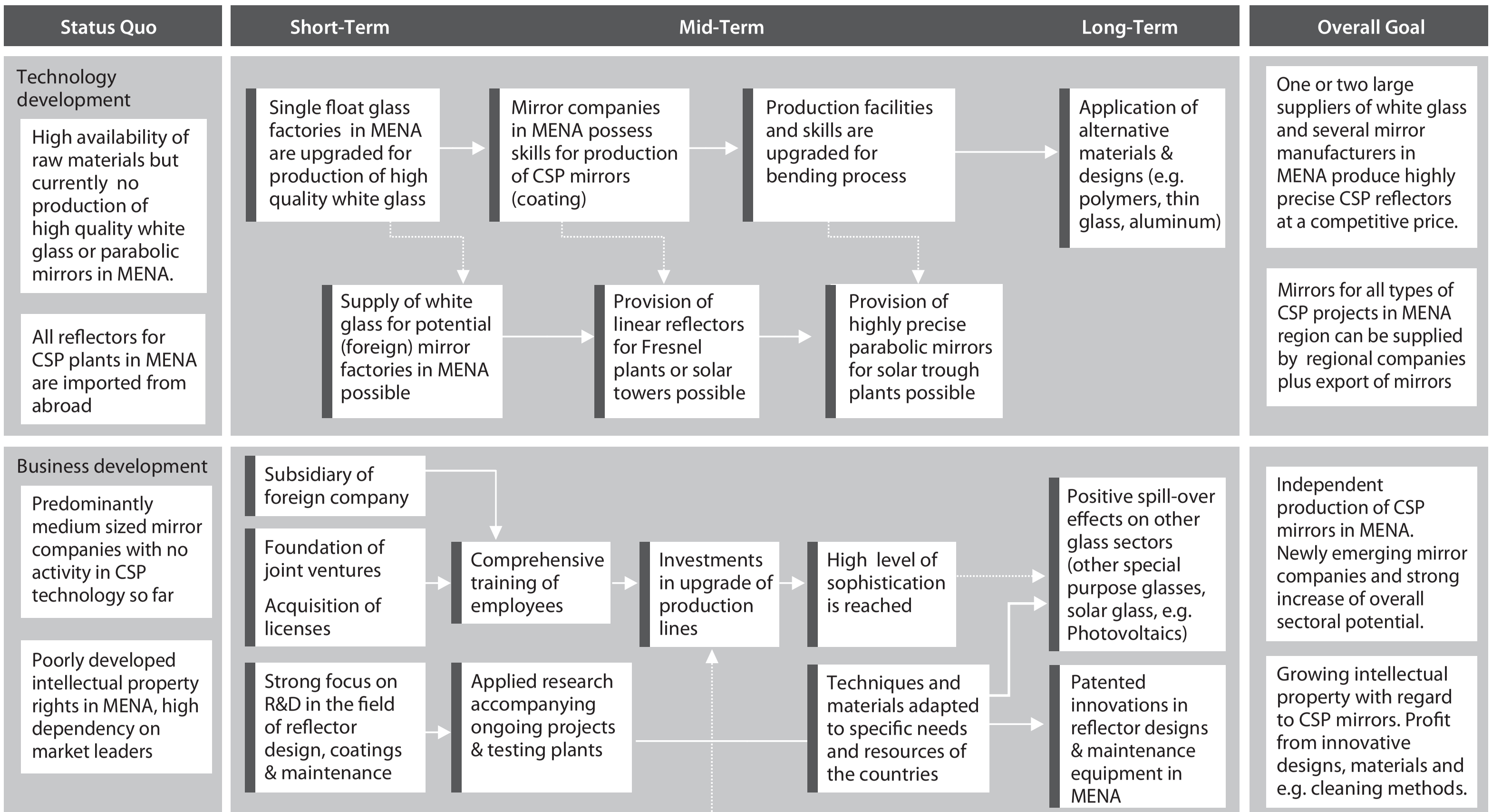

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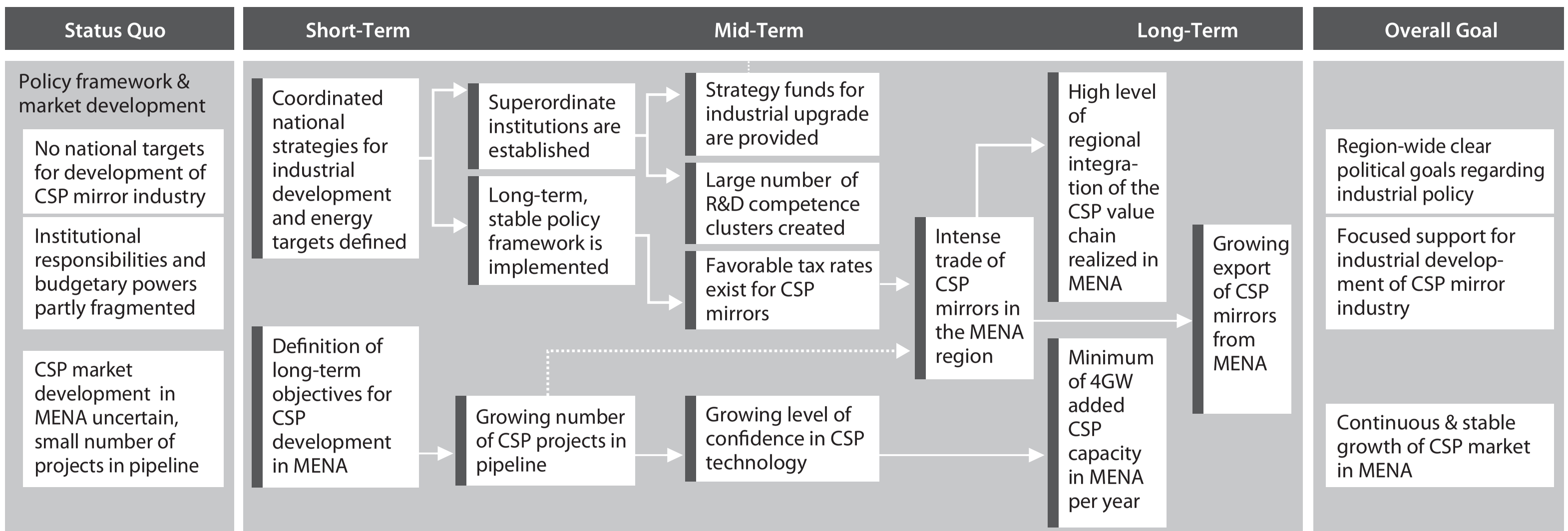
Figure 3.1 ■ Potential Roadmap for the Production of CSP-Mirrors in the MENA Region *(continued)*



the moment, float glass production lines exist only in Algeria and Egypt and the major share of the regional demand for conventional glass is covered by imports. In addition, most of the float glass plants today produce green glass, which is not suited for solar applications (cf. sections 1.2.2 and 1.2.3). Consequently, in order to achieve the standards needed for high quality white glass, it is necessary to adapt the glass production lines. A substantial amount of capital is needed for both measures since production lines are highly automated and the processes are very energy-intensive (cf. section 1.3.3). Here, the different countries should coordinate and exploit locational advantages. Glass plants for CSP applications could, for example, be set up in countries already operating conventional plants which only need to adapt production lines (Algeria and Egypt), or in those countries where energy prices are particularly low (e.g. Algeria), so that production might be more profitable than elsewhere. Plants in those countries could then supply the whole region. Independent of this, the mirror fabrication (coating- and, if necessary, bending process) could be undertaken in countries which are already experienced and specialized in mirror production (e.g. Egypt, cf. Figure A.15) and thus have the basic know-how and a skilled workforce at their disposal.

Based on these measures, further steps can be taken in the mid-term towards producing flat and parabolic mirrors for CSP plants. Flat mirrors for Linear Fresnel and Solar Tower power plants are easier to produce because they do not require a bending process. This energy-intensive and sophisticated step is only necessary for the curved mirrors of parabolic trough plants and the degree of precision here has a decisive influence on the later effectiveness of the whole plant. Upgrading conventional mirror production lines to produce such precisely bent CSP mirrors requires a considerable amount of capital. It should therefore be considered that the decision about which mirrors should be produced in the MENA region depends on which technology has the main proportion of CSP plants in this region. The ISCC plants that are currently under construction all apply the parabolic trough technology, which has proven its reliability in the Mojave Desert in California for more than 25 years.

Besides the necessary capital to set up highly automated plants for the coating- and bending processes, a comprehensive transfer of know-how is necessary. Particularly the bending of CSP mirrors with the necessary precision and scale is currently handled by only a few companies. Knowledge transfer can be achieved, for example, by acquiring licenses for CSP mirror production within the framework of a joint venture. Experienced companies can also contribute their experience in the adaptation of CSP mirrors to the special environmental conditions in coastal regions, where the mix of salt spray and sand dust in the air complicates mirror cleaning and reduces the effectiveness of the CSP plants. R&D efforts in this sector might be undertaken in cooperation with international companies and research institutions but might also be realized independently by the MENA countries themselves. In Egypt at the Cairo University, Faculty of Engineering, for example, first research activities have started to improve and adapt different CSP components to local conditions. In this context also a pilot plant is planned to conduct further experiments. Also single companies took first steps towards developing the know-how for the production of CSP mirrors by themselves, for example Dr. Greiche glass in Egypt.

Assuming a very favorable market development and the strong promotion of applied research in the field of CSP in the MENA region, it is thus conceivable that this region could develop its own technology for products specifically tailored to the conditions here. Also future technical advances, such as reflectors made of alternative materials like polymers or aluminum as well as front-surface or thin glass mirrors could possibly be developed further and customized to the needs of the MENA countries in the long term. However, these are currently research topics in countries with experienced research institutes and CSP industries like Spain, the United States or Germany.

To sum up, if CSP plants are constructed in the MENA region in the near future, there is a good potential that mirrors can be sourced from domestic companies if the above mentioned financial and knowledge barriers can be overcome. Assuming a growing level of regional integration and a reduction of trade barriers within the MENA region, also substantial economic benefits can be expected from an export of CSP mirrors.

Roadmap for the production of CSP mounting structures in the MENA region

Similar to mirror production, the manufacturing of complete CSP mounting structures or parts of them also has good potential in the MENA countries due to their overall low energy and labor costs. Also current steel production in CTF MENA countries is far above the volume needed to develop CSP plants. Figure 3.2 displays a potential roadmap for the production of CSP mounting structures in the MENA region. Since local companies have already delivered mounting structures for the ISCC plants in Egypt (and to a lesser extent in Morocco), a local provision of complete mounting structures for future CSP projects should be possible, even in the short-term perspective. The highest steel production capacities are currently located in Algeria, Egypt and Morocco. The latter have increased their capacities in the last year or plan to increase steel production in the next year, so that the amount of raw material should not be a bottleneck (cf. section 2.1.3 for production capacities). However, it should be mentioned that, overall, most MENA countries are still net importers of steel and that domestic steel faces competition with steel from other countries, e.g. Spain and Turkey. Moreover, experiences at the ISCC plant in Beni Mathar also revealed quality issues with the steel structures sourced from MENA.

Moreover, another crucial requirement for CSP mounting structures is the high precision of metal transformation and the assembly of the individual parts to warrant a safe and precise anchorage of the reflectors. This involves not only an experienced and well trained workforce, but also technological know-how in terms of cutting, coating and assembling metallic materials.

Therefore, in the short-term, joint ventures or other forms of collaboration with experienced companies might be useful to overcome this hurdle. To achieve the required precision and quality standards in production, production know-how

Figure 3.2 Potential Roadmap for the Production of CSP-Mounting Structures in the MENA Region

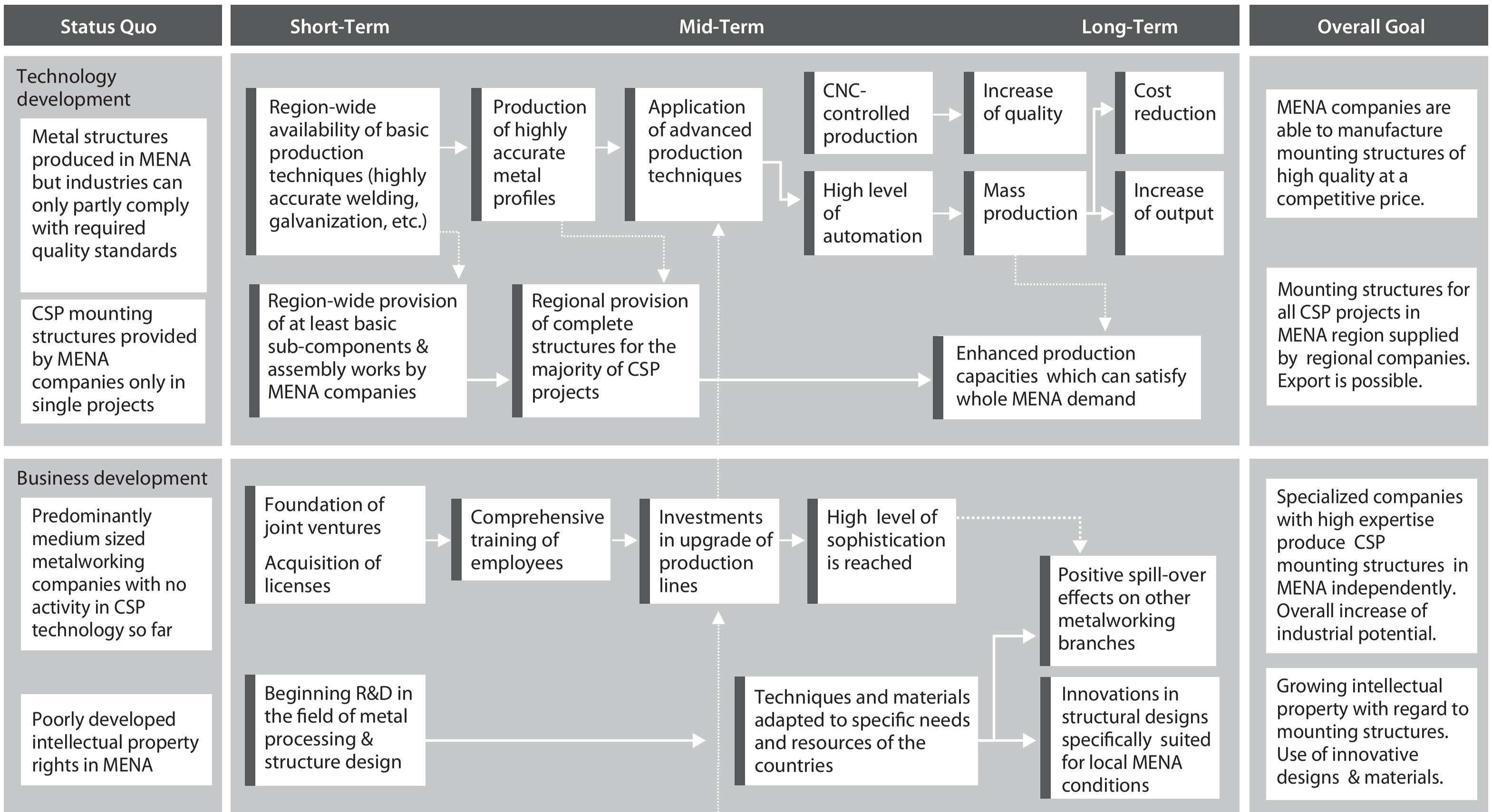


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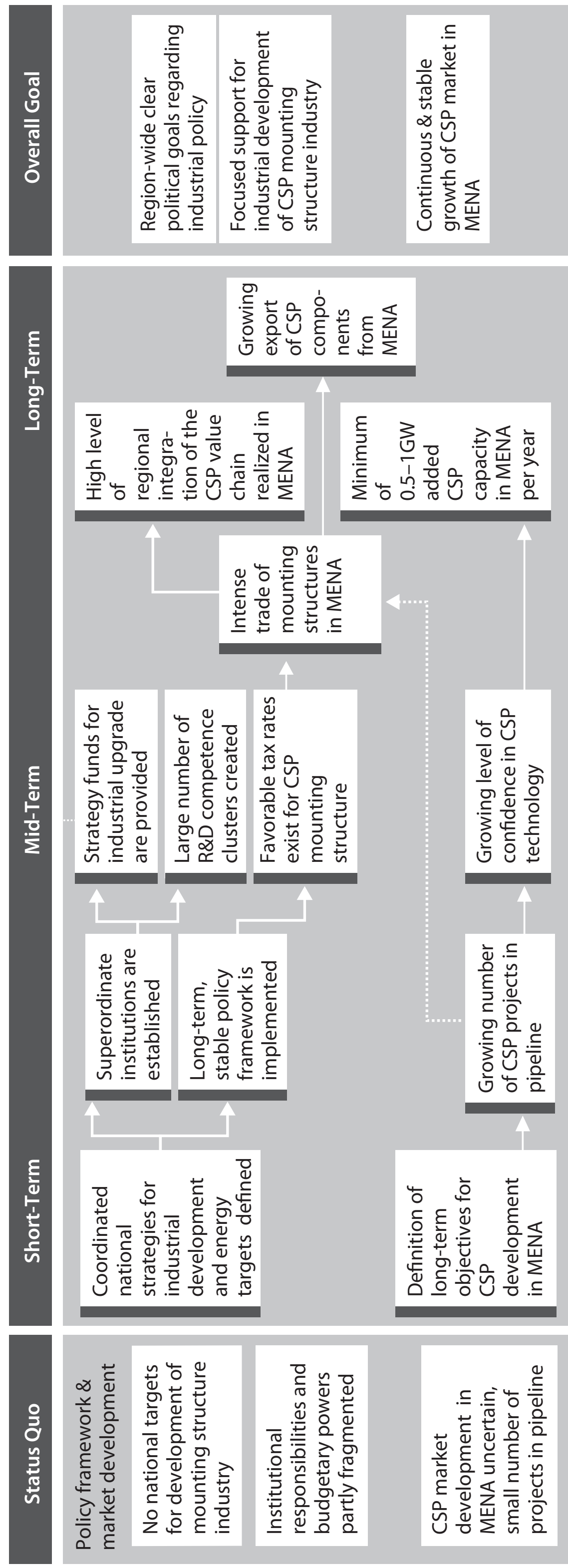
Figure 3.2 Potential Roadmap for the Production of CSP-Mounting Structures in the MENA Region *(continued)*



must be acquired. Staff have to be trained, e.g. in highly accurate welding skills to assemble the structures. Furthermore, there are different types of collectors (cf. section 1.1.3) each with specific processes in metal transformation, welding and assembly. Also, galvanization is indispensible to protect the structures against humidity from wet cooling, nightly condensation and/or high air salinity in coastal areas. However, both welding and galvanization are well established processes and potential quality issues should be manageable.

If there is an extension of installed CSP capacity in the MENA region, it should be possible in the short term for MENA companies to provide and assemble the complete mounting structure. Depending on the CSP market development and the available investment volumes, there are different routes the production of mounting structures could take. Labor-intensive, non-automated production might make sense because of the advantage of region-wide low labor costs and this would have extensive employment co-benefits. However, comprehensive training is still necessary to meet the required quality standards, obtain greater experience and achieve a higher output. Under the conditions of strong market growth, larger investment volumes might be available to deploy laser-cutting and other innovative manufacturing technologies as well as a higher level of automation in production. This could lead to a further increase in quality and substantial cost reductions. For example, installing machines for the automated stamping of parts for trough structures is one way to significantly reduce the production costs. A further step in the mid-term, especially for the welding process, could be the introduction of CNC-controlled machines which involves construction lines similar to, e.g. those used in the automotive industry.

Assuming an extensive expansion of CSP capacity in the MENA region and a strong promotion of regional R&D activities in this field, the countries could, in the long term, also develop their own mounting structures with technical advancements and the use of alternative materials specifically adapted to the respective conditions and available resources. Larger troughs and alternative materials like aluminum are examples for R&D projects in experienced CSP countries that could also be pursued in MENA which might lead to specialized techniques and a higher level of intellectual property rights in MENA. Regional R&D efforts might be either taken in co-operation with international players, e.g. with an initial procurement of production licenses, or the necessary know-how might be developed independently from the start. Some large companies in the MENA region apparently already possess the innovative potential and the necessary practice to successfully develop such new business areas by themselves (e.g. Orascom, El Sewedy, Al Babtain, TECI and others).

In conclusion, depending on market development and the support for CSP in the MENA region, the MENA countries have different options for CSP mounting structures which involve different requirements with regard to effort and capital intensity. Overall, there is a realistic potential to provide and assemble complete mounting structures in the short- and medium-term. Exporting mounting structures from MENA might even be realizable if the relevant production quantities are achieved.

Roadmap for the production of CSP receiver tubes in the MENA region

Based on the analyses in the preceding chapters, providing the receivers (absorber tubes) for solar trough technology in the MENA region is theoretically feasible, but development possibilities are limited. This is due to the highly sophisticated production processes involved (cf. section 1.1.3) and the fact that the market is currently dominated by only two large companies, namely Schott and Siemens (cf. section 1.2.2). None of the MENA countries holds intellectual property rights in this field or has experience in producing this component. Consequently, the possible developments shown in the roadmap in Figure 3.3 are limited.

In the short- or medium-term, the only realistic option to establish manufacturing capabilities in MENA is if the two current major suppliers, Schott and Siemens, were to set up subsidiaries in the region.

Experiences with other markets in Spain and the USA show that such production facilities only develop if there is significant growth of the respective local CSP market and a strong government focus on enhancing local content in CSP projects. Otherwise it is more profitable for suppliers to produce the receivers in their home countries (Germany for Schott, Israel for Siemens).

In the mid-term, some sub-components, like the steel pipes of the receivers, could be supplied and assembled locally, but it is questionable whether local suppliers would be able to deal with the quality issues without prior knowledge transfer from the existing market leaders. It is considered unlikely that receiver manufacturers will develop independently in the MENA region or that this region will produce its own receiver design due to the lack of experience and intellectual property in this highly advanced field.

A strong focus on early R&D activities related to receiver technologies is therefore necessary to pave the way to future development of intellectual property in this field. Research activities in this field will require strong co-operation with international companies and experienced research facilities, at least in the initial phases of the development. Initially, the according research facilities, e.g. in universities and technology clusters, must be created and a basic understanding of the technology must be developed in the region.

This fundamental research would also help to create a favorable environment for foreign subsidiaries, since a basic understanding of the technology in the recipient country facilitates production, e.g. through a better availability of maintenance personnel and engineers.

Roadmaps for the production of secondary components for CSP in the MENA region

As identified in section 2.2 there are some minor components of CSP plants which might easily be supplied by local MENA companies because the countries have already developed production facilities and technological know-how in the respective fields. Two examples of such secondary components are electric cables and metal pipes which are already partly being supplied to ongoing projects in the MENA region.

Figure 3.3 Potential Roadmap for the Production of CSP Receiver Tubes in the MENA Region

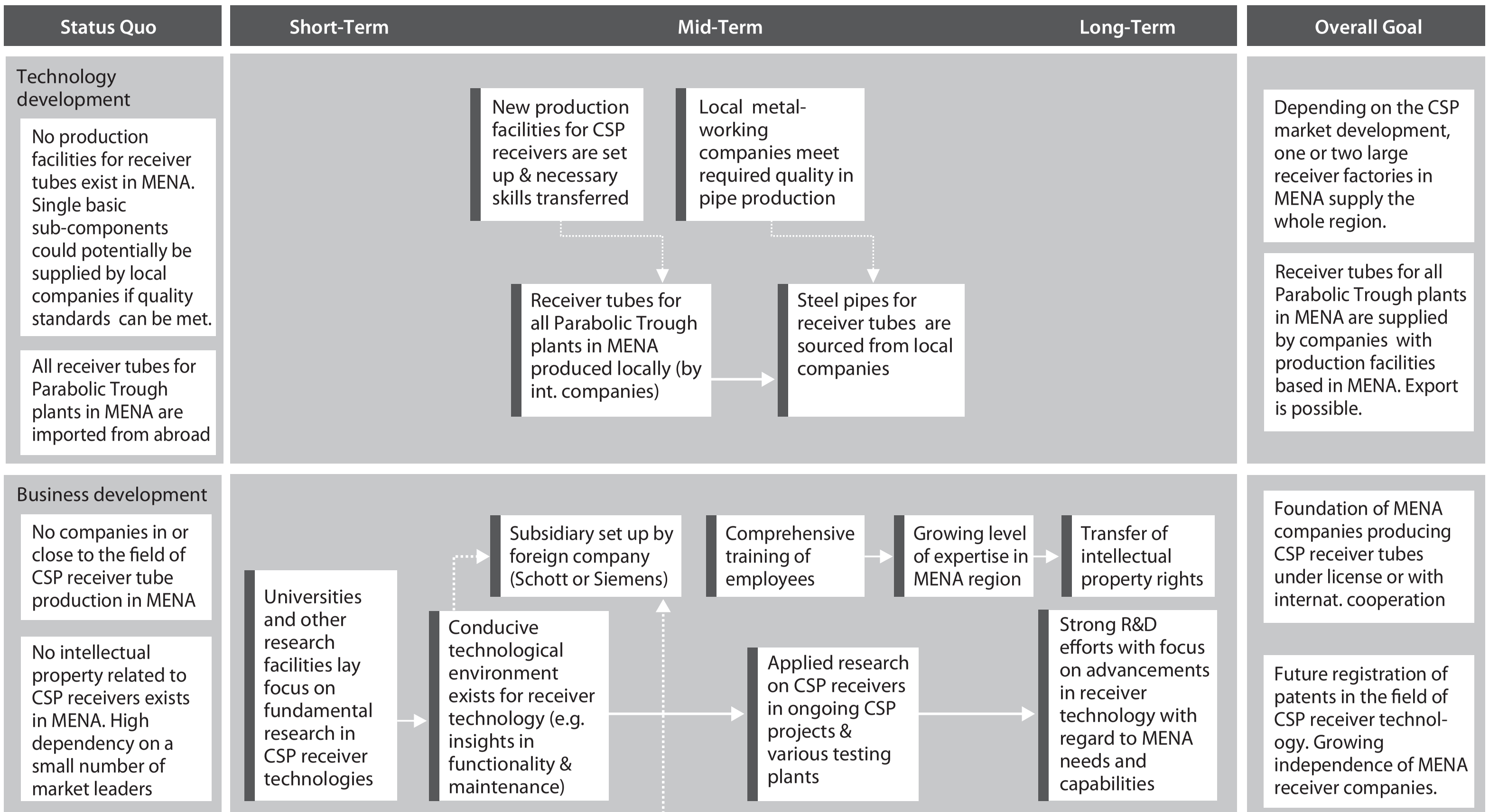


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Figure 3.3 ■ **Potential Roadmap for the Production of CSP Receiver Tubes in the MENA Region** *(continued)*

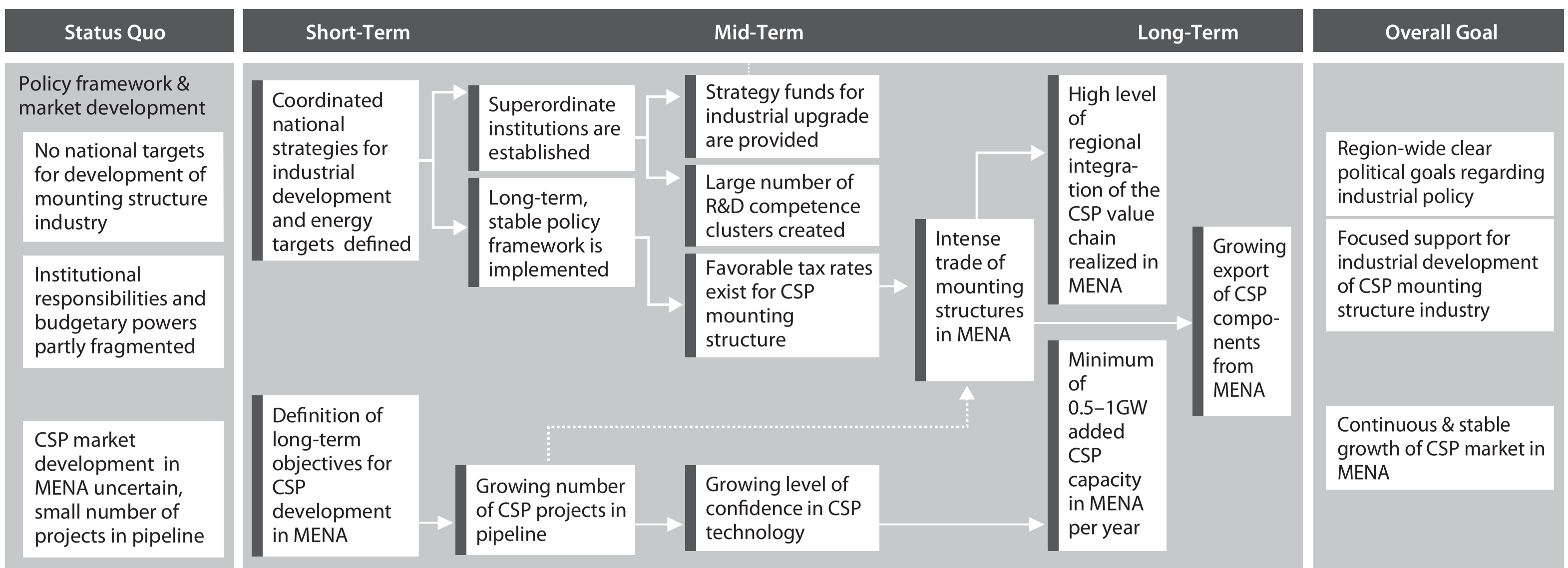
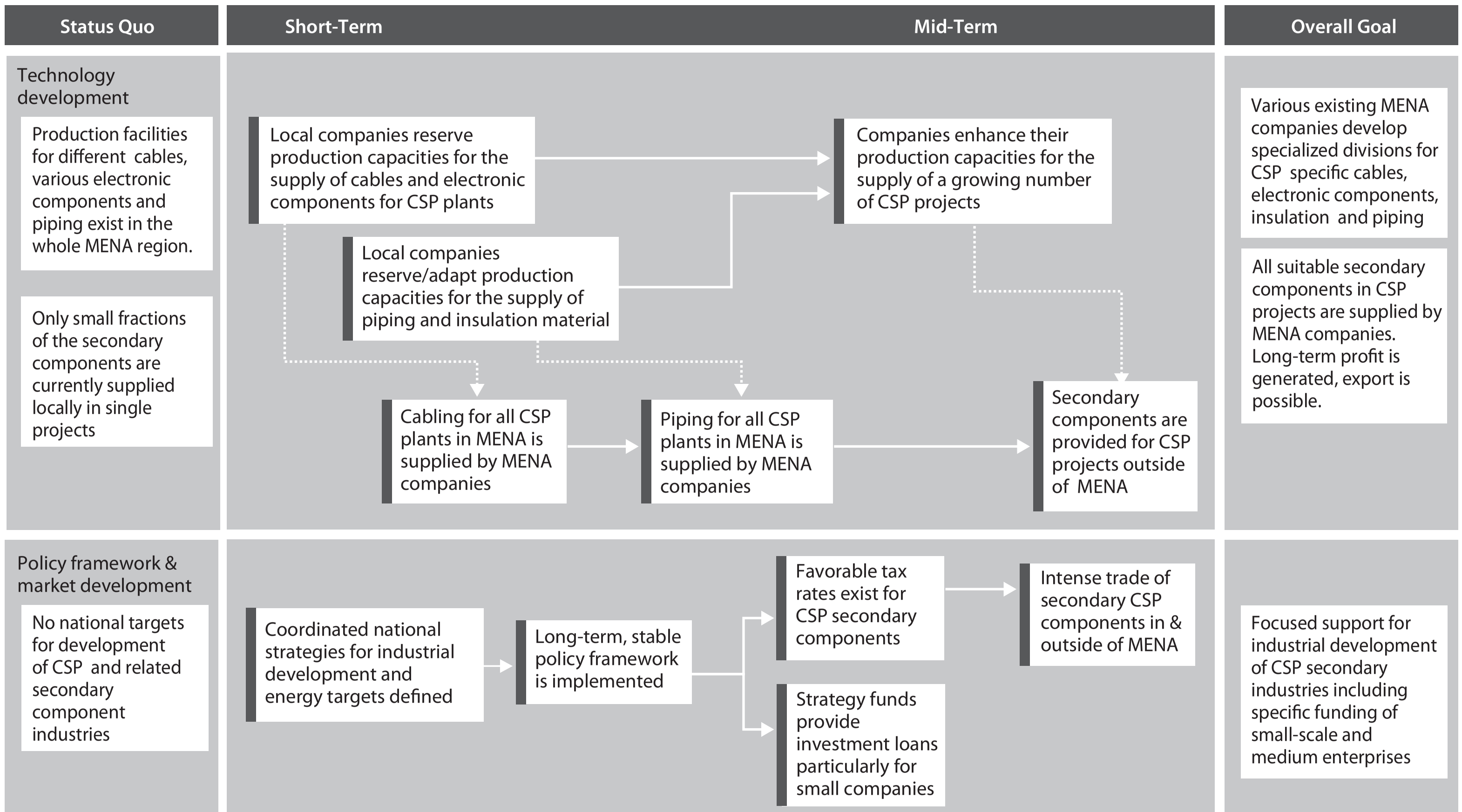


Figure 3.4 ■ Potential Roadmap for the Provision of Secondary Components (piping & Cables) for CSP Plants in the MENA Region



The fact that there are no big technology steps expected in these "secondary industries" is reflected in the reduced roadmap. It can be presumed that only smaller adjustments to production lines and technical skills are necessary to supply CSP components, although production upgrades might be necessary to supply larger volumes if the market grew strongly or for export.

Chakira cable from Tunisia, to name one example, is already producing cables for PV-plants and sees no problem in providing them for CSP plants as well (cf. 2.1.2). The cable industry in MENA is fragmented with no multinational player, which means that MENA companies have the potential to become a supplier for CSP plants in their respective country. However, there is no real cost advantage for the companies due to the lower labor and energy costs because the raw material costs constitute the main cost fraction of cables so they will face competition from other international players. However, after successfully providing cables for plants in their home countries, MENA-based cable companies could become competitors on the international market in the short and medium term and could use CSP as a first step for exports.

The provision of piping could develop in a similar way, albeit with a time lag due to the higher complexity of the piping and the insulation material. Hurdles to overcome from a technical point of view are the high precision and special heat resistance required for the steel-pipes. In addition, capital-intensive production lines have to be built. At the moment, the connection piping in ongoing CSP projects is supplied by big multinational companies (cf. section 1.2.2). The piping itself consists of a steel tube, a surrounding insulation and sheets that protect the insulation. First plants in MENA countries could be supplied by specialized steel and insulation manufacturers and after that exporting to other countries is also possible in the mid-term.

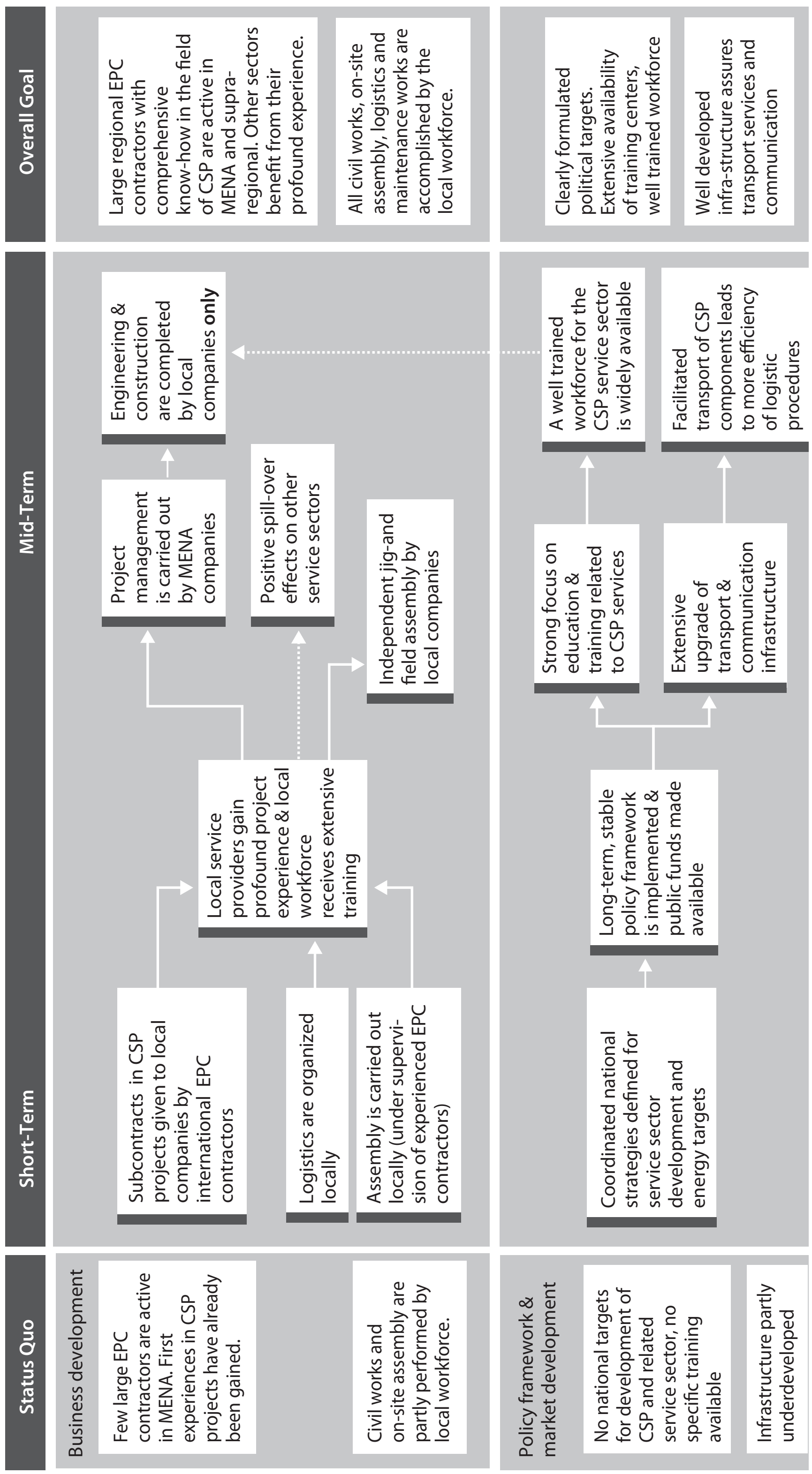
Roadmap for EPC and services in CSP projects in the MENA region

The services associated with the construction of CSP plants also represent an important factor for local value creation. In the following, a roadmap is described for the field of EPC (Figure 3.5). Currently, several companies in the MENA region are gaining first experiences with CSP projects as subcontractors or receiving substantial support from international companies experienced in CSP. For example, in Kuraymat, the EPC contractor for the solar field, Orascom, has been strongly supported by Fichtner Solar and Flagsol concerning the conceptual design, engineering and technical advice on assembling the solar part of the ISCC plant (cf. section 2.2.6).

With training and qualification, jig and field assembly could be done independently by local companies in the mid-term. Logistics are also already organized locally or could be in the short term in each country.

With the further expansion of CSP plants in MENA and as more experience is gained, service subcontracts could also be offered by local companies. In the mid-term, the whole project management at construction sites could be done by MENA companies with general contracting by locals as a further step. This

Figure 3.5 Potential Roadmap for EPC and Services in CSP-Projects in the MENA Region



could lead, along with a further expansion of CSP capacities, to engineering and construction being managed by MENA companies only. In the case of strong market growth, large regional EPC contractors would have the opportunity to gather comprehensive CSP know-how and could manage a growing number of CSP projects in MENA or even act as bidders for projects outside MENA.

3.2 Definition of Scenarios

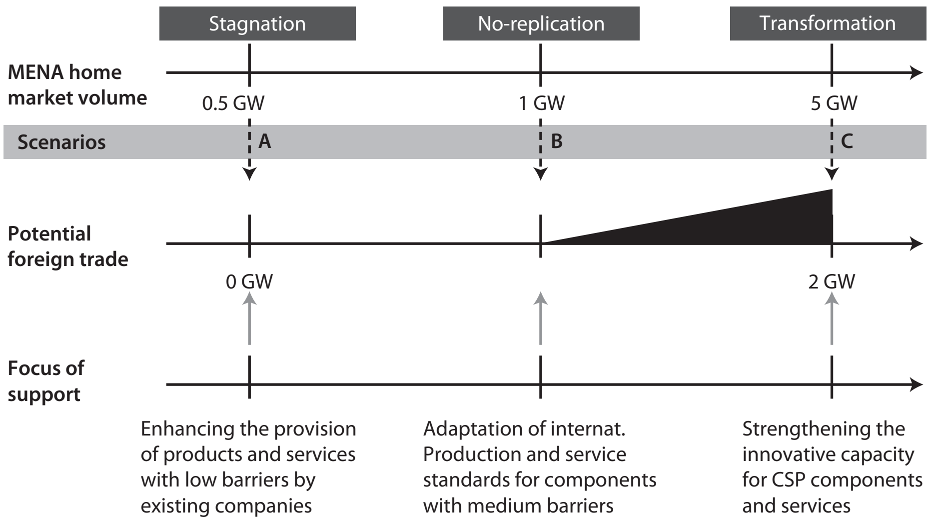
The action plan, with a time horizon until 2020, is developed based on three scenarios (see Figure 3.6). It is assumed that the volume of the installed CSP capacity within the MENA region (home market volume) is a main precondition for local manufacturing to take place. This assumption is based on experiences made in the wind turbine industry (Lund 2008) (Lewis & Wiser 2007). The home market volume and the potential amount of export (external market volume) are regarded as indicators to develop an optimal support scheme. **However, it is not subject of this study under which circumstances the market volume of the four assumed scenarios is reached (e.g. by energy policy measures like feed-in tariffs) and it is assumed that the home market is free of any fragmentation like adverse trade regulations within the MENA countries.** We will nevertheless briefly motivate the scenario development in this section by looking at similar developments in the markets for wind and solar PV.

The scenarios chosen here represent critical levels of market development for local manufacturing. Concerning the market volume, it is assumed that the newly installed CSP capacity in the CTF MENA countries is distributed equally over the years and that the market will continue to grow after 2020. The market volume is described for the five countries investigated in detail in this study. **For the MENA region has a whole it can be assumed that the market volume could be doubled as compared to the figures provided in the scenarios.**

The three scenarios proposed are the following:

- **Scenario A –** “Stagnation”: The domestic market volume of the five countries amounts to 0.5 GW: Strong obstacles to local manufacturing of CSP components remain on the country markets. Therefore, most components, particularly those whose production requires high investment costs, remain imported from other more advanced markets. In this case, support should focus on enhancing the manufacturing of low-tech products and basic services for which the market barriers are relatively small. This scenario implies an incomplete realisation of the CSP scale-up initiative.
- **Scenario B** – “**No-replication”**: The domestic market volume of the five countries amounts to 1 GW in 2020 based on the target of the MENA CSP IP. As a result of the success of the CTF’s CSP scale-up initiative and national initiatives, the market offers 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

Figure 3.6 ■ Assumed Interrelations between MENA Home Market Size, Possible Export Volume and Consequential Focus of Support for Local Industries



Source: Own design.

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 constitutes therefore the foundation on which more comprehensive policies can spur a larger CSP development in the region. The CSP scale-up initiative is intended to spur as much additional policy development as possible to cover the space towards scenario C. So it is by no means a reference development but represents the minimum development if only the CSP scale-up initiative alone would deliver. This is indicated by the red arrow in Figure 3.6 between scenario B and C.

- **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 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. The "Transformation" scenario may materialize under very favorable conditions only and a more realistic level of installed power may be found somewhere between the "No-replication" scenario and the "Transformation" scenario. We therefore provide 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 realised by 2020.

Figure 3.6 depicts the assumed interrelations between the home market size, the possible export volume and the consequential focus of support for local industries which stands in the centre of this analysis.

The basic underlying assumption is that local industries, as long as they are able to provide CSP components, should be given priority in support over the attraction of international players. The focus of support in the three scenarios is based on the one hand on the extent of barriers for the existing local industries to participate in the promotion of CSP components and -services and, on the other hand, on the expected total market volume which determines the size of the expected long-term profits.

Table 3.1 motivates the CSP market size chosen here for the five MENA countries by comparing the average annual growth rates of the cumulatively installed CSP capacities in the three scenarios with the rates for wind energy, solar PV and the expected annual average growth of the world-wide installed CSP plants.

Table 3.1 ■ 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

Scenario A represents an annual growth of 24 % between 2010 and 2020, while scenario B reaches 32 % and scenario C 61 % annual growth. Historically, for wind energy one observes levels in a similar range in terms of total installed capacity. Countries with initial booming markets and/or strong policies reach levels exceeding 60 % annual growth while countries facing more barriers and a less favourable policy environment may on average achieve 20–30 % annual growth. Mature markets, such as Germany, Spain and Denmark after 2000 achieve less important growth rates. Egypt and Morocco have achieved 29–36 % in the period 2003–2009. It is not excluded that a country can exceed the level of 60 % in a particularly booming period as illustrated with the example of Turkey for wind energy with a growth rate exceeding 150 % between 2005 and 2009. However, this may also be the sign of an overheated growth. This example shows, however, that a development beyond the scenario C is possible in the countries considered but requires well coordinated policies at different levels. In particular, it has to be assured that the R&D system as well as the education system can deliver with a sufficient large number of well-trained üersons

Looking at the PV development confirms further the choice of the growth rates. Germany which has a very strong policy for PV reaches levels of 60 % annual growth, while the US and Japan with less powerful policies are in the range 20–30 %.

The world-wide cumulative CSP installations have grown in the period 2007 to mid 2010 by around 40 % annually while the expected growth for the period 2007 to 2015 would be close to 60 % if all the plants described in section 1.1.4 will come on-line.

The second motivation for the three scenarios chosen is provided by taking an optimistic view of CSP developement as given by the Greenpeace (2009) scenarios (Table 3.4) as well as a more pessimistic view provided by Emerging Energy Research (2010) (Figure 3.7).

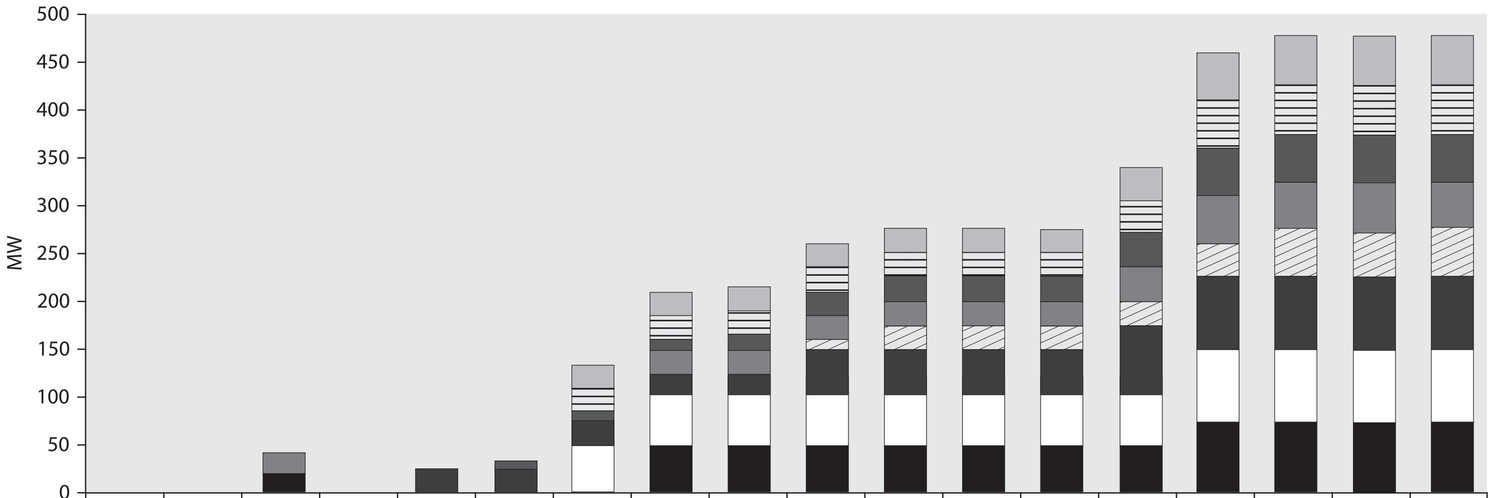
The figures from Greenpeace suggest that in the Middle East + Africa region (which also includes South Africa) in the advanced scenario around 20.7 GW are possible. This scenario could imply for the five countries considered here a figure of roughly 10 GW in 2020. This is somewhat higher than the 5+2 GW "Transformation" scenario, however indicates that this scenario presents a reasonable

Table 3.2 ■ Outlook for Cumulative Installed Capacity of CSP Per Region in 2020

	Europe (EU 27)	Transition Economies	North America	Latin America	Devel. Asia	India	China	Middle East	Africa	OECD Pacific
Advanced										
2020 (MW)	11,290	474	29,598	2,298	2,441	3,179	8,650	15,949	4,764	9,000
Moderate										
2020 (MW)	6,883	328	25,530	2,198	2,575	2,760	8,334	9,094	3,968	2,848
Reference										
2020 (MW)	3,065	100	1,724	121	0	30	30	612	1,113	475

Source: Greenpeace (2009).

Figure 3.7 ■ Middle East /Africa CSP Additions 2008–2025 (base Case)



	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Egypt						25	25	25	25	25	25	25	35	50	50	50	50	
Dubai							25	25	25	25	25	25	25	35	50	50	50	50
South Africa						10	10	10	25	25	25	25	25	35	50	50	50	50
Algeria			20					25	25	25	25	25	25	35	50	50	50	50
Other Middle East/ Africa										10	25	25	25	25	35	50	50	50
Israel					25	25	25	25	25	50	50	50	50	75	75	75	75	75
Morocco			20				50	50	50	50	50	50	50	50	75	75	75	75
Libya								50	50	50	50	50	50	50	75	75	75	75

Source: Emerging Energy Research (2010).

scope for what coherent and ambitious policies could reach. In particular, the Greenpeace "advanced" scenario implies more than 7200 MW in 2015 which could be hard to reach given the time scales to set up plants which are typically 3–4 years at present. Therefore scenario C can be considered a cautiously optimistic scenario. The base case projections from Emerging Energy Research (2010) are much more cautious with around 1600 MW for the group of countries considered, comparable to the Greenpeace reference case.

It is important to compare the scenario settings here with the production thresholds established in Table 2.11. We saw that typical thresholds for key components are in the range of 200–400 MW per annum for mirrors or receivers and 50–200 MW per annum for mounting structures. This implies that the total MENA market should reach in ten years up to 2020 a level of total installed CSP capacity of 2–4 GW in the first case and 0.5–2 GW in the second case. Assuming half to be installed in the five countries considered here the thresholds are 1–2 GW needed for the 5 countries if mirrors or receivers are considered for local production, and 0.25–1 GW in the case of mounting structures, hence, in between scenario B and C. This shows that the "No-replication" scenario is at the lower level to fulfill those thresholds and that the CTF effort must at least trigger a doubling of the CSP installations in these five countries.

3.3 Recommendations Actions on Different Levels to Enhance the Local CSP Manufacturing Capabilities

The comprehensive review of the structure, capabilities, and innovative potential of the existing industries (cf. section 2.1) and the analysis of current CSP projects in the MENA region (cf. section 2.2) clearly revealed some substantial obstacles for the development of an integrated CSP value chain in the MENA countries. Based on the identification of these potential barriers to local manufacturing of CSP components, a variety of measures is derived to overcome these barriers and to allow for a maximum of long-term value creation for the MENA countries. The proposed actions refer to two different levels of recommendation:

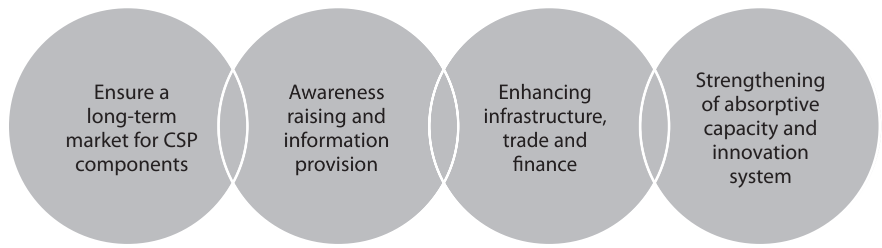
- **General recommendations** that are applicable **on a regional level** and are meant to create a more favorable framework for industrial innovation and
- **Component specific** recommendations which are specifically targeted at the promotion of individual parts of the CSP value chain (products and services).

Both levels of recommendation need to follow a long-term design of the respective measures to lower uncertainties for investors.

3.3.1 Recommendations at Regional Level

Figure 3.8 depicts the main pillars to facilitate the development of a CSP scale-up in the MENA region. These four aspects represent the major preconditions for the development of a sustainable CSP-industry.

Figure 3.8 ■ Main Pillars to Facilitate the Deployment of Local CSP Manufacturing and Service Provision in the MENA Region



Source: Own design.

Ensure a long-term market for CSP-components

CSP market development is one of the major variables for developing CSP manufacturing in the MENA region. Most interview partners (in the MENA region and Europe) stated they would only extend CSP manufacturing activities in the MENA region if the market developed sufficiently and governments expressed a clear interest in developing this technology. Therefore, clear signals in terms of energy policies have to be sent to reduce uncertainties and accelerate direct investments. Even though all the CTF countries have set renewable energy targets, there are still deficiencies in the **formulation of clear and binding political goals**, the creation of the necessary legal framework and specific support instruments for the CSP technology in particular on national and regional level (cf. also case studies on development of the wind energy industry in India and the CSP industry in Spain and the USA, pages 201 and 206 onwards). Among other things, clearly defined intermediate steps are required to achieve the set goals and objectives.

Introducing **local (domestic) content clauses** in CSP tenders and other support instruments is another direct political way to foster the long-term demand for CSP components (both key and secondary components). Specifying a share of goods and services that has to be provided locally could stimulate the local CSP component industry.[1] These obligatory content shares should be relatively low to start with and then rose as technology and management capabilities increase over time. A too high share in local content at the beginning might raise the project costs and thus hinder market deployment. To further stimulate the regional integration of CSP manufacturing, content clause could also be applied regionally, so that components which cannot be delivered by the country in which a CSP plant is built could still be supplied by other regional providers.

In particular the **employment of regional/local EPC contractors** might play an important role in enhancing the local share of manufacturing in MENA CSP projects. Local EPC contractors will make more extensive use of local suppliers and

[1] For example in the Spanish wind industry the creation of the company Gamesa can be partly traced back to the local content requirement (Lewis and Wiser 2007).

An example of strong regional efforts in the field of renewable energy legislation and R&D in the MENA region is the **Regional Center for Renewable Energy and Energy Efficiency (RCREE)**. The founding members are Egypt, Morocco, Algeria, Jordan, Tunisia, Lebanon, Libya, Palestine, Syria and Yemen. Germany, Denmark and the EU are the development partners who assist with financial support. The center was initially founded to develop and disseminate energy policies and energy-related R&D policies to promote technology research in the region. Other, self-imposed tasks include the support of pilot projects, training courses and the integration and promotion of regional industry as well as exchanges with actors outside the region. The RCREE's current focus is on renewable energy legislation enforcement but it could be further utilized and serve as a central hub for research activities, information distribution and coordination of further legislation efforts in the MENA region.

subcontractors (cf. analysis of current CSP projects described in section 2.2.3) since they have better access to the countries' supplier networks and are more familiar with the terms and conditions of doing business in the region. Therefore, in bidding procedures for CSP projects, such offers should be preferred which include involvement of local EPC contractors. Even if these service providers might not yet possess comprehensive experience with CSP or energy projects in general, this would strongly foster the development of local CSP know-how.

Additionally, to ensure regional and international quality requirements and to strengthen the competitiveness of future MENA CSP industries, implementing **quality assurance standards** for CSP components should be considered in the medium to long term.

An early **competitive positioning of the MENA countries among the emerging economies worldwide** is required since a strong CSP market growth in the MENA region might as well lead to a competition of uprising MENA CSP component producers with potential future CSP manufacturing industries in other

Several countries, e.g. China, have successfully used **local content requirements** to upgrade the local manufacturing of renewable energy components. In 2005, the Chinese National Development and Reform Commission (NDRC) stipulated that new wind farms have to meet a 70% local content requirement on value added. Previously, local content requirements were gradually increased from 20% (introduced by the Ride the Wind Program in 1996). This led to a rise in domestic demand and to international wind equipment companies establishing manufacturing facilities in China, increasing the wind industrial FDIs and the value chain. One disadvantage is that the domestic wind turbine technology is still immature, requiring intensive maintenance and lowering load hours (Dewey & LeBoeuf LLP 2010) (Walz unp). This needs to be kept in mind for applications in the MENA region to avoid price increases, but overall this instrument could strongly promote regional industry participation. In China, local content clauses are removed once internationally competitive local industries have been established.

Egypt also makes efforts to reach a higher local content in newly established wind parks. **In tenders/bidding procedures**, **projects with a large share of locally produced components are prioritize**d. This approach could also be introduced for CSP projects.

emerging countries, such as China and India. These countries are already strong in the field of manufacturing of renewable energy technologies (a.o. solar heaters, photovoltaic cells and wind turbines, cf. case study on wind turbine industry in India page 201 and textbox about Chinese wind industry above) and might as well develop expertise with regard to the CSP technology.

However, it is unlikely that CSP manufacturing industries in these countries will evolve exclusively based on export opportunities to the MENA region. In India as well as in China a strong home market demand, fostered by measures like e.g. tax- and investment incentives and local content requirements, led to the development of competitive manufacturing industries for renewable energy technologies with the notable exception of PV in China which had, however, a strong basis in the China's capabilities in the microelectronics field. In addition, China is developing the home market for PV at present.

Nevertheless, it can not be excluded that also in China and India markets for the CSP technology will arise in the future and that the countries will seize the opportunity of exporting CSP components to the MENA region, thereby competing with local suppliers. Thus it is even more significant for the MENA countries to benefit from an early commitment to the development of a regional CSP industry to be able to profit from competitive advantages like e.g. low transport costs, the proximity to the European market and the design of technologies specifically adapted to MENA conditions. In this respect it is of particular importance that the MENA countries take the lead in CSP related R&D activities and focus on a strong regional integration and a removal of inter-MENA trade barriers (see below) to strengthen their competitive position among emerging economies worldwide.

Awareness rising and information provision

Based on the interview findings, most potential companies have a low level of awareness and little information concerning CSP technology and are rather pessimistic about its future development due to technical, institutional and cost uncertainties. Besides awareness raising and information distribution on a company level, policy makers will also have to be addressed to draw more attention to the subject. To overcome informational gaps and create a higher level of certainty for potential investors, first of all **clearly framed national targets** and estimations of future CSP project development should be defined and communicated by the governments, e.g. in the public media. Awareness actions aimed at policy makers and high level technical officers with specific seminars and stages in operational plants could also be appropriate to enhance the interest and knowledge in the public sector.

Further on, a **regional co-operation** between the single countries of the MENA region must be strongly encouraged. Besides others, this can be achieved by broadly communicating on the one hand the large potential of a CSP industry in MENA but on the other hand the significance of reaching the respective critical output volumes (threshold values) in the factories to allow for a profitable production. Strong emphasis must be laid on pointing out locational and competitive advantages of the different countries (cf. section 2.2.7) and the diverse requirements for the production of individual CSP components. (e.g.; with regard to required capital investments, demands on infrastructure, energy demand and required skills for production processes, etc.).

The creation of a **regional CSP association** dealing with issues such as CSP market development, manufacturing options and the latest technology advancements could, at this point, be an important support measure to scale up awareness and to exchange information between the different parties concerned. For example, such an association could interact with CSP associations in other parts of the world, create an internet platform, publish regular newsletters, set up information centers as well as organize regional and international conferences and workshops involving the local industries and service providers. This might motivate industrial players to enter the CSP-value chain and it helps to establish first business contacts between regional and international players. Such events could address small and medium-sized companies, in particular, which might benefit from being involved in the provision of secondary components and minor services. Additionally, training courses could be offered to interested parties to provide insights into the technical requirements and complexity of the various production processes. In Europe, for example, the CSP associations "*Protermosolar*" (Spain) and the "European Solar Thermal Electricity Association" played an important role in the development of local CSP industries (cf. case study on page 206).

Within this framework, links to industrial federations, chambers, international institutions and other existing networks should also be encouraged and fostered.

Enhancing infrastructure, trade and finance

Besides direct, sector-specific policies, the success of industrial policy schemes also depends on policies which influence the overall framework conditions within the country, for example infrastructure, trade and financial market regulations. Potential obstacles have been identified in the physical as well as the institutional **infrastructure** of the MENA countries (cf. section 2.2.7). Concerning the transportation and trade of raw materials, intermediate products and finished components, improving logistic networks, road and railway connections is a crucial aspect. Maritime links between the countries in the region also need to be enhanced to accelerate regional integration (WB 2010). With regard to the institutional infrastructure, it is important to have better administrative and legislative support to simplify business processes for local manufactures.

Positive examples of government institutions in MENA, which are already **involved in the upgrade of CSP industrial potential**, are the Industrial Modernization Center (IMC) in Egypt and the Moroccan Agency for Solar Energy (MASEN). MASEN is the first institution in the region which combines the promotion of solar energy with the aim of industrial development.

Currently, trade regimes in the MENA region are still rather protectionist despite efforts like the Greater Arab Free Trade Area (GAFTA) under the Arab League. Tariff rates and especially non-tariff barriers (e.g. technical norms) have to be lowered to enhance and accelerate trade (World Bank 2008a). In the CSP technology context, a **regional free trade arrangement** for trading renewable energy components or primary/intermediate products for renewable energy components could contribute significantly to better market integration, accelerate the development of a stable and sizable CSP market and enlarge the regional content in future CSP projects. This could be of particular importance with regard to the competition of the MENA countries with other emerging economies which might develop expertise in the production of CSP components in the future (e.g. India or China): These countries might be favored in trading if high inter-MENA trade barrires exist. Non-tariff barriers might have to be particularly addressed. A free trade agreement is also seen as a crucial pre-condition for successful market development within the scenarios (see above).

Finally, the provision of financial resources in the form of soft loans and **tax incentives** for local companies and investors should be facilitated to increase the profit margin and reduce the time until investments, e.g. in new production lines, pay off. Possible incentives with regard to business related taxes are listed in Table 3.3.

Table 3.3 ■ Potential Tax Incentives to Foster CSP Related Industrial Development

Tax	Potential incentives
Corporate tax	Reduced corporate tax or tax exemptions for manufacturers of RE- technologies. E.g.: • Tax exemption for revenues from CSP component exports • Complete exemption for a certain period after starting CSP business • Permanently reduced rates for producers of CSP-technology
Property tax & land registration tax	Exemption from land registration tax and property tax for manufacturer of RE- technologies.
VAT	Facilitated VAT refund on business related activities for foreign companies producing CSP-technology in MENA.
Capital allowances	Enhanced capital allowances for investments related to production of renewable energy technologies. For example on: • Purchase of production equipment • Renovation/upgrade expenses • R&D spending • Training activities for employees • Marketing & networking activities • Allowances might be graduated, e.g. starting with 100% in the first year.
Customs duty	Exemption from/refund of customs duty e.g. for: • Equipment for production of RE-technologies • Materials and sub-components of RE-technologies which are re-exported as finished products

As described in the case studies for the aeronautics industry in Morocco (page 87) and the wind turbine industry in India (page 201), the introduction of long-term guaranteed tax holidays or attractive tax deductions is a significant factor for local manufacturing by national as well as international companies. A general reduction or periodic exemption from corporate tax, property tax and land registration tax and enhanced capital allowances for producers of CSP components (or renewable energy technologies in general) would make this business generally more attractive. However, a refund of customs duties for imported raw materials or sub-components for CSP technologies with export of the finished component, might make a production more attractive, particularly for CSP industries which rely on certain imports especially in the starting phase of the business (e.g. heat transfer fluid, parts of the CSP receivers or special production equipment) and for CSP companies that want to make extensive use of export opportunities.

Although some of these incentives have already been introduced in the MENA countries they are not specifically targeted at CSP, or other renewable energy technologies (Table A.15 in the annex provides an overview of some business related taxes in the 5 CTF MENA countries).

Providing **low interest loans and grants** specifically for the local manufacturing of renewable energy components might help local companies raise funds for production lines or company startups. **Strategy funds** could, for example, be specifically designated for upgrading existing glass production lines and assessing the required changes as well as for supporting company startups or technology transfer, e.g. in CSP mirror manufacturing. Here, easier procurement of land and connection to power and water supplies could be an additional incentive for companies planning to open a CSP-related business in MENA. Funds for such national financial support schemes as well as for R&D activities in this field could also be generated by revenues from the "Certified Emission Reductions" of other renewable energy projects (Khalil et al. 2010).

A favorable framework should be created to attract those foreign investments in strategic industrial fields with a maximum value added for the local economy, which involve technology spillovers, innovation processes and the demand for R&D. Simplifying bureaucracy could help where complex application procedures slow down innovation processes or hinder foreign investments. Enhanced protection of intellectual property rights might also be necessary.

Strengthening of the absorptive capacity and the innovation system

Examples of industrial catch-up processes in emerging countries (e.g. Korea and Taiwan, described, e.g. by (Mazzoleni 2007)) clearly pinpoint the essential role of supporting academic research and R&D activities. Public support for the formation of research facilities, particularly focused on industrial development, leads to new processing techniques, boosts national intellectual property through patent registration and promotes dissemination of technological know-how in the respective industrial sectors. Efficient R&D activities require highly specialized R&D funding. The focus should be on future strategic sectors or technologies like CSP. Other

Examples of past industrial upgrade programs in MENA:

Tunisia initiated a comprehensive industrial modernization program in 1995, aimed at supporting eligible enterprises in upgrading their technological capabilities, strengthening their financial structures and enhancing their overall competitiveness. The companies received financial support from the 'Industrial Competitiveness Development Fund' (FODEC) to cover expenditures for feasibility studies and other diagnostic procedures, investments in equipment, acquisition of technology and quality management skills and application of new technologies. Besides measures directly aimed at single companies, the program also focused on strengthening national support institutions, e.g. technology centers and vocational training facilities. Its success was visible in noticeable sales and export increases and positive employment effects, particularly in managerial positions.

A similar program launched in **Algeria** ('Structural Adjustment Programme') also addressed the restructuring of the industrial sector to achieve greater economic competitiveness. The 'Fund for promotion of industrial competitiveness' was created, which provides financial aid for enterprises aspiring to improve their manufacturing capabilities. Financial aid is provided for strategic diagnosis and formulating upgrade plans. Besides this company-focused support, the aim was to enhance the overall economic performance by providing funds, e.g. for training activities, promoting exports and specific R&D activities.

In **Egypt,** the 'Industrial modernization Bureau' (IMB) offers grants for industrial upgrades with capital from the 'Fund for Improving Competitiveness'.

Similar programs have also been implemented in **Morocco**. Here, there was a particular focus on dismantling tariff barriers (UNIDO 2003a) as well as the support measures mentioned above. Removing import duties on specific goods, spare-parts or raw materials is an important way to stimulate a strategic industrial sector and should be pursued.

These industrial upgrading programs generally cover a large variety of sectors (e.g. chemical, building, textile, engineering and agro-food industries) and do not target specific fields, but they could serve as the basis for designing programs and funds for targeted support of the manufacturing sector for renewable energy technologies.

under-utilized funds could be terminated or transferred into more specific ones to improve the overall efficiency of government spending (World Bank 2010).

Later, a larger number of technology parks/clusters and regional innovation platforms should be created to foster regional cooperation and enhance the innovative capacity of industrial sectors. This would help small and medium-sized firms in particular to overcome innovation barriers and access the latest technology advancements. To foster such competence clusters, building sites in dedicated areas could be offered to institutions in the respective field at a favorable price.

The promotion of higher level education and improving the quality of education are further crucial aspects of strengthening the innovation system of a country willing to develop its industrial capacities. To avoid unemployment among the higher educated workforce, it is crucial to tailor educational programs to the

In the MENA region the Sinai **Technology Valley** in Egypt and the **Technology Park** of Borj Cedria in Tunisia can serve as examples for technology clusters with focus on renewable energy technologies.

An example for a highly specific educational program related to renewable energy technologies is the study course "Renewable Energy and Energy Efficiency for the MENA region" (REMENA) at the faculty for engineering at Cairo University. This master program in cooperation with Kassel University (Germany) offers students from MENA countries and Germany the opportunity to acquire competences in the field of renewable energy and energy efficiency. The study course includes, besides general modules on renewable energy issues, classes on solar thermal systems and power generation. With a stronger regional focus on developing CSP technologies, programs like this could be extended and more emphasis placed on solar thermal applications.

needs of the respective emerging industrial sectors: If labor-intensive industries are involved, it might be preferable to focus on vocational education schemes or "on the job training"; if industries need highly advanced technologies, new study courses/faculties at universities should be created to ensure the availability of expert engineers. Maximum efficiency in promotional programs can only be achieved with a common approach and a clear national focus in policies concerning industrial development, education and research promotion.

Generally, providing students with more practical experience, e.g. by combining studies at universities with vocational training in companies, might also help to address the needs of emerging industries more specifically and provide suitably skilled and specialized graduates for every sector. Funds could also be used to implement or upgrade the required training institutions and in-house trainings. 'Train the trainers' programs are also an option.

3.3.2 Component Specific Recommendations

A coherent, direct, supply-side-oriented industrial strategy is needed which should be embedded in the overall market enhancement scheme described in the

In Egypt, several **capacity building programs** in the field of energy efficiency have already been implemented. Main institutions were the Organization of Energy Planning (OEP) and the Energy Conservation and Environment Project (ECEP). The training courses usually lasted two or three days and covered specific technology subjects. Up to now, more than 8000 persons have been trained by the two institutions. Most of the trainees are engineers from different industrial companies. Besides strictly technology-related topics, the programs also covered subjects like project management and the preparation of feasibility studies.

Other institutions offering training courses in energy efficiency technologies in Egypt include the Energy Efficiency and Greenhouse Gas Reduction Project (EEIGGR), the Energy Research Center in Cairo University, the Tabbin Institute for Metallurgical Studies (TIMS), the New and Renewable Energy Authority (NREA) and the Institute of Graduated Studies and Research and Syndicate of Engineers (ERC 2010).

A general training infrastructure seems to already exist in Egypt, which could be used for a potential capacity upgrade in the field of renewable energy and extended to cover CSP-specific requirements.

previous section. The component-specific action plan focuses on key components with significant shares in the value chain (cf. section 1.3). These comprise key CSP products and services. The latter encompass all the services related to the construction, operation and maintenance of a CSP plant.

For the key components and services, different promotional measures are discussed and rated with regard to overcoming the most critical steps for their deployment (see Table 3.4 and Table 3.5). Depending on the expected market growth (scenarios), specific recommendations are given with respect to different possible cooperative business relationships.

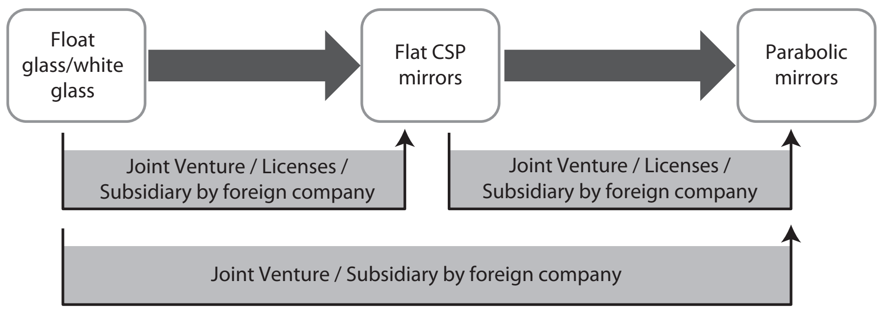
Cooperative agreements are particularly important as they enable CSP industries in the MENA region to absorb technology- and management know-how via technology transfer. Technology transfer is understood as the reception and utilization by one country of technology development in another (Graham 1982). There is a wide range of cooperative arrangements in international business. Considering the extent of inter-organizational dependence, cooperative agreements can vary from technical training or start-up assistance agreements of a short duration, through patent licensing and know-how licensing to equity joint ventures between firms (Contractor & Lorange 2002). For the purpose of this study, the wide range of cooperative agreements is simplified and limited to licensing and joint ventures. A local company remains strongly independent if only a license is procured. Nevertheless, licensing should be associated with extensive know-how transfer rather than simply a patent transfer. A joint venture may be based on a rather unequal cooperative arrangement between a local and an international company. This unevenly distributed cooperation agreement results, on the one hand, in a loss of independence for the local company (recipient), but, on the other hand, it offers the advantage of a potentially high knowledge transfer from the international company (transferor). Thus, the production of goods and services within the recipient country or region becomes feasible, which may have otherwise not been possible without the cooperation. For components with high barriers, and whose provision by independent local players or joint ventures is not possible in the foreseeable future, subsidiaries of international companies should be fostered. The local economy can still benefit here from job creation and tax revenues although the spillover effects of technology transfer may be lower.[2]

Figure 3.9, Figure 3.10 and Figure 3.11 depict simplified schemes of the most relevant technology milestones and critical production steps for three key components: mirrors, mounting structure and receiver tubes. The cooperative agreements of licensing and joint ventures as well as subsidiaries of international companies are potential routes to the next reachable milestones.

In the case of CSP mirrors, all three routes are possible to realize flat CSP mirror production based on existing float glass production. However, in case of mere acquisition of licenses without additional support (knowledge transfer) by experienced companies, the realization of a MENA parabolic mirror production

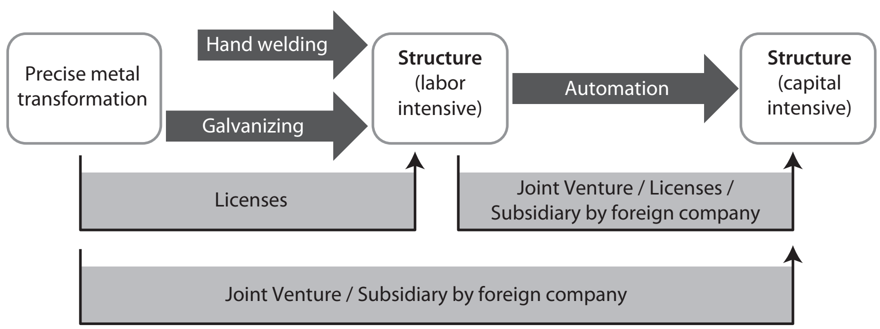
[2] Knowledge transfer might be smaller due to nondisclosure arrangements.

Figure 3.9 ■ Schematic Illustration of Potential Cooperative Forms to Overcome Critical Steps and Reach the Technological Milestones for the Production of CSP Mirrors



Source: Own design.

Figure 3.10 ■ Schematic Illustration of Potential Cooperative Forms to Overcome Critical Steps and Reach the Technological Milestones for the Production of CSP Mounting Structures

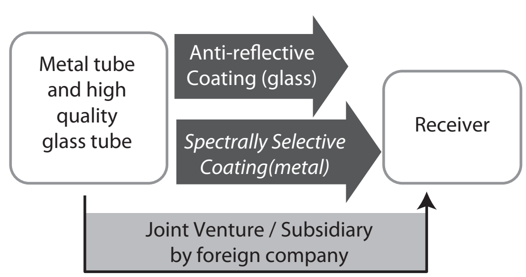


Source: Own design.

might take a longer time since extensive technological learning is required. A shortcut straight to parabolic mirror production could be taken by the opening of a subsidiary by an already established company or the formation of a joint venture between regional and experienced international players.

Concerning the production of CSP mounting structures in MENA, there are different approaches possible. In case of a labor-intensive, non-automated production, the foundation of

Figure 3.11 ■ Schematic Illustration of Potential Cooperative Forms to Overcome Critical Steps and Reach the Technological Milestones for the Production of CSP Receiver Tubes



Source: Own design.

a joint venture or the establishment of a local subsidiary by a foreign company seems improbable. Foreign players are more likely to enter the automated, capital-intensive manufacturing sector, as international production is already moving in this direction. Nevertheless, labor-intensive production might be reasonable and feasible for MENA companies in the short- to medium-term. Advantages due to lower labor costs may facilitate local production.

Based on the interviews with potential companies and industry experts, a production of high-tech CSP receivers under license is probably not feasible due to the high complexity of the production processes and the resulting strong industrial barriers. Furthermore, a transfer of licenses can be considered unlikely since the receiver tube market is dominated by only two large suppliers (Schott & Siemens). Consequently, the technological know-how for managing the critical steps in production would need to be transferred by a joint venture or by establishing a subsidiary of an experienced receiver company in MENA.

This general presentation of the possibilities for developing the key CSP industries in the MENA countries under different cooperation agreements is followed by an analysis of how the different market growth scenarios influence the choice of collaborative form and the focus of the support measures that can be applied to each component.

Scenario A: "Stagnation"

Under the conditions of a weak CSP market in MENA, it is not likely that local companies will **manufacture CSP mirrors** by acquiring licenses. Due to the existing high industrial barriers in the region (cf. Table 2.5 and Table 2.9), investments in acquiring licenses and upgrading production facilities would not pay off. The same applies to joint ventures as the regional market is too small and local R&D efforts insufficient to create the required technological environment, so that the conditions for entering the market are unfavorable for international companies. An example can be given regarding the company "Dr. Greiche Glass" in Egypt. An adaptation of the current production line to the production of curved CSP mirrors would involve the construction of a new factory. This would only pay off if sales of about one million m^2 of mirrors per year could be achieved. Consequently, this market value forms a threshold for the glass industry participating in CSP mirror production.

As the example of El Kuraymat (cf. section 2.2.3) showed, the provision of CSP **mounting structures by regional companies** is already feasible in the MENA region if licenses are available. Interviews revealed that several companies in MENA are interested in expanding their production lines to the manufacture of mounting structures. Because of the already high diversification of suppliers in this field (cf. section 1.2.2), licensing agreements seem a suitable option. Licensing agreements might be sufficient for labor-intensive manufacturing if adequate training measures are applied. However, capital-intensive, automated production may not be feasible yet as, in analogy to CSP mirrors, the market is not large enough to guarantee a long-term profit for the companies.

Receiver manufacturing under the "Stagnation" scenario can be considered to have an extremely low potential as, on the one hand, a sufficient production potential by local industries could not be identified in this study and, on the other, European companies clearly stated they would only enter the market if the MENA market volume were sufficiently large.

Scenario B: "No-replication"

One million m^2 CSP-mirrors per year, the threshold for a **CSP mirror factory** in MENA, corresponds roughly to the installation of one 100 MW plant per year (cf. section 1.1.3). Based on this figure, the "No-replication" scenario could already ensure the required demand if a single company covered the majority of CSP projects in the CTF MENA countries. The potential benefits of a growing CSP MENA market could be exploited by regional companies by acquiring licenses from market leaders like Flabeg, Guardian, Saint Gobain or Pilkington, although it is questionable whether market leaders would be willing to sell licenses. Countries with a more advanced glass and mirror industry (e.g. Egypt or Tunisia, cf. section 2.1.1) may even develop their own production know-how for the reflectors with some technical assistance by, e.g. machine suppliers and R&D support by research institutes and universities. A good example might be the Egyptian company "Dr. Greiche Glass," which is currently developing the capability of bent mirror production to supply a small research and test CSP plant of the Cairo University. The company developed its own mirror design with a mirror surface of 2.25 m^2 and a bending depth of 2cm. Even though only a small batch of 24 pieces is going to be produced for the test facility, this might be an important step for the company to gain first-hand experience with this technology.

Under the conditions of reliable market growth, a more automated production might develop for **mounting structures** for which much higher capital investments, a skilled workforce and greater R&D efforts are necessary. These could stem from single major suppliers, but assistance for small or medium-sized enterprises might be particularly important. Furthermore, joint venture agreements might be a way to achieve a quick alignment with international standards in production.

Therefore support for the CSP mirror and mounting structure branch should focus on matching regional and international players in CSP mirror production to encourage licensing and joint venture agreements. Joint ventures could be supported by international networks and exchange platforms as well as tax exemptions on joint venture agreements. To further support CSP technology advancements in the region, the promotion of stronger links between industry and research facilities should be incentivized, public spending on innovative CSP designs and new materials increased, and further incentives set to stimulate private R&D spending. One short-term focus of R&D activities could be the design of mirror and structure surfaces which are better adapted to sandstorms. In this scenario, knowledge transfer and the associated economic benefits could be much higher than in the case of a subsidiary of an international company.

In this scenario, a production of **CSP receiver tubes** in the MENA region is improbable, since the market volume is not sufficient for local companies to reap the benefits of acquiring licenses or upgrading production lines. License transfers are also unlikely because the market is currently dominated by only two large suppliers. In addition, the establishment of a foreign subsidiary of a receiver company in MENA will probably not take place without considerable growth of the regional market, but international companies could still be encouraged by providing support for bureaucratic processes and assistance in searching for qualified workers; tax deductions (cf. previous section) might also be an incentive.

Scenario C: "Transformation"

With a total trade volume of 7 GW, fast knowledge transfer to regional companies should remain the dominant strategy, so that these can quickly catch up with other international companies. Furthermore, strong R&D efforts should be pursued to support innovative technology designs and use of alternative materials in order to develop a first-mover advantage. Investments in the education and training of engineers and other high-skilled workforce will be particularly necessary under this scenario. Generally, it should be assumed that local manufacturing of the mounting structure and mirrors is fully feasible under this scenario so the emphasis should be on developing own designs, integrating the regional market and exploiting export opportunities to other world regions.

The following section discusses the critical steps for the local provision of each key component and evaluates the importance of support measures to overcome the most challenging obstacles.

Action plan to facilitate the manufacturing of the identified core CSP products

Regarding the solar field components, significant value shares of 10.7%, 6.4% and 7.1% have been identified for the mounting structure, CSP mirrors (parabolic) and the receiver, respectively[3] (cf. summary in Table 1.5). Moreover, the analysis classified synergies with other industries and/or side-market potentials as of medium to high importance for CSP mirrors and the mounting structure (cf. Table 1.5). Thus, favorable spillover effects can be expected if these industries develop. For example, in the case of CSP mirror production in the MENA region, white glass production might be established in some countries, or the quality of glass production in general might be improved as a 'by-product'. Therefore industries working with white glass, e.g. the window industry or even a potential PV-industry, would be strengthened and glass imports from abroad could be significantly reduced.

For the production of receivers, however, very limited complementarities to other industry sectors in MENA were identified (cf. Table 1.5). Furthermore, due to the complexity of the essential production steps of spectrally selective

[3] For a representative 50 MW parabolic trough plant with 7h storage capacity

coating the steel tube and anti-reflective coating the glass tube (cf. description of the production process in section 1.3.2), all the measures depicted in Table 31 are very important to overcome major critical production steps, but as there is currently no feasible production potential for local manufacturing facilities, the first sub-section below focuses on manufacturing CSP mirrors and the mounting structure. Nevertheless, the recommendations given can also be applied to receivers. Due to the similarities of the actions identified for the mounting structure and the mirrors, these two components are treated together.

Measures to overcome critical steps

As already pointed out when deriving the roadmap for CSP mirrors, the conditions for the **production of glass and mirrors** are quite favorable in the MENA region since the raw materials (e.g. high quality sand and limestone) are widely available and transport distances from the production facility to the plant should be fairly short because of mirror weight and size (typically 15% of total costs are transport costs.). Furthermore, the production of CSP mirrors is quite energy-intensive, so that countries with low energy costs, like Egypt and Algeria, have a considerable competitive advantage.

Mounting structure manufacturing has relatively high similarities to CSP mirror production in the MENA region concerning energy costs, labor costs, the availability and quality of raw materials and transport costs.

Table 3.4 shows the identified critical steps to reach CSP mirror- and mounting structure production and estimates the importance of related support measures. In the following, each measure is briefly discussed, focusing on the current parabolic collector technology. However, for other CSP collector designs, the importance of measures may differ in some cases, e.g. for the less complex CSP tower heliostats.

Assessing the feasibility of production line upgrade

A particularly important short-term measure is to provide external know-how to assess the technical feasibility of firms to upgrade their production lines to CSP mirrors and the mounting structure. This could, for example, be achieved by providing financial resources (e.g. from a strategy fund) to commission an external consultant or by nominating national/regional consortia of such experts funded by the governments.

Regarding **CSP mirrors**, this measure is particularly significant for adjusting production lines to float glass/white glass and for the process steps of coating and, in the case of parabolic mirrors, bending. Current producers of float glass are found in Egypt and Algeria; high-tech mirror production is located in Tunisia with the company SIALA, or in Egypt with "Dr. Greiche Glass" and Smart Glass, who have already showed interest in producing CSP mirrors by implementing or adapting the required process steps of coating and bending.

In the case of the **CSP mounting structure**, the most critical steps were identified as adjusting production lines to highly precise metal transformation and

Table 3.4 ■ Importance of Measures to Overcome Critical Steps in the CSP Mirror and Mounting Structure Production

Critical steps \ Measures	Assessing the feasibility of production line upgrades	Provision of financial resources	Training of low-skilled workforce	Education & training of high-skilled workforce	R&D enhancement
CSP Mirrors					
Adjustment of production lines to white glass	Blue	Light orange	Light blue	Light blue	Light orange
Coating (protection & silvering)	Blue	Light blue	Blue	Blue	Light blue
Bending (parabolic trough)	Blue	Light blue	Blue	Blue	Light blue
Quality of product	Light orange	Light blue	Blue	Blue	Light blue
Adaptation of mirror design and materials	Light orange	Blue	Light orange	Blue	Blue
Own mirror design and new materials	Light orange	Blue	Light orange	Blue	Blue
Mounting Structure					
Adjustment of metal transfor-mation facilities	Blue	Light orange	Light blue	Light blue	Light orange
Galvanization	Light orange	Light orange	Light orange	Light orange	Light blue
Hand welding	Light orange	Light orange	Blue	Light blue	Light orange
Automation (CNC for weld-ing and e.g. stamping)	Blue	Blue	Light blue	Blue	Light blue
Quality of product	Light orange	Light blue	Blue	Blue	Blue
Adaptation of structure design and materials	Light orange	Light blue	Light orange	Blue	Light blue
Own technology design	Light orange	Blue	Light orange	Blue	Blue

Light orange: minor influence, light **blue:** important influence, **blue:** very important influence
Source: Own design.

achieving a more automated production. Experiences with galvanization already exist in the MENA region (e.g. El Sewedy Power in Egypt has one of the largest galvanization factories worldwide).

The steel transformation industry was identified mostly in Egypt and Algeria as well as Morocco to a smaller extent. Some large global players are operating in the field of steel structures in MENA, e.g. Egypt.

Provision of financial resources

High quality white glass is the main input for **CSP mirror** production. The float glass/white glass processing industry is very capital-intensive as there is a high degree of automation. Thus, upgrading production to white glass requires considerable investments. These investments are typically pursued by a relatively small number of international companies who make decisions based on the size of the regional markets. These companies typically possess the necessary financial resources for the investment needed. For the other steps in the matrix, adequate financing is important to very important.

Overall, the financial resources needed to enhance **mounting structure** production are lower than for mirror production. Analogue to the float glass processing industry, the metal transforming industry including the galvanization process might be largely independent of financial resources because of enterprise scale.

Potential measures to integrate investment support mechanisms for upgrading include soft loans to companies, or offering a subsidy if companies decide to upgrade production facilities, e.g. a certain percentage of the investments needed. For such subsidies, a fund could be implemented which invokes certain criteria concerning the suitability for CSP technologies. Tax credits or deductions for investments in production lines or R&D expenditures (as discussed in the previous section, cf. Table 3.3) could further stimulate current glass and mirror as well as steel transforming companies to extend their efforts. If necessary, suitable institutions should be set up to coordinate applications for such financial support.

Training of low-skilled workforce

Capacity building programs are a very important measure to ensure the high quality of the components for CSP plants. This is particularly true for mirrors as even tiny changes in alignment have a high impact on the efficiency of the whole plant. Training courses for low-skilled workers could significantly reduce this risk assuming the presence of suitable machinery. Training courses of several weeks could already transfer the basic knowledge about single process steps in mirror and mounting structure manufacturing and could be offered within technical assistance agreements with companies deciding to upgrade production on their own. The training requirements for the mounting structure might be lower for single production steps as they are much less complex.

Education and training of high-skilled workforce

Universities should be encouraged to teach CSP technology-based courses to educate a potential workforce, particularly engineers and other highly skilled workers needed for the CSP branch. In general, the interview partners perceived few problems in the availability of a skilled workforce, but nevertheless specific CSP training will still be needed. CSP technology could offer a big opportunity for most CTF countries as a highly educated workforce is not being sufficiently absorbed by their markets because of rather low-skill-oriented industries (World Bank 2010). Furthermore, teaching courses should be offered by the companies in cooperation with universities, research institutes or other CSP experts to impart in-depth knowledge of the technology. Within the enerMENA project of the DLR (German Aerospace Center), training courses are already being offered, but the focus tends to be on project developers, plant manufacturers and operators to foster CSP market development and the program is due to end in December 2011. Another option is to build capacity by educating students and thus the future workforce abroad. This route is being taken by the Renewable Energy and Energy Efficiency for the MENA region (REMENA) master program, a cooperation of Cairo University and Kassel University (Germany) and financially supported by the Federal Ministry for Economic Cooperation and Development. Egyptian and German students are participating, although the number in the first round has been rather small. Co operations of this kind should be further accelerated in cooperation with other universities in the region and the CSP technology focus could be intensified.

Educating and training a high-skilled workforce is identified as important to very important for all the critical steps in CSP mirror and mounting structure production apart from the galvanization process. But in contrast to training low-skilled workers, this measure is much more capital and time intensive. Furthermore, if the workforce is highly qualified, wages will also have to be adjusted to prevent the emigration of professionals.

R&D enhancement

Universities could also become an important actor concerning R&D. R&D efforts need to be made by public as well as private institutions. Technology parks, which are currently expanding in the MENA region, could become an important platform to establish strong links between industry and research facilities. For example the Sinai Technology Valley in Egypt and the Technology Park of Borj Cedria in Tunisia have planned a focus on renewable energies. In general, networking between individual players should always be encouraged. Here RCREE could be a possible platform.

R&D enhancement is a very important measure concerning the adaptation of designs and materials as well as developing own designs and new materials. Furthermore, R&D is an important measure for layer protection in the case of mirrors and galvanizing in the case of the mounting structure. Materials might have to be adjusted to the environmental conditions of the MENA region with its high temperature fluctuations. Furthermore, mirror surfaces may have to be adjusted to higher volumes of dust and to sticky particles due to sea spray in coastal areas. Steel structures may have to be designed and adapted to the wind conditions in the MENA region. Because of the challenging environmental conditions, the maintenance equipment, e.g. cleaning machines for mirrors, may also be an interesting field for R&D efforts in the region.

The level of R&D enhancement depends on the assumed scenario. The more ambitious the scenario, the stronger R&D efforts should be in the beginning to exploit potential profits from first-mover advantages. More basic requirements for R&D are project-parallel research activities at CSP sites or the implementation of CSP-mirror testing plants.

Action plan to facilitate the manufacturing of the identified core CSP services

As a reminder, CSP services are defined as those needed to construct, operate and maintain a power plant; there is no clear line between the engineering activities required for CSP services and those needed for CSP products. For CSP related services the market size is not as critical as it is for technical components of a CSP plant. Nevertheless, the larger the installed capacity under the assumed scenario, the faster the services provided can evolve into more advanced business sectors. CSP-related services can be split into 'civil work, collector installation and assembly', 'EPC (engineering and project management)' and 'O&M' (operation and maintenance).

Shares in the value chain during the plant construction phase amount to 2.5% for assembly, 8.9% for civil work (5.8% infrastructure and 3.1% solar field), 5.3% for collector installations on the plant site and 7.7% for EPC engineers and project managers, CSP services have high spillover effects as they can easily be transferred to other sectors (cf. Table 1.5).

Services can be further divided into management skills and technical skills. Management skills are particularly important for EPC, but are also necessary in assembly and O&M. Technical skills cover assembly and construction as well as engineering activities.

Measures to overcome critical steps

The experiences gained to date from implemented projects in the MENA region indicate that mostly less advanced services, mainly **civil work and assembly,** have been carried out by local companies and workforce.

The Egyptian company, Orascom, is a positive example for an **EPC contractor** in the solar field. In the Kuraymat project, Fichtner Solar and Flagsol acted as subcontractors supporting Orascom with the conceptual design, engineering activities and technical advice about assembly (cf. section 2.2.3). The example of Kuraymat further showed that Orascom, which networks with other Egyptian companies due to other business activities, influenced the selection of supplier companies and local content considerably. This indicates the importance of overcoming information deficiencies concerning potential suppliers in the context of quality assurance standards, as international EPC contactors may rely less on local capacities because of their lack of experience in the region. Consequently, as already mentioned in the previous section, the deployment of local EPC contractors might be a key factor for enhancing the local content in CSP projects and thus to maximize the local added value from such projects for the countries.

O&M, the third type of service, has a different standing because it is important in the phase following plant construction. Job figures appear low at first sight, with about 40 persons needed for a 50 MW plant (cf. Table 1.10). However, O&M is a service required over the long term, generating a number of permanent jobs, not to be neglected.

Table 3.5 illustrates the identified grouped services for a CSP plant and the importance of measures for each group of services. Each measure is briefly discussed below.

Assessing the feasibility of service upgrade

Similar to CSP products, local companies could be offered the chance to consult with external experts about upgrades, also to raise awareness about the resources needed. Besides technical requirements, also management skill gaps should be addressed as the interview results show. Assessing the feasibility of service upgrades is important for construction companies as well as companies for collector installation and assembly.

Provision of financial sources

The provision of financial resources is important for all the services presented. Besides training requirements, providing services depends indirectly on investments in equipment and infrastructure. Small and medium-sized local companies involved in civil work might for example be dependent on investments in large shovels and trucks, and assembly services might require financial support to build assembly halls with the necessary machinery. Soft loans or other subsidies may be required; it needs to be discussed whether companies not directly related to CSP technology should be supported. Concerning EPC, a well trained workforce may be more important than providing financial resources as the companies currently involved are large and seem financially secure.

Table 3.5 ■ Importance of Measures to Overcome Critical Steps in the Provisions of Services Related to CSP Projects

	Assessing the feasibility of service upgrade	Provision of financial resources	Training of low-skilled workforce	Education & training of high-skilled workforce	R&D enhancement
Civil work, collector installation and assembly	gray	gray	black	gray	light gray
EPC engineering and project managing	gray	gray	light gray	black	gray
Operation and maintenance	gray	gray	gray	black	light gray

Light gray: minor influence, **gray:** important influence, **black:** very important influence

Training of low-skilled workforce

Low-skilled workers are needed for civil work, collector installation and assembly and to a lesser extent for O&M (e.g. for mirror cleaning). Foreign expertise in the form of supervision and training is needed to provide support in developing further competencies and improve productivity to overcome poor organizational structures in the labor force and to ensure quality demands are met. On-the-job-training might be sufficient for low-skilled workers. One option could be to 'train the trainers': Higher qualified workers of a company attend training courses and pass on the knowledge gained to the rest of the workforce. Under the regional recommendations already mentioned, this might be sufficient.

Education and training of high-skilled workforce

As already stated, the links between industry and research centers have to be strengthened considerably. Integrating educational programs into R&D institutions, e.g. technology parks, might be particularly useful to ensure a high quality of technical training and to support the information exchange about new technology developments.

It has to be determined which teaching programs already exist to be able to build on existing structures and networks.

Especially small and medium-sized engineering companies could be addressed here as potential, highly specialized sub-contractors (e.g. mechanical, electrical or thermo dynamical) to support the greater diversification of potential service providers. Management skills including logistics and quality standards will also have to be addressed. Some specialized knowledge could be gained abroad.

Service upgrades necessitating higher skills might require large investments, which small and medium-sized companies cannot afford. Here, support is needed from government and international sponsors in the form of grants for training, soft loans and tax incentives (cf. Table 3.3).

R&D enhancement

Concerning EPC, and in particular engineering, R&D could help local capacities to improve the conceptual design of plants. Although the R&D in this context is different to that for product development, the companies and research facilities of both types should collaborate to integrate training courses into R&D product networks.

Concluding, Table 3.6 summarizes the potential measures to stimulate the production of CSP components and provide CSP-related services in the MENA region.

3.4 Conclusion of Chapter 3

Based on the status quo analyses of the foregone chapters, the present chapter introduces roadmaps for development potentialities of CSP industries in the

Table 3.6 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 3.6 ■ 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

(*continued on next page*)

Table 3.6 Action Plan for Stimulation of Production of CSP Products in the MENA Region (*continued*)
Actors/financers: ∆ = 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	∆ ▲♦◊	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	∆ ▲♦	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	∆ ♦◊	Short to medium term
	Support of training activities for local workforce	Review of existing national training facilities, upgrade/creation of specific institutions if needed		∆ ▲	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	∆ ▲	Short to medium term
		Support the training of regional workforce by financial support if external training facilities are involved	Regional companies, international companies	∆ ▲	Short to medium term
		Promotion of financial incentives for 'train the trainers' programs	Regional companies, international companies	∆ ▲	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	∆ ▲	Short to medium term
		Creation of master programs at foreign universities and student exchange programs with regard to RE/CSP	Regional students	∆ ▲	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)	∆ ▲	Medium to long term

(*continued on next page*)

Table 3.6 ■ 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 3.7 ■ Examples of Potential Actors for Stimulation of Production of CSP Products in the MENA Region

Potential actors		Examples
∆	**National authorities & research facilities**	**Regional:** Regional Centre for Renewable Energy and Energy Efficiency (RCREE)
		EG: New and Renewable Energy Authority (NREA), Energy Supreme Council, Industrial Modernization Centre, Egypt National Cleaner Production Centre (ENCPC), Council of Electricity and Energy researches in the National Academy for Science and Technology, Egyptian Electricity Utility and Customer Protection Regulatory Agency (EEUCPRA), Tabbin Institute for Metallurgical Studies (TIMS), Energy Research Centre (ERC) at the Cairo University, all ministries related to energy issues.
		MO: Moroccan Solar Energy Agency (MASEN), Centre for Renewable Energy Development (CDER), Office National de l'Electricité (ONE)
		TN: National Agency for Energy Conservation (ANME), Chambre Syndicale Nationale des Energies Renouvables
		DZ: New Energy Algeria (NEAL), Centre de Recherche et de Développement de l'Ectricité et du Gaz, Agence National pour la Promotion et la Rationalisation de l'Utilisation de l'Energie, UDTS Research Centre
		JO: Ministry of Energy and Mineral Resources (MEMR), Ministry of planning and international cooperation (MoPIC), National Energy Research Center (NERC), National Electric Power Company (NEPCO), Electricity Regulatory Commission (ERC)
▲	**International donors**	World Bank (WB), African Development Bank (AfDB), Kreditanstalt für Wiederaufbau (KfW), United Nations Industrial Development Organization (UNIDO), German International Agency for Technical Support (GTZ), United Nations Development Program (UNDP), Global Environment Facility (GEF), EU, United States Agency for International Development (USAID), Canadian International Development Agency (CIDA), Agence Francaise de Développement (AFD), Danish International Development Agency (DANIDA), other national development agencies.
◊	**(Potential) national CSP players**	**EG:** Orascom, Arab Organization for Industrialization (AOI), Al Babtain Power & Telecommunication Co., El Sewedy Power, Middle East Engineering & Telecommunications (MEET), Dr. Greiche Glass, Sphinx Glass
		MO: Delattre Levivier Maroc, Inabensa Maroc, Induver Glass, LEONI Cable Maroc, Sonasid Steel, TAQA, YNNA Holding, TENESOL, GIMAS
		TN: Tunisie Cables, Tunisie Engineering et Construction Industrielle (TECI), Inter Metal
		DZ: Cevital, Africaver Societe African du Verre, Les Câbleries Electriques d'Alger, Algerian Energy Company (AEC), Sonatrach
		JO: Several service providers
♦	**International CSP players**	Abener, Abengoa Solar, Acciona, Alstom, Areva, BASF, Brightsource, Esolar, Ferrostaal, Flagsol, Flabeg, Fichtner, Guardian, Iberdrola, MAN Turbo, Novatec Biosol, Pilkington, Saint-Gobain, Sener, Siemens, Schott, Solar Millenium and many others (cf. section 1.2.2).

MENA region and presents action plans to foster the manufacturing potential for the key components and key services of the CSP value chain. Technological, entrepreneurial as well as policy and market developments, which are crucial for the establishment of local manufacturing in MENA have been pointed out. The suggested actions were adapted to different levels of potential market development (represented by three growth scenarios). From the analysis the following main conclusions could be derived:

Key preconditions for the development of local manufacturing of CSP components in the MENA region are the creation of a **stable policy framework** and a **sustained domestic market**. 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. 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 is depending on the expected market size: In the case of a stagnating growth of the CSP market in the region (scenario A), support should rather 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 structure, civil works and assembly). Assuming a moderate but stable growth of the CSP MENA market (scenario B) an adaptation of international production standards and techniques in existing industries should be aspired to achieve a region-wide supply of at least some suitable CSP components produced locally in the MENA region (e.g. mounting structure, piping, cables/electronic equipment and a wide range of related services). Under the "Transformation" scenario (scenario C) policy actions should strongly support innovations 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 for MENA conditions. A strong export orientation should be motivated to benefit from the proximity to other emerging markets. Thus a production of a wide range of CSP components could be achieved (parabolic mirrors and potentially receivers).

National strategies for industrial development and energy policy should be well coordinated and involve besides clearly defined and broadly communicated targets for the market diffusion of CSP, substantial R&D efforts and a 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 the related feasibility assessment) and the implementation of training courses for the local workforce. For this purpose, a provision of low interest loans, grants and tax incentives specifically designed for fostering local manufacturing of renewable energy components would help MENA companies to enter the CSP business. In this context, 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. Besides for the technical upgrade, funds could also be provided to facilitate know-how transfer, e.g. via purchase of licenses. For CSP receivers it is considered as improbable that local companies enter the production business due to the high complexity of this component. Here, tax incentives (e.g. in form of reduced corporate- and land registration taxes and facilitated VAT refunds) could help to attract international companies to the MENA region.

Besides financial aid, market actors will also need good **access to CSP related information** and certainty about the market development in order to engage in such investments. 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 advancements might be an essential element in this respect. Furthermore, to **enhance the innovative capacity** of the industrial sectors and to foster company networking and R&D, the creation of a larger number of technology parks/clusters and regional innovation platforms should be aspired. This would help particularly small and medium-sized firms to overcome innovation barriers and to gain access to the latest technological advancements.

Individual business models should build on the comparative advantages of certain sectors in MENA countries and also involve international cooperation agreements, e.g. in the form of joint ventures and licensing, to accelerate the development of a 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 in the beginning. Governments could assist the private sector in the matchmaking leading to such co-operations.

Another direct political measure to foster a long-term demand for CSP components would be the careful introduction of local (domestic) content clauses within CSP project tenders and in particular bringing forward the deployment of local EPC contractors. These have better access to local supply chains and service networks and might thus play a key role in raising the share of local value added in future CSP projects. Requirements in **bidding procedures** might thus be adjusted to prioritize local contractors.

Moreover entering local manufacturing of CSP components will involve comprehensive **education and training programs** for the industrial workforce in relevant sectors. Universities should be encouraged to teach CSP technology based courses to educate potential workforce, particularly engineers and other technical graduates related to the CSP branch. Additionally, to ensure regional and international quality requirements and to strengthen the competitiveness of future MENA CSP industries, it should be considered to implement **quality assurance standards** for CSP components in the medium to long term.