Local Manufacturing Potential for CSP Projects in MENA

- Roadmaps and Action Plan -

Dr. Wolfgang Eichhammer, Dr. Mario Ragwitz, Inga Boie, Dorothea Hauptstock
Introduction

Objectives:

• Analyse the relevant options to create a proper framework and to overcome the critical steps to establish a local CSP industry in MENA
• Support an active industrial policy for CSP technologies in MENA countries
• Derive roadmaps and action plans for the development of main CSP components
• Show the main technical and entrepreneurial developments needed to achieve local manufacturing in MENA
• The underlying essential preconditions include reliable CSP market growth and a stable political framework
Approach

Definition of **key-components** based on:

- Complexity of production processes
- Potential for local manufacturing
- Cost share in value chain

**Secondary components:**

- Industries already developed in MENA

---

**Road Map**

- CSP Key Components
- CSP Key Services
- CSP Secondary Components
- CSP other Components

**Action Plan**

- Mounting Structure
- Mirrors
- Receivers
- Assembling
- O&M
- EPC
- Electronics
- Cable
- Piping
- Trackers, HTF, Pumps, Storage, Power Block, Control System, etc.
Roadmaps for Local Manufacturing of CSP Components

Principle:

- Display current status of manufacturing for each component in MENA
- Define overall long-term objectives for each sector
- Depict corresponding intermediate milestones in development

- Developments are shown on different levels:
  - Technological
  - Entrepreneurial
  - Market & policy framework

Timeframe:

<table>
<thead>
<tr>
<th></th>
<th>Short-term (2-5 years)</th>
<th>Mid-term (6-10 years)</th>
<th>Long-term (after 2020)</th>
</tr>
</thead>
</table>

Examples of two key components: CSP mirrors & CSP receivers
Roadmap for CSP Mirrors

**Policy framework & market development**
- Coordinated national strategies for industrial development and energy targets defined
- Superordinate institutions are established
- Long-term, stable policy framework is implemented
- Strategy funds for industrial upgrade are provided
- Large number of R&D competence clusters created
- Intense trade of CSP mirrors in the MENA region
- Intense trade of other glass sectors (other special purpose glasses, solar glass, e.g. Photovoltaics)
- Growing number of CSP projects in pipeline
- Growing level of confidence in CSP technology
- Definition of long-term objectives for CSP development in MENA
- Growing number of CSP projects in pipeline
- Growing level of confidence in CSP technology
- CSP market development in MENA uncertain, small number of projects in pipeline
- Region-wide clear political goals regarding industrial policy
- Focused support for industrial development of CSP mirror industry
- Continuous & stable growth of CSP market in MENA

**Technology development**
- High availability of raw materials but currently no production of high quality white glass or parabolic mirrors in MENA.
- Supply of white glass for potential (foreign) mirror factories in MENA possible
- Mirror companies in MENA possess skills for production of CSP mirrors (coating)
- Production facilities and skills are upgraded for bending process
- Application of alternative materials & designs (e.g. polymers, thin glass, aluminum)
- Positive spill-over effects on other glass sectors (other special purpose glasses, solar glass, e.g. Photovoltaics)
- Mirrors for all types of CSP projects in MENA region can be supplied by regional companies plus export of mirrors

**Business development**
- Predominantly medium sized mirror companies with no activity in CSP technology so far
- Poorly developed intellectual property rights in MENA, high dependency on market leaders
- Subsidiary of foreign company
- Foundation of joint ventures
- Acquisition of licenses
- Comprehensive training of employees
- Investments in upgrade of production lines
- High level of sophistication is reached
- Positive spill-over effects on other glass sectors (other special purpose glasses, solar glass, e.g. Photovoltaics)
- Patented innovations in reflector designs & maintenance equipment in MENA
- Independent production of CSP mirrors in MENA. Newly emerging mirror companies and strong increase of overall sectoral potential.
- Growing intellectual property with regard to CSP mirrors. Profit from innovative designs, materials and e.g. cleaning methods.

**Status Quo Overall Goal**
- Single float glass factories in MENA are upgraded for production of high quality white glass
- Mirror companies in MENA possess skills for production of CSP mirrors (coating)
- Production facilities and skills are upgraded for bending process
- Application of alternative materials & designs (e.g. polymers, thin glass, aluminum)
- One or two large suppliers of white glass and several mirror manufacturers in MENA produce highly precise CSP reflectors at a competitive price.
- Mirrors for all types of CSP projects in MENA region can be supplied by regional companies plus export of mirrors

**Production**
- Production facilities and skills are upgraded for bending process
- Mirror companies in MENA possess skills for production of CSP mirrors (coating)
- Investment in upgrade of production lines
- High level of sophistication is reached
- Techniques and materials adapted to specific needs and resources of the countries
- Positive spill-over effects on other glass sectors (other special purpose glasses, solar glass, e.g. Photovoltaics)
- Patented innovations in reflector designs & maintenance equipment in MENA

**All reflectors for CSP plants in MENA are imported from abroad**

**CSP market development in MENA uncertain, small number of projects in pipeline**

**Minute of 4GW added CSP capacity in MENA per year**

**Continuous & stable growth of CSP market in MENA**

**Definition of long-term objectives for CSP development in MENA**

**Growing number of CSP projects in pipeline**

**Growing level of confidence in CSP technology**

**Minimum of 4GW added CSP capacity in MENA per year**
Extract from the Mirror Roadmap
Technological Development

**Status Quo**

**Technology development**

- High availability of raw materials but currently no production of high quality white glass or parabolic mirrors in MENA.
- All reflectors for CSP plants in MENA are imported from abroad.

**Short-Term**

- Single float glass factories in MENA are upgraded for production of high quality white glass.
- Mirror companies in MENA possess skills for production of CSP mirrors (coating).
- Supply of white glass for potential (foreign) mirror factories in MENA possible.
- Provision of linear reflectors for Fresnel plants or solar towers possible.

**Mid-Term**

- Production facilities and skills are upgraded for bending process.
- Provision of highly precise parabolic mirrors for solar trough plants possible.
Roadmap for CSP Receivers

**Short-Term**
- **Policy framework & market development**: No national targets for development of CSP receiver branch. CSP market development in MENA uncertain, small number of projects in pipeline.
- **Technology development**: No production facilities for receiver tubes exist in MENA. Single basic sub-components could potentially be supplied by local companies if quality standards can be met.
- **Business development**: No companies in or close to the field of CSP receiver tube production in MENA. No intellectual property related to CSP receivers exists in MENA. High dependency on a small number of market leaders.

**Mid-Term**
- **Policy framework & market development**: Coordinated national strategies for industrial development and energy targets defined. Long-term, stable policy framework is implemented. Superordinate institutions are established. High level of regional integration of the CSP value chain realized in MENA. Growing export of CSP receivers from MENA.
- **Technology development**: New production facilities for CSP receivers are set up & necessary skills transferred. Local metal-working companies meet required quality in pipe production.
- **Business development**: Universities and other research facilities lay focus on fundamental research in CSP receiver technologies. Conducive technological environment exists for receiver technology (e.g. insights in functionality & maintenance).

**Long-Term**
- **Policy framework & market development**: Region-wide clear political goals in terms of industrial- & foreign investment policy. Continuous & stable growth of CSP market in MENA. Focused support for development of MENA CSP receiver industry.
- **Technology development**: Receiver tubes for all Parabolic Trough plants in MENA are supplied locally (by int. companies). Steel pipes for receiver tubes are sourced from local companies.
- **Business development**: Subsidiary set up by foreign company (Schott or Siemens). Comprehensive training of employees. Applied research on CSP receivers in ongoing CSP projects & various testing plants. Transfer of intellectual property rights. Strong R&D efforts with focus on advancements in receiver technology with regard to MENA needs and capabilities.

**Overall Goal**
- Depending on the CSP market development, one or two large receiver factories in MENA supply the whole region.
- Receiver tubes for all Parabolic Trough plants in MENA are supplied by companies with production facilities based in MENA. Export is possible.
- Future registration of patents in the field of CSP receiver technology. Growing independence of MENA receiver companies.
- Strong R&D efforts with focus on advancements in receiver technology with regard to MENA needs and capabilities.
- Growing export of CSP receivers from MENA.
Action Plan - Definition of scenarios and related focus of support

<table>
<thead>
<tr>
<th>MENA home market volume</th>
<th>0.5 GW</th>
<th>1 GW</th>
<th>5 GW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scenarios</td>
<td>A</td>
<td>B</td>
<td>C</td>
</tr>
<tr>
<td>Potential foreign trade</td>
<td>0</td>
<td></td>
<td>2 GW</td>
</tr>
</tbody>
</table>

Pessimistic scenario: Slow market growth
- Enhancing the provision of products and services with low barriers; focus on already existing local companies

CTF scenario: Steady, moderate market growth
- Adaptation of international production and service standards for components with medium barriers

Optimistic scenario: Strong market growth + export
- Strengthening the innovative capacity for CSP components and services
Basic requirements for all CSP components:

- **Ensure a long-term market for CSP components**
- **Awareness raising and information provision**
- **Enhancing infrastructure, trade and finance**
- **Strengthening of absorptive capacity and innovation system**

**Formulation of binding targets, creation of the necessary legal framework and of specific support instruments for CSP technology**

**Overcome informational gaps and create a higher level of certainty for potential investors**

**Enhancement of physical as well as institutional infrastructure and of international free-trade agreements**

**Public support for the formation of research facilities, particularly focused on industrial development**
Goals and Selected Measures to Facilitate CSP Manufacturing in MENA

Upgrade and increase of existing industrial- & service capacities
- Provision of information on CSP market development & opportunities
- Support of feasibility studies for production line upgrade of local industries
- Implementation of investment support mechanisms for production line upgrades and training of employees

Activation of further market players
- Formulation of clear national targets for CSP industrial policy
- Provision of financial support for company startups
- Introduction of quality assurance for locally manufactured CSP components
- Creation of a favorable tax- and trade framework for CSP components

Facilitation of skill enhancement & knowledge transfer
- Promotion of joint venture formation & networking (e.g. creation of specific technology clusters)
- Support of training activities for local workforce
- Promotion of private and public R&D and higher education
Component-specific Options of Collaborative Agreements - Example of CSP Mirrors

- Technical barriers must be overcome
- An acquisition of the required know-how is possible in different ways:

  - Float glass/white glass → Coating → Flat CSP mirrors → Bending → Parabolic mirrors
    - Joint Venture / Licenses / Subsidiary by foreign company

- Alternatively suppliers of machines needed for manufacturing could facilitate knowledge spillovers towards MENA glass manufacturers
Due to the high complexity of the receiver technology, the possibilities to realize a local production are limited. The degree of international cooperation needs to be substantially higher than e.g. for mirrors.

Component-specific Options of Collaborative Agreements – Example of CSP Receivers

Metal tube and high quality glass tube

Joint Venture / Subsidiary by foreign company

Anti-reflective Coating (glass)

Spectrally Selective Coating (metal)

Receiver
Importance of measures to overcome critical steps in the CSP mirror production

<table>
<thead>
<tr>
<th>Measures</th>
<th>Assessing the feasibility of production line upgrades</th>
<th>Provision of financial resources</th>
<th>Training of low-skilled workforce</th>
<th>Education &amp; training of high-skilled workforce</th>
<th>R&amp;D enhancement</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSP Mirrors</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adjustment of production lines to float glass/white glass</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coating (protection &amp; silvering)</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bending (parabolic trough)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quality of product</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adaptation of mirror design and materials</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Own mirror design and new materials</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
</tbody>
</table>
### Importance of measures to overcome critical steps in the CSP mounting structure production

<table>
<thead>
<tr>
<th>Measures</th>
<th>Assessing the feasibility of production line upgrades</th>
<th>Provision of financial resources</th>
<th>Training of low-skilled workforce</th>
<th>Education &amp; training of high-skilled workforce</th>
<th>R&amp;D enhancement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Critical steps</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adjustment of production lines to metal transformation</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
</tr>
<tr>
<td>Galvanization</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
</tr>
<tr>
<td>Hand welding</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
</tr>
<tr>
<td>Automation (CNC for welding and e.g. stamping)</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
</tr>
<tr>
<td>Quality of product</td>
<td></td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
</tr>
<tr>
<td>Adaptation of structure design and materials</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
</tr>
<tr>
<td>Own technology design</td>
<td></td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
</tr>
</tbody>
</table>
Conclusion

- The creation of a stable policy framework and sustained domestic market for CSP is a key precondition for the development of local manufacturing in MENA.
- National strategies for industrial development and energy policy should be well coordinated and involve besides clear targets for the market diffusion of CSP substantial R&D efforts, strategy funds for industrial development of CSP industry sectors and stronger regional integration of policies.
- A provision of low interest loans and grants specifically designed for local manufacturing of renewable energy components might help local companies to raise the funds for the innovation of production lines or new company startups.
- The introduction of moderate local (domestic) content clauses within CSP tenders and other support instruments could stimulate domestic demand.
- To enhance the innovative capacity of the industrial sectors, the creation of a larger number of technology parks/clusters and regional innovation platforms should be aspired.
Conclusion

• Business models should build on the comparative advantages of certain sectors in MENA countries and also involve international cooperation agreements. Governments could assist the private sector in the matchmaking leading to such co-operations.

• The investment in new production lines based on highly automated processes for the mounting structure and in white glass production as well as adaption of techniques for coating and bending in case of mirrors will be the crucial first step. (Provision of CSP related information, technical feasibility studies on production line upgrades and creation of a regional CSP- or renewable energy associations)

• Entering local manufacturing will involve the comprehensive education and training programs for the industrial workforce in relevant sectors.

• For the service sector the local assembly of the plants and involvement of local EPC contractors are important initial steps for increasing the local component
Contact:

Wolfgang Eichhammer
Deputy Head Competence Centre Energy Policy and Energy Systems
Fraunhofer Institute for Systems and Innovation Research ISI
Breslauer Strasse 48 | 76139 Karlsruhe | Germany

Phone +49 721 6809-158 | Fax +49 721 6809-272
wolfgang.eichhammer@isi.fraunhofer.de
http://www.isi.fraunhofer.de
Additional Slides
CSP Mounting Structure

Status Quo

Technology development
- Metal structures produced in MENA but industries can only partly comply with required quality standards

CSP mounting structures provided by MENA companies only in single projects

Short-Term
- Region-wide availability of basic production techniques (highly accurate welding, galvanization, etc.)
- Production of highly accurate metal profiles

Mid-Term
- Application of advanced production techniques
- CNC-controlled production
- High level of automation
- Increase of quality
- Mass production
- Increase of output

Long-Term
- Enhanced production capacities which can satisfy whole MENA demand

Overall Goal
- MENA companies are able to manufacture mounting structures of high quality at a competitive price.

Business development
- Predominantly medium sized metalworking companies with no activity in CSP technology so far
- Poorly developed intellectual property rights in MENA

Policy framework & market development
- No national targets for development of mounting structure industry
- Coordinated national strategies for industrial development and energy targets defined
- Superordinate institutions are established
- Long-term, stable policy framework is implemented

CSP market development in MENA uncertain, small number of projects in pipeline
- Definition of long-term objectives for CSP development in MENA
- Growing number of CSP projects in pipeline
- Growing level of confidence in CSP technology

No institutional responsibilities and budgetary powers partly fragmented

Continuous & stable growth of CSP market in MENA
- Minimum of 0.5-1GW added CSP capacity in MENA per year
- Growing export of CSP components from MENA
- Focused support for industrial development of CSP mounting structure industry

Negative spill-over effects on other metalworking branches

Positive spill-over effects on other metalworking branches
- Innovations in structural designs specifically suited for local MENA conditions

Innovations in structural designs specifically suited for local MENA conditions

Growing intellectual property with regard to mounting structures. Use of innovative designs & materials

Innovations in structural designs specifically suited for local MENA conditions

Continuous & stable growth of CSP market in MENA
- Minimum of 0.5-1GW added CSP capacity in MENA per year
- Growing export of CSP components from MENA
- Focused support for industrial development of CSP mounting structure industry

Continuous & stable growth of CSP market in MENA
- Minimum of 0.5-1GW added CSP capacity in MENA per year
- Growing export of CSP components from MENA
- Focused support for industrial development of CSP mounting structure industry

Continuous & stable growth of CSP market in MENA
- Minimum of 0.5-1GW added CSP capacity in MENA per year
- Growing export of CSP components from MENA
- Focused support for industrial development of CSP mounting structure industry

Continuous & stable growth of CSP market in MENA
- Minimum of 0.5-1GW added CSP capacity in MENA per year
- Growing export of CSP components from MENA
- Focused support for industrial development of CSP mounting structure industry
Secondary CSP Components

**Status Quo**

**Technology development**
- Production facilities for different cables, various electronic components and piping exist in the whole MENA region.
- Only small fractions of the secondary components are currently supplied locally in single projects.

**Policy framework & market development**
- No national targets for development of CSP and related secondary components industries.

**Short-Term**

- Local companies reserve production capacities for the supply of cables and electronic components for CSP plants.
- Only small fractions of the secondary components are currently supplied locally in single projects.
- Cabling for all CSP plants in MENA is supplied by MENA companies.

**Mid-Term**

- Companies enhance their production capacities for the supply of a growing number of CSP projects.
- Local companies reserve/adapt production capacities for the supply of piping and insulation material.
- Piping for all CSP plants in MENA is supplied by MENA companies.

**Overall Goal**

- Various existing MENA companies develop specialized divisions for CSP specific cables, electronic components, insulation and piping.
- Secondary components are provided for CSP projects outside of MENA.
- All suitable secondary components in CSP projects are supplied by MENA companies. Long-term profit is generated, export is possible..

**Policy framework & market development**

- Focused support for industrial development of CSP secondary industries including specific funding of small-scale and medium enterprises.
- Strategy funds provide investment loans particularly for small companies.
- Intense trade of secondary CSP components in & outside of MENA.
- Coordinated national strategies for industrial development and energy targets defined.
- Long-term, stable policy framework is implemented.
- Favorable tax rates exist for CSP secondary components.
CSP Services

**Status Quo**

**Business development**
- Few large EPC contractors are active in MENA. First experiences in CSP projects have already been gained.
- Logistics are organized locally
- Assembly is carried out locally (under supervision of experienced EPC contractors)

**Policy framework & market development**
- No national targets for development of CSP and related service sector, no specific training available
- Infrastructure partly underdeveloped

**Short-Term**

**Business development**
- Subcontracts in CSP projects given to local companies by international EPC contractors
- Local service providers gain profound project experience & local workforce receives extensive training

**Policy framework & market development**
- Coordinated national strategies defined for service sector development and energy targets
- Long-term, stable policy framework is implemented & public funds made available

**Mid-Term**

**Business development**
- Project management is carried out by MENA companies
- Positive spill-over effects on other service sectors
- Independent jig- and field assembly by local companies

**Policy framework & market development**
- Strong focus on education & training related to CSP services
- Extensive upgrade of transport & communication infrastructure
- A well trained workforce for the CSP service sector is widely available

**Overall Goal**

**Business development**
- Large regional EPC contractors with comprehensive know-how in the field of CSP are active in MENA and supra-regional. Other sectors benefit from their profound experience.
- All civil works, on-site assembly, logistics and maintenance works are accomplished by the local workforce.

**Policy framework & market development**
- Clearly formulated political targets. Extensive availability of training centers, well trained workforce
- Well developed infrastructure assures transport services and communication