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Evaluating Renewable Energy Manufacturing Potential in the Arab Region:

Jordan, Lebanon, United Arab Emirates

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Abbreviations

ADFD	Abu Dhabi Fund for Development
CSP	Concentrated Solar Power
DEWA	Dubai Electricity and Water Authority
EDL	Electricity of Lebanon
EE	Energy Efficiency
EIB	European Investment Bank
EPC	Engineering, Procurement and Construction
ESCWA	Economic and Social Commission for Western Asia
FEMIP	Facility for Euro-Mediterranean Investment and Partnership
FDI	Foreign Direct Investment
FIT	Feed-In-Tariff
GDP	Gross Domestic Product
IPP	Independent Power Producer
IRI	Industrial Research Institute
IRENA	International Renewable Energy Agency
JREEEF	Jordanian Renewable Energy and Energy Efficiency Fund
LAS	League of Arab States
LCEC	Lebanese Center for Energy Conservation
LCOE	Levelised Cost of Electricity
LSES	The Lebanese Solar Energy Society
LGBC	Lebanon Green Building Council
MENA	Middle East and North Africa region
NEPCO	National Electric Power Company in Jordan
OECD	Organisation for Economic Co-operation and Development
O&M	Operation and Maintenance
PPA	Power Purchase Agreement
PPP	Public Private Partnership
PV	Photovoltaic
PYE	Person Years of Employment
RCREEE	Regional Center for Renewable Energy and Energy Efficiency
RE	Renewable Energy
RET	Renewable Energy Technology
R&D	Research and Development
SMEs	Small and Medium Enterprises
SWOT	Strength, Weakness, Opportunities, Threats
UAE	United Arab Emirates

Executive Summary

Countries in the Arab region possess rich resource potential for solar, wind and other renewable energy development. Less widely recognised is their potential to develop domestic manufacturing industries in the renewable energy sector.

Jordan, for example, has -the capacity to manufacture some windfarm components locally, creating jobs and laying the foundation for a future industry. Lebanon possesses some of the key materials for concentrated solar power (CSP) plants, given capacity-building assistance to develop manufacturing. The United Arab Emirates, meanwhile, could leverage its extensive oil and gas experience with a variety of renewable energy technologies, including CSP and onshore or offshore wind power.

The present report is the culmination of a study by the International Renewable Energy Agency (IRENA) and the United Nations Economic and Social Commission of Western Asia (ESCWA) on the potential for local manufacturing of renewable energy equipment in the Arab region.

The study expands on work already undertaken by IRENA in other countries in the region. In May 2015, IRENA, in co-operation with the European Investment Bank (EIB), published a study, *Evaluating Renewable Energy Manufacturing Potential in the Mediterranean Partner Countries*. That report assessed the capabilities of the Arab Republic of Egypt, the Kingdom of Morocco and Tunisia in developing the local renewable energy manufacturing industry (EIB/IRENA, 2015).

This further study focuses on Jordan, Lebanon and the United Arab Emirates (UAE) and is based on the methodology developed in the study published in 2015.

The objectives here are threefold:

- Assess the potential of renewable energy component manufacturing, in view of the renewable energy technology (RET) supply chain, industrial structure, regional co-operation in technology and export opportunities.
- Identify the gaps and the barriers in producing each selected technology in view of developing local RET manufacturing capacity such as technical skills, manufacturing processes, extensions in industrial capacity, political support and incentives, local and regional markets, investments and financing infrastructure.
- Provide recommendations and action plans to support and promote the development of manufacturing renewable energy components based on the four key success factors and gaps in each technology and the potential regional linkages.

The study assesses the potential for manufacturing RET components in Jordan, Lebanon and the UAE. The selection of these pilot countries was based on three criteria:

- The existence of ambitious national targets, support policies and progress recorded;
- Potential for market growth;
- Local industrial assets and the level of investment dedicated to renewable energy.

The study focuses on renewable energy technologies for which the selected pilot countries have strong advantages in terms of natural resources, market size potential or track record of related industries. As a result, solar PV, concentrated solar power (CSP) and onshore wind have been included in the scope of the study.

The analysis of the gaps for the development of a local RET manufacturing capacity in each country has been carried out according to four key success factors listed below:

- Substantial political support with an aim of creating a long-term stable market;
- Competitive local players in the global market;
- Strong industry innovation potential and skilled workforce;
- Investment capacity and strong financing infrastructures.

The resulting list of recommendations is designed to improve, at the national level, the development of local manufacturing capacity, while highlighting the vital role of supporting entities, such as public authorities, business associations and financers, in the development of renewable energy-related industrial capacities. In turn, this study responded to the main barriers identified and suggested possible actions to overcome them, under the framework of the key success factors.

Opportunities and recommendations for each country

Each country's industrial assets for local RET manufacturing can be considered in relation to the key success factors for local integration. Such analysis highlights manufacturing opportunities in Jordan, Lebanon and the UAE for the three selected technologies. Based on this, the recommended actions to advance the identified opportunities and encourage renewable energy component manufacturing have been summarised in the following points.

Jordan

A. Opportunities

Solar photovoltaics (PV): Despite high resource potential across the region, solar PV is still not economically feasible for certain segments in solar PV manufacturing. The nascent structure of component manufacturing is subject to limitations in the market and the presence of international players that undermine the development of this sector to further investment in new facilities and production lines.

Therefore, technology transfer will be required to strengthen PV manufacturing capabilities through establishing joint ventures. The presence of local PV panel manufacturers, in turn, could motivate other local industries, such as glass manufacturers, to enter the solar PV market, initially as supplier and later in roles like module assembly.

Concentrated solar power (CSP): Potential investments in the installation of a CSP project, which would generate more than 250 megawatts (MW) of electric power in the Ma'an development zone, is promising. In line with the energy diversification strategy of Jordan, at full capacity, the project could satisfy approximately 4% of Jordan's electricity need requirements, thus reducing dependence on electricity imports.

Steel support structures, piping systems, storage vessels, coating, connection boxes and cables may be manufactured locally, amounting to at least 30% of a CSP project. In this context, there is great potential for that share to expand. For example, the essential raw material required to manufacture mirrored solar concentrators exists in the country. However, training and capacity building programs would be necessary to instill the required skills needed in the manufacturing of specific shapes, such as curvature or bent glass. Incentives may provide substantial technology transfer by attracting international joint ventures of experienced companies in the field to further increase local manufacturing capabilities.

Wind: The master plan for renewables in Jordan has set a target of 1,200 MW for wind generated energy by 2020, with wind projects having already been achieved and new ones just recently launched. However, there are still local market limitations, mainly due to limited space and lack of an environmental impact assessment for the submitted projects. In addition, limited grid capacity represents a barrier to producing generated wind power. Some wind plant components can be manufactured locally, whereas components, such as rotor blades cannot be manufactured locally due to limited expertise and the associated high costs.

B. Recommended Actions:

- Define a national plan for renewable energy equipment manufacturing
- Reconsider the electricity tariff structure to favour the industrial sector
- Enhance visibility of renewable energy technology on the public and private levels
- Contribute to awareness-raising initiatives
- Conduct feasibility and marketing studies in order to begin developing local CSP and wind components based on existing industries, especially steel, electrical and mechanical industries.
- Establish national collaboration and partnerships for research and development (R&D) in order to support local manufacturing: budget and training
- Extend loans and grants to large-scale projects, especially wind and CSP

Lebanon

A. Opportunities

Solar PV: The current technological environment lacks infrastructure sufficient to support the growth of the renewable energy market, while significantly exceeding its absorption capacity. Furthermore, the administrative setting lacks the skilled workforce and expertise able to keep track of new renewable energy technologies, their features, economic and fiscal costs and benefits.

CSP: Although CSP feasibility studies have been conducted by several Lebanese companies, no projects have been implemented. Consequently, neither the market nor the industrial sector is oriented towards CSP. The demand for CSP applications is negligible, and the interest of suppliers and importers in CSP components is low. Therefore, the exclusive manufacturing of CSP components in Lebanon would be difficult. Some of the materials, including steel, copper, glass, and plastic that are used to manufacture CSP components like reflectors, receivers, heat storage equipment, steel structure, are available locally. However, components, such as steam turbines and heat transfer fluids (molten salt) need to be imported. Civil works, installation and construction can be delivered by local construction companies and renewable energy suppliers. Capacity building might be needed initially, in addition to improvements in industrial processes and investment in production lines.

Wind: Given the presence of an active PV market in residential, commercial, industrial and even agricultural projects in cities and rural settings, together with the flexibility of rooftop installation and lower capital costs, the prospects for the development of a local wind market still remains uncertain.

Different sites with a high potential for wind farms have been identified in Lebanon. Engineering, design and management teams, in addition to component suppliers, construction and maintenance teams, are available for the implementation of the electrical and civil parts of a project. Moreover, local industry has the capability to manufacture wind towers using local raw materials, while assembling gearboxes from local or imported electronic components. However, blade manufacturing requires composite material that needs to be imported. Nevertheless, regular upgrades would be required in ongoing industrial processes, testing, inspection and continuous research and development.

B. Recommended Actions:

- Define a national plan for renewable energy equipment manufacturing
- Profit from existing industries to create local renewable energy components manufacturing
- Reconsider the electricity tariff structure in order to favour the industrial sector
- Conduct awareness-raising activities on component manufacturing and value chains, and on the benefits of implementing renewable energy technologies
- Involve national centres in the practice of inspecting and testing locally manufactured components based on international standards
- Establish partnerships and collaborate with international agencies and industrial companies for R&D, training and capacity building programmes.

UAE

A. Opportunities

Solar PV: Considering the cost and the availability of resources, solar PV, in the short term, is increasingly the most attractive renewable energy technology in the UAE.There are several companies in the UAE that are active in the manufacturing of solar components. For example, DuSol Industries, the first PV module manufacturing company in Dubai, uses automatic production lines for all types of module manufacturing, including those for off-grid purposes. Microsol International is a solar-cell manufacturer located in Fujairah. The Dubai Silicon Oasis Free Zone, houses Almaden MENA that manufactures ultra-thin, double glass, and frameless PV modules. Noor Solar Technologies (NST), a solar panel and inverters manufacturer based in Dubai (The National, 2013).

CSP: Coupling thermal energy storage with CSP is arguably a viable technology for the UAE, given its potential to provide baseload power. However, the main challenges to CSP plants in the Gulf region, including the UAE, are dust particles and humidity that significantly reduce DNI and negatively affect CSP operations and solar mirrors and panels. Although many components can be locally sourced, Shams I project was mainly designed and implemented by international companies.

The UAE has extensive experience in oil and gas and chemical processes, namely, piping, tanks, vessels, control. In turn, this could be useful for CSP projects, especially in disciplines related to fluid and steam. Transformers, cables and other components are already locally manufactured. Possibly, more than 30% of components for CSP plants could be locally manufactured, a share that could increase to 60% if solar concentrators were locally produced.

Wind: Wind resources in the UAE is less prevalent than solar resources. Nevertheless, there is reasonable potential for specific applications and isolated grids, especially in the Northern Emirates and offshore areas. Wind projects are limited in the UAE, with the ones already operational having a relatively low capacity. The necessary skills and expertise are thus underdeveloped. However, many of the components required for such projects could be sourced locally, and include cables, connection boxes, transformers and the needed elements for building foundations. Moreover, the well-established steel industry could adapt or install production lines to include wind tower manufacturing processes.

B. Recommended Actions:

- Develop an extensive strategy and regulatory framework of renewable energy implementation
- Define a national plan for renewable energy equipment manufacturing
- Reconsider the electricity tariff structure to favour the industrial sector
- Prepare a social and economic assessment for upgrading or creating production lines
- Establish a strategy targeting some industries related to small-scale PV systems
- Assess the industrial sector and propose support mechanisms for heavy industries such as steel tower, tanks, and vessels, etc.

Outlook for renewable energy manufacturing in Jordan, Lebanon and the UAE

There are ample capabilities to advance renewable energy manufacturing in Jordan, Lebanon and the UAE. However, given the dynamics observed from both studies, components would require significant capital investment and a specialised workforce to advance industrial capacities. Therefore, co-operation and access to a larger regional renewable energy market and manufacturing capacities should be considered to attract and justify such investments.

In this context, several measures and actions have been identified to enhance renewable energy manufacturing interregional co-operation, including:

- **Establishing a shared R&D centre for countries manufacturing the same component.**

Shared R&D activities would not only enhance co-operation, but also ensure the consistency of regional plans, while providing the effective exchange of skills and expertise in a cost-effective approach.

- **Unified Arab standards and an accredited testing facility in at least one of the Arab countries.**

  A co-ordinated approach involving shared product standards among the Arab countries would enhance interregional trade and would increase consumer confidence.

- **Free trade zones for RETs across the Arab region and anti-dumping duties for products outside trade agreement.**

  Free trade zones could offer immense potential for trading locally manufactured renewable energy components between Arab countries, thus enhancing the regional and international RET market. Therefore, investors would be more willing to integrate RET manufacturing.

- **Shared zones for products in common.**

  Given that all six countries analysed in both studies, have a well-established manufacturing industry along component manufacturing, co-operation could build on the momentum in the project realisation phase.

Building on these parameters, agreements in regional trade to include different countries in the Arab world manufacturing the same product or along different areas in the project life-cycle could encourage renewable energy manufacturing. In turn, forming complementary value chains in the region, would also reinforce the co-operation between these countries at the capacity building and market regulation level.

1. Introduction

The International Renewable Energy Agency (IRENA) and the United Nations Economic and Social Commission of Western Asia (ESCWA) conducted a study on the potential of the local manufacturing of renewable energy (RE) equipment in the Arab region. The study falls under the scope of the Memorandum of Understanding (MoU) signed by both parties.

The study aims to expand on the work already undertaken and initiated by IRENA. In May 2015, IRENA, in co-operation with the European Investment Bank (EIB), published a study, *Evaluating Renewable Energy Manufacturing Potential in the Mediterranean Partner Countries*. It assesses the capabilities of the Arab Republic of Egypt, the Kingdom of Morocco and Tunisia in developing the local renewable energy manufacturing industry (EIB/IRENA, 2015).

In 2017, IRENA published studies on *Renewable Energy Benefits: Leveraging Local Capacity* that outlined the requirements along the value chain for solar PV (IRENA, 2017a) and onshore wind[1] (IRENA, 2017b), particularly in terms of human resources and skills, to produce, install and operate plants or facilities. This involves assessing the materials and equipment needed in each segment, with a focus on identifying potential for local value creation.

The study herein focuses on the Hashemite Kingdom of Jordan (Jordan), the Lebanese Republic (Lebanon) and the United Arab Emirates (UAE) and is based on the methodology developed in the study published in 2015.

The analysis of the gaps for the development of a local renewable energy manufacturing capacity in each country has been carried out according to four key success factors listed below:

- Substantial political support with an aim of creating a long-term stable market
- Competitive local players in the global market
- Strong industry innovation potential and skilled workforce
- Investment capacity and strong financing infrastructures

The objectives of the study herein are threefold:

- Assessing the potential of renewable energy component manufacturing in view of the renewable energy supply chain, industrial structure, regional co-operation in technology and export opportunities.
- Identifying the gaps and the barriers in producing each selected technology[2] in view of developing local renewable energy manufacturing capacity such as technical skills, manufacturing processes, extensions in industrial capacity, political support and incentives, local and regional markets, investments and financing infrastructure.
- Providing recommendations and action plans to support and promote the development of component manufacturing based on the four key success factors, gaps for each technology, and potential regional linkages.

The analyses included conducting a literature review following discussions with stakeholders in the three countries Jordan, Lebanon, and the UAE. The findings supported the SWOT analysis provided for each country, in addition to the analysis on the strengths and weaknesses of renewable energy value chains in terms of the availability of raw material, manufacturing capabilities, the state of the local industrial sector, the availability of suppliers and manufacturers, trade, electrical networks and grid infrastructure, technical expertise, and socioeconomic impact.

[1] The studies on solar water heaters and offshore wind will be published in 2018.
[2] Solar PV, Concentrated Solar Power (CSP) and onshore wind will be addressed in this study as mature and commercially scalable technologies.

The list of recommendations presented herein are designed to improve, on the national level, the development of local manufacturing capacity and to support such entities as public authorities, business associations and financers impacting the development of industrial renewable energy capacity responded to the main barriers identified and suggested possible actions to overcome them, under the framework of the key success factors.

Selection of Pilot Countries

The study assesses the potential of manufacturing renewable energy components in Jordan, Lebanon and the UAE.

The selection of these pilot countries is based on three criteria:

- **The existence of ambitious national targets, support policies and progress recorded**
- **Potential for market growth**
- **Local industrial assets and the level of investment dedicated to renewable energy**

In the last five years, the three countries have been committed to advancing their renewable energy mandate. Fiscal and financial incentives, along with other policy instruments such as auctions and net metering schemes have been implemented to support renewable energy project initiation and implementation in all three countries.

Renewable energy has provided unprecedented socioeconomic benefits, on a worldwide scale, providing 9.8 million jobs in 2016 (IRENA, 2017c), as a result of the widespread adoption of renewable energy projects. In this context, Jordan, Lebanon and the UAE have realised the benefits of renewable energy sources given the strong advantages in terms of natural resources, market size potential and track record of related industries.

Figure 1. Key success factors framework

	A	B	C	D
Success Factors	Substantial political support aiming at creating a long-term stable market	Competitive local players in the global market	Strong industry innovation potential and skilled workforce	Investment capacity and strong financing infrastructures
Classes of Recommendations	Formulate a long-term renewable energy strategy with national targets	Conduct awareness -raising initiatives	Support research and development	Encourage local banks to implement low-interest loans, grants
	Define an extensive renewable energy regulatory framework	Assess the feasibility of upgrading production lines	Educate and train high-skilled workforce	Implement investment support mechanisms for the adaptation or creation of production lines
	Define a national plan for renewable energy equipment manufacturing	Faster business linkages, especially international joint ventures	Implement upgrading programs targeting specific industrial players	
	Reform fossil-fuel subsidies	Support the structuring of the sector	Identify niche technologies and set-up national centres of excellence	

Source: Data compiled by LCEC

Renewable energy resources in the UAE feeds directly into its economic diversification strategy and its strategic positioning as a potential regional green energy hub for the Arab Gulf region. Among the countries in the Gulf Cooperation Council (GCC), the UAE is one of the most active in mandating specialised institutions to promote renewables (IRENA, 2016).

All three countries have adopted ambitious renewable energy targets, confirming the significance of renewables asan emerging solution. Jordan plans to source 10% of its primary energy from renewables by 2020, and Lebanon aims to meet 12% of its energy demand from renewable energy by 2020. Emirates in the UAE have set subnational targets for renewable power totalling 44% by 2050, including 18% renewables by 2030 in Dubai and 7% by 2020 in Abu Dhabi (IRENA, 2016).

Support policies, regulations and incentives in Jordan and the UAE could attract national and international stakeholders to invest in local renewable energy manufacturing systems. The solid banking sector in Lebanon is influential in attracting international investors to local industrial activities. All three countries possess the industrial capabilities and adequate national expertise that is necessary for local manufacturing of renewable energy systems.

Overview of Local Renewable Energy Manufacturing Potential in the Selected Countries

Table 1. Current status of renewable energy in Jordan, Lebanon and the UAE

Country	National Renewable Energy Plans	Market Potential	Industrial Assets
Jordan			
	• 10% renewables in power generation by 2020 (1,850 MW) • Renewable Energy and Energy Efficiency Law passed in 2012[3]	• Implemented RE projects (1,132 MW) by 2018[4] leading to O&M value creation • Net-metering • Feed-in tariff • Wheeling application and direct proposal submission	• Well established industrial sector • Expertise in numerous basic components
Lebanon			
	• Target of 12% of electricity demand • National Renewable Energy Action Plan • Energy efficiency and renewables law under development	• Well established financing mechanism • Rapid development of decentralised solar PV • Large-scale solar PV projects (150 MW) through a tender mechanism by 2020. • Distributed generation solar projects (30 MW) through net-metering scheme expected by 2020	• Expertise in the real estate sector • Expertise in control and automation
UAE			
	• Dubai target of 18% renewable power generation by 2030, part of "clean energy" targets of 25-30% by 2030 and 75% by 2050; plans include CSP (1 GW) and PV (4 GW), including up to 1 GW rooftop solar • Abu Dhabi target of 7% renewable power capacity (c. 1,500 MW) by 2020	• Implemented large-scale projects (Shams 1, PV projects, etc.) • Net-metering for rooftop PV • Strategic location proximity to other Mediterranean countries offering promising export potential.	• Proven-track record in infrastructure • Well established, fundamental industries • Experience in the oil & gas industry

Source: Data compiled by LCEC

[3] http://www.memr.gov.jo/EchoBusV3.0/SystemAssets/PDFs/AR/General/LawNo13.pdf (Ministry of Energy and Mineral Resources) and Arab Future Energy Index 2016 (AFEX 2016), RCREEE (2016).

[4] Including implemented and ongoing projects, data were compiled by LCEC.

2. Assessment of the Local Manufacturing Potential in the Selected Countries

JORDAN COUNTRY REPORT

A. Overview of the national policy framework

The total capacity of installed renewable power generation in Jordan, excluding hydro power, is approximately 550 MW divided between solar PV (347 MW), wind (197 MW) and biogas (3.5 MW). Looking forward, the country has set targets to further advance renewable energy deployment and has implemented support instruments to reach the set targets (ATA Insights, 2017).

1. Renewable energy policies and targets

- Master Strategy of Energy Sector in Jordan for the period 2007-2020:

  10% target for electricity generated from renewables by 2020, amounting to 1,850 MW[5], of which 800 MW is wind, 1,000 MW PV and 50 MW is waste-to-energy. Several CSP projects in the pipeline, are expected to amount to 325 MW.
- The Renewable Energy and Energy Efficiency Law (REEEL) No.13 was issued in 2010 and adopted in April 2012
- The by-laws and regulations pursuant to REEEL for renewable power generation projects allow for:
  - Exemption from sales taxes and customs duties for imported and locally manufactured renewable energy equipment.
  - A national reference price list, including the indicative prices for each type of renewable technology.
  - Sale of excess electricity generated by customers of the network from small renewable-based systems of no more than 5 MW, as specified in Article (10/B) of REEEL. The value of which will be transferred by the customer for consumption during the following month. This net-metering scheme applies to PV rooftops. The energy regulatory committee (ERC) shall issue new instructions on the specifications of small renewable energy facilities for homes, and the selling price of the generated electrical power to the Bulk Supply Licensees and to the Retail Supply Licensees.
  - Regulations related to the cost of renewable connection to the distribution system are specified in Article (9/B, C) of REEEL, which indicates that the:
    - » ERC shall issue new instructions to determine the connection costs of the renewable energy facility with the distribution network.
    - » ERC may exempt renewable energy facilities from any provision of the Grid Code or the Distribution Code, where such a waiver is necessary, in co-ordination with the relevant licensees.
  - Electric power wheeling directives
    - » Direct proposal submission for independent renewable-based power producers with a set list of ceiling tariffs for different technologies, including wind, CSP, PV, biomass and biogas, based on which bidders compete as specified in Article 2/A.
  - Establishment of the Maan Development Area, expanding opportunities for developers to select specific sites under the country's direct proposal submission scheme.
- **Financial support:**
  - The Jordanian Renewable Energy and Energy Efficiency Fund (JREEEF) was launched in 2013. It is designed to boost the uptake of renewables and energy

[5] Arab Future Energy Index 2016 (AFEX 2016), RCREEE (2016).

efficiency targeting small-to-medium-sized renewable energy and energy efficiency enterprises. This is conducted through the funding of activities across the project development stage, including project preparation and access to capital, among other things. The fund is sourced from the Government's general budget, foreign investments and grants from the GCC and EU. It covers interest rates and guarantees access to loans for enterprises, in partnership with the Jordan Guarantee Loans Company as part of Jordan's Central Bank.

- The Jordan Chamber of Industry's Factories Support Program provides non-refundable capital subsidies to support small industrial enterprises with the installation of solar PV or solar water heaters.[6] The subsidy covers up to 35% of production costs for foreign products and up to 50% for local products. The Higher Council of Science and Technology Industrial Research and Development Fund (IRDF) provides industrial organisations with grants of up to EUR 32,792 (USD 36,617) for implementing a solar PV project in partnership with an academic institution.[7]

2. Strategy to support the manufacturing of renewable energy systems and equipment

- A mandatory local contribution of 20% in competitive bidding for renewable energy projects, including EPC and O&M
- Development of national capacity in co-operation with regional and international agencies such as RCREEE through creating regional learning centres related to renewables and engineering
- Simplified procedure for international investments
- Foreign and domestic investment laws grant specific incentives to the industry, agriculture, tourism, health, transportation, energy, and water distribution sectors
- Two-year exemption on income and social services taxes for industrial projects
- Life time exemption on property taxes for industrial projects

The evaluation of renewable energy policy maturity in Jordan is given according to the following colour index:

Table 2. Previous and ongoing projects in Jordan

Technology[8]	Previous and ongoing projects	RE policy maturity
Solar PV	• 35 MW of small-scale systems (2015) • 20 MW at Al Mafraq (2015) • 10 MW at Aqaba (2015) • 10 MW at Al Mafraq (2015) • 5 MW at Azraq (2015) • 200 MW by direct proposal submission-stage I (12 projects, nine of which are at Ma'an, first quarter (Q1) 2016, PPA signed between NEPCO and Masdar) - 200 MW by direct proposal submission-stage II north and east Jordan (2016-2017) - 100 MW at Qweira/GCC Grant (2017) • 100 MW small-scale PV rooftops in pipeline	
Concentrated solar power	• No CSP projects has been realised as of yet	
Wind	• 117 MW at Tafila (2015) • 90 MW at Amman (2016) • 80 MW at Ma'an (first quarter 2016) • 320 MW-direct proposal submission-Stage I (mid-2018)	
Very Low	Low	Medium	High	Very High

[6] Circulars - Amman Chamber of Industry launched a range of technical and financial support programs: http://www.aci.org.jo/staging/development/aci_new_design/ar/programs_details.php?PROGRAM_ID=382&page=1

[7] Arab Future Energy Index (AFEX 2016, Renewable Energy), RCREEE (2016).

[8] Latest information available, as reported by Jordanian authorities during consultation meetings

B. Synthesis of strengths, weaknesses, opportunities and threats for local manufacturing for renewable energy components

Key findings on Jordan's renewable energy manufacturing potential are shown in the following SWOT analysis:

Strengths	Weaknesses
➢ **Industry maturity** • Local PV module manufacturer Philadelphia Solar ➢ **Technological skills** • Available manufacturing skills for the assembly of PV modules • Established PV manufacturers • Availability of skilled staff able to meet economic and regulatory assets to build manufacturing units. ➢ **Economic and regulatory assets** • Feed-in tariff • "Green Corridor" project to expand electricity grid	➢ **Industry maturity** • Limited R&D • Limited local market ➢ **Technological skills** • Lack of expertise in the manufacturing of several components, especially related to CSP and wind ➢ **Economic and regulatory assets** • Limited space, especially in urban areas • High land cost, especially in urban areas • High energy cost

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Opportunities	Threats
➢ **Finance** • Attractiveness in starting a business • Ease in obtaining construction permits • Ease in registering properties • Widespread electricity access across industrial and rural areas. ➢ **Competitiveness** • Increase in local manufacturing can reduce LCOE • Joint ventures with foreign companies • Export to neighbouring countries ➢ **Technology and expertise** • Existing industries such as metal, glass and rubber ➢ **Economic and Regulatory assets** • Mandatory local contribution of 20% in the bidding process, including EPC and O&M • Local certification system and testing facilities • Tax benefit system • Import policy to promote domestic manufacturing industries through access to cheaper imported capital goods, raw material, and other intermediate inputs rather than granting monopoly markets • Easy access for foreign investors • Restructure of electricity tariffs	➢ **Finance** • Difficulty in obtaining credit • Low protection for minority investors ➢ **Competitiveness** • Increase in local manufacturing can increase LCOE • Very strong international manufacturing competition, especially form Asia ➢ **Technology and expertise** • Rapid technology development worldwide • No local testing facilities ➢ **Economic and Regulatory assets** • Emerging national critical and urgent matters might shift interests away from the renewable energy sector • No action to update the feed-in tariff system in line with developments

C. Solar PV - Opportunities for local manufacturing

Grid capacity and land access are two major challenges hindering the renewable energy deployment sector in Jordan. Permits to acquire land must be obtained from the Department of Land and Survey. However, the National Electric Power Company (NEPCO) is currently upgrading the grid capacity under the "Green Corridor" project, which upon completion in 2019 is expected to increase overall the power load.

Solar PV is still not economically feasible for certain segments for solar PV manufacturing. The nascent structure of component manufacturing is subject to limitations in the market and the presence of international players that undermine the development of this sector to further investment in new facilities and production lines.

Therefore, technology transfer will be required to strengthen PV manufacturing capabilities through establishing joint ventures. The presence of a local manufacturer of PV panels could motivate other local industries, such as the glass industry, to enter the solar PV market, for example in module assembly.

Key findings on Jordan's solar PV manufacturing potential are summarised in the following SWOT analysis:

Strengths	Weaknesses
➢ **Industry maturity** • Mature technology with current installed capacity equal to 15 MW • Existing local PV module manufacturer ➢ **Technological skills** • Available installation, operation and maintenance skills for solar PV • Available manufacturing skills for PV module assembly ➢ **Economic and regulatory assets** • Financial aid through JREEEF for small-scale projects • Off-grid solutions (systems with batteries) are possible	➢ **Industry maturity** • Limited R&D • Under-developed SMEs ➢ **Technological Skills** • Limited know-how on components such as wafers, cells, glass and inverters ➢ **Economic and regulatory assets** • Limited local market • High automation in manufacturing process limits job creation
S	**W**
O	**T**
Opportunities	**Threats**
➢ **Finance** • Available Financial support • Electricity tariff restructuring ➢ **Competitiveness** • Available installation, operation and maintenance skills for PV • Entry of local manufacturers from existing industries to leverage on local capacities, such as glass, aluminum, steel and concrete to support manufacturing ➢ **Technology and expertise** • Solar PV manufacturers already established • Experience of several components • Existing industries such as metal, glass and rubber industries ➢ **Regulation** • Mandatory 20% local contribution in bidding rounds, including EPC and O&M • Close to achieving set targets before 2020 • Local certification system and testing facility for solar PV	➢ **Finance** • Difficulty in obtaining credit • Low protection for minority investors ➢ **Competitiveness** • Restricted local market • Strong foreign PV manufacturing p of specific components such as crystalline type panels • No suitable local development for local manufacturing ➢ **Technology and expertise** • Rapid technology development worldwide ➢ **Regulation** • Net-metering limited to small-scale systems (Rooftop PV)

Local value chain and industrial assets

The table below provides an overview of the value chain for component manufacturing for solar PV plants, classified according to the presence of different local players. The analysis is subject to their willingness to produce different components, given their overall industrial, technological and economical know-how.

The momentum of the solar PV system is supported by relatively easy installation procedures and the potential for off-grid solutions, albeit at the expense of wind and CSP solutions. The limited grid capacity has impeded the growth of the PV market. Subsequently, the "Green Corridor" project has allowed further PV installations and an expansion in the market due to grid rehabilitation initiatives.

(a) Raw material

The industrial sector comprises a combination of manufacturing and conversion activities. The sector is active in transforming raw materials into refined products, including phosphate, cement, plastics and glass. The glass industry constitutes around 1% of the total manufacturing output of the sector. Middle East Regional Development Enterprises (MEREN), a private company established in Jordan in 1996, owns a silica sand plant in Al Humema. Raw materials required for construction purposes such as metal and concrete are delivered by local manufacturers established in the real estate market.

Table 3. Local manufacturing assets - Solar PV - Jordan

Key assets of local industries	Industry maturity			Technological skills			Economic assets			Conclusion on local manufacturing assets
	Presence of active local companies	Level of industry structuring	Presence of local suppliers	Skilled workforce availability	Product quality	R&D capacity	Manufacturing cost competitiveness	Regulatory framework	Financial health	
Raw materials	●○○○	●●○○	●○○○	●○○○	○○○○	○○○○	●○○○	●○○○	●○○○	Low
Solar module manufacturing										
- Wafer production	○○○○	○○○○	○○○○	●○○○	○○○○	○○○○	○○○○	●○○○	●○○○	Very Low
- Solar cell production	●○○○	○○○○	○○○○	●○○○	○○○○	●○○○	●○○○	●○○○	●○○○	Low
- PV-module manufacturing	●●○○	●●●○	●●○○	●●○○	●●○○	●○○○	●●○○	●●●○	●●●○	Medium
PV plant										
- Electronics & cables	●●●○	●●●○	●●●○	●●●○	●●●○	●●○○	●●●●	●○○○	●○○○	High
- Steel support structures	●●○○	●●●○	●●●○	●●○○	●●●○	●●○○	●●●○	●○○○	●●○○	High
Construction	●●●○	●●●○	●●●○	●●●●	●●●○	●○○○	●●○○	●●●○	●●○○	High

Source: Data compiled by LCEC

(b) Solar module manufacturing

Philadelphia Solar, the sole local solar module producer, annually produces panels with the capacity of approximately 15-20 MW PV. In view of the limited local solar PV market, the company has strengthened its export base, exporting the majority of products to the United Kingdom, the Kingdom of the Netherlands and the Federal Republic of Germany (Philadelphia Solar, 2016).

(c) Electronics and cables

Al Raoui, UCIC-Cables, MESC, and CableCo are all local companies manufacturing cables. CableCo recently began manufacturing DC cables to meet recent growing demand. Additional cable companies are exploring the possibility of expanding their products to include PV cables.

Electrical Equipment Industries Co., a local company, manufactures transformers and provides services for electricity distribution in Jordan. Within this regard, the presence of international players, such as ABB, Horizons-Switchgear, TSB Co. and AEI, has allowed local companies to advance their technical skills and establish a skilled workforce able to meet international standards. The demand for the following high -quality products among neighbouring countries has fostered market dynamism and has led to success in the export markets. The success can be maintained and supported through furthering investment in new production facilities and staff training.

(d) Steel support structures

The well-established metal industry consists of plants that have been operating for more than 25 years. The industry develops different types of frames from diverse metal. Requests by developers for renewable energy components has required some existing industries to diversify their manufacturing range to include solar PV frames. However, the rising price of energy is a major challenge faced by such companies as United for Metal Industries and Najjar Steel that specialise in steel frames.

(e) Engineering, Procurement and Construction

Bids for RE projects must include 20% local content, thus favouring the participation of local engineering, procurement and construction (EPC) companies. This has enabled companies to increase their expertise.[9] However, First Solar, the EPC contractor for the 52.5 MW Shams Ma'an solar plant, has commissioned ABB, an international technology company, to construct a sub-station to integrate solar energy into the grid. Part of the project requires ABB to engineer, manufacture and supply the 33kV interconnection facility with the grid in a prefabricated electrical centre (PEC). The PEC includes the 33kV gas-insulated switchgear, sub-station automation, control and protection systems, 33kV capacitor banks and ancillary equipment to ensure proper interfacing with the remote-end utility sub-station that was supplied by ABB in 2016. In addition, ABB will supply a two-megavolt-ampere reactive (MVAR) static compensator (STATCOM), a first for ABB in Jordan, including coupling transformer. The installation of a STATCOM into the grid will increase power transfer capability by enhancing voltage stability and maintaining a smooth voltage profile under different network conditions, thus improving power quality.

Assessment of local renewable manufacturing

A. Analysis of the key success factors for future local manufacturing

The purpose of this section is to analyse the local manufacturing perspectives in the solar PV value chain for Jordan. Interviews conducted with local stakeholders in Jordan have enabled to identify a set of key success factors for the development of local solar PV component manufacturing.

[9] Data provided by the stakeholders interviewed in Jordan

Table 4. Key success factors for future local manufacturing - Solar PV - Jordan

Key barriers for future local manufacturing capability	Investment capacity and strong financing infrastructures	Competitive local players	Strong industry innovation	Stable policy support	Conclusion on future local industrial capability
Raw materials	●	●	●	●	Medium
Solar module manufacturing					
- Wafer production	●	●	●	●	Very Low
- Solar cell production	●	●	●	●	Very Low
- PV-module manufacturing	●	●	●	●	Medium
PV plant					
- Electronics & cables	●	●	●	●	High
- Steel support structures	●	●	●	●	High
Construction	●	●	●	●	High

Source: Data compiled by LCEC

B. Potential Involvement of International Players in local production

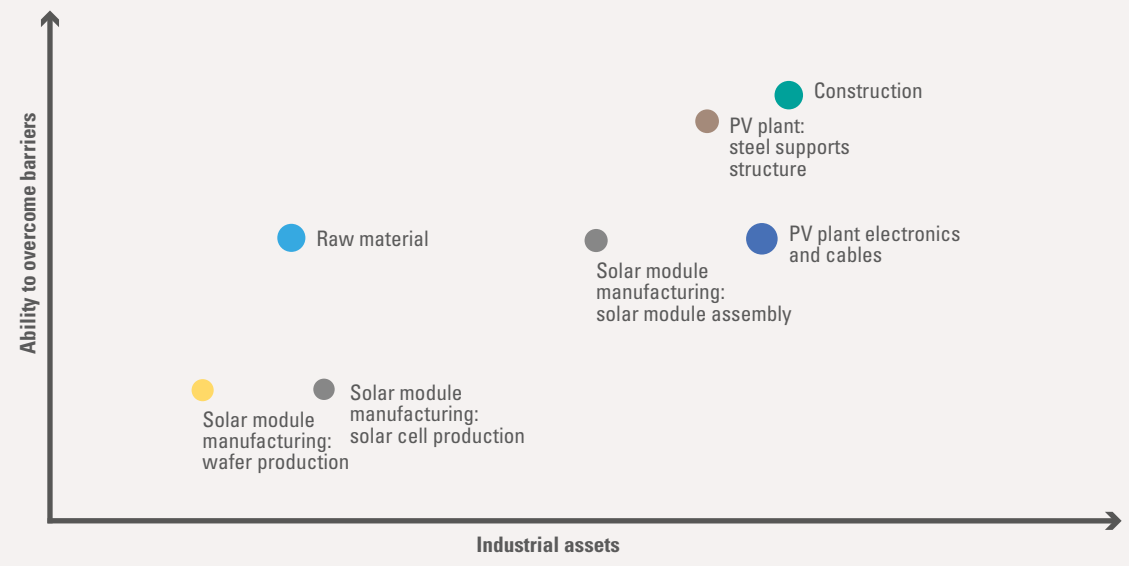
The presence of local modules manufacturer Philadelphia Solar, which has the capacity to export to local and regional markets, provides an initial positive outlook for a strengthened capacity of a potential local PV industry. Initiating joint ventures with international companies could reinforce the manufacturing of solar PV components, thus assist the country in increasing competitiveness and decreasing system costs. Training and capacity building activities and programmes could also strengthen existing technical skills and expertise.

In a Jordanian context, First Solar and Suntech are the main contributors of installed PV projects, and Vestas Wind and Gamesa are the main contributors for the installed wind projects.

C. Conclusion on future local manufacturing opportunities

Based on the analysis of these industrial assets, the figure below provides a review on the key success factors for local integration in PV. The size of each "bubble" represents weightt of jobs created by industry activity per MW installed. The size of each bubble does not provide information on the local part of the production, but only gives indication on the potential of each industrial sector. Moreover, it provides a synthetic vision on the needs for improvement, as highlighted in the case of solar PV.

Figure 2. Future local manufacturing opportunities - Solar PV - Jordan



Source: Data compiled by LCEC

1. Various inputs offer promising local capacity potential:

- Solar PV is already provided locally by Philadelphia Solar that operates a module assembly plant. However, local market limitations discourage increased production rates or the addition of new lines. One solution would be to establish joint ventures with international companies experienced in solar PV manufacturing which could increase market volume, at least on the regional level.
- Cable manufacturers and connection boxes manufacturers, are well established in the local and export markets. However, establishing license agreements and joint ventures with international manufacturers could further develop the electronic components and cables sub-sector. Deploying international expertise in developing products compliant with PV application standards would avoid related R&D costs, resulting in a reduction of production costs.
- Civil works, infrastructure and material could be locally delivered considering the local market expertise in construction and large projects.

2. Additional components show potential but challenges need to be overcome to unlock this potential:

- Raw material used to produce solar glass is available in Jordan. However, investment in new production lines would be needed in order for such local firms as Sanam Glass to be able to manufacture the glass sheets required for PV modules and thus be delivered to local and regional PV module manufacturers.
  - Local capacity is likely to remain limited in the medium-term on the remaining parts: The local manufacturing of such components such as solar cells and wafers does not exist. It is still expensive and requires significant investment, in addition to the highly automated process limiting job creation opportunities. However, local industries can provide the raw material required for cell manufacturing and the glass sheets, back and front, for module assembly. Investing in cell and wafer manufacturing requires government support to boost local manufacturing and challenge international competition with countries leading in module manufacturing, such as China.

D. Concentrated solar power - Opportunities for local manufacturing

Jordan is one of many countries located in the Solar Belt region, thus creating great potential for solar energy. The average solar radiation ranges between 5 and 7 kWh per square metre (m^2), which potentially equates to at least 1,000 GWh per year annually.[10] In the short-to-medium term, the Government expects to construct the first concentrated solar power (CSP) demonstration project and is considering Aqaba and the south east of Jordan for this purpose.

Potential investments in the installation of a CSP project, which would generate more than 250 MW of energy in the Ma'an development zone, is promising. In line with the energy diversification strategy of Jordan, at full capacity the project could satisfy approximately 4% of Jordan's electricity need requirements, thus reducing dependence on electricity imports. Excess energy could be sold to Egypt, Palestine and Syria, where networks are already connected to Jordan (Zafar, 2016).

The following CSP projects are in the pipeline:

- CSP in Al-Queira with a total capacity of 100 MW developed privately on a BOO basis
- CSP projects through direct proposal submission with total capacity of 225 MW developed on a BOO basis
- CSP hybrid system project in the south of Jordan with a total capacity of 1 MW and a 2 MW wind project developed by public works and financed through EU grants

Steel support structures, piping systems, storage vessels, coating, connection boxes and cables may be manufactured locally, amounting to at least 30% of a CSP project. In this context, there is great potential for that figure to increase. For example, the essential raw material required to manufacture mirrored solar concentrators exists in the country. However, training and capacity building programs would be necessary to teach the required skills in the manufacturing of such specific shapes as curvature or bent glass. Incentives could provide significant technology transfer by attracting international joint ventures of experienced companies in the field to further increase local manufacturing capabilities.

Moreover, electric power wheeling directives allow electric power generated by renewable-based systems, delivered via transmission and/or distribution lines and associated facilities, to specific customers, to be billed by the electrical company providing power to the same customers. Wheeling presents opportunities for the development of large-scale CSP projects, especially in large industrial facilities. Direct proposal submissions can also have an impact on increasing the installation of CSP projects in Jordan.

Key findings on Jordan's CSP manufacturing potential are summarised in the following SWOT analysis:

[10] Sustainable Energy Mix and Policy Framework for Jordan, 2011.

Strengths	Weaknesses
➢ **Industry maturity** • Local manufacturing potential of up to 30% ➢ **Technological skills** • Installation, operation and maintenance skills available for CSP ➢ **Economic and regulatory assets** • Wheeling can be an incentive for the private sector • Public projects in the pipeline	➢ **Industry maturity** • CSP is not widely spread among suppliers ➢ **Technological Skills Constraints** • Need capacity building and training for manufacturing specific components (e.g. power trains) • Operation and maintenance of CSP plants is complex (plant administration, operation and control and technical inspections for both turbines and collectors). ➢ **Economic and regulatory assets** • Limited local market due to high land costs
S W **O T**	
Opportunities	**Threats**
➢ **Finance** • Easy for foreign investments to integrate into the local market ➢ **Competitiveness** • CSP with storage can be a competitive product • Local manufacturing would decrease tariffs ➢ **Technology and expertise** • Potential of adapting local industries for CSP components ➢ **Regulation** • Mandatory local contribution of 20% in bidding rounds, including EPC and O&M • Public support and a masterplan for CSP projects could easily boost local manufacturing	➢ **Finance** • Limited incentives and direct aid for CSP projects • The bankability of projects for CSP (parabolic trough) is low compared to more established technologies such as PV ➢ **Competitiveness** • Restricted local market • High costs compared to conventional energy ➢ **Technology and expertise** • No direct experience with local manufacturing in CSP components ➢ **Regulation** • Limited grid capacity, limiting the absorption of CSP peaks, unless Green Corridor project is finalised.

Local value chain and industrial assets

The table below provides an overview of the value chain for component manufacturing for CSP plants, classified according to the presence of different local players. The analysis is subject to their willingness to produce different components, given their overall industrial, technological and economical know-how.

Large-scale CSP projects are expensive compared to other renewable energy technologies (such as solar PV), creating a significant barrier to the development of CSP projects.[11] However, the levelised cost of electricity (LCOE) of CSP projects could be decreased by increasing the share of local manufacturing. The local component of 20% in any public project can be revised upward to include components other than EPC and O&M.

(a) Raw material

Part of the large quantity of raw material required to build CSP plants can be sourced locally, including such metals as steel for support structures, concrete for foundations, and the material required for mirror manufacturing, providing promising potential for semi-finished components. However, heat transfer fluids, or molten salt used for storage, must be imported.

(b) Solar field – mirrors, receivers, support structures

Flat mirrors can be produced locally by such glass manufacturers as Middle East Regional Development Entreprises.

[11] Typical ranges and weighted averages for the total installed costs of utility-scale renewable power generation technologies by region 2013/2014 http://www.irena.org/DocumentDownloads/Publications/IRENA_RE_Power_Costs_Summary.pdf, (IRENA, 2015).

Table 5. Local manufacturing assets - CSP - Jordan

Key assets of local industries	Industry maturity			Technological skills			Economic assets			Conclusion on local manufacturing assets
	Presence of active local companies	Level of industry structuring	Presence of local suppliers	Skilled workforce availability	Product quality	R&D capacity	Manufacturing cost competitiveness	Regulatory framework	Financial health	
Raw materials	●●○○	●●○○	●●○○	●○○○	●○○○	○○○○	●○○○	○○○○	●●○○	Low
Solar field										
- Mirrors	●○○○	●○○○	●○○○	●●○○	●●○○	●●○○	●○○○	●●○○	●●●○	Medium
- Mounting structures	●●○○	●●○○	●●●○	●●●○	●●●○	●●○○	●●●○	●●●○	●●●○	High
Power block										
- Balance of plant	●●○○	●●○○	●●●○	●●○○	●●●○	●○○○	●●●○	●●●○	●●○○	High
- Power train	○○○○	●○○○	●○○○	●○○○	○○○○	○○○○	○○○○	○○○○	○○○○	Very Low
Thermal storage										
- Storage systems	●●○○	●●○○	●●○○	●●○○	●●○○	●●○○	●●○○	●●○○	●●○○	Medium
Grid connection	●●●○	●●●○	●●●○	●●●○	●●●○	●●●○	●●●○	●●●○	●●○○	High
Construction	●●○○	●●●●	●●●○	●●●○	●●●○	●○○○	●●●○	●●●○	●●●○	High

Source: Data compiled by LCEC

However, high costs could be incurred manufacturing bent mirrors, which requires the implementation of capacity building, training and new production lines.

The steel structures required for CSP plants can be manufactured by local steel companies such as United for Metal Industries and Najjar Steel. The involvement of some existing industries in the manufacturing of support structures for CSP solar field would be based on specific requests from developers.

(c) Grid connection

Electrical Equipment Industries Company Ltd. (ELICO), an affiliated company to the Lebanese Matelec Group established in Jordan, manufactures distribution, power transformers and switchgears. Jordan Electric Power Company (Manufacturing Department) are experts in building sub-station distribution panels, control panels, breakers and metal towers. Arfan Est. For Industrial Electrical Switchboards is a local company with expertise in medium-to-low-voltage distribution systems.

(d) Steam turbines

Skills, such as design, engineering and assembly, required for steam turbine manufacturing are unavailable locally. The high costs associated with installing local steam turbine manufacturing plants are unjustified if local and regional markets are not well developed such that the demand is non-existent or low.

(e) Storage systems

Vessel, valve and pipe manufacturing can benefit from local experience in the water, solar water heaters and conventional power industries. However, storage liquid is unavailable locally and should be imported. Storage solutions such as thermos-fluids systems based on silica sands, which is available, could be developed and produced locally due to the availability of raw materials, such as silica.

Assessment for local renewable energy manufacturing

A. Analysis of the key success factors for future local manufacturing

The purpose of this section is to analyse the local manufacturing perspectives in the CSP value chain for Jordan. Interviews conducted with local stakeholders in Jordan have enabled to identify a set of key success factors for the development of local CSP component manufacturing.

B. Potential involvement of international players in local production

Jordan presents great potential for CSP development in terms of infrastructure. However, the limited capacity of 325 MW of CSP in the pipeline by 2020 is unappealing for international investors compared to highly ambitious targets in other Arab countries. For example, the target for Egypt is 1,100 MW and 1,500 MW for Algeria (IRENA, 2015).

In addition, foreign investments could be limited by the negative pull regional political uncertainties have on Jordan, and the narrow local market. Unlike PV systems, the lack of incentives directed towards CSP deployment is a major barrier preventing accelerated development of the local CSP market.

C. Conclusion on future local manufacturing opportunities

Local manufacturing opportunities are directly related to local demand for CSP components. The potential identified is mainly subject to market limitations and public initiatives. The afore-mentioned pipeline projects might increase local interest in CSP projects and may allow the LCOE to decrease.

Table 6. Key success factors for future local manufacturing - CSP - Jordan

Key barriers for future local manufacturing capability	Investment capacity and strong financing infrastructures	Competitive local players	Strong industry innovation	Stable policy support	Conclusion on future local industrial capability
Raw materials	●	●	●	●	Medium
Solar Field					
- Mirrors	●	●	●	●	Medium
- Mounting structures	●	●	●	●	High
Power block					
- Balance of plant, piping, electronics	●	●	●	●	Medium
- Power train	●	●	●	●	Very Low
Thermal storage					
- Storage systems	●	●	●	●	Medium
Grid Connection	●	●	●	●	Very High
Construction	●	●	●	●	Very High

Source: Data compiled by LCEC

Local glass and steel industries might be adapted to correspond to CSP manufacturing requirements. The transformer manufacturing industry is already related to an experienced international group. In addition, electric components, connection boxes and sub-station installations are well-established sectors locally.

Based on the analysis of these industrial assets, the figure below provides a review on the key success factors for local integration in CSP. The size of each "bubble" represents weight of jobs created by industry activity per MW installed. The size of each bubble does not provide information on the local part of the production, but only gives indication on the potential of each industrial sector. Moreover, it provides a synthetic vision on the needs for improvement, as highlighted in the case of CSP.

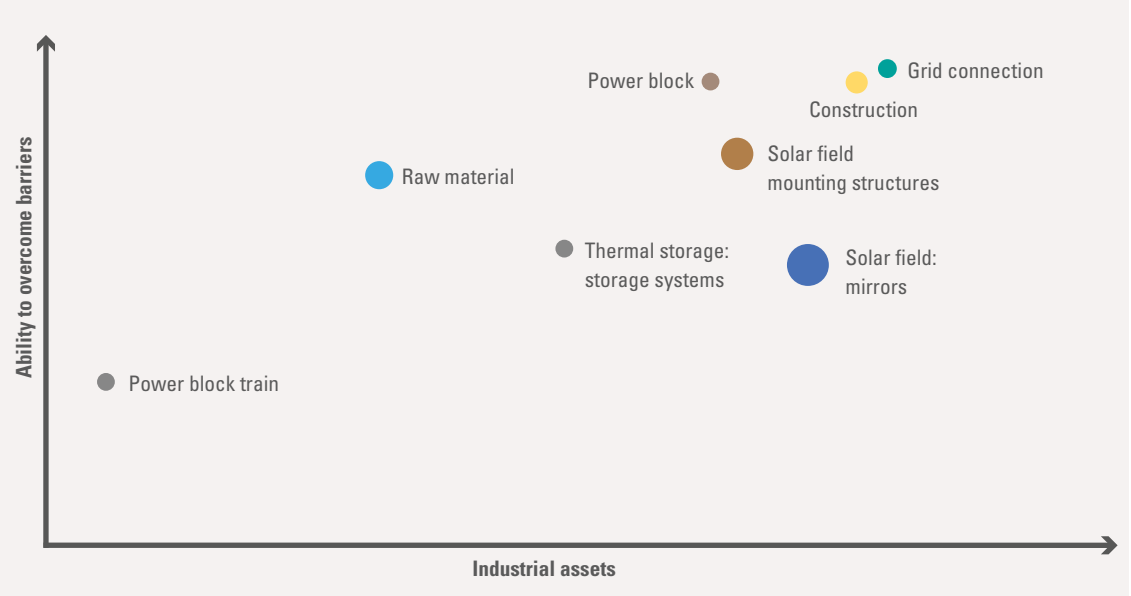
1. Various inputs offer promising local capacity potential:

- Local grid connection, buildings and foundations
- National entities are skilled in infrastructure components, installation and maintenance
- Liquid and steam systems, except for steam turbines and storage liquid, could be sourced locally
- Expertise exists in additional industries, for example water systems and conventional power plants
- Electronic components are manufactured locally, including cables, junctions and connection boxes, and transformers by Matelec Group, an international distribution transformer producer already established in Jordan.

2. Barriers to overcome in order to unlock the potential of other components:

Solar-reflecting mirrors and flat concentrators could be manufactured locally. However, manufacturing bent mirrors locally requires investment in capacity building and new production lines in order to be produced to a high standard. Therefore, collaboration with experienced international companies is needed in order to gain the technical know-how.

Figure 3. Future local manufacturing opportunities - CSP - Jordan



Source: Data compiled by LCEC

(a) Main barrier: Limited local and regional CSP market, and limited interest in CSP technology compared to PV systems.

Local manufacturing capacity is likely to remain limited in the medium-term on the remaining parts. The receiver for tower systems, steam turbines and power trains for CSP plants remain specialised components that require high investment and specialised expertise in design and manufacturing processes. Research and development and technology collaboration is necessary.

(b) Main barrier: Technology transfer

Locally produced components for CSP projects account for approximately 30%. This share could be increased if technology development were to be supported by additional incentives, for instance, through Jordan's National Energy Master Plan. Local manufacturing potential has been identified, including in liquid and steam systems, infrastructure, electronic components and the aforementioned solar-reflecting mirrors.

E. Onshore wind – Opportunities for local manufacturing

The master plan for renewable energy in Jordan has set a target of 1,200 MW for wind-generated power by 2020; thus wind projects have already been achieved and new ones have been recently launched.

The following projects have been achieved (ATA Insights, 2017):

- Tafila: 117 MW (2015)
- Ma'an: 80 MW (2016)

The following projects are ongoing:

- Direct proposal submission-stage I: 320 MW (Mid-2018)
- Ma'an: 86 MW (October 2018)

The 66 MW Ma'an Wind Farm, owned by the Jordan Ministry of Energy (MEMR) and expanded to 80 MW, is currently operational. It was funded through a USD 150 million grant from the "Kuwait Fund for Arab Economic Development" and "Abu Dhabi Fund for Development", and was awarded to Elecnor, a Spanish contractor, to implement the project (T.T, 2015).

The Tafila Wind Farm is owned by the Jordan Wind Project Company (JWPC), incorporated under the laws of Jordan, of which 51% is held by EP Global Energy Ltd (EPGE) and 49% by InfraMed Infrastructure (InfraMed). EP Global Energy Ltd is a wind farm development company associated with the J&P Group of Cyprus. InfraMed, a Paris-based fund, is owned by several European public-sector institutions focused on developing infrastructure in the Mediterranean region. In May 2013, Masdar signed a share purchase agreement to acquire 31% shareholding of JWPC, with InfraMed and EP Global Energy retaining the remaining shares of 50% and 19% respectively.

Jordan develops and adopts grid codes for distribution and utility-scale PV systems and wind farms, thus creating a pipeline of utility-scale renewable energy projects to be developed by IPPs.

However, there are still local market limitations, mainly due to limited space and the lack of environmental impact assessment for the submitted projects. Again, limited grid capacity represents a barrier to producing generated wind power. Some wind plant components can be manufactured locally, whereas such components as rotor blades cannot be manufactured locally due to the lack of expertise and the associated high costs.

Key findings on Jordan's CSP manufacturing potential are summarised in the following SWOT analysis:

Strengths	Weaknesses
➢ **Industry maturity** • High local manufacturing potential • Existing projects ➢ **Technological skills** • Available installation, operation and maintenance skills for wind projects • Available skills in tower manufacturing and system assembly ➢ **Economic and regulatory assets** • Direct proposal submission • Feed-in tariff	➢ **Industry maturity** • Limited grid capacity • Limited local market size ➢ **Technological constraints** • Lack of specialised expertise for such components as blades ➢ **Economic and regulatory assets** • Lack of specific incentives • Lack of environmental impact assessment

S W

Opportunities	Threats
➢ **Finance** • Expected increase of investments to meet the national target ➢ **Competitiveness** • On-site assembly • Main components exist in the local market for other applications • Joint ventures with well-established manufacturers ➢ **Technology and expertise** • Existing and adaptable local industries ➢ **Regulation** • Mandatory local contribution of 20% in bidding tenders, including EPC and O&M • R&D and knowledge transfer potential • 1,200 MW wind target	➢ **Finance** • Limited incentives and direct aid for wind projects • The bankability of wind projects for wind is low compared to such established technologies as PV ➢ **Competitiveness** • Limited local market size • High export cost if regional market is considered ➢ **Technology and expertise** • Rapid technology development worldwide ➢ **Regulation** • Lack of direct incentives for local manufacturing

O T

Local value chain and industrial assets

The table below provides an overview of the value chain for component manufacturing for onshore wind plants, classified according to the presence of different local players. The analysis is subject to their willingness to produce different components, given their overall industrial, technological and economical know-how.

The ongoing wind projects and the target to produce 1,200 MW of wind energy are encouraging the development of the capacity and in-depth assessment of the local wind market. The policy that public projects must include 20% of locally manufactured components allows for the integration of national companies in the renewable energy market. Moreover, this share could be increased if electric components, infrastructure and foundations were given an opportunity.

(a) Raw materials

Several local players are already active in the steel industry and have produced over 856,000 metric tonnes per year(t/yr) under favourable market conditions, the steel products fulfill thickness requirements needed to manufacture towers for

Table 7. Local manufacturing assets - Onshore wind - Jordan

Key assets of local industries	Industry maturity			Technological skills			Economic assets			Conclusion on local manufacturing assets
	Presence of active local companies	Level of industry structuring	Presence of local suppliers	Skilled workforce availability	Product quality	R&D capacity	Manufacturing cost competitiveness	Regulatory framework	Financial health	
Material	●○○○	●●○○	●●●○	●●○○	●●○○	●○○○	●●○○	●○○○	●●○○	Low
Wind turbines										
- Wind towers	●○○○	●●○○	●●○○	●●●○	●●●○	●○○○	●●●○	●●●○	●●○○	Medium
- Blades	●○○○	●●○○	●○○○	●●○○	●●○○	○○○○	●○○○	●●○○	●●○○	Low
- Gearboxes	○○○○	●○○○	●●○○	●●○○	●○○○	●●○○	●○○○	●○○○	●●○○	Low
- Generators	●○○○	●○○○	●●○○	●●○○	●○○○	●●○○	●○○○	●○○○	●●○○	Low
- Electronics and cables	●●●○	●●●○	●●●○	●●●○	●●●○	●●○○	●●●●	●○○○	●○○○	High
Construction	●●●●	●●●○	●●●●	●●●○	●●●○	●○○○	●●●○	●●●○	●●○○	High

Source: Data compiled by LCEC

large- capacity wind turbines, varying from 6 to 32 mm with a grade of 40.60 and 75 due to the presence of a skilled workforce to adapt their technical know-how, thus ensuring product quality.

(b) Wind towers

Despite the potential of these companies to manufacture wind towers locally they are imported due to the limited presence of active Jordanian tower manufacturing companies.

(c) Rotor blades

The Tafila Wind Farm has 38 Vestas V112 wind turbines that are 150 meters tall. Under a comprehensive design, build, operate and maintain (DBOM) contract, the project will be developed and operated by Vestas, a Danish manufacturer, supplier, installer, and service provider of wind turbines. The Ma'an project, currently being developed by Elecnor, was the first wind project in Jordan by Gamesa, a Spanish turbine manufacturer that plans to install 33 G97-2MW turbines. Blade manufacturing requires highly specialised and extensive skills in design and implementation. Local blade manufacturers do not exist. However, licenses from foreign or regional companies could offer a solution for integrating blade manufacturing into the local market. Capacity building and investment in production lines could also create a potential for local rotor blade manufacturing. Given the wide availability of expertise and technological skills, system assembly can be provided by local entities.

(d) Electronics and Cables

Electrical components can be provided locally by different manufacturers.

(e) Construction

The needed infrastructure can be sourced locally since the local market includes several established entities. Ongoing projects present an opportunity for local companies to benefit from international experience in the construction field.

Assessment for local Renewable Energy manufacturing

A. Analysis of the key success factors for future local manufacturing

The purpose of this section is to analyse the local manufacturing perspectives in the onshore wind value chain for Jordan. Interviews conducted with local stakeholders in Jordan have enabled to identify a set of key success factors for the development of local onshore wind component manufacturing.

B. Potential involvement of international players in local production

International wind companies, like the aforementioned Vestas and Gamesa, are active in Jordan and participate in public tenders for wind projects. However, the companies have not expressed an interest in locally manufacturing components. Projects such as Ma'an and Tafila use imported products, a situation open to change when the Government enforces its 1,200 MW wind target and possibly opts for an increase in the current 20% local share in public projects.

C. Conclusion on future local manufacturing opportunities

The local manufacturing opportunities that have been identified could be realised through solid governmental support. Since importing steel towers and rotor blades is expensive, locally manufacturing and assembling these components could reduce the LCOE of wind projects.

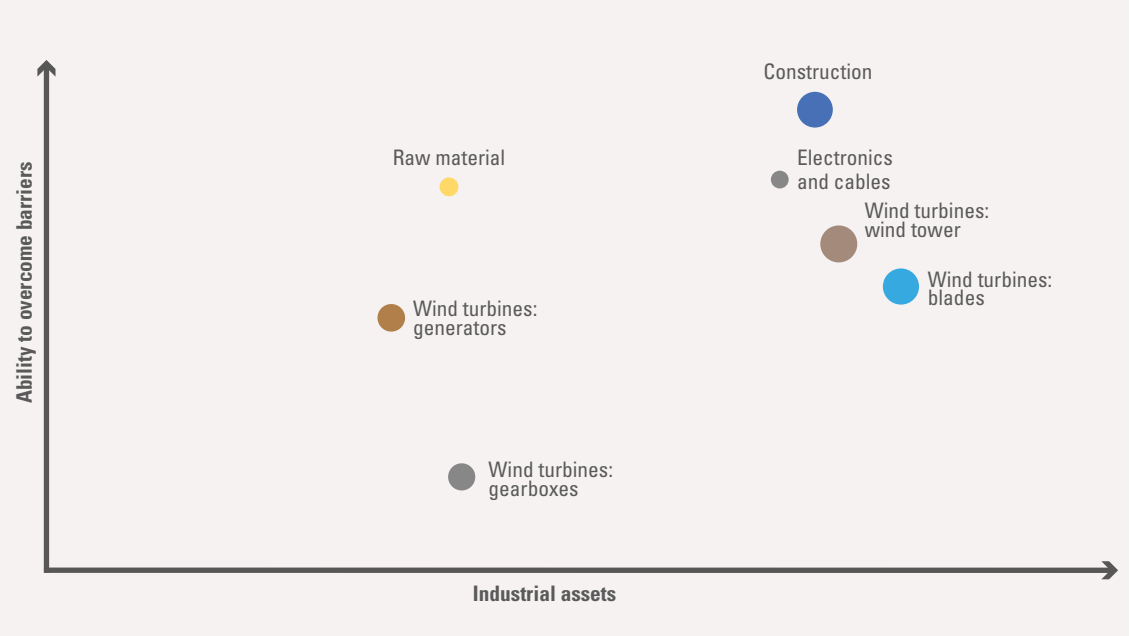
Based on the analysis of these industrial assets, the figure below provides a review on the key success factors for local integration in onshore wind. The size of each "bubble" represents weight of jobs created by industry activity per MW installed. The size of each bubble does not provide information on the local part of the production, but only gives indication on the potential of each industrial sector. Moreover, it provides a synthetic vision on the needs for improvement, as highlighted in the case of onshore wind.

Table 8. Key success factors for future local manufacturing - Onshore wind - Jordan

Key barriers for future local manufacturing capability	Investment capacity and strong financing infrastructures	Competitive local players	Strong industry innovation	Stable policy support	Conclusion on future local industrial capability
Raw materials	●	●	●	●	High
Wind turbines					
- Wind towers	●	●	●	●	Medium
- Blades	●	●	●	●	Medium
- Gearboxes	●	●	●	●	Very Low
- Generators	●	●	●	●	Low
- Electronics and cables	●	●	●	●	High
Construction	●	●	●	●	Very High

Source: Data compiled by LCEC

Figure 4. Future local manufacturing opportunities - Onshore wind - Jordan



Source: Data compiled by LCEC

1. Various inputs offer promising local capacity potential:

- Local steel tower manufacturing for wind turbines is limited. Achieving the target of 1,200 MW wind projects may encourage steel manufacturers to integrate the wind market, the raw material is viable and compliant with wind application.
- Electronic components necessary for wind turbines such as cables, inverters and transformers, including connection to the grid, can be delivered by established local companies.
- Infrastructure, for example foundations and concrete, can be provided by local, experienced construction companies. Local specialised companies could also be involved with project development.

2. Other components show potential but barriers need to be overcome to unlock this potential:

- Blade manufacturing requires the kind of in-depth knowledge that is locally unavailable. This presents a barrier since blades are the most critical component in the system. In order to overcome this, joint ventures or license agreements by already established Jordanian companies with experienced international companies could enhance and support local blade manufacturing, thus reducing the LCOE of wind projects.
- Gearbox manufacturing suffers from a lack of knowledge and significant investment associated with local technology deployment.

- **Main barriers: Lack of expertise and high investments**
  The potential for manufacturing wind energy components locally relies on the implementation of the governmental target to install 1,200 MW and the regulatory framework to support it. Many components could be locally provided, however, essential components such as rotor blades and gearboxes require a high investment and skilled workforce in order to guarantee high quality products.

LEBANON COUNTRY REPORT

A. Overview of the national policy framework

Lebanon has realised its renewable energy potential and aims to build on its current small-scale decentralised renewable energy projects to meet specific targets by 2020. These targets amount to a total installed capacity of 150 MW for PV farms, 200 MW for onshore wind and 50 MW for CSP. Looking forward, the country has set targets to further advance renewable energy deployment and has implemented support instruments to reach the set targets.

1. Renewable energy policies and targets[12]

- The policy paper for the electricity sector in 2010 committed Lebanon to launching, supporting and reinforcing public, private and individual initiatives to adopt the utilisation of renewables, with the aim of reaching 12% of electric and thermal supply by 2020.
- The first National Energy Efficiency Action plan for Lebanon (NEEAP 2011-2015) involved keys actors from five categories: legal, institutional,financial, communications and technical, for both energy efficiency and renewable energy. This NEEAP was approved by the Council of Ministers in 2010. The first NEEAP was evaluated in December 2014 and the main outcome was to separate targets and measures related to EE and RE in two separate documents: the NEEAP (2016-2020) and the National Renewable Energy Action Plan (NREAP 2016-2020). The NEEAP (2016-2020) and the NREAP (2016-2020) were published in March and November 2016, respectively. This NREAP is developed with specific targets for different technologies including by 2020 150 MW for PV farms, 200 MW for onshore wind and 50 MW for CSP.
- Under Law 28, The Lebanese Government will allow the Ministry of Energy and Water to grant licenses and permits for private power generation, every two years. The duration of Decree 288 is extended until April 2018. Lebanon has adopted the net-metering scheme for wind and solar, which is held and regulated by Electricité du Liban (EDL), the electric utility of the State.

2. Strategy to support renewable energy equipment manufacturing

- The Central Bank of Lebanon (BDL) promotes industrial development by offering loans with subsidised interest rates for industrial projects.13 Tax exemptions are also available for investments in Nabatiyeh in south Lebanon, and the Bekaa Valley, under Decree No. 3361, dated 2 July 2000.
- Financial incentives have been created by the Government for increased industrial investments in rural areas through tax exemptions ranging from 6 to 10 years. A 50% exemption on industrial export custom duties also exists. Moreover, only 2% custom duties are levied on the imports of machinery, equipment, spare parts and building material to set up new industrial firms, while no custom duties are set for textiles, semi-manufactured goods and raw materials (Export.gov, 2017).
- Fiscal exemptions granted by the Investment Development Authority of Lebanon (IDAL) could stand at 100% on corporate income tax for a period of up to 10 years for industrial companies depending on the project investment size and number of jobs created.

The evaluation of renewable energy policy maturity in Lebanon is given according to the following colour index:

[12] http://lcec.org.lb/en/LCEC/DownloadCenter/Others#page=2.

[13] Under Law No. 27, dated 19 July 1980, Law No. 282, dated 30 December 1993, and Decree No. 127, dated 16 September 1983

Table 9. Previous and ongoing projects in Lebanon

Technology	Previous and ongoing projects	RE policy maturity
Solar PV	• 360 MW to be issued in 2018 • Small- and medium-scale projects financed under the Lebanese Financing Mechanism (NEEREA): The total installed capacity of PV projects had reached 19.5 MWp by April 2017 • Small-scale projects implemented by UNDP-CEDRO: 218.3 kWp • The Beirut River Solar Snake – BRSS (Bid), implemented in July 2014 – 1 MWp has been installed out of 10 MWp • Zahrani Oil Installations, implemented in July 2015 – 1 MWp is installed out of 3 MWp • UNDP-CEDRO has implemented seven projects of 1 MWp total • UNDP-DREG is now working on the installation of multiple PV projects with a 2.6 MWp total capacity • 1.9 MWp PV systems have been installed in malls, and buildings of various uses • 800 kWp off-grid street lighting and 29.4 kWp BIPV system	
Concentrated solar power	• Not Identified	
Wind	• Three micro-wind projects of 2 kWp total installed capacity[14] • Four installed hybrid solar-wind systems of 35 Amps total capacity • Three wind farms with a total capacity of 200 MW have been approved by the council of ministers.	
Very Low	Low	Medium	High	Very High

Source: Data compiled by LCEC

[14] http://www.cedro-undp.org/projects/7/Renewable%20Energy/12.

B. Synthesis of strengths, weaknesses, opportunities and threats for local manufacturing of renewable energy components

Key findings on Lebanon's renewable energy manufacturing potential are displayed in the SWOT analysis presented below:

Strengths	Weaknesses
➢ **Industry maturity** • Existing electronic, electric, steel, concrete, aluminum and plastic industries ➢ **Technological skills** • Available technical expertise • Skilled workforce in existing industries • Research capabilities and renewable energy programs in universities ➢ **Economic and regulatory assets** • Subsidised loans and tax exemption on industrial projects • Favourable geographic location	➢ **Industry maturity** • Limited industrial capabilities • Lack of raw materials • Limited R&D ➢ **Technological constraints** • Lack of expertise for manufacturing of some renewable energy components ➢ **Economic and regulatory assets** • High land cost and limited space availability • High energy cost • High investment is needed in industrial processes and materials for the manufacturing of some components • Small renewable energy market size locally
S	**W**
Opportunities	**Threats**
O	**T**
➢ **Competitiveness** • Decrease in LCOE due to falling cost of technology • Export to neighbouring countries ➢ **Technology** • Steel, aluminum, glass and cables industries are already established with skilled workforce • RE suppliers with skilled engineers and technicians • Capacity building programs are provided by projects funded by international stakeholders ➢ **Economic and Regulatory Assets** • Well-defined target • Regulatory and institutional framework (support instruments such as net-metering) • Financial support such as subsidies • Fiscal incentives such as taxes and custom reduction • Financial incentives for industrial investments such as tax exemptions, reduction of custom duties, subsidised loans, etc. • Liberal economy • Favourable foreign direct investment policies • Geographic location	➢ **Competitiveness** • Limited local market • Strong and competitive foreign manufacturing potential of specific components such as crystalline type panels ➢ **Technology** • Continuous development and advancement in technologies, processes and tools • Lack of testing facilities • Lack of R&D centres • Practical workforce training insufficient, especially for CSP and wind ➢ **Economic and Regulatory Assets** • Lack of minimum threshold of local content in any project • No priority is given for use of local products

C. Solar PV - Opportunities for local manufacturing

Lebanon has considerable solar potential with a yearly Direct Normal Irradiation (DNI) exceeding 2100 kWh/m^2 (Ministry of Energy and Water/LCEC, 2016).

The number of installed PV projects installed under NEEREA increased from 58 kWp in 2012 to 6,614 kWp by November 2015. In early 2012, PV installation mainly involved the residential sector. In 2015, the commercial, industrial and non-profit sectors also accelerated their uptake of PV. Notably, in addition to the increase in the number of projects, the installed capacity per project also increased. The number of PV suppliers that applied for loans under NEEREA exceeded 80 suppliers in 2015 compared to two suppliers in 2012 (LCEC, 2016).

The net-metering scheme and the successful financing mechanism of NEEREA, which are part of the National Energy Efficiency Action Plan for Lebanon 2011-2015, are the main drivers behind the development of the renewable energy market.

However, issue of high manufacturing costs stemming from the lack of a promising market forecast and regulatory framework, thus restrains domestic and foreign investment in solar PV projects. Moreover, highly subsidised fossil fuels are hindering the deployment of clean energy.

Furthermore, 91 percent of electricity in Lebanon is supplied by EDL, limiting engagement of the private sector to generate electricity. The monopoly of the market is hindering commercial viability and the competitiveness of technology.

The technological environment still lacks infrastructure to support the growth of the renewable energy market and significantly exceeds its absorption capacity. Meanwhile, the administrative setting lacks a skilled workforce and expertise, which, in turn, does not allow the country to keep track of new renewable energy technologies, their features, economic and fiscal costs and benefits.

Key findings on Lebanon's solar PV manufacturing potential are summarised in the following SWOT analysis:

Strengths	Weaknesses
➢ **Industry maturity** • PV technology is mature; pilot projects are implemented, bids are taking place, and residential, commercial, industrial and agricultural sectors are installing PV systems ➢ **Technological skills** • Available installation, operation, and maintenance skills • Available assembly of inverters and control systems • Available manufacturing skills for steel structures, cables and electronics like control and monitoring devices • Available PV standards	➢ **Industry maturity** • PV suppliers are importers rather than manufacturers • Strong competition with imported equipment at highly competitive prices • Assembly of PV panels is not established ➢ **Technological constraints** • Experience in systems installation is greater than component manufacturing • No local manufacturing facility is available for training • Training programs provide installation courses rather than manufacturing ➢ **Economic assets** • High manufacturing cost mainly due to high energy costs and the need to import raw materials • Manufacturing processes are semi-automated, which means less workforce is needed

S	W
O	T

Opportunities	Threats
➢ **Competitiveness** • PV suppliers are implementing projects with joint ventures domestically and internationally. Similar co-operation could be applied to manufacturing ➢ **Technology** • Skilled engineering teams and technicians that can shift towards manufacturing • Possibility of technology transfer by implementing pilot projects ➢ **Economic and Regulatory Assets** • National renewable energy target • Availability of soft loan programmes from EU, UNDP. USAID and Chinese government for decentralised PV generation in all sectors • Free market economy • Tax benefits for foreign investors • Incentives for industrial investments in rural areas • Net -metering scheme is available for the distributed generation market of PV and solar water heaters.	➢ **Competitiveness** • Continuous decrease in the cost of imported components • The energy shortage and implied high cost of energy will not be solved in the short or medium term ➢ **Technology** • Rapid innovation and development in technologies would need upgrades in production lines and technical know-how, thus requiring continuous investment. ➢ **Economic and Regulatory Assets** • EDL has a monopoly in selling generated electricity • Custom duties might be negligible on PV panels, increasing imports and decreasing local manufacturing potential.

Local value chain and industrial assets

The table below provides an overview of the value chain for component manufacturing for solar PV plants, classified according to the presence of different local players. The analysis considers their readiness to produce different components, given their overall industrial, technological and economical know-how.

(a) Construction materials

The raw materials used to produce cement, concrete and steel, by local companies such as Cimenterie Nationale S.A.L., Ciment de Sibline S.A.L., Demco Steel, and Bardawil & Co., are available. In this context, Lebanon holds a comparatitive advantage for the manufacturing of construction materials applied in solar PV projects.

(b) Component materials

Raw materials used to produce solar modules, such as glass, is available locally. The processing and customisation of glass to meet module production, can be conducted locally by existing glass companies such as Glass Premium and El Ghoul Co. S.A.L. However, the silicon needed to produce solar wafers is unavailable locally and needs to be imported.

(c) Solar module manufacturing

Currently, there is no operating industrial facility to manufacture or assemble PV modules. However, other components can be procured locally, including glass, cables and steel support structures.

(d) Glass industry

The manufacturing of glass, lamination, and aluminum framing of modules can be conducted locally in terms of available components, although it may require new production lines, machinery, and training.

(e) Electronics and cables

Cable production in Lebanon is led by Liban Cables. Any request to import cables must be approved by the company. Therefore, many types of cables for small- and large-scale PV projects are already manufactured in Lebanon, thus supporting the consumption of domestically manufactured cables. Some transformers and other electronic components are locally manufactured by groups like Matelec; others are made in China or Europe and imported through dealers like the Debbas Group and Harb Electric. Product selection depends on the project type, size and budget.

Table 10. Local manufacturing assets - Solar PV - Lebanon

Key assets of local industries	Industry maturity			Technological skills			Economic assets			Conclusion on local manufacturing assets
	Presence of active local companies	Level of industry structuring	Presence of local suppliers	Skilled workforce availability	Product quality	R&D capacity	Manufacturing cost competitiveness	Regulatory framework	Financial health	
Raw Material	●●○○	●●○○	●●○○	●●●○	●●●○	●○○○	●●○○	●○○○	●○○○	Medium
Solar module manufacturing										
- Wafer production	○○○○	○○○○	○○○○	○○○○	○○○○	○○○○	●○○○	●○○○	○○○○	Very Low
- Solar cell production	○○○○	○○○○	○○○○	○○○○	○○○○	○○○○	●●○○	●○○○	○○○○	Very Low
- PV-module manufacturing	○○○○	○○○○	●○○○	●○○○	●●○○	○○○○	●●○○	●○○○	●○○○	Low
PV plant										
- Electronics & cables	●●○○	●●○○	●●●○	●●○○	●●○○	●○○○	●○○○	●●○○	●●○○	Medium
- Steel support structures	●●●○	●●●○	●●●○	●●●○	●●●○	●○○○	●●●○	●●●○	●●●○	High
Construction	●●●●	●●●○	●●●●	●●●○	●●●●	●○○○	●●●○	●●●○	●●○○	High

Source: Data compiled by LCEC

(f) Steel support structures

Local steel companies currently deliver the steel mounting structures needed for PV modules, in addition to importing aluminum structures for specific projects. Low, medium and high elevation structures, which are treated to resist corrosion, are also supplied by local steel manufacturers. For medium- and large-projects, the average wind speed and other climatic conditions (such as humidity), along with the mechanical load that a structure can support is taken into consideration.

(g) Engineering, Procurement and Construction (EPC)

Experience of PV in Lebanon is mainly concentrated on the construction of the project rather than the manufacturing or assembling of components. Indeed, most solar PV components are imported.

More than 104 companies have been involved in installing PV systems, whether for residential, industrial or commercial use (LCEC, 2016). In addition, several companies have installed PV projects abroad, for example, in the Gulf, Egypt and Jordan.

Assessment of local PV manufacturing

A. Analysis of the key factors for successful future local manufacturing

The purpose of this section is to analyse the local manufacturing perspectives in the solar PV value chain for Lebanon. Interviews conducted with local stakeholders in Lebanon have enabled to identify a set of key success factors for the development of local solar PV component manufacturing.

Table 11. Key success factors for future local manufacturing - Solar PV - Lebanon

Key barriers for future local manufacturing capability	Investment capacity and strong financing infrastructures	Competitive local players	Strong industry innovation	Stable policy support	Conclusion on future local industrial capability
Raw materials	🔴	🔴	🟠	🟠	Low
Solar module manufacturing					
- Wafer production	🔴	🔴	🔴	🟠	Very Low
- Solar cell production	🔴	🔴	🔴	🟠	Very Low
- PV-module manufacturing	🟠	🔴	🟠	🟠	Medium
PV Plants					
- Electronics & cables	🟡	🟠	🟠	🟠	Medium
- Steel support structures	🟡	🟠	🟡	🟠	High
Construction	🟡	🟡	🟡	🟠	Very High

Source: Data compiled by LCEC

B. Potential involvement of international players in local production

Solar PV systems, especially small-scale systems, are already installed in Lebanon, making PV a relatively mature technology among suppliers and some component manufacturers. However, the Lebanese market is limited. Therefore, the geographical location of Lebanon could be an opportunity for increasing trade from Europe to the Arab region and vice-versa. The business environment is attractive for FDI inflows, opening the door for joint ventures with international companies and/or creating new manufacturing lines in existing industries. The initiatives provided by BDL, including financial facilities, subsidies, and tax exemptions to help the industrial sector, could unlock significant manufacturing potential and provide easy access to obtaining credit and could attract international investors.

C. Conclusion on future local manufacturing opportunities

Based on the analysis of these industrial assets, the figure below provides a review on the key success factors for local integration in solar PV. The size of each "bubble" represents weight of jobs created by industry activity per MW installed. The size of each bubble does not provide information on the local part of the production, but only gives indication on the potential of each industrial sector. Moreover, it provides a synthetic vision on the needs for improvement, as highlighted in the case of solar PV.

1. Various inputs offer promising local capacity potential:

➢ The recent introduction of DC solar cables into the local cable industry, in addition to the availability of AC cable ranges, is an asset for the industry in terms of future PV system installations.

- Local EPC companies can provide high quality civil, mechanical and electric engineering services.
- Specific steel companies focused on PV installations do not exist due to the limited size of the market. However, steel support structures of different mechanical loads, sizes, complexity and specs are delivered by local companies.

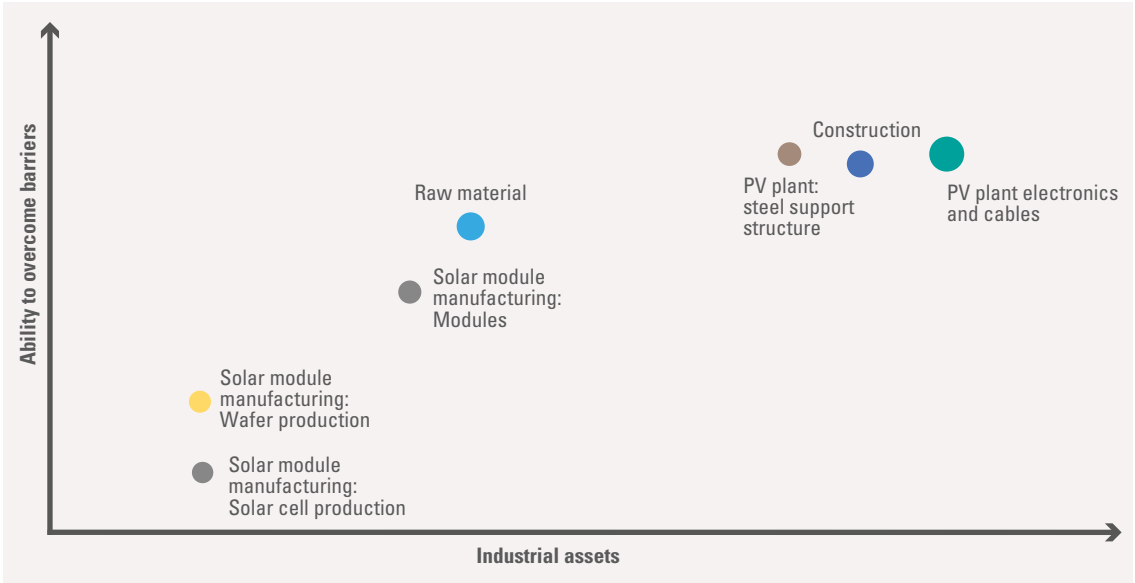
2. Other components show potential but barriers need to be overcome to unlock this potential:

Since aluminum, glass, and electronics industries are already active in Lebanon, the potential for assembling PV modules is good. However, the small market size, high production costs, and low custom duties on imported panels make them more attractive for project developers presenting an obstacle for domestic PV assembly.

3. Local capacity is likely to remain limited in the medium-term on the remaining parts:

The manufacturing of solar cells and wafer production requires investment in raw materials, machinery, facilities and human resources. Production costs in Lebanon would not be competitive with the international market due to the need to import raw materials, high energy costs, and high land costs. Furthermore, the continuous drop in the cost of solar modules by about 30 percent from 2009 to 2015, accompanied by overcapacity, technological advancement and more efficient manufacturing processes has shifted major manufacturing to China, Malaysia and Singapore (IRENA, 2017a).

Figure 5. Future local manufacturing opportunities - Solar PV - Lebanon



Source: Data compiled by LCEC

D. Concentrated solar power - Opportunities for local manufacturing

A significant advantage of CSP compared to other renewable energy technologies is arguably the possibility of thermal storage for nighttime use or on days when there is cloud cover. Different requirements should be met for the implementation of a CSP plant: a fair level of DNI, vast and unpopulated areas that are flat with available water resources nearby, and moreover, financial incentives and regulations that would promote CSP and RETs.

Although CSP feasibility studies have been conducted by some Lebanese companies, no projects have been implemented. Arguably, dealers prefer to promote PV systems that seem to be more appealing to developers since such systems have a lower capital cost, higher return on investment, flexible geographical location and can be installed in all types of facilities.

Currently, neither the market nor the industrial sector is oriented towards CSP.

The demand for CSP applications is negligible, and the interest of suppliers and importers in CSP components is low. Therefore, the exclusive manufacturing of CSP components in Lebanon would be difficult.

Some of the materials, including steel, copper, glass, and plastic that are used to manufacture CSP components like reflectors, receivers, heat storage equipment, steel structure, are available locally. However, such components as steam turbines and heat transfer fluids (molten salt) need to be imported. Civil works, installation and construction can be delivered by local construction companies and renewable energy suppliers. Capacity building might be needed initially, in addition to improvements in industrial processes and investment in production lines.

Currently, the CSP market is slow in Lebanon. Therefore, investing in the local manufacturing of technology components would not be possible in the medium-term.

Key findings on Lebanon's CSP manufacturing potential are summarised in the following SWOT analysis:

Strengths	Weaknesses
➢ **Industry maturity** • Existing industries: steel structures, storage equipment, and assembling electronic components ➢ **Technological skills** • Skilled engineering teams available in renewable energy companies can shift towards CSP • Skilled industrial players in steel, glass, pipes, etc. ➢ **Economic assets** • Subsidised loans and tax exemption on industrial projects • Geographic location	➢ **Industry maturity** • No projects have been implemented so far • Suppliers have not shown interest in CSP ➢ **Technological constraints** • Lack of expertise in design, installation and the manufacturing of CSP components • Training and capacity building is needed for component manufacturing • O&M for CSP is complex, technical inspection for mechanical and electrical equipment is needed ➢ **Economic assets** • High capital cost • High cost of land
S	**W**
O	**T**
Opportunities	**Threats**
➢ **Competitiveness** • Local manufacturing of certain components and assembling of others along the value -chain might decrease the capital cost of CSP ➢ **Technology** • Potential of benefiting from existing engineering companies and industries to manufacture CSP components ➢ **Economic and Regulatory Assets** • CSP target share in the national renewable energy action plan • Availability of soft loans	➢ **Competitiveness** • Restricted local market • PV and wind are more competitive in the local market ➢ **Technology** • Experience in manufacturing is limited to some components (steel structure, cables) ➢ **Economic and Regulatory Assets** • Lack of grid code might impose restrictions on net-metering

Local value chain and industrial assets

The table below shows the value chain for component manufacturing for CSP plants, highlighting the presence of different local players. The analysis is subject to their willingness to produce different components, given their overall industrial, technological and economical know-how.

(a) Raw and construction material

The main raw materials used in manufacturing CSP components and construction projects are glass for solar mirrors, silver coating, steel for mounting structures and pipes, concrete for foundations and the construction of towers, silica, and molten salt or synthetic oil as a heat transfer medium. This is in addition to materials as copper, plastic or PVC. Glass, steel, copper, concrete, plastic and PVC are available in the local market for conventional use. Thermal oil and molten salt are produced by specialised international companies.

(b) Mirrors and receivers

Glass is imported and processed locally according to design specifications and requirements. The mirrors consist of

Table 12. Local manufacturing assets - CSP - Lebanon

Key assets of local industries	Industry maturity			Technological skills			Economic assets			Conclusion on local manufacturing assets
	Presence of active local companies	Level of industry structuring	Presence of local suppliers	Skilled workforce availability	Product quality	R&D capacity	Manufacturing cost competitiveness	Regulatory framework	Financial health	
Raw Material	●●○○	●○○○	●○○○	●●○○	●●○○	●○○○	●○○○	●●○○	●●○○	Medium
Solar field										
- Mirrors	●○○○	●○○○	●○○○	●○○○	●○○○	●○○○	○○○○	●●○○	●●○○	Low
- Mounting structures	●●●○	●●●○	●●●○	●●●○	●●●○	●○○○	●●○○	●●○○	●●○○	High
Power block										
- Balance of plant, piping, electronics	●●○○	●○○○	●●○○	●●○○	●●○○	●○○○	●●○○	●●○○	●●○○	Medium
- Power train	●○○○	○○○○	○○○○	○○○○	●○○○	●○○○	●●○○	●●○○	●●○○	Low
Thermal storage										
- Storage systems	●●○○	●●●○	●●●○	●●○○	●●○○	●○○○	●○○○	●●○○	●●○○	Medium
Grid connection	●●○○	●●○○	●●○○	●●●○	●●○○	●○○○	●●●○	●●○○	●●○○	Medium
Construction	●●●○	●●●○	●●●●	●●○○	●●●●	●●●○	●●●●	●●●○	●●○○	High

Source: Data compiled by LCEC

bent or flat glass sheets, silver coating and, at times, polyvinylbutyral (PVB) for laminated mirrors. Since glass is imported, investments in new production lines, tools and machinery, and training would be needed for bending the glass into parabolic shapes.

Receivers consist of a silver-coated steel tube surrounded by an evacuated glass tube. Although glass and steel based tubes could be manufactured locally, investments need to be made in the required tools and in continuous research and development programs.

The local industry has not progressed sufficiently to produce the mirrors. As for the steel support structures for components, they can be produced locally by active steel manufacturers.

(c) Steam turbines

Different power system suppliers deal with steam turbines that are imported from such companies as Siemens, Dresser-Rand, Elliott Group, etc. Steam turbine components are unable to be manufactured locally since a highly skilled workforce and advanced industrial processes are needed.

(d) Storage systems

The storage materials used in CSP plants, such as molten salt, are unavailable locally. Storage equipment such as valves, vessels, tanks and additional equipment are not specifically made for CSP plants but are supplied locally by conventional suppliers. Any design variations or additional requirements can be made without having to allocate a significant budget. Local companies involved in construction and civil works can deliver the necessary concrete foundations.

(e) Balance of plant and construction

Steel and plastic tubes and pipes are available locally and can be supplied by companies like DEMCO Steel and API. The products are resistant to corrosion, high pressure and temperatures. However, no components have been identified to withstand the severe corrosion and higher temperature levels witnessed in CSP plants.

Local PV and wind energy systems suppliers could be involved in the installation of CSP plants if they were trained in the necessary skills or had the support and supervision of international companies. Foundations for the plants could be easily constructed by local civil companies and contractors.

Assessment for local CSP manufacturing

A. Analysis of the key factors for success in future local manufacturing

The purpose of this section is to analyse the local manufacturing perspectives in the solar

Table 13. Key success factors for future local manufacturing - CSP - Lebanon

Key barriers for future local manufacturing capability	Investment capacity and strong financing infrastructures	Competitive local players	Strong industry innovation	Stable policy support	Conclusion on future local industrial capability
Raw materials	🟠	🔴	🟠	🔴	Low
Solar Field					
- Mirrors	🟠	🟠	🔴	🔴	Low
- Mounting structures	🟡	🟡	🟡	🔴	High
Power block					
- Balance of plant, piping, electronics	🟡	🟠	🟡	🔴	Medium
- Power train	🟠	🔴	🟠	🔴	Low
Thermal storage					
- Storage systems	🟠	🔴	🟠	🔴	Medium
Grid Connection	🟠	🟠	🟠	🔴	Medium
Construction	🟡	🟡	🟡	🔴	High

Source: Data compiled by LCEC

CSP value chain for Lebanon. Interviews conducted with local stakeholders in Lebanon have enabled to identify a set of key success factors for the development of local CSP component manufacturing.

B. Potential involvement of international players in local production

Increase the CSP target in the Lebanese national renewable energy plan would create momentum for the CSP market. However, the absence of strong supportive governmental policies and strategies prevents CSP being developed further.

Nevertheless, setting such a target and moving towards inviting CSP bids and proposals would provide an opportunity for local RET suppliers to collaborate with international stakeholders in joint ventures, consultations or the supply of components. Building a track record in the implementation and development of CSP plans, whether from public bids and government intervention or private initiatives, for industrial facilities, would provide opportunities for the local manufacturing of CSP components and thus would appeal to foreign investors.

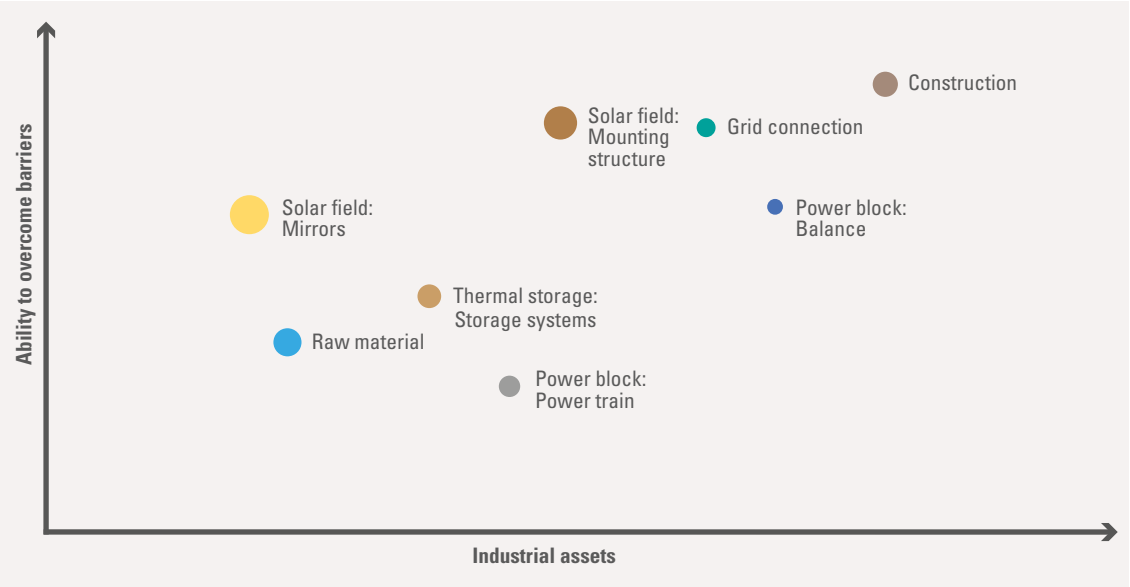
C. Conclusion on future local manufacturing opportunities

Based on the analysis of these industrial assets, the figure below provides a review on the key success factors for local integration in CSP. The size of each "bubble" represents weight of jobs created by industry activity per MW installed. The size of each bubble does not provide information on the local part of the production, but only gives indication on the potential of each industrial sector. Moreover, it provides a synthetic vision on the needs for improvement, as highlighted in the case of CSP.

1. Various inputs offer promising local capacity potential:

- Local electrical and cable industries could provide electrical control, balance of

Figure 6. Future local manufacturing opportunities - CSP - Lebanon



Source: Data compiled by LCEC

system components, cabling, and other elements, for CSP plants.

- Civil, electrical and mechanical works can be delivered by local EPC companies with the required technical and financial power.
- Steel support structures are not CSP specific and can be supplied by local steel producers.
- Storage equipment such as vessels and tanks can be supplied locally by active companies and manufacturers.

2. Other components show potential but barriers need to be overcome to unlock this:

The potential for manufacturing CSP mirrors locally will be determined by the ability to increase local skills, empower R&D investment and foster market dynamism. Glass manufacturing companies already active in the market could focus on niche markets like glass transformation and processing activities like bending, cutting and tempering

- Local capacity is likely to remain limited in the medium-term on the remaining parts:
  - Thermal storage materials and steam turbines are supplied by specialised international manufacturers and need a highly skilled workforce.

E. Onshore wind - Opportunities for local manufacturing

The National Wind Atlas of Lebanon identifies a wind energy potential of 6.1 GW (The National Wind Atlas of Lebanon 2011). The first Lebanese NEEAP (2011-2015) promoted wind generated electricity and set a target to install a wind farm of up to 100 MW. The first request for the proposal of the first wind farm in Lebanon was launched in 2012. In July 2017, the Council of Ministers approved in July 2017 the implementation of three wind farms with a total capacity of 200MW.

However, with the presence of an active PV market in residential, commercial, industrial and even agricultural projects in cities and rural settings together with the flexibility of rooftop installation and lower capital costs, the prospects for the development of a local wind market still remains uncertain.

Different sites with a high potential for wind farms have been identified in Lebanon. Engineering, design and management teams, in addition to component suppliers, construction and maintenance teams, are available for the implementation of the electrical and civil parts of a project. Moreover, local industry has the capability to manufacture wind towers using local raw materials and assembling gearboxes from local or imported electronic components. However, blade manufacturing requires composite material that needs to be imported. Nevertheless, regular upgrades would be required in ongoing industrial processes, testing, inspection and continuous research and development. This could necessitate upgrades in infrastructure such as roads and ports to allow for easier imports and the transportation of wind technology components, given the size of the blades and other components. In view of that, increased consumer interest in wind technology would follow, thus leading to market growth and motivating industries to manufacture towers and assemble electronics locally.

Key findings on Lebanon's onshore wind manufacturing potential are summarised in the following SWOT analysis:

Strengths	Weaknesses
➢ **Industry maturity** • Strong local industries: steel, cables, EPC, etc. ➢ **Technological skills** • Available installation, O&M skills • Available Assembly of components and control systems • Manufacturing skills are available for steel structures, steel towers, cables and electronics ➢ **Economic assets** • LCOE less than PV and fossil fuels • Capital cost can be reduced if towers are locally manufactured	➢ **Industry maturity** • Lack of private initiatives for wind installation • Market more favourable to PV • No experience in large-scale wind projects • Local market might not be sufficient to develop local manufacturing ➢ **Technological constraints** • Lack of experience in system installation and components manufacturing • Need for innovation and improvement in existing industries such as steel ➢ **Economic assets** • Higher capital cost than PV • High manufacturing costs due mainly to high energy costs and the need to import raw material
S	**W**
O	**T**
Opportunities	**Threats**
➢ **Competitiveness** • Steel industry has a potential in manufacturing towers ➢ **Technology** • Skilled engineering teams and technicians capable of shifting towards manufacturing • Possibility of technology transfer through pilot projects implementation • Three wind farms of capacity up to 200 MW have been approved ➢ **Economic and Regulatory Assets** • National target specific to wind power: 200 MW by 2020 • Soft loans availability for manufacturing facilities and for project development	➢ **Competitiveness** • Market development restricted • Competition with other countries in the region • Product quality requires investments in industrial and testing facilities ➢ **Technology** • Rapid technology innovation • Need for R&D • Need for training and capacity building ➢ **Economic and Regulatory Assets** • Lack of grid code might impose restrictions on net-metering

Local value chain and industrial assets

The table below provides an overview of the value chain for component manufacturing for onshore wind projects, classified according to the presence of different local players. The analysis is subject to their willingness to produce different components, given their overall industrial, technological and economical know-how.

(a) Raw materials

The raw materials used in the construction phase such as aggregate, steel and cement, which is used to construct concrete foundations for wind turbines, is available locally and can be supplied by conventional companies working in the domain. In addition, steel and copper are available for manufacturing the components for towers and electronics. Fiberglass, if required, can be supplied from local companies such as General Reconstruction Co. Middle East. However, carbon-fiber used in rotor blade manufacturing is unavailable.

(b) Towers

Despite the local industrial capacity to manufacture steel, due to a well-

Table 14. Local manufacturing assets - Onshore wind - Lebanon

Key assets of local industries	Industry maturity			Technological skills			Economic assets			Conclusion on local manufacturing assets
	Presence of active local companies	Level of industry structuring	Presence of local suppliers	Skilled workforce availability	Product quality	R&D capacity	Manufacturing cost competitiveness	Regulatory framework	Financial health	
Raw Material	●○○○	●●○○	●○○○	●○○○	●○○○	●○○○	●○○○	●●○○	●●○○	Low
Wind turbines										
- Wind towers	●○○○	●○○○	●○○○	●●○○	●●○○	●○○○	●○○○	●●○○	●●○○	Medium
- Blades	○○○○	○○○○	○○○○	●○○○	●○○○	●○○○	●○○○	●●○○	●●○○	Very Low
- Gearboxes	○○○○	●○○○	●○○○	●●○○	●○○○	●○○○	●●○○	●●○○	●●○○	Low
- Generator	○○○○	●○○○	●○○○	●●○○	●○○○	●○○○	●●○○	●●○○	●●○○	Low
- Electronics & cables	●●○○	●●○○	●●○○	●●●○	●●○○	●○○○	●●○○	●●○○	●●○○	Medium
Construction	●●●○	●●●○	●●●○	●●●○	●●●○	●○○○	●●●○	●●○○	●●○○	High

Source: Data compiled by LCEC

established technical and industrial capacity, local manufacturers are reluctant to further investments in new production lines and appropriate facilities for fabrication (i.e the process of welding steel sections and plates and for surface preparation). Similar processes are used by local steel works, and the necessary components could be delivered by local companies. However, manufacturers would be reluctant to invest in the new production lines and appropriate facilities that would be required since the current demand for wind technology is low.

(c) Rotor blades

Manufacturing rotor blades for wind turbines is a labor-intensive operation that requires advanced industrial processes that include molding and assembly systems, laser tracking and ultrasonic inspection. However, blades can also be made of glass and carbon reinforcements or resins like epoxies and thermoplastics. Although this would require engineering and development centres to test the composites used to manufacture the blades and to improve the selection of materials. Since there is a lack of raw material, expertise and R&D centres in Lebanon, blade manufacturing cannot be developed in the medium-term.

(d) Other components

» Electronic components, control equipment, cabling and balance of system components can be either supplied by Lebanese manufacturers such as Matelec, Liban Cables or traders.

(e) Construction

The civil, construction and contracting companies in Lebanon can deliver the needed grading and foundation works, along with related equipment, to install wind turbines. However, since the local market for wind technology is limited, assembling different components on-site might require investing in human resources and training programs.

Assessment of local renewable energy technology manufacturing

A. Analysis of the key factors of successful future local manufacturing

The purpose of this section is to analyse the local manufacturing perspectives in the onshore wind value chain for Lebanon. Interviews conducted with local stakeholders in Lebanon have enabled to identify a set of key success factors for the development of local onshore wind component manufacturing.

B. Potential involvement of international players in local production

A small number of micro-wind projects have been installed as stand-alone systems, in addition to PV-wind hybrid systems. Moreover, three wind farms of capacity ranging from 50 MW to 100 MW each have been approved by the Council of Ministers.

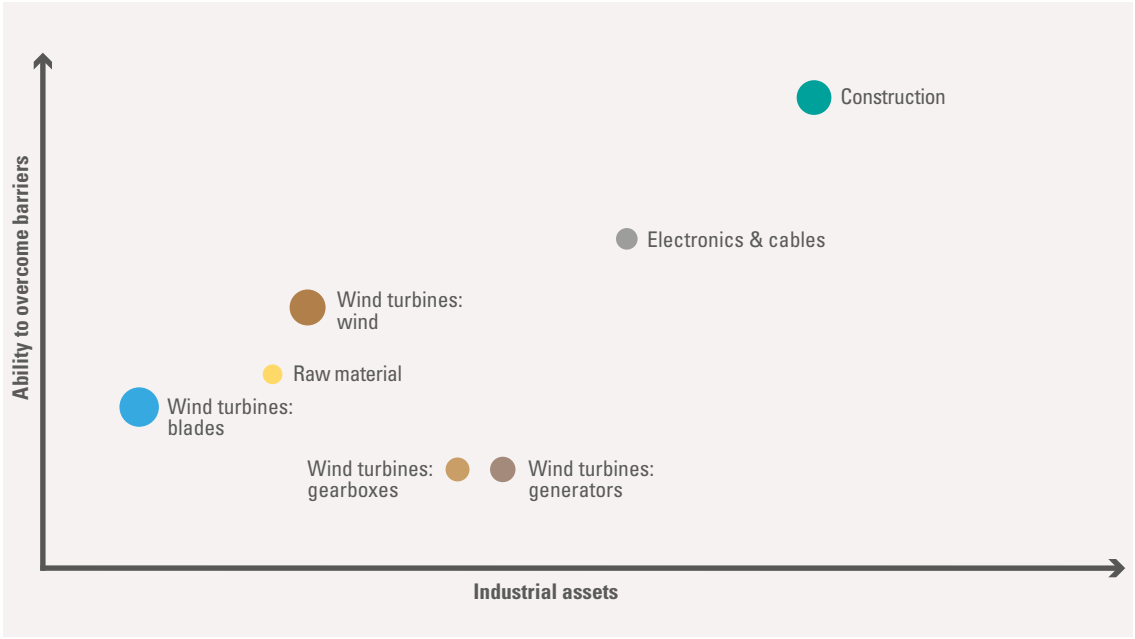
The intervention of international suppliers, consultants and investors requires a good market size comprising a continuous flow of projects that encourages local and international stakeholders to invest in new production lines and businesses. However, international suppliers are not currently active in the Lebanese wind energy market. Further requests for bids and the construction of large-scale wind farms to reach the targeted 12% renewable energy by 2020 might require the intervention of international companies or joint ventures.

Table 15. Key success factors for future local manufacturing - Onshore wind - Lebanon

Key barriers for future local manufacturing capability	Investment capacity and strong financing infrastructures	Competitive local players	Strong industry innovation	Stable policy support	Conclusion on future local industrial capability
Raw materials	●	●	●	●	Medium
Wind turbines					
- Wind towers	●	●	●	●	Medium
- Blades	●	●	●	●	Very Low
- Gearboxes	●	●	●	●	Low
- Generator	●	●	●	●	Low
- Electronics & cables	●	●	●	●	Medium
Construction	●	●	●	●	High

Source: Data compiled by LCEC

Figure 7. Future local manufacturing opportunities – Onshore wind - Lebanon



Source: Data compiled by LCEC

A. Conclusion on future local manufacturing opportunities

Based on the analysis of these industrial assets, the figure below provides a review on the key success factors for local integration in onshore wind. The size of each "bubble" represents weight of jobs created by industry activity per MW installed. The size of each bubble does not provide information on the local part of the production, but only gives indication on the potential of each industrial sector. Moreover, it provides a synthetic vision on the needs for improvement, as highlighted in the case of onshore wind.

1. **Various inputs offer promising local capacity potential:**

   Electronic components required for wind turbines, e.g. cable, and transformers, could be delivered by local companies. Wind generators and nacelle assembly can be undertaken locally following training sessions.

2. **Other components show potential but barriers need to be overcome to unlock this potential:**

   The existing steel industry in Lebanon can be extended to include wind tower manufacturing. This would require investing in new production lines, expanding industrial facilities, improving industrial processes, and training for human resources.

➢ The local capacity is likely to remain limited in the medium-term on the remaining parts:

- Rotor blade manufacturing in Lebanon cannot be developed in the medium-term due to the lack of raw material, the need for upgrading and advancing existing industrial processes and facilities for testing and inspection, and continuous research and development programmes to ensure good quality products.

UNITED ARAB EMIRATES COUNTRY REPORT

A. Overview of the national policy framework

1. Renewable energy policies and targets

- The UAE is committed to the global carbon agenda, and therefore plans to reduce CO_2 emissions by 30% by 2030.
- Abu Dhabi aims to install approximately 1.5 GW of renewable power by 2020, constituting 7% of its power generation capacity.
- The Integrated Energy Strategy of Dubai aims to install 5,000 MW of renewables by 2030, constituting approximately 25% of its power generation capacity.
- The UAE lacks a complete outline of policies and incentives for a renewable energy scheme.
- In 2014, Dubai adopted a net-metering scheme to promote the development of renewable energy projects. In the same year, the Executive Council of the UAE allowed rooftop PV systems to operate under the aforementioned scheme. In March 2015, DEWA applied the scheme to encourage the owners of commercial and residential buildings to fit solar PV panels through the Shams Dubai framework. No limit on time and quality was set on the amount of power that could be generated. This encouraged the building owners to generate more electricity than is consumed, as any surplus energy was credited to the subsequent billing period. However, installation should be compliant with the standards of DEWA.
- In October 2017, DEWA has raised AED 2.4 billion for its green fund formally known as the Dubai Green Fund established in 2016 (Gulf News, 2017).
- The UAE has adopted a competitive IPP scheme that has attracted large-scale power producers. As a result, the fourth phase of the Mohammed Bin Rashed 200 MW CSP Solar Park received the lowest international bid at that time, based on the competitive Independent Power Producer (IPP) model.
- The UAE provides funds for renewable energy projects. For example, Mubadala, an investment company that is advancing the development of renewables, has established the Abu Dhabi Future Energy Company (known as Masdar) which is a renewable energy company, along with Masdar City (a sustainable low-carbon urban development). In 1971, the government of Abu Dhabi has established the Abu Dhabi Fund for Development (ADFD), which provides loans to promote renewable energy project implementation.

2. Strategy to support the manufacturing of renewable energy equipment

- Easy procedure for international investments
- No corporate or income tax
- No personal income taxes
- No foreign exchange controls, 100% repatriation of capital and profits
- Free zones

The evaluation of renewable energy policy maturity in the United Arab Emirates is given according to the following colour index:

Table 16. Previous and ongoing projects in the UAE

Technology	Previous and ongoing projects	RE policy maturity
Solar PV	➢ **Asdar projects:** • Al Jarnain – 750 kW • Al Wathba stables – 120 kW • Ras Al Khaimah – rooftop PV 450 kW • Sea Palace, Abu Dhabi – 200 kW • Masdar City Solar Photovoltaic Plant– 10 MW • Um Al Zomul – 100 kW • Murawah Island – 500 kW ➢ **Dubai-Mohammed bin Rashid Al Maktoum Solar Park – 1,000 MW (IPP model)** • 13 MW of the first phase implemented • 200 MW commissioned in March 2017 and now operational • 800 MW commissioned in June 2016 and operational by 2020 ➢ **Dubai more than 10 MW of rooftop PV** ➢ **1,170 MW in Sweihan to be implemented by 2019.** ➢ **Abu Dhabi 500 MW of rooftop PV**	
Concentrated solar power	➢ **Shams 1– 100 MW in 2013** ➢ **Dubai-Mohammed bin Rashid Al Maktoum Solar Park** • 700MW to be commissioned in stages starting 2020	
Wind	➢ **Sir Bani Yas Island – 30 MW**	
	Very Low / Low / Medium / High / Very High	

Source: Data compiled by LCEC

B. Synthesis of strengths, weaknesses, opportunities and threats for local manufacturing of renewable energy components

Key findings on renewable energy manufacturing potential in the UAE are presented in the following SWOT analysis:

Strengths	Weaknesses
➢ **Industry maturity** • PV and CSP are mature technologies installed in large capacity • R&D activities in the production of raw materials ➢ **Technological skills** • Available installation, O&M skills for PV and CSP • Available manufacturing skills for PV module assembly, cables, transformers, structured EPC and O&M ➢ **Economic assets** • Free market economy • Jebal Ali Free Trade Zone • New and well-maintained infrastructure • Promotion of industrial growth through industrial cities. • Easy access for foreign investors • (Free market) • GCC proximity	➢ **Industry maturity** • Limited wind projects • Limited wind potential ➢ **Technological constraints** • Lack of expertise in the manufacturing of several components, especially related to CSP and wind turbines ➢ **Economic assets** • Limited space, especially in urban areas • High land cost, especially in urban areas • Unstable energy costs
S W **O T**	
Opportunities	**Threats**
➢ **Finance** • Very attractive for starting a business • Ease in issuance of permits for foreign investors • Possibility of obtaining credit • Feed-in-tariff policy • Ease in obtaining electricity ➢ **Competitiveness** • Low LCOE for PV • Possibility of joint ventures with foreign companies • Export to neighbouring countries ➢ **Technology and expertise** • Experienced in several components • Existing industries, including metal, glass and rubber ➢ **Regulations** • Well defined target • ADFD (Abu Dhabi Fund for Development) • Net-metering • Possibility of feed-in-tariff and electricity price restructuring • Additional local projects could increase local manufacturing potential • Initiative through an organised master plan for RET implementation • No personal income tax or foreign exchange controls	➢ **Finance** • Bureaucracy in financing procedures, limited access to funding from sustainable funds in banks. • Low protection for minority investors • Funding options are limited for small to medium scale projects since the funding would be geared to the wholesale side. • Bank rejection rate for SME lending is 50-70% (*The National*, 2015, 2016) • Higher electricity and water tariffs • VAT charges as of 2018 may discourage investors from dealing with renewable energy technologies. ➢ **Competitiveness** • Restricted local market • Strong foreign manufacturing potential of such specific components as crystalline type panels ➢ **Technology and expertise** • Unsustainable workforce • Rapid technology development worldwide • No local testing facilities ➢ **Regulations** • No clear strategy and master plan, especially in Abu Dhabi • No mandatory standards • No minimum threshold of local content in any project • Weak public and private partnership at the national level. • No prioritisation of local product usage

C. Solar PV - Opportunities for local manufacturing

The average duration of sunlight in the UAE exceeds 10 hours per day, arguably a significant factor considering that on average there are roughly 350 sunny days per year. The total solar energy received per day is approximately 6.5 kWh/m^2. Depending on the location and the time of year, Direct Normal Irradiance (DNI) is 4-6 kWh/m^2 per day.

In view of the cost and the availability of resources, solar PV is, in the short term, increasingly the most attractive renewable energy technology in the UAE.

Humidity and haze caused by dust particles remains a major challenge to large-scale solar PV systems in the country and the Gulf region. Nevertheless, solar PV systems are easily scalable and simple to operate, allowing them to provide the largest contribution of renewable energy in the UAE. The 10 MW facility at Masdar City has provided the UAE with a proven-track record in PV operations. A combination of 87,777 polycrystalline and thin film modules, provided by Suntech and First Solar, were installed in the 220,000 m^2 field of the PV facility at Masdar City.

Although high temperatures reduce performance, the amount of available solar irradiance adequately meets daily demand peaks, and thus reduces demand for peaking power plants operating on expensive fossil fuels. Records from the 10 MW solar PV installation at Masdar City shows that 1,700 full-load hours of solar PV can be achieved. Arguably, higher values should be achieved in locations further in-land due to lower concentrations of atmospheric dust.[15]

There are several companies in the UAE that are active in the manufacturing of solar components. For example, DuSol Industries, the first PV module manufacturing company in Dubai, uses automatic production lines for all types of module manufacturing, including those for off-grid purposes. Microsol International is a solar-cell manufacturer located in Fujairah. The Dubai Silicon Oasis Free Zone, houses Almaden MENA that manufactures ultra-thin, double glass, and frameless PV modules. Noor Solar Technologies (NST), a solar panel and inverters manufacturer based in Dubai.

Key findings on the United Arab Emirates' solar PV manufacturing potential are summarised in the following SWOT analysis:

[15] Masdar Institute/IRENA (2015), Renewable Energy Prospects: United Arab Emirates (REmap 2030 analysis), IRENA, Abu Dhabi.

Strengths	Weaknesses
➢ **Industry maturity** • Export experience in several industries • PV technology is well established • Local PV modules manufacturer • R&D for PV panels relating to the effects of temperature and dust ➢ **Technological skills** • Available PV installation and O&M skills • Available manufacturing skills for PV modules assembly ➢ **Economic regulatory assets** • Financial aid (ADFD) • IPP-PPA business model • Auction and tendering policy • Net-metering for rooftop PV systems	➢ **Industry maturity** • Limited manufacturing of inverters, charge controllers and batteries • Limited raw materials for glass manufacturing ➢ **Technological constraints** • Lack of skills in power component manufacturing ➢ **Economic regulatory assets** • High automation in manufacturing process limits job creation
Opportunities	**Threats**
➢ **Finance** • Feed-in-tariff policy • Strong financial sector ➢ **Competitiveness** • Available PV skills in installation and O&M • Existing local manufacturers of PV modules, cables, transformers, and infrastructure ➢ **Technology and expertise** • Established PV manufacturers • Experienced with several components • Established industries, including metal, glass and rubber ➢ **Regulation** • DEWA standards for rooftop PV systems • Electricity tariff restructuring	➢ **Finance** • Funding options are limited for small to medium scale projects since the funding would be geared to the wholesale side, such that SME lending is 50 to 70%. • Low protection for minority investors • Lack of awareness in the financial sector about renewable energy industry opportunities ➢ **Competitiveness** • Strong foreign PV manufacturing potential of such specific components as crystalline type panels ➢ **Technology and expertise** • Rapid technology development worldwide ➢ **Regulation** • Existing regulation hinders achieving the 2020 target • Net-metering limited to small-scale roof-top PV systems

S W O T

Local value chain and industrial assets

The table below provides an overview of the value chain for component manufacturing for solar PV plants, classified according to the presence of different local players. The analysis is subject to their willingness to produce different components, given their overall industrial, technological and economical know-how.

(a) Raw material

The glass industry is well established in the UAE, and includes Gulf Glass Industries (GGI), Emirates Glass, Emirates Float Glass, Spectrum Glass & Metal Industries Factory, Al Jazeera Fibre Glass Works LLC, and Al Rawaa Glass & Mirror Factory LLC. Although such material as steel and concrete is available, the raw material needed for glass manufacturing is imported.

(b) Solar cell production

The availability of raw material would motivate the industrial sector to adapt production lines to support solar cell manufacturing. Since technical expertise does not exist in this field, the automation of production lines can reduce the need for a highly trained workforce. Nevertheless, training and capacity building programmes would still be needed on the many levels of the industrial process.

(c) Solar module manufacturing

Solar module manufacturers are established in the UAE. For example, DuSol Industries, in partnership with Japanese and German equipment manufacturers, has an automated line of 50 MW annual capacity for off-grid and on-grid modules. In 2012, Microsol acquired the Solon Group, a PV manufacturer, thus increasing penetration in international markets, and Almaden established a 100 MW solar module factory in Dubai.

Table 17. Local manufacturing assets - Solar PV - UAE

Key assets of local industries	Industry maturity			Technological skills			Economic assets			Conclusion on local manufacturing assets
	Presence of active local companies	Level of industry structuring	Presence of local suppliers	Skilled workforce availability	Product quality	R&D capacity	Manufacturing cost competitiveness	Regulatory framework	Financial health	
Raw Material	●○○○	●●○○	●○○○	●○○○	○○○○	○○○○	●○○○	●○○○	●○○○	Low
Solar module manufacturing										
- Wafer production	○○○○	○○○○	○○○○	●○○○	○○○○	○○○○	○○○○	●○○○	●○○○	Very Low
- Solar cell production	●○○○	○○○○	○○○○	●○○○	○○○○	●○○○	●○○○	●○○○	●○○○	Low
- PV-module manufacturing	●●○○	●●○○	●●○○	●●○○	●●○○	●●○○	●●○○	●●●○	●●●○	Medium
PV plant										
- Electronics & cables	●●●○	●●●○	●●●○	●●●○	●●●○	●●○○	●●●●	●○○○	●●○○	High
- Steel support structures	●●○○	●●●○	●●●○	●●○○	●●●○	●●○○	●●●○	●○○○	●●○○	High
Construction	●●●○	●●●○	●●●○	●●●●	●●●○	●●○○	●●○○	●●●○	●●○○	High

Source: Data compiled by LCEC

(d) Electronics and Cables

Several companies manufacture cables:

- Ducab manufacturing facilities in Dubai and Abu Dhabi produce high, medium and low-voltage cables
- Tekab Company Limited, part of the GIBCA Group, manufactures instrumentation control data, fire resistant, and low-voltage power cables

Other electric component manufacturers established in the UAE include Intact Controls Transformer Industries LLC, a transformer manufacturer for the Middle East, and Al Amer Electrical and Al Hail Electrical, manufacturers of switchgear, control gear, and control panels.

(e) Steel support structure

PV module frames, could be manufactured locally given the presence of aeveral steel and metal manufacturers in the UAE, including Gulf Steel Industries (GSI FZC), Tiger Steel Industries, Emirates Global Aluminum (EGA), Al Jazira, Alumco LLC, Abu Dhabi Pipe & Profile Industries Complex LLC, and Al Ameen Steel Fabrication Engineering.

(f) Engineering, Procurement and Construction (EPC)

Several local contractors are established in the PV sector in the UAE, including Zohal and ALJ. Moreover, many EPC companies are well established in the real estate sector and therefore could manage the construction of PV plants.

Assessment of local renewable energy manufacturing capability

A. Analysis of the key factors for future successful local manufacturing

The purpose of this section is to analyse the local manufacturing perspectives in the solar PV value chain in the United Arab Emirates. Interviews conducted with local stakeholders in United Arab Emirates have enabled to identify a set of key success factors for the development of local solar PV component manufacturing.

Table 18. Key success factors for future local manufacturing - Solar PV - UAE

Key barriers for future local manufacturing capability	Investment capacity and strong financing infrastructures	Competitive local players	Strong industry innovation	Stable policy support	Conclusion on future local industrial capability
Raw materials	🟠	🟠	🟡	🟡	Medium
Solar module manufacturing					
- Wafer production	🔴	🔴	🔴	🟡	Very Low
- Solar cell production	🔴	🔴	🔴	🟡	Very Low
- PV-module manufacturing	🟠	🟠	🟠	🟡	Medium
PV Plants					
- Electronics & cables	🟡	🟡	🟡	🟡	High
- Steel support structures	🟡	🟡	🟡	🟡	High
Construction	🟡	🟡	🟡	🟡	High

Source: Data compiled by LCEC

B. Potential involvement of international players in local production

DuSol manufactures several sizes of PV modules ranging from 40Wp to 150Wp for off-grid markets and high efficiency panels ranging from 240Wp to 260Wp using 60 polycrystalline cells for on-grid markets.

Collaboration between local and international companies has been established. In this context, Masdar previously worked with Abengoa and SENER, which are established technology providers and EPC companies. Nevertheless, manufacturing solar modules requires investment and support. New lines for solar modules could be manufactured through joint ventures with international companies, leading to an increase in competitiveness and a decrease in system costs. There is capacity for such components as cables, control panels and steel structures for PV projects to be locally sourced.

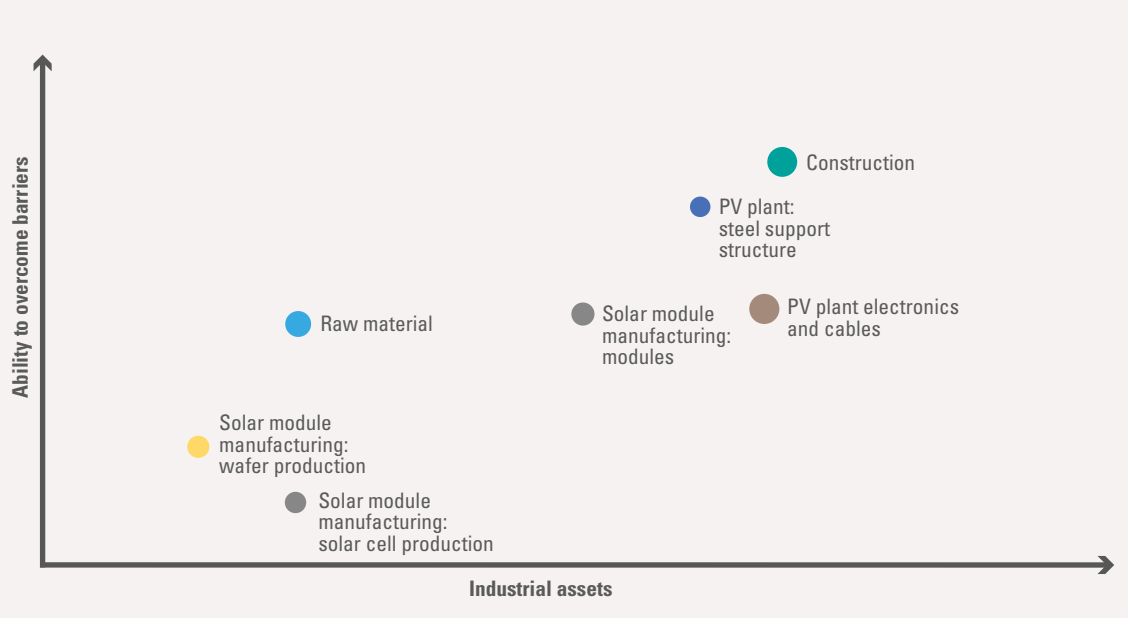
C. Conclusion on future local manufacturing opportunities

1. **Various inputs offer promising local capacity potential:**

   Solar PV panels are produced locally by a module manufacturer. However, the aim of Dubai to reach 5,000 MW of renewables by 2030 could encourage the establishment of international manufacturers in the UAE. This would require support from the public sector, to facilitate a decrease in the cost of PV projects. Furthermore, DuSol shows that establishing PV panel production lines does not necessarily lead to the creation of jobs on a large scale since the process is automatised and thus requires a minimum number of employees.

- Cable and connection box manufacturers are well established in the local market, many of which received certification in safety and quality from international companies like ABB. Adapting these components to PV applications could easily be done by establishing contacts

Figure 8. Future local manufacturing opportunities - Solar PV - UAE



Source: Data compiled by LCEC

with international experience therefore avoiding the cost of R&D processes. Infrastructure works and material could be locally delivered since the local market has expertise in the construction sector, including the development of large projects.

2. Additional components show potential but barriers need to be overcome to unlock this potential:

Raw material for solar glass is unavailable in the UAE. However, the glass industry is well established, and targeted training and capacity building with investment could allow for solar glass manufacturing.

- Local capacity is likely to remain limited in the medium-term on the remaining parts: Manufacturing components such as solar cells and wafers is not currently achievable in the UAE and would require increased investment. In addition, the UAE suffers from an unsustainable workforce, because the workforce largely consists of non-UAE nationals, making it unappealing for investors. In addition, the market for crystalline and thin-film production is being monopolised by existing companies. Nevertheless, the major barriers can be summarised in the following points: Manufacturing solar cells and wafers that would be able to withstand the climate conditions in the Gulf region, including the UAE, limited market size and strong international competition.

D. Concentrated solar power - Opportunities for local manufacturing

Coupling thermal energy storage with CSP is arguably a viable technology for the UAE, given its potential to provide baseload power. Moreover, Dubai has invited bids for a 700 MW CSP power plant, which is the fourth phase of the Mohammed bin Rashid Al Maktoum Solar Park.

Shams I in Abu Dhabi is a 100 MW concentrating solar power station that uses parabolic trough technology. It displaces 175,000 tons of CO_2 per year and generates enough energy to power 20,000 homes. Covering an area of approximately 2.5 km^2,[16] the station consists of 258,048 parabolic trough mirrors, 192 solar collector assembly loops with eight solar collector assemblies per loop, 768 solar collector assembly units, and 27,648 absorber pipes.

However, the main challenges to CSP plants in the Gulf region, including the UAE, are dust particles and humidity that significantly reduce DNI and negatively affect CSP operations and solar mirrors and panels. Ongoing research to improve cleaning processes and dust-resistant surfaces is conducted in collaboration with real-time weather monitoring and data collection on dust by Masdar Institute's Research Center for Renewable Energy Mapping and Assessment.

Although many components can be locally sourced, Shams I project was mainly designed and implemented by international companies. For example, AG Ingeniería, in consultation with Fichtner Consulting Engineers, developed basic and detailed engineering, Foster and Wheeler designed and delivered the required equipment, Abengoa equipped the power station with solar ASTRO collectors, MAN Turbo provided the 125 MW steam turbine, Flabeg provided parabolic glass mirrors, Schott AG provided the PTR 70 absorber tubes, and Solutia provided Therminol heat transfer fluid.

The UAE has extensive experience in oil and gas and chemical processes, namely, piping, tanks, vessels, control. This could be useful for CSP projects, especially in disciplines related to fluid and steam. Transformers, cables and other components are already locally manufactured.

[16] Masdar Institute/IRENA (2015), Renewable Energy Prospects: United Arab Emirates (REmap 2030 analysis), IRENA, Abu Dhabi.

Arguably, more than 30% of components for CSP plants could be locally manufactured, a share that could increase to 60% if solar concentrators were locally produced.[17]

Key findings on the United Arab Emirates' CSP manufacturing potential are summarised in the following SWOT analysis:

Strengths	Weaknesses
➢ **Industry maturity** • Local manufacturing potential up to 30 percent • Shams I project has a proven-track record • R&D on dust problems is ongoing ➢ **Technological skills** • Available CSP installation skills based on Shams I experience • Available skills for high pressure processes ➢ **Economic regulatory assets** • Public engagement • Considerable ongoing CSP projects • GCC grid interconnection	➢ **Industry maturity** • CSP is not widely spread among suppliers • Shams 1 entirely procured by foreign companies • Large-scale projects pose a difficulty for small-scale local manufacturing to flourish. ➢ **Technological constraints** • Capacity building and training needed for manufacturing specific components (e.g. steel structure, glass, some electro-mechanical parts) • O&M of CSP plants is complex: plant administration, operation and control and technical inspections for both turbines and collectors. ➢ **Economic regulatory assets** • Limited local market mostly related to public initiatives • High labour cost, especially at the mid and top management levels
Opportunities	**Threats**
➢ **Finance** • Feed-in-tariff policy • Electricity tariff restructure • Possible financial aid (ADFD) ➢ **Competitiveness** • CSP with storage can be a competitive product • Existing local manufacturers: PV modules, cables, transformers, infrastructure • Leveraging on local manufacturing will incentivise further development and eventually lower manufacturing prices ➢ **Technology and expertise** • Potential to adapt such local industries as oil and gas and chemical industries for CSP components ➢ **Regulation** • Need for public support and a master plan for CSP projects	➢ **Finance** • Limited incentives and direct aid for CSP projects • The bankability of projects for CSP (parabolic trough) is low compared to more established technologies such as PV ➢ **Competitiveness** • Local market is restricted • Unfavourable local CSP manufacturing market due to high costs in comparison to conventional energy sources. ➢ **Technology and expertise** • Local manufacturers have no direct experience in technical know- how of CSP specific components (e.g. vacuum tubes, steel absorber, sun trackers). ➢ **Regulation** • Remapping renewable energy target by technology and lowering CSP share

S W O T

[17] The information is based on interviews with consultants and stakeholders.

Local value chain and industrial assets

The table below provides an overview of the value chain for component manufacturing for CSP plants, classified according to the presence of different local players. The analysis is subject to their willingness to produce different components, given their overall industrial, technological and economical know-how.

Experience in existing CSP projects has been achieved, particularly in relation to the impact of climate in soiling solar mirrors. Presently, CSP technologies for power generation are considered expensive compared to solar PV and require complex operations. Installation of dry cooling technology for the power cycle heat exchangers is possible and would reduce water use. Nevertheless, this would lead to increased capital costs and reduced plant efficiency.

Table 19. Local manufacturing assets - CSP - UAE

Key assets of local industries	Industry maturity			Technological skills			Economic assets			Conclusion on local manufacturing assets
	Presence of active local companies	Level of industry structuring	Presence of local suppliers	Skilled workforce availability	Product quality	R&D capacity	Manufacturing cost competitiveness	Regulatory framework	Financial health	
Raw Material	●●○○	●●○○	●●○○	●○○○	●○○○	●○○○	●○○○	○○○○	●●○○	Low
Solar field										
- Mirrors	●○○○	●○○○	●○○○	●●○○	●●○○	●●○○	●○○○	●●○○	●●●○	Medium
- Mounting structures	●●○○	●●○○	●●●○	●●●○	●●●○	●●○○	●●●○	●●○○	●●●○	High
Power block										
- Balance of plant, piping, electronics	●●○○	●●○○	●●●○	●●●○	●●●○	●●○○	●●●○	●●○○	●●○○	High
- Power train	○○○○	●○○○	●○○○	●○○○	○○○○	○○○○	○○○○	○○○○	○○○○	Very Low
Thermal storage										
- Storage systems	●●○○	●●○○	●●○○	●●●○	●●○○	●●○○	●●●○	●●○○	●●○○	High
Grid connection	●●●○	●●●○	●●●○	●●●○	●●●○	●●●○	●●●○	●●●○	●●○○	High
Construction	●●○○	●●●●	●●●○	●●●○	●●●○	●●○○	●●●○	●●●○	●●●○	High

Source: Data compiled by LCEC

The main barrier to CSP project development is the high cost of the large-scale investments that are needed. However, the LCOE of CSP projects can be decreased through increasing the local manufacturing sector. The unsustainable workforce also presents a major barrier in the UAE, making investment in capacity building difficult to achieve.

(a) Raw material

Raw material required for CSP projects vary from steel and other metals for support structures and concrete for foundations. Both steel and concrete can be provided locally. The raw material needed for solar mirror manufacturing is currently being imported, as is heat transfer fluid or molten salt used for storage.

(b) Solar field – Mirrors and receivers

Solar mirror manufacturers like Al Rawaa Glass & Mirror Factory LLC could adapt their production lines for flat concentrator production. Nevertheless, manufacturing curve mirrors would require capacity building, training and new production lines, which could be expensive.

(c) Solar field – Support structures

Gulf Steel Industries (GSI FZC) or Tiger Steel Industries, among others, can manufacture steel structures for CSP plants.

(d) Grid connection

Many companies established in the UAE have a proven-track record in manufacturing such electric components as cables, control panels and switchgears. Intact Controls Transformer Industries is also a well-known transformer manufacturer.

(e) Steam turbines

Skills needed for steam turbine manufacturing are currently unavailable in the UAE. The installation and operational costs of a local steam turbine manufacturing plant would be highly expensive, and the investment would be unjustified if the local and the regional markets are underdeveloped.

(f) Storage system and plant balance

Manufacturers of vessels, valves and pipes like Cochin Steel LLC can benefit from the experience the UAE has in oil gas and chemical industries. For example, ARCON UAE offers a wide range of products that include fuel and chemical tankers, water tankers, tippers, silos. Moreover, it can create products to the specifications of the American Petroleum Institute (API) and British Standards (BS). Spira Power is engaged in the designing, manufacturing and marketing of a complete range of fluid sealing products and rubber extrusion and CNC machined components to serve all kind of industrial sectors in the Middle East.

The metal industry delivers numerous types of tubing and pipes for industrial applications and different purposes. Local industries can provide pipes that are compliant with the high operating temperatures and pressure of CSP plants.

(g) Construction

Such companies as Abnia Cement Products LLC and Abu Dhabi National Cement Factory are well established in the UAE market and could easily adapt their business model to include the construction of CSP plants and projects. Moreover, there are several local contractors established in the UAE, including Zohal and ALJ.

Table 20. Key success factors for future local manufacturing - CSP - UAE

Key barriers for future local manufacturing capability	Investment capacity and strong financing infrastructures	Competitive local players	Strong industry innovation	Stable policy support	Conclusion on future local industrial capability
Raw materials	●	●	●	●	Medium
Solar Field - Mirrors	●	●	●	●	Medium
- Mounting structures	●	●	●	●	High
Power block - Balance of plant, piping, electronics	●	●	●	●	High
- Power train	●	●	●	●	Very Low
Thermal storage - Storage systems	●	●	●	●	Medium
Grid Connection	●	●	●	●	Very High
Construction	●	●	●	●	Very High

Source: Data compiled by LCEC

Assessment for local renewable energy technology manufacturing

A. Analysis of the key factors for success in local manufacturing

The purpose of this section is to analyse the local manufacturing perspectives in the CSP value chain in the United Arab Emirates. Interviews conducted with local stakeholders in United Arab Emirates have enabled to identify a set of key success factors for the development of local CSP component manufacturing.

B. Potential involvement of international players in local production

The potential for CSP development in the UAE is relatively high. Moreover, the 5,000 MW target for Dubai could encourage local and international investors to establish factories in the country.

Again, the main barriers include limited private initiatives, an unsustainable workforce, and the need for R&D for product adaption in the UAE, and in the Gulf region. The free market zones could be an important factor in attracting investors to the UAE, and eventually the Gulf region.

Capacity building and training programmes are needed for CSP component manufacturing, starting with bent mirrors and moving towards specific O&M procedures for CSP plants.

C. Conclusion on future local manufacturing opportunities

Opportunities in locally manufactured CSP components rely on public support, incentives and high investments with limited opportunities for private initiatives. However, if the high solar target of Dubai is met by CSP technologies, it could boost the demand for CSP components. The ambitious renewable energy targets set by Dubai can be met by furthering investment in CSP projects, given the added value in the energy produced for different end-use sectors. Within this context, demand for these projects can be met through local component manufacturing. Glass and steel industries in the UAE could be trained and supported to adapt to CSP manufacturing requirements. Transformers, electric components, connection boxes and sub-station installation are reputed industries in the UAE.

Based on the analysis of these industrial assets, the figure below provides a review on the key success factors for local integration in CSP. The size of each "bubble" represents weight of jobs created by industry activity per MW installed. The size of each bubble does not provide information on the local part of the production, but only gives indication on the potential of each industrial sector. Moreover, it provides a synthetic vision on the needs for improvement, as highlighted in the case of CSP.

1. Various inputs offer promising potential for local capacity:

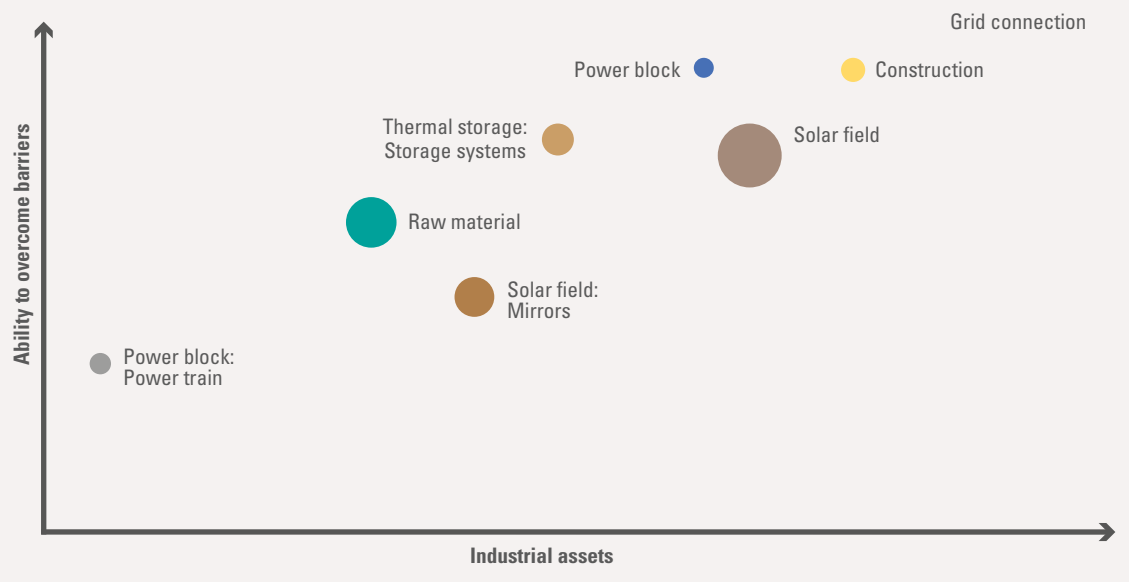
- Steel structures and the elements needed for building foundations could be locally sourced. Local entities are skilled in the components needed for infrastructure, installation and maintenance.
- Storage systems could be linked to the oil and gas and chemical industries, since they have the necessary skills and manufacturers have a proven track-record.
- Cables, junction and connection boxes, and transformers are locally manufactured.

2. Barriers to overcome to unlock the local capacity potential:

Solar mirrors and flat concentrators can be locally manufactured from imported raw material, but this increases the cost of the product. In addition, the manufacturing of bent mirrors needs specialised skills and new production lines, thus requiring increased investment and capacity building. However, joint ventures or license agreements with experienced international manufacturers would be useful to the CSP industry in the UAE.

- Local capacity is likely to remain limited in the medium-term on the remaining parts:
- The receiver for parabolic trough and tower systems, solar tracking solution, steam turbines and power trains for CSP plants are specialised components that need high investments and specialised knowledge in design and manufacturing processes. Therefore, R&D and collaborative technology is necessary.
- Main barrier: Technology transfer
- The share of local components in CSP projects has the potential to reach 60% the UAE (based on interviewed stakeholders). However, the development of CSP needs increased support from the public sector and initiatives that would encourage the private sector to invest in this technology.

Figure 9. Future local manufacturing opportunities - CSP - UAE



Source: Data compiled by LCEC

E. Onshore wind - Opportunities for local manufacturing

Wind resources in the UAE are less abundant than solar resources. Nevertheless, there is reasonable potential for specific applications and isolated grids, especially in the Northern Emirates and offshore areas. In January 2015, Masdar launched the UAE Wind Atlas, which was designed to support the development of wind farms in coastal areas and on islands. Consequently, the forecast for the production of total electricity generated from wind energy is 0.16 Terawatt hours (TWh) per year by 2030.

Wind projects are limited in the UAE and those that are operational have a relatively low capacity. The necessary skills and expertise are thus underdeveloped. However, many of the components required for such projects could be sourced locally, and include cables, connection boxes, transformers and the needed elements for building foundations. Moreover, the well-established steel industry could adapt or install production lines to include wind tower manufacturing processes.

The UAE Wind Atlas has identified favourable locations for potential turbine sites, including Sir Bani Yas Island where Masdar presented plans to the Government for a 30 MW project.[18]

The highest wind speed ever recorded in the UAE was on the coast of Fujairah and on Sir Bani Yas Island. However, issues relating to the landscape in Fujairah have prevented the development of wind projects. For example, the Northern Emirates terrain is steep and would require additional infrastructure to transport the rotor blades needed for wind turbines.

Key findings on the UAE's onshore wind manufacturing potential are summarised in the following SWOT analysis:

Strengths	Weaknesses
➢ **Industry maturity** • High local manufacturing potential • Existing renewable energy projects ➢ **Technological skills** • Available skills in tower manufacturing and system assembly • Innovation capacity ➢ **Economic regulatory assets** • New and well-maintained infrastructure	➢ **Industry maturity** • Limited experience in wind projects • Limited wind resources ➢ **Technological constraints** • Specialised expertise for such components as blades ➢ **Economic regulatory assets** • Lack of specific incentives • High investment costs • Unsustainable workforce
S	**W**
Opportunities	**Threats**
O	**T**
➢ **Finance** • Expected increase of investments to meet the renewable energy target ➢ **Competitiveness** • On-site assembly • Main components exist in the local market for other applications • Joint ventures with well-established manufacturers • Export potential to GCC countries ➢ **Technology and expertise** • Existing local industries that can be adapted	➢ **Finance** • Limited incentives and direct aid for new industrial lines • The bankability of projects for wind is low compared to more established technologies such as PV ➢ **Competitiveness** • Increased interest in local manufacturing in countries with high wind targets such as Egypt ➢ **Technology and expertise** • Rapid technology development worldwide

[18] The information is based on interviews with consultants and stakeholders

Table 21. Local manufacturing assets - Onshore wind - UAE

Key assets of local industries	Industry maturity			Technological skills			Economic assets			Conclusion on local manufacturing assets
	Presence of active local companies	Level of industry structuring	Presence of local suppliers	Skilled workforce availability	Product quality	R&D capacity	Manufacturing cost competitiveness	Regulatory framework	Financial health	
Material	●○○○	●●○○	●●●○	●●●○	●●○○	●●○○	●●○○	●○○○	●●○○	Medium
Wind turbines										
- Wind towers	●○○○	●●○○	●●○○	●●●○	●●○○	●●○○	●●●○	●●●○	●●○○	Medium
- Blades	●○○○	●●○○	●○○○	●●○○	●○○○	○○○○	●○○○	●●○○	●●○○	Low
- Gearboxes	○○○○	●○○○	●●○○	●●○○	●○○○	●●○○	●○○○	●○○○	●●○○	Low
- Generators	●○○○	●○○○	●●○○	●●○○	●○○○	●○○○	●○○○	●○○○	●●○○	Low
- Electronics & cables	●●●○	●●●○	●●●○	●●●○	●●●○	●●○○	●●●●	●○○○	●○○○	High
Construction	●●●●	●●●●	●●●●	●●●○	●●●○	●○○○	●●●○	●●●○	●●○○	High

Source: Data compiled by LCEC

Local value chain and industrial assets

The table below provides an overview of the value chain for component manufacturing for onshore wind plants, classified according to the presence of different local players and range from their willingness to produce different components, given their overall industrial, technological and economical know-how.

(a) Raw material

The cement and steel industries needed for foundations and tower manufacturing, respectively, are well established in the UAE and could be involved in CSP projects.

(b) Component material

The composite materials needed for wind masts could be provided by local manufacturers such as Innovative Composite Engineering FZE and Premier Composite Technologies (PCT). For example, PCT is a global manufacturer of advanced composite material for marine, automotive and aerospace applications. The PCT facility can produce mockups, prototypes and samples, providing a starting point for the integration of wind mast manufacturing.

(c) Towers

Again, the local steel industry is well developed and could create tower manufacturing processes. However, the significant investments needed to create new production lines is a barrier.

(d) Rotor blades

Local blade manufacturers in the UAE have not been identified, and thus the extensive expertise in design and implementation required for blade manufacturing purposes are negligible. Integrating this type of manufacturing into the local market would require license agreements or joint ventures with international companies specialised in the field. Therefore, manufacturing blades locally makes sense, especially if demand were to increase in the country, the GCC and other countries close by. Again, the transportation of rotor blades to projects located in remote mountainous regions also presents a challenge since investments into infrastructure would be needed.

Assembly systems can be provided by local entities since the technological skills and expertise are widely available.

(e) Additional components

Although electrical and mechanical components can be provided locally by different manufacturers, production of electrical and mechanical components such as generators, power converters, screws, yaw and pitch systems is limited.

(f) Construction

Materials for groundworks could be sourced locally. Moreover, the UAE market includes several entities that are already well established and any further projects would provide opportunities for local companies to adapt to wind plant requirements by collaborating with experienced international players.

Table 22. Key success factors for future local manufacturing - Onshore wind - UAE

Key barriers for future local manufacturing capability	Investment capacity and strong financing infrastructures	Competitive local players	Strong industry innovation	Stable policy support	Conclusion on future local industrial capability
Raw materials	🟡	🟡	🟡	🟠	Very High
Wind turbines					
- Wind towers	🟠	🟠	🟠	🟠	Low
- Blades	🟠	🟠	🟡	🟠	Medium
- Gearboxes	🔴	🔴	🔴	🟠	Very Low
- Generators	🟠	🟠	🟠	🟠	Low
- Electronics & cables	🟡	🟡	🟠	🟠	High
Construction	🟡	🟡	🟡	🟠	Very High

Source: Data compiled by LCEC

Assessment for local renewable energy manufacturing

A. Analysis of the key success factors for future local manufacturing

The purpose of this section is to analyse the local manufacturing perspectives in the onshore wind value chain in the United Arab Emirates. Interviews conducted with local stakeholders in United Arab Emirates have enabled to identify a set of key success factors for the development of local onshore wind component manufacturing.

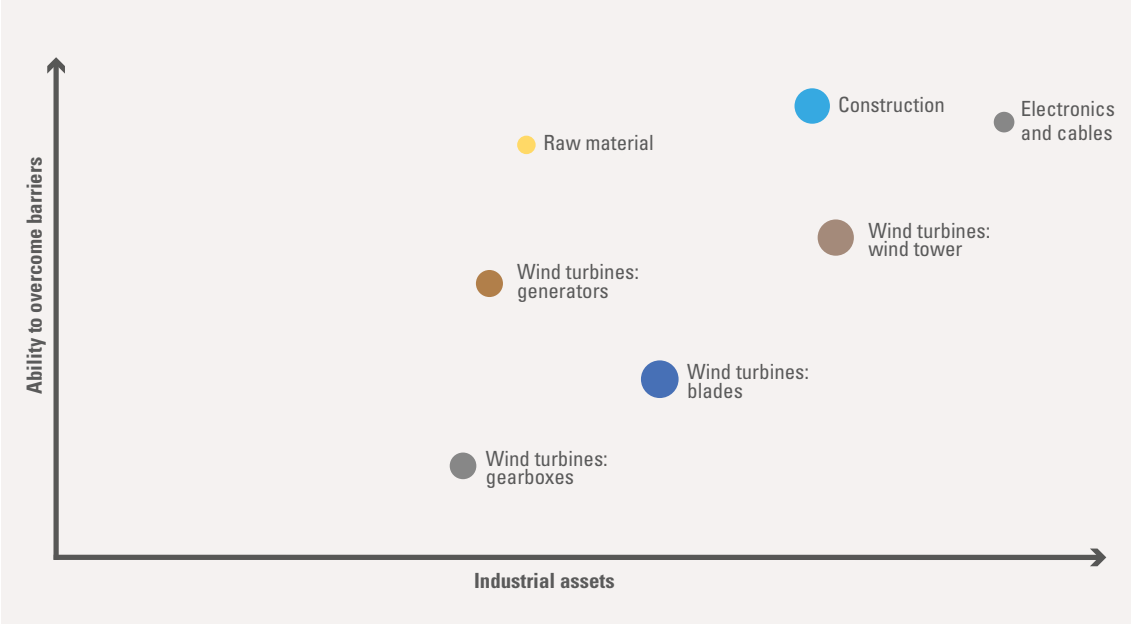
B. Potential involvement of international players in local production

Although wind projects are limited in the UAE, the intention of Masdar to implement a 30 MW plant at Sir Bani Yas Island provides an opportunity to partner with international manufacturers and investors. Nevertheless, the lack of a well-defined wind target, limited wind potential, and limited public and private initiatives in the wind sector could prevent international or local investors developing the capacity for manufacturing wind components in the UAE. However, the local free zones, proximity to GCC markets, and the experience of Emiratis in export and trade are advantageous in that they could convince investors to penetrate the local market. Moreover, a supportive policy scheme by the public sector is needed to develop the local wind sector in terms of market growth and manufacturing opportunities.

C. Conclusion on future local manufacturing opportunities

Manufacturing and assembling steel towers and rotor blades locally could reduce the LCOE of wind projects since importing such components is costly. Several components for wind power are available locally.

Figure 10. Future local manufacturing opportunities - Onshore wind - UAE



Source: Data compiled by LCEC

However, in order for wind power to be deeply integrated into the UAE market, the manufacturing of additional components requires support in such areas as the installation of new production lines and capacity building programmes.

Based on the analysis of these industrial assets, the figure below provides a review on the key success factors for local integration in onshore wind. The size of each "bubble" represents weight of jobs created by industry activity per MW installed. The size of each bubble does not provide information on the local part of the production, but only gives indication on the potential of each industrial sector. Moreover, it provides a synthetic vision on the needs for improvement, as highlighted in the case of onshore wind,

1. Various inputs offer promising local capacity potential:

- Electronic components necessary for wind turbines, including cables, transformers, and connection to the grid, can be delivered by local companies.
- Infrastructure could be developed by experienced local construction companies, and project development could be conducted by specialised local companies.
- Production of industrial raw materials, especially by companies producing composite material for prototyping, could have a considerable impact on blade manufacturing since it would reduce manufacturing cost. Moreover, the steel industry could be adapted for tower manufacturing.

2. Additional components show potential but barriers need to be overcome to unlock this potential:

- The manufacturing of rotor blades and gearboxes is highly specialised and requires expertise that is unavailable in the UAE. However, investments in capacity building and new production lines could overcome this barrier, but only if local market forces justify such investments.

  - **Main barriers: lack of expertise, unsustainable workforce and high investment requirements**

    Arguably, many of the components needed for wind technology could be produced locally. However essential components like rotor blades and gearboxes need significant investment and a skilled workforce in order to guarantee high quality products. Limited wind projects and, in most areas, limited wind potential could prevent investment in local component manufacturing.

3. Achieving Local Manufacturing Potential: Identified Gaps and Recommendations

Jordan: Identified gaps and recommendations

This chart summarises both the current status and the priority level for each renewable power source, with key measures recommended on the basis of four broad success factors. Moreover, a focus on high priorities, with further explanations and details to provide options about how these recommendations can be translated into action.

Jordan - Success factor A: Substantial political support aiming to create a sustainable market

Focus on high priorities

A. Define a national plan for renewable energy technology manufacturing

Market barrier

Currently, the local manufacturing of renewable energy components in Jordan is only supported by the governmental policy that stipulates that 20% of components should be locally manufactured. Moreover, this share can easily be covered by EPC and O&M.

In addition, the local renewable energy market in Jordan is limited in terms of private investment compared to other countries in the region. Therefore, the need for investments in capacity building and new production lines is unjustified for international investors unless the regional market is also considered.

Table 23. Identified gaps and recommendations - Jordan - Success factor A

Key measures	Status assessment / Priority level					
	Solar (PV)		*Solar (CSP)*		*Wind (onshore)*	
	Status	Priority	Status	Priority	Status	Priority
Formulate a long-term renewable energy strategy with national targets		-		High		-
Define an extensive renewable energy regulatory framework		-		High		-
Define a national plan for renewable energy equipment manufacturing		High		High		High
Reform fossil-fuel subsidies		High		Medium		Medium

Source: Data compiled by LCEC

Recommendation: Develop a master plan to support the renewable energy component manufacturing industry in Jordan

An overall master plan for renewable energy component manufacturing should be separated into the diverse innovations and technologies, highlighting their specific requirements. The comprehensive strategy should officially incorporate existing support systems, such as the existing support for the industrial sector, and grow to cover all related renewable energy technologies, fundamentally focusing on the local energy market with special consideration of regional market potential. The strategy should rethink the tax exemption law on imported renewable energy systems and components.

The local components identified for solar PV could cover up to 80% of a PV plant. However, the focus should be on cell and wafer manufacturing.

The CSP projects being planned could help in developing the necessary expertise, especially in terms of installation and O&M. Therefore, the strategy should focus on strengthening existing CSP-related industries such as tanks, vessels, heat exchangers and electric and mechanical component manufacturing. Moreover, the manufacturing of bent concentrators, which, due to its complexity and the required significant investment, could be added to the future stages of the strategy.

In terms of wind, the master plan could focus on the development of the steel industry in order to cope with the ambitious target of 1,200 MW of renewable energy in Jordan, and thus could reduce the cost of wind plants. Moreover, public engagement in reaching this target could encourage international manufacturers to deploy the required technology for blade manufacturing in Jordan.

B. Reform fossil-fuel subsidies

Jordan, which is facing a fiscal crisis, initiated substantial petroleum subsidy reforms in 2012. The Government has also been contemplating how to reduce electricity subsidies, which surpass the fiscal burdens imposed by petroleum subsidies. However, this reform impacted all sectors, including the industrial sector, particularly as the original energy prices were relatively high compared to other countries in the region. A reform on fossil-fuel subsidies will encourage a greater use of renewable energy systems. Nevertheless, the industrial sector should be treated differently than other sectors such as residential and tourism sectors.

Jordan - Success factor B: Competitive local players in the global market

Focus on high priorities

A. Inform on market size and feasibility of production lines concerning solar PV, CSP and wind

Market barrier

Existing solar PV and wind projects, those in the pipeline, and the ambitious targets for renewable power has strengthened the ground for the potential of local component manufacturing. However, studying the development, expenses and innovations required for solar PV and wind technology must be supported by the public and private sectors.

The Tafila wind project is on the road towards developing wind components. However, expensive key components such as steel towers and rotor blades need to be imported.

Recommendation: Enhance the visibility of this technology on the public and private levels

The development of CSP should be supported by the public and private sectors. This can be done by identifying the potential of CSP on the local and regional levels. However, feasibility and marketing studies need to be undertaken in order to begin developing local CSP and wind components within existing

Table 24. Identified gaps and recommendations - Jordan - Success factor B

Key measures	Status assessment / Priority level					
	Solar (PV)		*Solar (CSP)*		*Wind (onshore)*	
	Status	Priority	Status	Priority	Status	Priority
Provide information on market size and opportunities of production adjustments		-		High		-
Assess the feasibility of upgrading production lines		High		High		High
Foster business linkages, particularly international joint ventures		-		Medium		-
Support awareness-raising initiatives		Medium		High		Medium
Support the structuring of the sector		Medium		High		Medium

Source: Data compiled by LCEC

industries, especially steel, electrical and mechanical. The ambitious renewable energy targets set by Dubai can be met by furthering investment in CSP projects, given the added value in the energy produced for different end-use sectors. Within this context, demand for these projects can be met through local component manufacturing.

B. Conduct awareness-raising initiatives

Market barrier

Further action must be considered to boost the local manufacturing of renewable energy components for the three technologies. There is a lack in market transparency (project pipeline and pricing) combined with technical, regulatory and cost uncertainties, especially on less mature technologies such as CSP.

Recommendation

Support systems need to be developed for renewable energy components throughout the whole value chain, noting the necessary high costs for upgrading or creating existing and new production lines respectively. Awareness-raising activities should focus on the industrial sector, as it could easily be involved with electric components and structure manufacturers, installers, and potential component assemblers, and others. Moreover, direct public engagement would encourage investment in the manufacturing of more sophisticated components.

Jordan - Success factor C: Strong industry innovation potential and skilled workforce

Focus on high priorities

A. Support Research and Development

Market barrier

Research and development is key to ensure local and regional competitiveness of products, especially since international players are present in the CSP and wind market and technology is being rapidly developed. However, R&D is still limited in Jordan, if non-existent.

Table 25. Identified gaps and recommendations - Jordan - Success factor C

Key measures	Status assessment / Priority level					
	Solar (PV)		*Solar (CSP)*		*Wind (onshore)*	
	Status	Priority	Status	Priority	Status	Priority
Support research and development		-		High		High
Educate and train high-skilled workforce		-		High		High
Implement upgrading programs targeting specific industrial players		Medium		Medium		Medium
Identify niche technologies and set-up national centres of excellence		High		High		High

Source: Data compiled by LCEC

Recommendation

National collaboration and partnerships are needed for R&D in order to support local manufacturing. Moreover, applying internationally compliant standards on all components and acquiring testing facilities could help in extending new products to the regional market. However, collaboration should extend to the private and public sectors and different types of institutions, including governmental ministries, laboratories, and universities. Public support could be channeled through budget allocations for R&D for renewable energy components. Training could also be conducted by public and private entities, especially on complexed tasks like the O&M of CSP plants, and the manufacturing of bent glass for solar concentrators. Regional co-operation could also enhance the training process through, for instance, the exchange of expertise between the Arab countries. A successful example of this is the co-operation between RCREEE and Arab countries, especially in terms of training.

B. Identify niche technologies

Market barrier

Jordan is one of the few Arab countries that has an established, well-defined grid code. However, the limited capacity of the grid is a main barrier in developing renewable energy projects.

Recommendation

In order to cope with the capacity limitation of the national grid, Jordan has already started implementing the first phase of the "Green Corridor" project. However, capacity is still limited and subsequent phases of the project are still pending.

This barrier could be overcome by exporting electricity to neighbouring countries and extensive research on energy storage particularly in CSP projects.

Jordan - Success factor D: Investment capacity and strong financing infrastructures

Focus on high priorities

A. Encourage local banks to implement low-interest loans and grants

Market barrier

Jordan has already established a fund in support of implementing PV systems.

Table 26. Identified gaps and recommendations - Jordan - Success factor D

Key measures	Status assessment / Priority level					
	Solar (PV)		*Solar (CSP)*		*Wind (onshore)*	
	Status	Priority	Status	Priority	Status	Priority
Encourage local banks to implement low-interest loans and grants		High		High		High
Implement investment in support mechanisms for the adaptation or creation of production lines		High		High		High
Implement price, tax and other incentives		Medium		Medium		Medium

Source: Data compiled by LCEC

In addition to foreign investments and grants, the Jordanian Renewable Energy and Energy Efficiency Fund finances renewable energy projects. Moreover, the strategic objectives of JREEEF aim to develop the renewable energy and energy efficiency industries in Jordan. However, JREEEF is mainly designated for such small-scale projects as net-metering and feed-in-tariff processes, which have helped create momentum in the Jordanian renewable energy market.

Recommendation

The recommendation would be to expand funding to large-scale projects to increase the local renewable energy market, particularly in terms of wheeling possibilities, as the case of funding the first CSP projects of Morocco and Egypt, by the Government and granting the incremental cost by the Global Environment Facility (GEF) for each project. The Government should encourage banks to support special low-interest loans for renewables-related industries.

In summary – key actions

Based on the detailed recommendations presented in this section:

- Define a national plan for renewable energy equipment manufacturing
- Reconsider the electricity tariff structure to favour the industrial sector
- Enhance visibility of renewable energy technology on the public and private levels
- Contribute to awareness-raising initiatives
- Conduct feasibility and marketing studies in order to begin developing local CSP and wind components based on existing industries, especially steel, electrical and mechanical
- Establish national collaboration and partnerships for R&D in order to support local manufacturing: budget and training
- Extend loans and grants to large-scale projects, especially wind and CSP

Lebanon: Identified gaps and recommendations

This chart summarises both the current status and the priority level for each renewable power source, with key measures recommended on the basis of four broad success factors. Moreover, a focus on high priorities, with further explanations and details to provide options about how these recommendations can be translated into action.

Lebanon - Success factor A: Substantial political support aims to create a sustainable market

Focus on high priorities

A. Define a national plan for renewable energy technology manufacturing

Market Barrier

The renewable energy market in Lebanon is focused more on PV than on wind and CSP. However, the Council of Ministers recently approved three permits for private companies to operate wind farms signals the start of the wind energy market. Nevertheless, there has been no interest in investing in CSP plants. Since the market for solar PV is the most dynamic, it would make more sense to focus on renewable energy equipment manufacturing for PV technologies.

Recommendation: develop an overall master plan to support the PV components manufacturing industry in Lebanon

There is a lack of raw material, energy and land costs are high, and establishing a manufacturing facility would require significant investment costs. In addition, importing PV panels from China weakens the opportunities for local PV module assembly by local PV suppliers.

In the short term, keeping component manufacturing, subject to ripple effect

Table 27. Identified gaps and recommendations - Lebanon - Success factor A

Key measures	Status assessment / Priority level					
	Solar (PV)		*Solar (CSP)*		*Wind (onshore)*	
	Status	Priority	Status	Priority	Status	Priority
Formulate a long-term renewable energy strategy with national targets		-		Low		-
Define an extensive renewable energy regulatory framework		-		Low		-
Define a national plan for renewable energy equipment manufacturing		Low		Low		Low
Reform fossil-fuel subsidies		Medium		Medium		Medium

Source: Data compiled by LCEC

resulting from improvements in production lines and the products of existing industries such as steel, electronics, cables, and glass would help create local value, reducing the cost of PV systems without causing major financial burden.

B. Reform fossil-fuel subsidies

Market Barrier

Electricity in Lebanon is highly subsidised. However, energy costs have increased due to the integration of diesel generators to compensate for regular grid outages. Accordingly, renewable power projects are being implemented to reduce monthly energy bills and dependence on diesel generators. However, net-metering would have been of more value if utility tariffs were higher. Indeed, whenever fuel prices decrease, return on investments for renewable energy projects also decrease, further decreasing deployment

Recommendation

The fossil-fuel subsidy reforms should be reconsidered by policy makers in order for renewable energy projects to appear more financially appealing to consumers and to increase the deployment of renewable energy, especially by the private sector.

Lebanon - Success factor B: Competitive local players in the global market

Focus on high priorities

A. Support awareness-raising initiatives

Market barrier

There is a possibility that PV systems are compliant with different types of applications

Table 28. Identified gaps and recommendations - Lebanon - Success factor B

Key measures	Status assessment / Priority level					
	Solar (PV)		*Solar (CSP)*		*Wind (onshore)*	
	Status	Priority	Status	Priority	Status	Priority
Provide information on market size and opportunities of production adjustments		Low		Low		Low
Assess the feasibility of upgrading production lines		Low		Low		Low
Foster business linkages, particularly international joint ventures		-		Medium		Medium
Support awareness-raising initiatives		Medium		High		High
Support the structuring of the sector		Medium		Medium		Medium

Source: Data compiled by LCEC

in residential, commercial, industrial and pumping facilities. Moreover, constraints in space and location are less than those needed by onshore wind and CSP. However, the installation of wind farms or CSP plants for some industrial applications might be more beneficial and profitable in terms of energy supply, LCOE and return on investment, taking into consideration the characteristics of the projects' site, local conditions, loads, distance from the grid, economic activities in the present and future. Increasing the awareness of CSP and wind technologies would expand the market and enhance the potential of local manufacturing. The awareness campaign should not only focus on the installation of such systems, but on the possibility of involving the industrial sector by integrating and assembling local components in the renewable energy industry.

Recommendation

Awareness campaigns usually focus on various types of renewable energy systems, their financial and environmental benefits, and their major components. However, the detailed value chain, including the needed raw material, components, involved industries and processes, are not tackled. Therefore, engaging the relevant public in this aspect of renewable energy technology could set the stage for exploiting the potential of components manufacturing.

Lebanon - Success factor C: Strong industry innovation potential and skilled workforce

Focus on high priorities

A. Support research and development

Market barrier

Research and development is a necessity, whether in constructing and installing projects or manufacturing components, since technologies and industrial processes

Table 29. Identified gaps and recommendations - Lebanon - Success factor C

Key measures	Status assessment / Priority level					
	Solar (PV)		*Solar (CSP)*		*Wind (onshore)*	
	Status	Priority	Status	Priority	Status	Priority
Support research and development		High		High		High
Educate and train high-skilled workforce		-		High		High
Implement upgrading programs targeting specific industrial players		Low		Low		Low
Identify niche technologies and set-up national centres of excellence		Medium		Medium		Medium

Source: Data compiled by LCEC

are continuously being advanced. Finding efficient and cost-effective strategies for manufacturing, assembling or the installation of systems would be reflected in the cost of technologies and eventually renewable energy development and expansion. Research into PV, CSP and wind power systems is being conducted through numerous university projects and renewable energy programmes. Despite efforts in this area, additional research is needed in order to prepare the basis for greater manufacturing capacity.

Recommendation

The set of PV conformity marking standards that have been voluntarily issued by the Lebanese Standards Institution (LIBNOR) in order to ensure the quality of Lebanese-made products should be extended to cover component manufacturing. Moreover, the Industrial Research Institute (IRI) is tasked with testing imported renewables-related products. However, upgrades in the testing facility would allow the IRI to inspect and perform tests for locally manufactured products. In addition, LIBNOR also offers product testing to manufacturers through IRI to check for compliance with international standards. In order to continuously advance, the renewable energy sector depends on research and development. Therefore, collaboration with international agencies, organisations and industrial centres would offer the necessary assistance in developing and maintaining the renewable energy manufacturing industry.

Lebanon - Success factor D: Investment capacity and strong financing infrastructures

Focus on high priorities

A. Implement price, tax and other incentives

Market barrier

The investment cost for different renewable energy systems depends on the system type. For example, the cost to invest in a battery solar PV system might reach threefold that of one connected to the grid. However, investment costs for renewable energy systems are still considered high despite a

Table 30. Identified gaps and recommendations - Lebanon - Success factor D

Key measures	Status assessment / Priority level					
	Solar (PV)		*Solar (CSP)*		*Wind (onshore)*	
	Status	Priority	Status	Priority	Status	Priority
Encourage local banks to offer low-interest loans and grants		-		-		-
Implement investment support mechanisms for the adaptation or creation of production lines		Low		Low		Low
Implement price, tax and other incentives		High		High		High

Source: Data compiled by LCEC

decrease in recent years. Moreover, the profit margins of suppliers have also decreased due to the increase in the number of local players. Although manufacturing potential is correlated with market growth, a reduction in taxes and custom duties on imported renewable energy components would favour the adoption of renewables. However, this would negatively affect the local manufacturing and assembly of components.

Recommendation

Taxes on complete finalised components such as PV modules, inverters, and reflectors, should not be reduced in order to avoid eliminating local manufacturing. However, taxes and custom duties on raw material, semi-final products and required tools in the renewables-related manufacturing must be reconsidered in order to promote local manufacturing.

In summary – key actions

Based on the detailed recommendations presented in this section:

- Define a national plan for renewable energy equipment manufacturing
- Profit from existing industries to create local renewables-related components manufacturing
- Reconsider the electricity tariff structure in order to favour the industrial sector
- Conduct awareness-raising activities on component manufacturing and value chains, and on the benefits of implementing renewable energy technologies
- Involve national centres in the practice of inspecting and testing locally manufactured components based on international standards
- Establish partnerships and collaborate with international agencies and industrial companies for R&D, training and capacity building programmes

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UAE: Identified gaps and recommendations

This chart summarises both the current status and the priority level for each renewable power source, with key measures recommended on the basis of four broad success factors. Moreover, a focus on high priorities, with further explanations and details to provide options about how these recommendations can be translated into action.

UAE - Success factor A: Substantial political support aims to create a sustainable market

Focus on high priorities

A. Develop a long-term renewable energy strategy with national targets

Market barrier

The renewable energy targets in Dubai and Abu Dhabi are not supported by effective implementation strategies. Moreover, the targets are not technology focused.

Recommendation: develop an extensive strategy and regulatory framework for the implementation of renewable energy targets

Establishing well-defined renewable energy targets with a technology focus and developing

a regulatory framework, such as a National Renewable Energy Action Plan or a renewable energy law, would create momentum in the local market and increase the installation of renewable energy projects.

B. Define a national plan for renewable energy equipment manufacturing

Market barrier

Existing and ongoing renewable energy projects mostly rely on imported components. However, local manufacturing potential has been identified in many sectors such as the steel industry. Electric components and composite materials seem to be proven industries in the UAE.

Recommendation: develop an overall master plan to support renewable energy component manufacturing

The ambitious renewable energy target of the UAE could constitute the main driver for developing local renewables-related manufacturing. Nevertheless, a public support scheme is needed and an overall master plan for the manufacturing of RET components needs to be developed. Co-operation between ministries, specifically industry and energy, is essential in order to evaluate renewable energy market potential and act accordingly.

C. Reform fossil-fuel subsidies

Market Barrier

In 2008, Dubai implemented electricity and water reforms, subsequent pricing reforms followed in 2011. After years of internal debate, Abu Dhabi followed suit in January 2015. However, low overall electricity prices reduce the cost of production. All of these

Table 31. Identified gaps and recommendations - UAE - Success factor A

Key measures	Status assessment / Priority level					
	Solar (PV)		*Solar (CSP)*		*Wind (onshore)*	
	Status	Priority	Status	Priority	Status	Priority
Formulate a long-term renewable energy strategy with national targets		High		High		High
Define an extensive renewable energy regulatory framework		High		High		High
Define a national plan for renewable energy equipment manufacturing		High		High		High
Reform fossil-fuel subsidies		High		High		High

Source: Data compiled by LCEC

factors have encouraged local solar PV manufacturing across small and medium enterprises domestically or through joint ventures with international companies and manufacturers. Within this regard, Microsol, a company based in Fujairah, UAE, and Solon, a German company, are strengthening its outreach to the markets in the EU, US, Africa, Middle East and India (IRENA, 2016).

Recommendation

Reforming fossil-fuel subsidies would enhance the use and implementation of renewable energy projects, creating momentum in the local market and promoting local manufacturing. However, the subsidies should be well structured in order to favour the industrial sector since high energy tariffs would prevent industries from establishing factories in the UAE.

UAE - Success factor B: Competitive local players in the global market

Focus on high priorities

Assess the feasibility of upgrading production lines.

Market barrier

The ambitious renewable energy targets set by the UAE, and existing and ongoing renewable energy projects, might create local manufacturing momentum. Moreover,

Table 32. Identified gaps and recommendations - UAE - Success factor B

Key measures	Status assessment / Priority level					
	Solar (PV)		*Solar (CSP)*		*Wind (onshore)*	
	Status	Priority	Status	Priority	Status	Priority
Provide information on market size and opportunities of production adjustments		-		-		-
Assess the feasibility of upgrading production lines		High		High		High
Foster business linkages, particularly international joint ventures		-		-		Medium
Support awareness-raising initiatives		Medium		Medium		Medium
Support the structuring of the sector		Medium		Medium		Medium

Source: Data compiled by LCEC

the UAE free zone and its presence in the GCC would be appealing for national and international investors.

Recommendation: Conduct assessments to identify potential of subsectors

International investors are well established in different types of projects in the UAE. Therefore, an assessment is recommended for the industrial sector to identify, in detail, the potential of each industrial subsector's contribution to renewable energy component manufacturing. The assessment should include the cost of investment and the needed workforce and skills. In addition to a public support scheme, the results from the assessment and the overall master plan would be used to initiate a local renewable energy component manufacturing subsector.

UAE - Success factor C: Strong industry innovation potential and skilled workforce

Focus on high priorities

A. Educate and train a highly skilled workforce

Market barrier

Solar PV and CSP projects have helped the local workforce integrate into the renewable energy market. In view of the limited projects that have been implemented, training and capacity building are needed to increase the deployment of wind projects. In addition, several existing local industries, including glass and steel, can be integrated into the renewable energy manufacturing sector if the required skills are available. Therefore, the main barrier would be the unsustainability of its workforce.

Recommendation: regular national and regional training programmes

Training the workforce in the industrial sector would drive local renewables-related

Table 33. Identified gaps and recommendations - UAE - Success factor C

Key measures	Status assessment / Priority level					
	Solar (PV)		*Solar (CSP)*		*Wind (onshore)*	
	Status	Priority	Status	Priority	Status	Priority
Support research and development		-		-		Medium
Educate and train high-skilled workforce		High		High		High
Implement upgrading programs targeting specific industrial players		High		Medium		Medium
Identify niche technologies and set-up national centres of excellence		High		High		High

Source: Data compiled by LCEC

manufacturing. Establishing national training programmes for the manufacturing of specific technologies would create the necessary skills and encourage investors or existing industries to integrate renewable energy components.

At the educational level, master programmes and detailed technician programmes would help boost manufacturing, assembling, and implementing renewable energy components. Regional training could also promote interregional expertise exchange. RCREEE has organised several training sessions, for example on grid-connected renewable systems and the installation of PV systems. However, training in manufacturing renewable energy components should be considered.

B. Implement upgrading programs, targeting specific industrial players

Market barrier

Solar PV, particularly on the small scale, presents an opportunity for renewable energy market development. However, PV manufacturing is still limited in the UAE. Such basic components as cables and steel structures are widely available but would need a boost for adaptation to PV systems.

Recommendation

Establishing a strategy targeting the industries that could be upgraded, especially small-scale PV systems, that offer high market potential in the UAE and the region.

UAE - Success factor D: Investment capacity and strong financing infrastructures

Focus on high prioritiess

A. Implement investment support mechanisms for adaptation or creation of production lines

Table 34. Identified gaps and recommendations - UAE - Success factor D

Key measures	Status assessment / Priority level					
	Solar (PV)		*Solar (CSP)*		*Wind (onshore)*	
	Status	Priority	Status	Priority	Status	Priority
Encourage local banks to implement low-interest loans and grants		Medium		Medium		Medium
Implement investment support mechanisms for the adaptation or creation of production lines		High		High		High
Implement price, tax and other incentives		Medium		Medium		Medium

Source: Data compiled by LCEC

Market barrier

The UAE has already established a fund to support the installation of renewable energy systems. However, local manufacturing should act in consideration of the LCOE, especially for large-scale CSP and wind projects. Dubai's fourth phase MBR 700 MW CSP solar park established world- record prices (IRENA, 2016).

Recommendation

Supporting existing industries to create new production lines for CSP and wind component manufacturing where such components impact the LCOE, such as steel towers, tanks, and vessels. A national assessment of the industrial sector would initiate this task with recommendations on the possibilities and the feasibility of new production lines.

The assessment should be accompanied by financial support schemes and joint ventures with international companies and manufacturers.

In summary – key actions

Based on the detailed recommendations presented in this section:

- Develop an extensive strategy and regulatory framework of renewable energy implementation
- Define a national plan for renewable energy equipment manufacturing
- Reconsider the electricity tariff structure to favour the industrial sector
- Prepare a social and economic assessment for upgrading or creating production lines
- Establish a strategy targeting some industries related to small-scale PV systems
- Assess the industrial sector and propose support mechanisms for heavy industries such as steel tower, tanks, and vessels, etc.

4. Achieving Local Manufacturing Potential: Policy Recommendations

This section summarises the main recommended actions that should be taken in the selected countries in order to encourage renewable energy component manufacturing.

A. Substantial political support that aims to create a sustainable market size

(a) Formulate a long-term renewable energy strategy with national targets and a regulatory framework

A clear national renewable energy strategy that is technology-focused would make it easier for foreign and local investments in components related to renewable energy technology. This would help existing industries to adapt to market demand and, depending on market need, upgrade or create production lines.

The regulatory framework should be well developed to attract financiers and project developers. Jordan's regulatory framework, which includes the JREEEF fund for developing renewables-related manufacturing, is a good example of an enabling regulatory framework.

Assessing whether domestic manufacturing creates more value for the renewable energy sector should be followed by supportive measures. However, providing financial support to manufacturing can fail due to the trade-off between local content potential and mobilising funds for project development.

(b) Define a national plan for renewable energy equipment manufacturing

A national strategy for renewable energy component manufacturing in the short, mid and long-term is key if each of the countries is to achieve its targets. In the short term, governments could support existing industries to upgrade production lines for existing components such as cables. In the mid-term, complex components such as inverters, CSP pressurised systems, and wind towers could be targeted. In the long-term, components such as rotor blades and steam turbines could be tackled.

(c) Implement support mechanism for renewable energy industry actors

Jordan and the UAE have started to reduce fossil-fuel subsidies. However, since the industrial sector is a major energy consumer, it should be assigned a special tariff in order to create momentum in the local renewable energy market.

B. Competitive local players in the global market

(a) Conduct awareness-raising initiatives

Awareness-raising campaigns have a significant impact on the end-user, and therefore could help increase the local renewable energy market. This strategy has been successful in Lebanon where there has been an annual increase in renewable energy projects, especially for decentralised PV. However, such campaigns

must target project developers to enhance the local manufacturing segments. National and regional market potential should form part of the campaigns to demonstrate the positive economic impacts of manufacturing of renewable energy components to investors. Meanwhile, insinuating collaboration between national agencies and related ministries can result in an even higher impact.

(b) Assess the feasibility of production line upgrades

Assessing the feasibility of upgrading production lines should be undertaken in partnership between the public and the private sectors, while targeting existing industries such as electric, steel and glass. The assessment, including payback periods and low-investment costs, would encourage the industries to invest in renewable energy component manufacturing.

(c) Foster business links through international joint ventures

The three countries studied in this report are of interest to international joint ventures. However, governmental support of the renewable energy sector, in terms of setting up relevant policies and regulations, would provide confidence to international companies, especially since renewable energy is an emerging sector in the Arab region.

Business fairs, exhibitions and online platforms could be key to creating contacts with international manufacturers. The International Beirut Energy Forum, the Arab Forum for Renewable Energy and Energy Efficiency and the World Future Energy Summits (WFES) are examples of yearly fairs that attract regional and global renewable energy stakeholders.

(d) Support the structuring of the sector

The renewable energy sector, including the national strategy and the RET component manufacturing master plan, should be organised and specific agencies should be created in each country. The UAE has started to change the structure of its energy sector by diversifying its national energy mix through adoption of alternative energy sources for electricity production. Stakeholder roles in the renewable energy sector should be defined in order to guarantee optimum organisation and operation. The structure should include all types of institutions, including public, laboratories, standardisation entities, educational institutions, and training centres, such that it can unfold in the following manner:

- Good governance and the regulatory environment: establishing standards, targets, taxes, subsidies, and eco-labeling.
- Organising public-private partnerships, encouraging private and public development, investment in public infrastructure.
- Finance loan guarantees: green banks and public ventures.
- Constructing markets: feed-in tariffs, standards, public procurement, awareness campaigns.

C. Strong industry innovation potential and skilled workforce

(a) Support research and development

The renewable energy sector is dominated by relatively few international entities, especially for PV panels, rotor blades, and solar concentrator manufacturing. Research and development is essential if the local renewable energy sector is to compete successfully with international players. Therefore, the implementation of R&D programmes should be mandatory in the Arab region. Moreover, the extreme climate conditions in the Gulf region would require further research in order to adapt existing renewable energy technologies.

Funds should target both R&D and capacity building. The funds could be used to develop

R&D centres as well as setting up tailored training programs for O&M technicians and could involve universities. Collaboration with international players, including universities and developers, could stimulate R&D.

(b) Educate and train a highly skilled workforce

Training and capacity building programmes are needed on all levels of the value chain. University programmes, regular training and workshops should be organised under the umbrella of a public entity, requiring co-operation at the governmental level between the different ministries. Special funds and programmes could be created in order to enhance the knowledge of engineers, technicians, and installers on renewable energy components.

(c) Implementation of upgrading programmes targeting specific industrial players

The programmes should include upgrading the innovative capacity of small and medium enterprises (SMEs) by empowering them to obtain approval for renewables-related proposals and encourage closer links with business partners. Similarly, such projects encourage business connections between SMEs and suppliers, which is vital to encourage and the sourcing of segments and components locally.

(d) Identify niche opportunities and establish national centres of excellence

Several local opportunities exist that are specific to each pilot country. However, the opportunities may depend on existing industries, such as electric and mechanical, to create a broad range of abilities in assembling the different parts of the quality chains. Developing flagship products based on R&D, specific standards and certification could have an impact on the local, regional and international levels.

D. Investment capacity and strong financing tools

(a) Encourage financial institutions to implement low-interest loans and grants and implement investment support mechanisms

The NEEREA financing mechanism in Lebanon could be replicated in the UAE and Jordan. The system of low-interest loans is successful and has boosted the Lebanese PV market. The Central Bank of Lebanon also grants low-interest loans for specific industrial sectors, as in the case of IT development. However, this could be extended to renewable energy component manufacturing. Furthermore, the Central Bank with the assistance of the Ministry of Finance could create a new credit line targeting the renewable energy component industries.

(b) Implement price, tax and other incentives

Financial motivators focused on speculators and potential local producers can form different structures incorporating feed-in-tariffs, net-metering, tax reduction, sponsorships, credit warrants, and duty exemptions. Free commerce zones, as found in the UAE's Jebal Ali Free Zone, would provide an alternative in easing the weight of taxes on the industrial sector. This should help to attract local and international investors to engage in the renewable energy market, noting that the vast resources and geographical locations of the pilot countries should favour product exports to the regional market.

5. Enhancing Regional Collaboration for Industrial Development

The ambitious targets set in each country can create momentum in renewable energy component manufacturing. However, such components would require significant capital investment and a specialised workforce. Therefore, the regional market should be considered in order to justify such investments.

The several parameters presented below could enhance region-wide Arab co-operation:

(a) Mutually shared R&D centre for countries manufacturing the same component:

Since R&D is essential for the development of the renewable energy sector, shared R&D activities would allow for regional co-operation on specific components and would ensure the exchange of skills and expertise.

(b) Unified Arab standards and an accredited testing facility in at least one of the Arab countries:

Shared product standards between the Arab countries would enhance interregional trade and would increase consumer confidence. However, this should be accompanied by certified testing facilities. Co-operation is needed between entities in each country. For example, Lebanon has already developed a testing facility for solar water heaters, which is now available for use by Arab manufacturers willing to certify their products.

(c) Free trade zones for RET across the Arab region and anti-dumping duties for products outside trade agreement:

Free trade zones could offer great potential for trading locally manufactured renewable energy components between Arab countries, thus enhancing the regional renewable energy market. This should make investors more willing to take on renewable-energy related manufacturing.

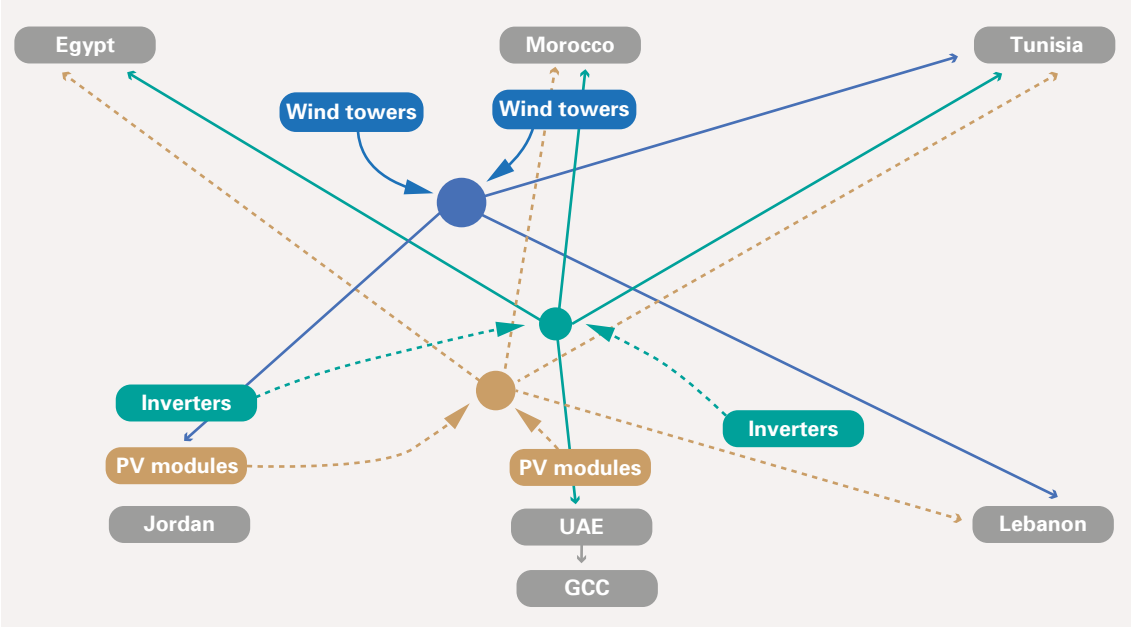
(d) Shared zones for products in common:

Figure 43 shows a possible example of broad regional trade, taking into consideration Egypt, Morocco and Tunisia that were analysed in the first study of this report entitled "Evaluating Renewable Energy Manufacturing Potential in the Mediterranean Partner Countries". Since each country, including Jordan, Lebanon and the UAE, has a well-established manufacturing industry along component manufacturing, co-operation between the six countries could build on the momentum in the project realisation phase. For example, the previous report identified significant potential for wind tower manufacturing in Egypt and Morocco. Therefore, a common zone for manufacturing could be created between these two countries to encourage wind tower manufacturing. Moreover, both countries could create complementary industries for this component. This would position them as wind tower manufacturers in the region.

The same reasoning is applicable for the PV modules assembled in Jordan and the UAE, and inverter manufacturing in Jordan and Lebanon.

Agreements on regional trade could be expanded to include different countries in the region, including countries manufacturing the same product or along different areas in the project life-cycle. In turn, this would lead to reinforcing its production without any competition that might lead to a decrease in the price of the product. In an effort to form complementary value chains in the region, the agreements would also reinforce the co-operation between these countries at the capacity building and market regulation level.

Figure 11. Possible regional trade patterns



Source: Data compiled by LCEC

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