Regional Initiative to Promote Small-Scale Renewable Energy Technologies and Applications in Rural Areas of the Arab Region REGEND

Social, Economic, and Environmental Impact Assessment Report

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Economic and Social Commission for Western Asia

Regional Initiative to Promote Small-Scale Renewable Energy Technologies and Applications in Rural Areas of the Arab Region
REGEND

Social, Economic, and Environmental Impact Assessment Report

United Nations
Beirut

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Key messages

A total of **31 small-scale renewable energy field projects** and **26 capacity building workshops** were conducted in rural communities in Jordan, Lebanon, and Tunisia.

A total of **216 kilowatt-peak** of installed **solar energy capacity** will help eliminate the emission of **3,376 tones of CO_2** over the **25-year** lifetime of the systems.

REGEND helped rural women entrepreneurs and farmers overcome high electricity bills, water scarcity, and poverty by diminishing reliance on state electricity grids, providing efficient irrigation systems, and powering income-generating activities.

REGEND reduced the impact of Lebanon's financial crisis on rural communities by ensuring continuous electricity supply and transferring valuable knowledge.

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Abbreviations

ANME	Agence Nationale pour la Maîtrise de l'Energie
AOAD	Arab Organisation for Agricultural Development
APIA	Agence de Promotion des Investissements Agricoles
ARABFFI	Arab Federation for Food Industries
CBO	Community-Based Organisation
CGDR	Commissariat Général au Développement Régional
CO_2	Carbon dioxide
CRDA	Commissariat Régional de Développement Agricole
CTVA	Cellule Territoriale de Vulgarisation Agricole
EDL	Electricité du Liban
EE	energy efficiency
GDA	Groupement de Développement Agricole
ILO	International Labour Office
Kg	kilogram
kWp	kilowatt-peak
kWh	kilowatt-hour
MWh	megawatt-hour
LARI	Lebanese Agriculture Research Institute
LFT	Local facilitating team
MEMR	Ministry of Energy and Mineral Resources
MOA	Ministry of Agriculture
NGO	Non-governmental organisation
RE	renewable energy
SMSA	Mutual Agricultural Services Company
STEG	Tunisian Company of Electricity and Gas
SWH	solar water heating

01.

REGEND overview

01.
REGEND overview

The United Nations Economic and Social Commission for Western Asia (UNESCWA) is working on the Regional Initiative to Promote Small-Scale Renewable Energy Applications in Rural Areas of the Arab region (REGEND), which is funded by the Swedish International Development Cooperation Agency (Sida). By addressing energy poverty, water scarcity and vulnerability to climate change, as well as other natural-resource challenges, the initiative aims to improve livelihoods, economic benefits, social inclusion and gender equality, particularly for the marginalised groups in the rural communities in three countries; namely, Jordan, Lebanon, and Tunisia.

Within the framework of the initiative, solar-energy field projects and capacity building programmes have been implemented. In addition, production equipment was procured and provided to beneficiaries to facilitate production activities, reduce production time, and/or develop new production lines. The selected beneficiary communities are Al-Achaari in the Maan governorate and Batir in the Al-Karak governorate in Jordan; Akkar Al-Atika and Chaqdouf in the Akkar governorate in Lebanon; and Chorbane in the Mahdia governorate in Tunisia.

Selection of the communities and beneficiaries was based on clearly defined criteria and was carried out in close coordination and consultation with the respective national partner in each country, as well as with the respective Local Facilitating Team (LFT) established for the purposes of the initiative.

National partners in Jordan are the Ministry of Energy and Mineral Resources (MEMR) and the Ministry of Agriculture (MOA), while the LFT comprises, in addition, the municipalities of Al-Achaari and Al-Karak, the Arab Organisation for Agricultural Development (AOAD), Al-Jawhara Community-Based Organisation (CBO), and Shabbat Batir Al-Khayriya CBO.

In Lebanon, national partners are the municipalities of Akkar Al-Atika and Chaqdouf and the Lebanese Agriculture Research Institute (LARI), while the LFT comprises, in addition, the Agri-food Women Cooperative, the Union of Beekeepers Cooperative and the Agriculture Cooperative, all in Akkar Al-Atika, and the Live Akkar NGO in Chaqdouf[1].

In Tunisia, national partners are Agence Nationale pour la Maîtrise de l'Energie (ANME), Commissariat Général au Développement Régional (CGDR), and Agence de Promotion des Investissements Agricoles (APIA), while the LFT comprises, in addition, the municipality of Chorbane, Commisariat Régional de Développement Agricole (CRDA), Cellule Territoriale de Vulgarisation Agricole (CTVA), Mutual Agricultural Services Company (SMSA - El Faouz), and Groupement de Développement Agricole (GDA) pour l'Eau Potable (El Intilaka).

02.

Projects beneficiaries

02.
Projects beneficiaries

A baseline study comprising an Assessment Report on Prevailing Situations in Rural Areas was conducted in each of the three countries (**Jordan, Lebanon and Tunisia**) to select beneficiaries in accordance with a set of criteria detailed in the study. The following are the selected beneficiaries:

Jordan

Al-Achaari:

1. Al-Jawhara CBO.
2. Farm of Saleh Afash.
3. Household of Shayesh Saleh Afash Al-Jazi.
4. Household of Abed Al-Aziz Fayed Khalaf Al-Jazi.
5. Household of Falah Kasi Suleiman Al-Jazi.
6. Household of Aouda Anad Al-Jazi.
7. Household of Ali Maleeh Sfouk Al-Jazi.

Batir:

1. Shabbat Batir Al Khayriya CBO.
2. Farm of Rida Salah.
3. Household of Salem Abed Rahim Al-Shurafa.
4. Household of Mohammad Abed Karim Al-Hindawi.

Lebanon

Akkar Al-Atika:

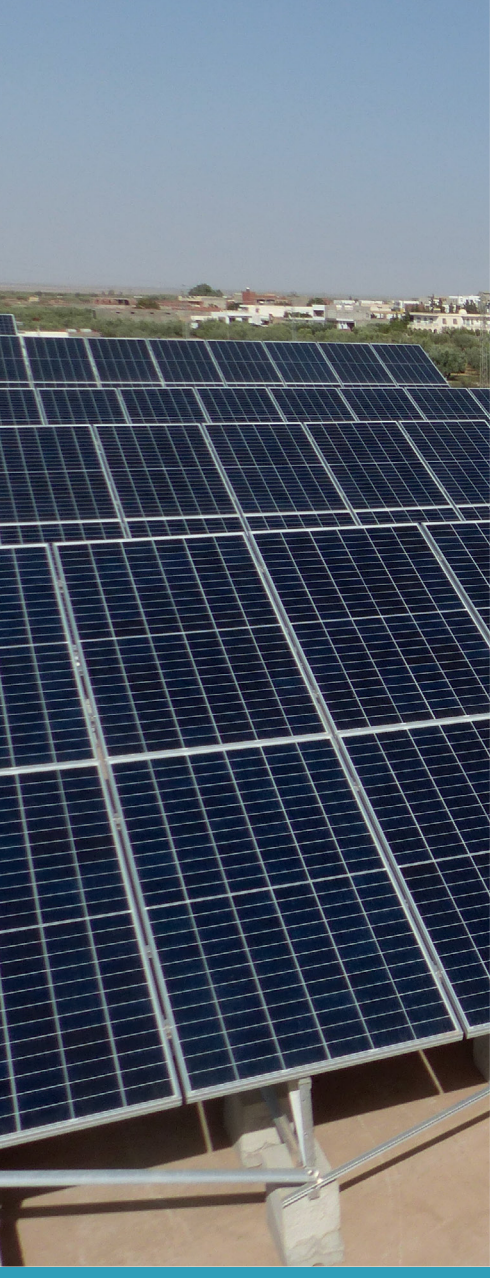
1. Women Agri-Food Cooperative.
2. Union of Beekeepers Cooperative.
3. The Agriculture Cooperative.
4. The municipality.
5. The local health clinic.

Chaqdouf:

1. Live Akkar NGO and its Sewing and Embroidery Workshop.
2. The municipality.

Tunisia

1. SMSA (El Faouz).
2. GDA pour l'Eau Potable (El Intilaka).
3. Farm of Ms. Fethia Bougtif.
4. Farm of Abdallah Mansour.
5. Farm of Ali Baccouche.
6. Farm of Houssine Ltaief.
7. Farm of Salah Belmabrouk Amor.



03.

Implemented projects and activities

03.
Implemented projects and activities

In the following, REGEND implemented field projects, as well as other forms of assistance and support, in each of the three countries are listed.

Jordan

- **Project #1:** A 22-kWp solar PV on-grid ground-mounted system for the farm of Saleh Afash in Al-Achaari (figure 1).
- **Project #2:** A 12-kWp solar PV on-grid rooftop system for the Al-Jawhara CBO in Al-Achaari.
- **Project #3:** A 10-kWp solar PV on-grid rooftop system for the farm of Rida Salah in Batir.
- **Project #4:** A 4-kWp solar PV on-grid system mounted on an elevated structure for Shabbat Batir Al- Khayriya CBO in Batir.
- **Project #5:** Three 4-kWp solar PV on-grid rooftop systems; the first two in Batir, Al-Karak, the third in Al-Achaari, Maan, in the homes of:
  - Salem Abed Rahim Al-Shurafa.
  - Mohammad Abed Karim Al-Hindawi.
  - Shayesh Saleh Afash Al-Jazi.
- **Project #6:** Four 3-kWp solar PV on-grid rooftop systems in Al-Achaari, Maan, in the homes of:
  - Abed Al-Aziz Fayed Khalaf Al-Jazi.
  - Falah Kasi Suleiman Al-Jazi.
  - Aouda Anad Al-Jazi.
  - Ali Maleeh Sfouk Al-Jazi.
- **Project #7:** A 500-litre SWH system for Al-Jawhara CBO.
- **Project #8:** A 200-litre SWH system for Shabbat Batir Al-Khayriya CBO.
- **Project #9:** A Water drip irrigation system connected to the 22-kWp system of Project #1.
- **Project #10:** A Water drip irrigation system connected to the 10-kWp system of Project #3.
- **Project #11:** Renovation of electrical works (wiring and panels), replacing lighting units with LED units, and rehabilitation of building envelope insulation for Al-Jawhara CBO.
- **Project #12:** Renovation of electrical works (wiring and panels), replacing lighting units with LED units, and addition/repair of building envelope insulation for Shabbat Batir Al-Khayriya CBO.

Figure 1. 22-kWp solar PV on-grid ground-mounted system for farm of Saleh Afash in Al-Achaari.

Table 1. Production equipment provided in Jordan

Beneficiary	Equipment
Al-Jawhara CBO	A freezer
	Two dough kneaders
	Two milk shakers
	A packaging machine and supplies
	IT equipment
	Four air conditioning units
Shabbat Batir Al-Khayriya CBO	A freezer
	Two dough kneaders
	Two milk shakers
	A packaging machine and supplies
	An industrial cooking stove
	A washing machine
	IT equipment
	Two caravans, 3.6 x 6 m each
	Two air conditioning units

In addition, in line with its integrated approach, REGEND provided a variety of production items and equipment, as shown in table 1.

Further, REGEND implemented for the beneficiaries, in both Al-Achaari and Batir, a joint 6-workshop capacity building programme covering the following topics:

- Good agricultural practices for enhanced energy sustainability.
- Good food manufacturing and hygiene practices and hygiene requirements for food storage.
- Good food packaging, labelling, and marketing practices.

Lebanon

- **Project #1**: A 25-kWp solar PV hybrid on-grid rooftop system, with a 90 kWh battery capacity in Akkar Al-Atika, serving the Union of Beekeepers Cooperative building, the municipality building, and the clinic (figure 2).
- **Project #2:** A 10-kWp solar PV hybrid on-grid rooftop system, with a 17.7 kWh battery capacity, for the Live Akkar Sewing and Embroidery Workshop in Chaqdouf.
- **Project #3:** A 200-litre SWH system for the Union of Beekeepers Cooperative building in Akkar Al-Atika.
- **Project #4:** A 200-litre SWH system for Live Akkar in Chaqdouf.
- **Project #5:** Supply and installation of LED light bulbs for the Union of Beekeepers Cooperative building and the clinic in Akkar Al-Atika.
- **Project #6:** Supply and installation of LED light bulbs for Live Akkar in Chaqdouf.
- **Project #7:** Supply and installation of 400 solar PV lighting kits with batteries for energy-poor households in Akkar Al-Atika.

Figure 2. 25-kWp solar PV hybrid on-grid rooftop system, with a 90-kWh battery capacity in Akkar Al-Atika serving Union of Beekeepers Cooperative building, municipality building, and clinic

Table 2. Production equipment provided in Lebanon

Beneficiary	Equipment
Municipalities of Chaqdouf and Akkar Al-Atika	Two kishek grinders
	A pomegranate juicer
	Desktop computers
	Office chairs and tables
	A projector and a screen
	A food mixer
Municipality of Akkar Al-Atika	A pomegranate peeler
Municipality of Chaqdouf	A kishek dryer
	A freezer and fridge
	A cooking stove
	A fan
Women Agri-food Cooperative in Akkar Al-Atika	A commercial cooking stove
	Two portable/floor commercial cooking stoves
	A commercial fridge
	Two fans
	A dual-mode space heater
Union of Beekeepers Cooperative in Akkar Al-Atika	A sugar grinder
	A sugar kneader
	Three syrup barrels
Live Akkar Sewing and Embroidery Workshop in Chaqdouf	A sewing machine (electronic embroidery)
	A sewing machine (automatic buttonholer)

In addition, REGEND provided a variety of production items and equipment, as shown in table 2.

Further, REGEND implemented for the beneficiaries in Akkar Al-Atika and Chaqdouf a joint 12-workshop capacity building programme covering the following topics:

- Renewable energy and energy efficiency technologies and applications for rural development in Lebanon.
- Food manufacturing, safety and best methods of food packaging and preservation.
- Financial management, accounting, and economic benefits of access to sustainable and secure energy.
- Project design, drafting proposals, feasibility studies, and managing projects in the water-energy-food nexus.
- Marketing through social media, and promoting production activities using renewable energy.
- Sustainable and effective methods in embroidery and weaving.
- Training on operation and maintenance of solar systems.

Tunisia

- **Project #1:** A 65.5-kWp medium-voltage on-grid solar PV system for the SMSA (El-Faouz) in Mahdia.
- **Project #2:** A 16.6-kWp medium-voltage on-grid solar PV system for GDA pour l'Eau Potable (El Intilaka) in Chorbane.
- **Project #3:** A 4.8-kWp solar PV water pumping system for the farm of Ms. Bougtif in Chorbane.
- **Project #4:** A 10.4-kWp solar PV water pumping system for the farm of Mr. Ben Mansour in Chorbane (figure 3).
- **Project #5:** A 7.04-kWp solar PV water pumping system for the farm of Mr. Baccouche in Chorbane.
- **Project #6:** A 7.04-kWp solar PV water pumping system for the farm of Mr Ltaief in Chorbane.
- **Project #7:** A 7.04-kWp solar PV water pumping system for the farm of Mr. Amor in Chorbane.

Figure 3. 10.4-kWp solar PV water pumping system for farm of Abdallah Ben Mansour in Chorbane

Table 3. Production equipment provided in Tunisia

Beneficiary	Equipment
Municipality of Chorbane	IT equipment
Cellule de Vulgarisation Agricole	IT equipment
Agricultural Development Complex for Rural Women	Six egg incubators
	Two aromatic plant distillers
Mutual Agricultural Services Company (El-Faouz)	Six milk cooling tanks

In addition, REGEND provided a variety of production items and equipment, as shown in table 3.

Further, REGEND implemented for the beneficiaries, in Chorbane, a 9-workshop capacity building programme covering the following topics:

- Use of small-scale renewable energy and energy efficiency for rural development.
- Good agricultural practices.
- Distillation of medicinal and aromatic plants.
- Good practices for packaging, labelling, and marketing.
- Municipal planning, management, and finance.
- Women entrepreneurship in the agriculture sector.
- Cattle breeding.

04.

System monitoring

04.
System monitoring

To ensure optimised system performance, REGEND included remote monitoring as part of the solar PV systems, along with internet access for 2 years provided by the contractor, as per the scope of work and signed contract. Data are recorded by a logger and remotely monitored using an internet connection through the portal of the data manager of each system. Thus, remote access is assured using an internet-connected computer or smartphone from anywhere around the world. Moreover, the monitoring system is configured to raise an alert when a system error occurs to enable speedy diagnostics and resolution.

The systems were completed only recently, having undergone software updates, configuration tweaking, and fine tuning. Hence, data are currently available for a limited period only.

The following graphs depict the electricity generation data collected, stored, and relayed by the monitoring systems, attesting to their efficacy.

Jordan

The following 4 figures below present the data collected for the four systems that were equipped with remote data monitoring capabilities.

Figure 4. Electrical energy (kWh) generated daily by Shabbat Batir Al-Khayriya system —January 2022; total for month = 405 kWh.

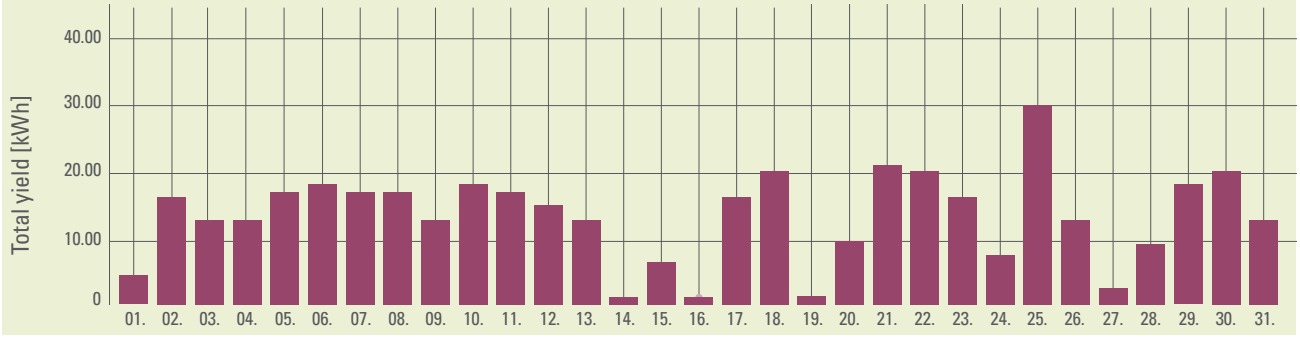


Figure 5. Electrical energy (kWh) generated daily by farm of Rida Salah (Batir) system —January 2022; total for month = 1,153 kWh.

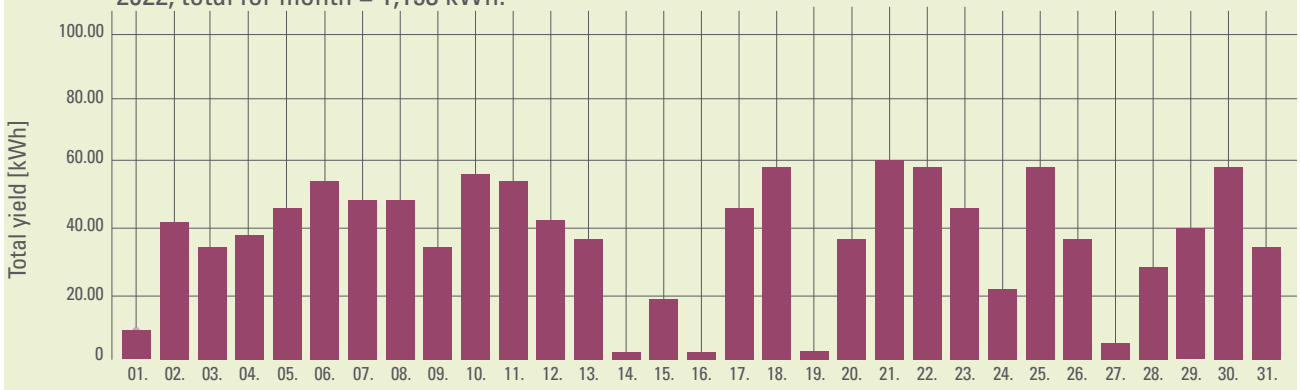


Figure 6. Electrical energy (kWh) generated daily by Al-Jawhara (Al-Achaari) system —January 2022; total for month = 1,823 kWh.

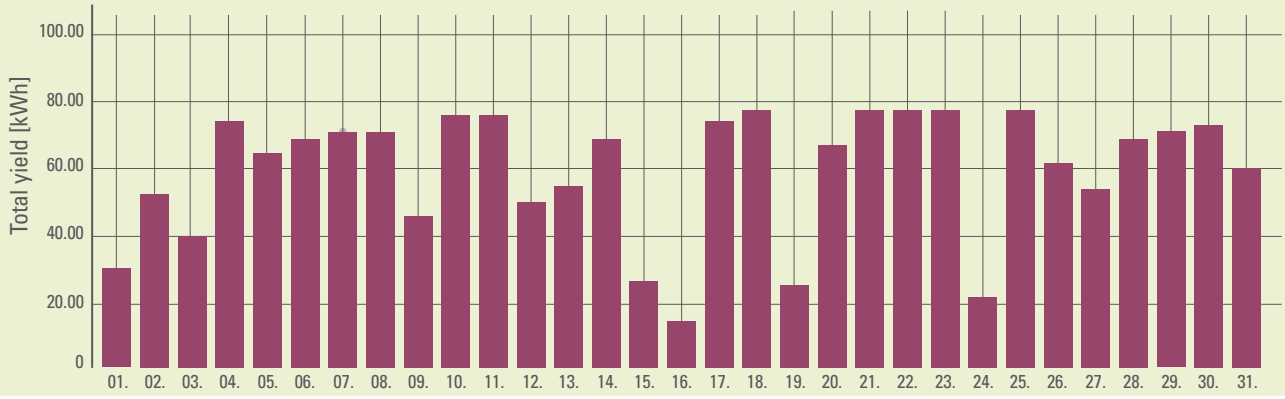
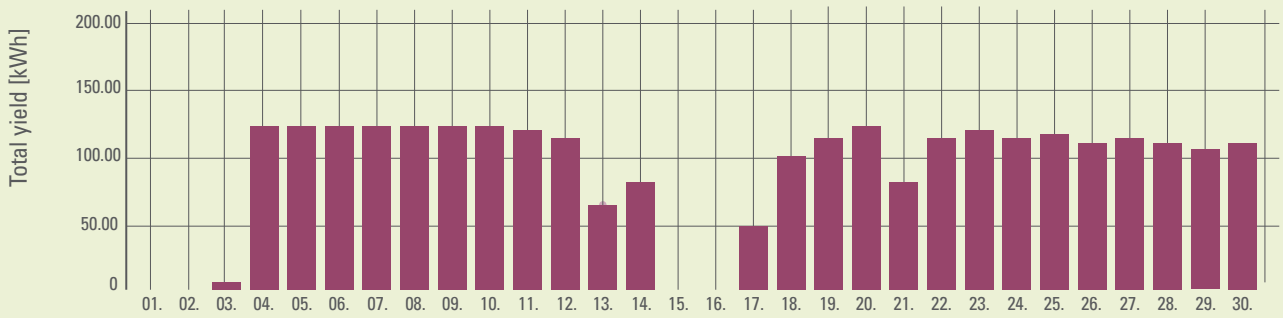


Figure 7. Electrical energy (kWh) generated daily by farm of Saleh Afash (Al-Achaari) system — November 2021; total for month = 1,766 kWh.



Data gaps in the last figure are due to communication (SIM card) problems; the system was generating electricity trouble-free throughout, but data were not captured on the days concerned.

Lebanon

Figures 8 and 9 present the data collected for the two systems that were equipped with remote data monitoring capabilities.

Figure 8. Electrical energy (kWh) generated daily by Akkar Al-Atika system — January 2022; total for month = 864 kWh.

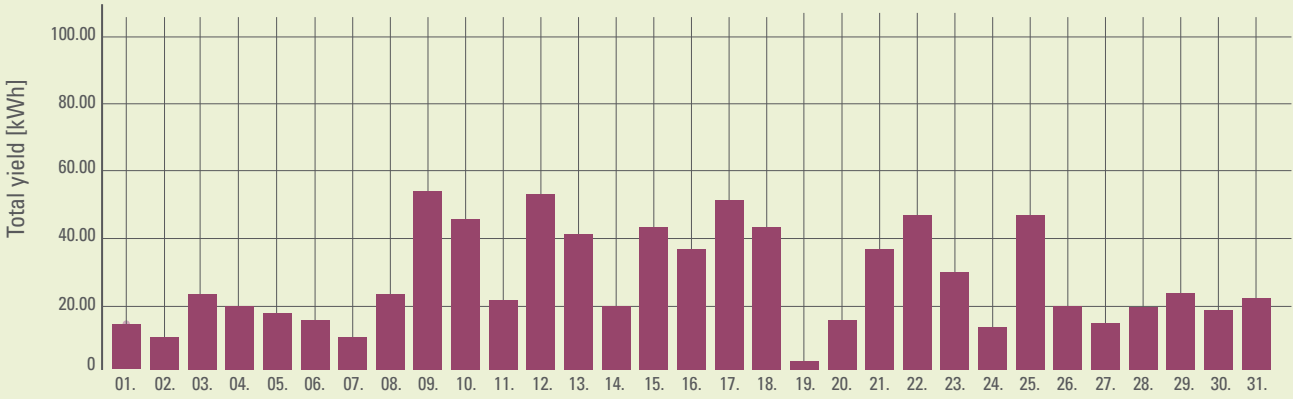
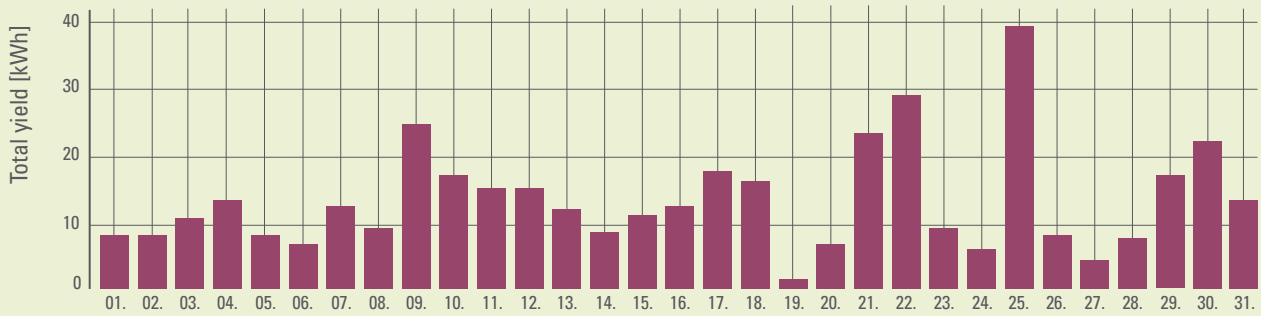


Figure 9. Electrical energy (kWh) generated daily by Chaqdouf system — January 2022; total generation for month = 414 kWh.



By the time of writing, due to delays caused by the supply chain crisis worldwide, the solar PV lighting kits have not been installed. By design, these, due to their basic lighting purpose, are not equipped with a remote monitoring capability; instead, monitoring will be carried out by regular site visits.

Tunisia

The five solar PV pumping systems were equipped with remote data monitoring capabilities. Since these systems operate only on demand, their monitoring capabilities are limited, and the data ranges presented in the figures below are shorter. Still, the graphs attest to the efficacy of the systems.

Figure 10. Electrical Energy (kWh) generated for water pumping at farm of Ms. Bougtif over period from 13 to 14 February 2022; total = 1,494 – 1,490 = 4 kWh.

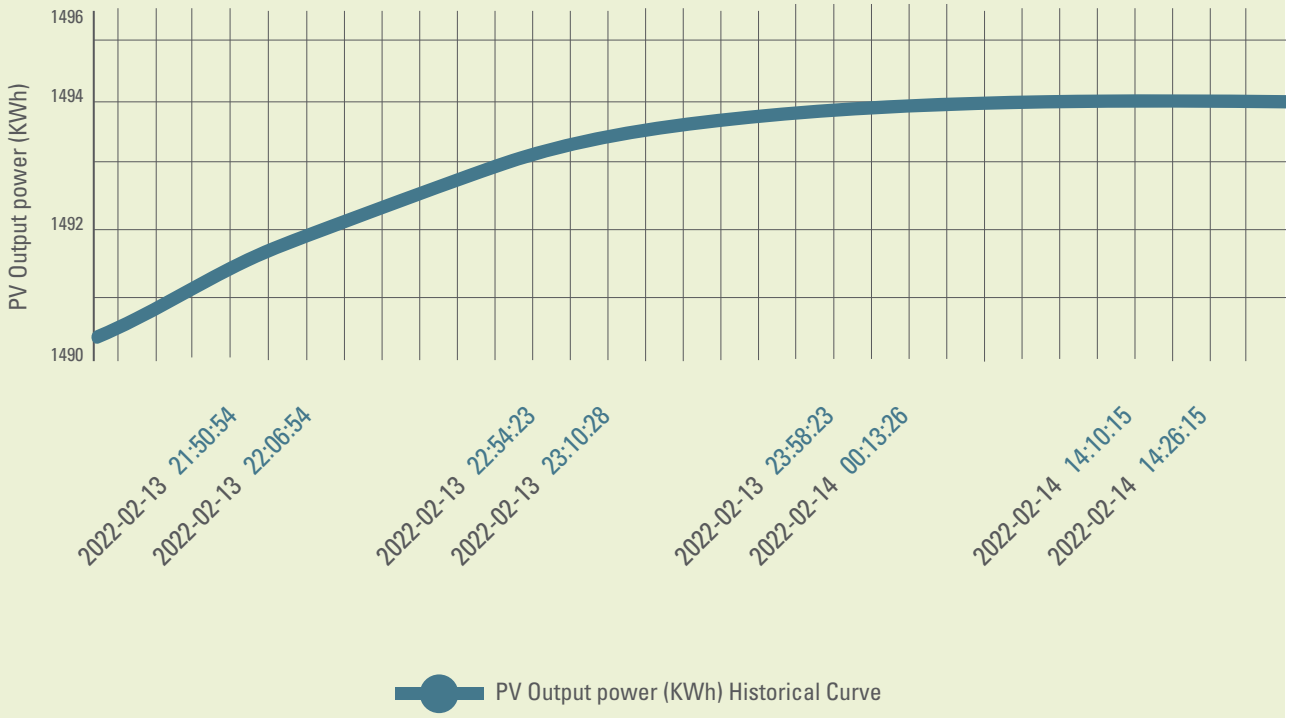


Figure 11. Electrical Energy (kWh) generated for water pumping at farm of Abdallah Mansour over period from 28 to 29 January 2022; total = 2,031– 1,958 = 73 kWh.

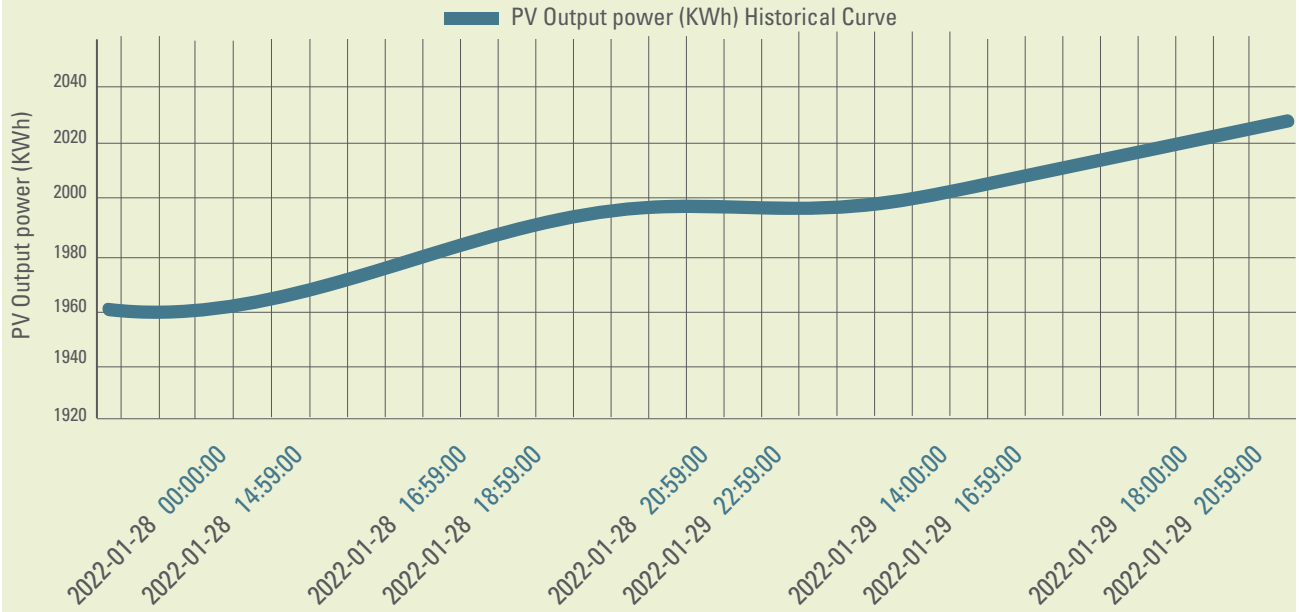


Figure 12. Electrical Energy (kWh) generated for water pumping system at farm of Salah Belmabrouk over period from 14 to 15 February 2022; total = 1,526 – 1,510 = 16 kWh.

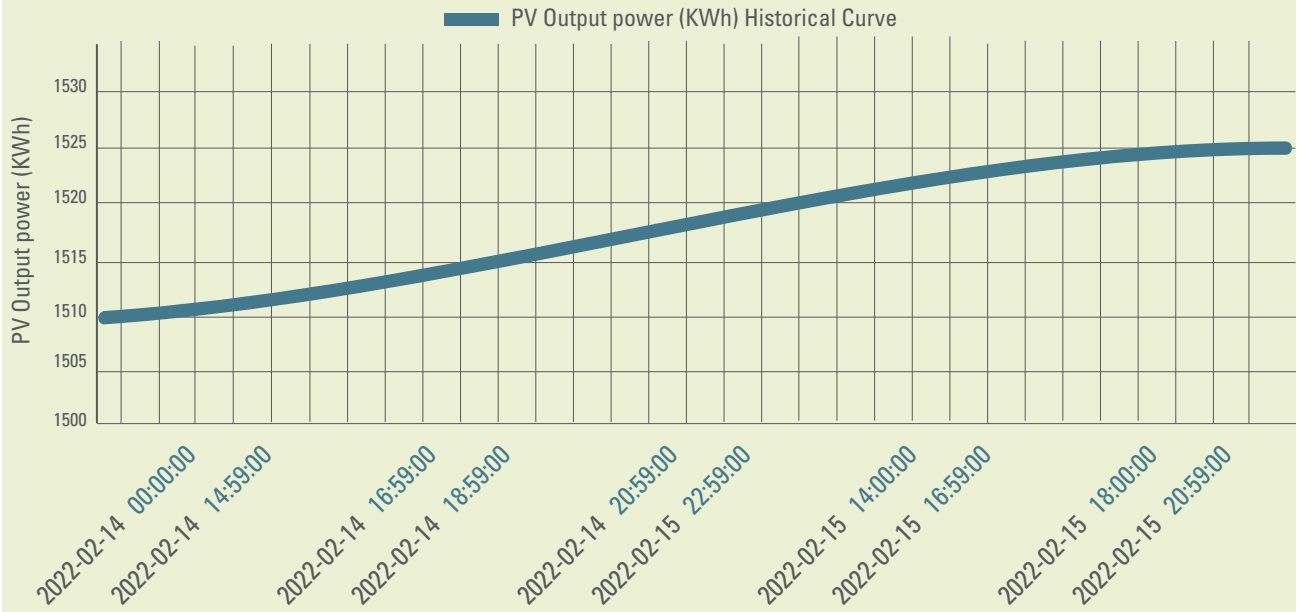


Figure 13. Electrical Energy (kWh) generated for water pumping system at farm of Ali Baccouche over period from 19 to 20 February 2022; total = 265 – 260 = 5 kWh.

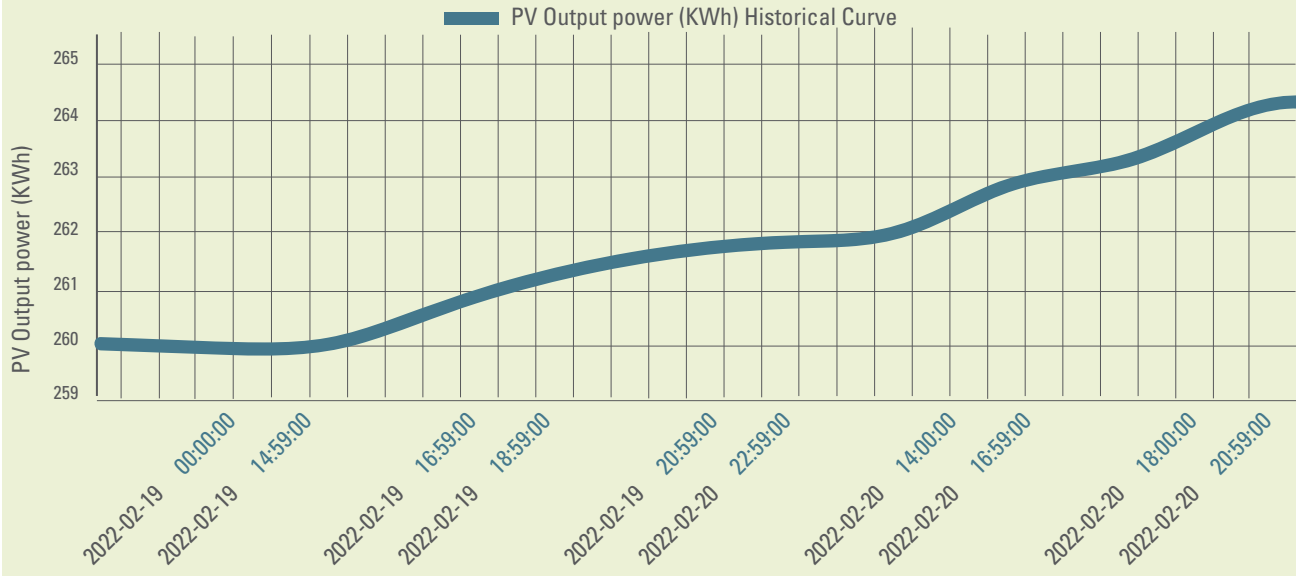
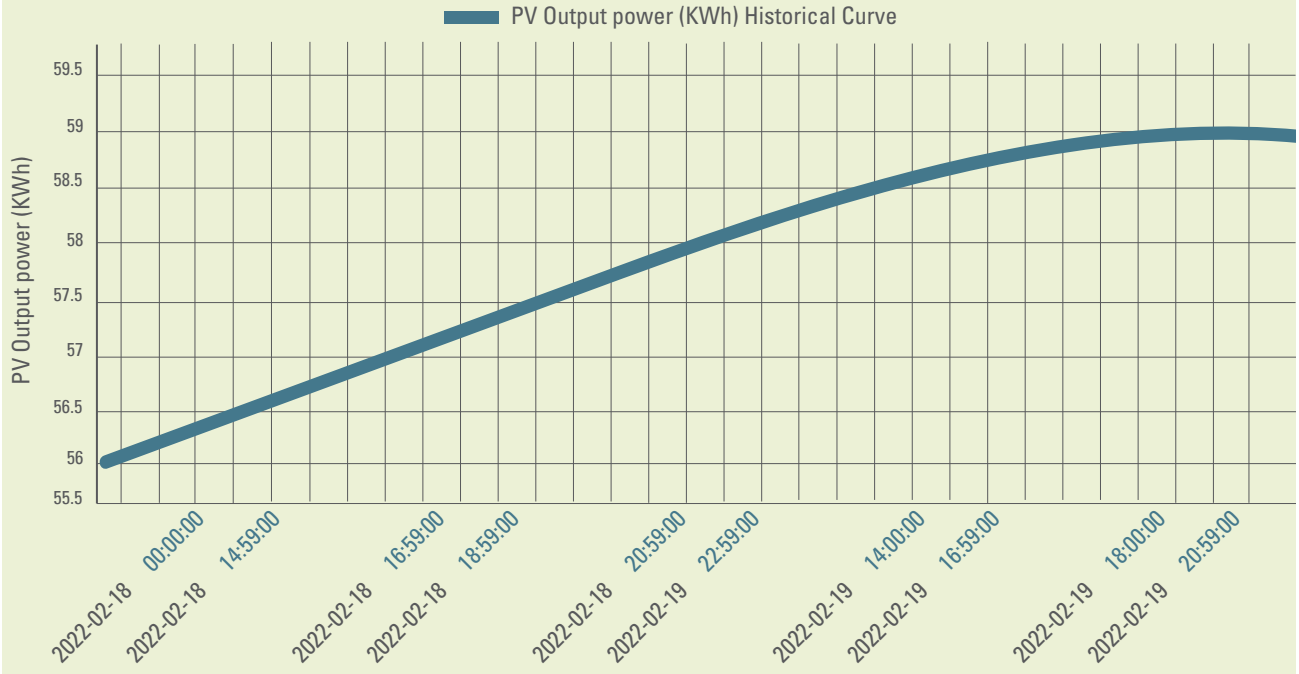


Figure 14. Electrical Energy (kWh) generated for water pumping system at farm of Houssine Ltaief over period from 18 to 19 February 2022; total = 59 – 56 = 3 kWh.



The two projects at SMSA (El Faouz) and GDA pour l'Eau Potable (El Intilaka) are awaiting commissioning by the Tunisian Company of Electricity and Gas (STEG), which was delayed due to the high workload at the company. Once commissioning is carried out and the projects become operational, their monitoring systems will go live and accessible.

05.

Addressing challenges in rural areas

05.
Addressing challenges in rural areas

Jordan

High electricity bills, water scarcity, and poverty are the main challenges to rural communities. The small-scale renewable energy systems should help beneficiaries meet these challenges by meeting their annual electricity and hot water needs.

Availability and cost of water is another important challenge. The irrigation systems should reduce irrigation water needs by approximately 60 per cent, thus also reducing the cost of electricity for irrigation. Equally important, energy poverty is a widespread problem.

Thermal comfort at the two CBOs, in Al-Achaari and Batir, was addressed by providing the building envelope of each with the requisite thermal insulation, as well as by using energy efficient air conditioners.

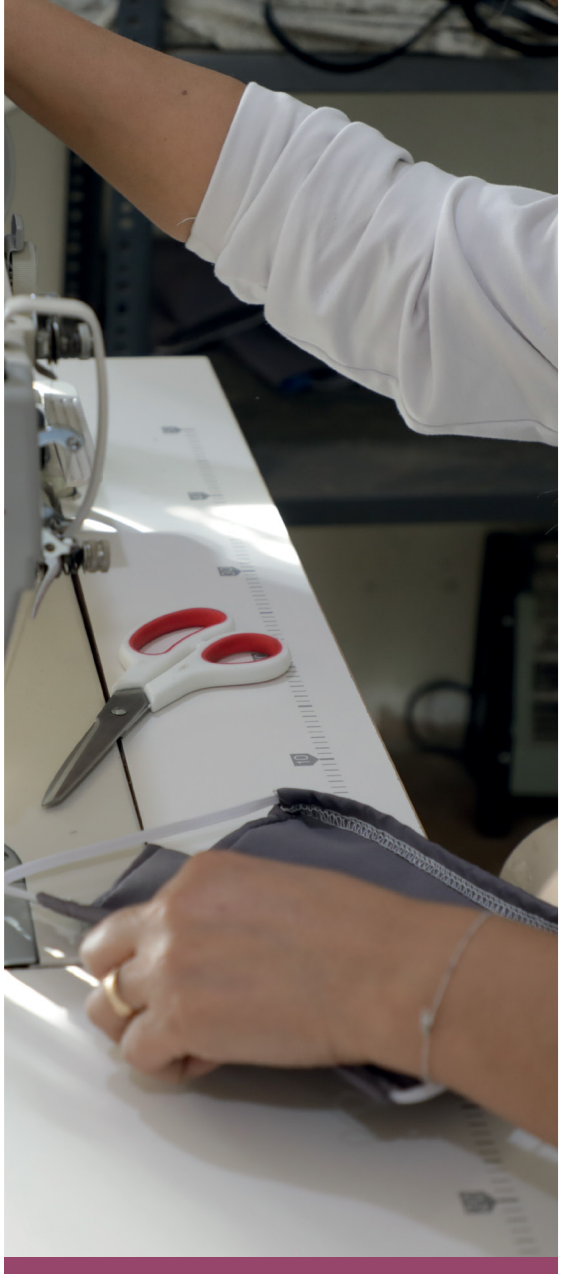
Lebanon

Challenges have been aggravated by the financial and economic crises and hyperinflation that Lebanon has endured since 2019. Unreliable electricity supply is a major barrier to growth of production activities, particularly in rural areas. Although Akkar Al-Atika and Chaqdouf are fully electrified, the two villages have chronically suffered acute shortages in electricity supply from the national electricity utility, EDL, and these have drastically worsened in recent months. As a result, consumers have had to rely, if at all, on increasingly unaffordable supply from private neighbourhood diesel generators. However, designed to provide back-up supply only, these generators are incapable of operating round the clock, leading their operators throughout the country to resort to rationing. Generators now provide an average supply of 9-12 daily hours in major cities, and 3 hours in most rural areas, including Akkar Al-Atika and Chaqdouf.

REGEND has, to a large extent, ensured continuity of operations of the production activities of the beneficiaries, who acknowledge that they would otherwise have been out of business since EDL is barely providing two hours of supply per day. Similarly, for numerous energy-poor households that cannot afford a subscription to private neighbourhood supply, the solar PV lighting kits ensure that basic household lighting needs are met.

Tunisia

In rural Chorbane, notwithstanding the high rate of connectivity to the national electrical grid, cost of access constitutes a heavy financial burden on institutions, organisations, and farmers. Generally, high tariffs exacerbate prevalent poverty among the rural population. By meeting all or a large portion of the annual electricity demand of SMSA, GDA, and beneficiary farmers, REGEND projects will eliminate or reduce the cost of electricity burden, thus reducing poverty by improving the financial performance of the beneficiaries; mitigating cost increases on their customers, the majority of whom are farmers; and creating jobs in rural productive sectors.



06.

Addressing challenges to rural women

06.
Addressing challenges to rural women

Jordan

Unemployment among rural women, which stood at 26 per cent in 2016,[2] is still high. Moreover, rural women are significantly deprived of their inheritance and property ownership rights, which reduces their access to finance and leads to their marginalisation. By 2015, they owned only 3 per cent of agricultural land, 12 per cent of livestock, 8 per cent of poultry and 5 per cent of agricultural machinery.[3] Equally important, the high cost of electricity is a major handicap for rural women seeking to start or grow income-generating production activities.

REGEND addressed several of the social, economic, financial, and technical challenges faced by rural women. Its activities bridged the technology access gap that impeded their ability to benefit from clean energy sources to grow their income, which, in turn, will result in financial and social benefits that address challenges such as lack of employment opportunities, limited choice of activities, lack of access to finance, and lack of knowledge of and skills on how renewable energy technologies and applications can be utilised to increase efficiency and productivity.

Lebanon

The impact of REGEND was multifaceted. Socially, it challenged the dearth of employment opportunities for women in a patriarchal society by creating gainful work in agri-food, sewing and embroidery. Economically, challenges included lack of access to reliable electricity, lack of income-generating activities, and soaring costs of products and agri-food services. These were tackled through the solar PV systems and their batteries, which have provided continuous and reliable electricity, while contributing, along with capacity building and production equipment, to growth in the revenues of the beneficiaries by 20 to 38 per cent. As a result, beneficiaries were also able to provide products and services at prices lower than market prices by between 38 and 85 per cent. Financially, lack of financing capacity and access to finance for investing in small-scale renewable energy technologies and production equipment were met by fully covering the costs of the renewable energy systems and production equipment. Technically, the lack of skills and know-how required to improve and grow existing and new income generation activities was fully remedied through 12 capacity building workshops attended by 252, mostly female, participants.

Tunisia

Women living in rural areas constitute 35 per cent of total female population. In addition to the absence of social security coverage, women also suffer a gender wage gap, long work hours in agriculture (about nine hours per day), and major sociocultural constraints. Only 4 per cent of women are landowners and only 6 per cent own cattle. Participation of rural women in production

activities is also subject to severe constraints, including limited access to land, notwithstanding a law stipulating that both genders should have equal access. Also limited is access to bank finance, which is increasingly essential for modern agriculture. Another constraint is the limited access to means of production, assistance and support services, agricultural equipment, water resources, fertilisers, and new technologies. Moreover, involvement in agri-food processing is low, with the role of women limited to being merely underpaid employees. A 2012 survey of microenterprises conducted by the National Institute of Statistics indicated that self-employed women accounted for 22 per cent of 666,284 registered firms, and that in the agri-food sector, average income of women is 70 per cent that of men.[4]

The renewable energy systems, production equipment, and 9 capacity building workshops offered by REGEND have addressed these social, economic, financial, and technical challenges, empowering rural women to increase their production, reduce their costs, expand their activities, and build their skills and knowledge, paving the way to further growth.

07.

Finance of field projects

07.
Finance of field projects

Jordan

Without REGEND, none of the beneficiaries would have been able to invest in solar energy systems, energy efficiency, or production equipment. Most had electricity bills outstanding for up to 12 months, which highlights that prevalence of energy poverty in rural areas is a significant barrier to rural income-generation and entrepreneurial activity, as well as indicating that defaults constitute a burden on government finances.

REGEND field projects incentivised a new co-financing arrangement with the Rural Electrification Programme of the Ministry of Energy and Mineral Resources (MEMR), which covered the cost of the electrical distribution infrastructure (transformers, poles, cables) for connecting the farm of Rida Salah in Batir to the national grid.

Lebanon

Though aware of the need for energy systems, efficient lighting, and new production equipment for business growth, beneficiaries lacked the financial capacity to invest in them, nor were they aware of possible financing mechanisms. REGEND interventions eased this constraint, ensuring continuity and improvement of their production activities. Such interventions were necessary, for solar systems are capital-intensive and financing opportunities had been dwindling. Indeed, even when such opportunities were available, awareness of them and of the associated application processes was lacking.

Tunisia

Prior to REGEND, beneficiaries could not invest in renewable energy due to lack of both finance and awareness. Even though subsidies by a national financing mechanism range between 40 and 50 per cent, the residual investment is still too high for farmers and the attendant administrative procedures are cumbersome. Moreover, some commercial banks decline offering credit for solar PV water pumping projects deeming them to be infeasible.

08.

Capacity building impact

08.
Capacity building impact

Beneficiaries have voiced the opinion that the capacity building workshops, which comprised lectures, exercises, and practical training, will have a lasting impact. The knowledge and skills acquired by participants enabled them to improve and expand their income-generating activities, while becoming keenly aware of renewable energy and energy efficiency and their applications and benefits. Throughout the workshops, beneficiaries also benefited from the use of the production equipment procured by REGEND.

Notably, partnerships were formed with AOAD and the Arab Federation for Food Industries (ARABFFI). Both assisted in preparation and organisation of the workshops, as well as in developing a **Good Practices Guide for Agriculture, Post-harvest Processing, Manufacturing, Packaging, and Labelling within the Framework of Training on the Sustainable Use of Energy** which has been published by ESCWA and disseminated throughout the Arab region.

Jordan

The workshop on **Agriculture Practices for Enhanced Energy Sustainability**, organised in Al-Achaari then in Batir, covered: good agricultural practices, pests and proper use of pesticides, drip irrigation, solar water pumping, solar disinfection, renewable energy and energy efficiency, sustainable energy and the water-energy-food nexus, rural development and women empowerment, economic feasibility and entrepreneurial development, and general safety. As a result, participants are now successfully planting new crops using new techniques and selling the produce in local markets.

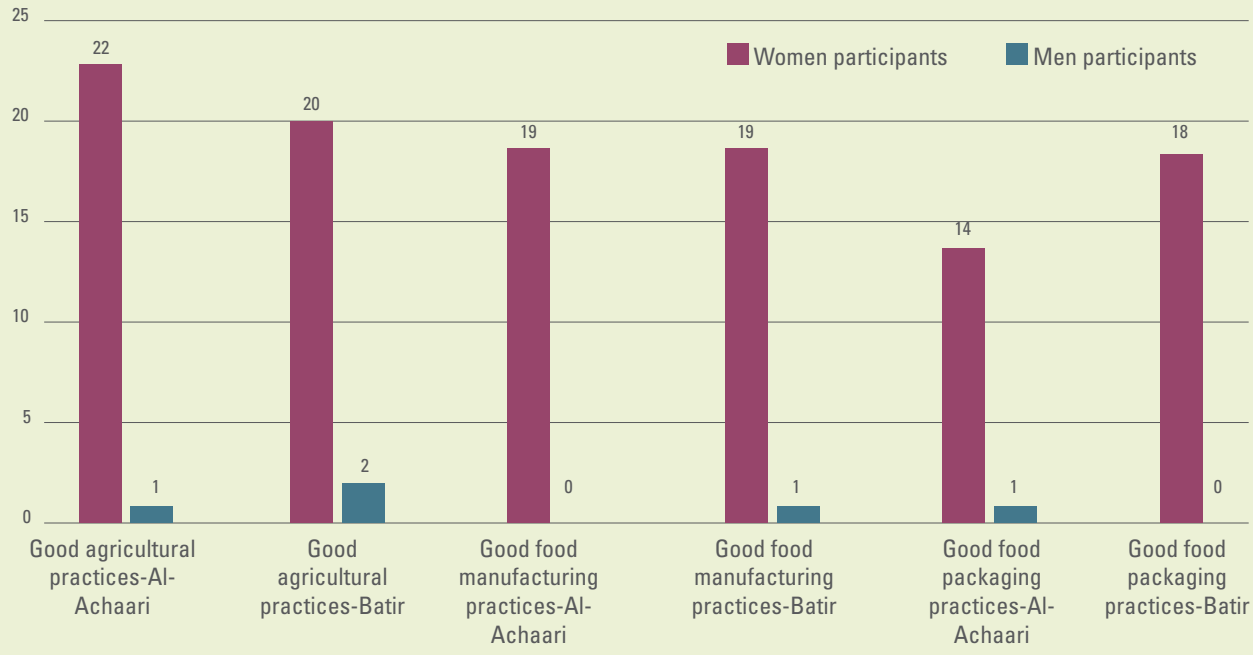
The workshop on **Good Food Manufacturing and Hygiene Practices and Hygiene Requirements for Food Storage**, organised in Al-Achaari then in Batir, covered: good manufacturing practices for dairy and jam products, personal hygiene, food safety and quality, public health and pesticides, production cost accounting, integrated pest management of disease vectors, health requirements for food-sector workers, agriculture and agricultural manufacturing, and preparation of monitoring records. As a result, the beneficiaries are now producing new agri-food products, such as jams, juices and cheese, and selling them in both the local market, as well as in the capital city, Amman, during exhibitions and fairs.

The **workshop on Good Food Packaging, Labelling, and Marketing Practices**, organised in Al-Achaari then in Batir, covered: importance of preserving food products and proper labelling, types of contaminants and methods for guarding against contamination, safe transportation methods, art of marketing and use of social media, identification of packaging materials, and design of labels and selection of appropriate labelling. As a result, Al-Jawhara CBO has created a brand and labels for its products, and social media pages that kickstarted their online sales and increased their market outreach (figure 15).

Figure 15. Workshop on Good Food Packaging, Labelling, and Marketing Practices in Al-Achaari

The total number of participants was 117. Figure 16 presents participation data by gender and topic.

Figure 16. Jordan Capacity Building Programme participation data



Lebanon

The workshop on **Food Manufacturing and Safety, and Best Methods of Food Packaging and Preservation** included a hands-on session on producing and storing two tomato-related products; ketchup and tomato sauce, which were new types of products for the participants. It also provided crucial information on best practices in food manufacturing, especially in relation to personal hygiene and work environment. Thus, participants gained the skills necessary for expanding product lines and increasing revenues.

In the workshop on **Marketing through Social Media**, participants learned the essential skills of

operating and managing social media accounts, and two young women from each village were assigned as administrators of the social media pages. Subsequently, social media activities, including promotion of activities and products, of **Live Akkar in Chaqdouf** and the **Women Agri-food Cooperative in Akkar Al-Atika**, improved significantly, with the number of posts by the former increasing six times and by the latter twelve times in the five months succeeding the workshop.

In the workshop on **Financial Management and Accounting**, participants learned basic financial management and pricing skills, enabling them to rectify and update their accounting and pricing practices to ensure profitability and sustainability.

In the workshop on **Project Design, Proposal Development, and Feasibility Studies**, active citizens and members of the municipalities of Chaqdouf and Akkar Al-Atika learned and brainstormed project proposal and feasibility ideas for local sustainable development. Subsequently, Ms. Iman Dabboul from Chaqdouf reported that, utilising the skills acquired, she applied to an international NGO for funding.

The workshop on **Sustainable and Effective Methods in Embroidery and Weaving** was attended by more than 80 women and girls of various ages. Participants carried out their own projects to a very high standard, and the workshop uncovered latent talent. A participant, Ms. Jana Osman from Akkar Al-Atika, launched an **Instagram page** (profile name: jan_art0) to market and sell her products. In addition, the four full-time women employees of Live Akkar Sewing and Embroidery Workshop in Chaqdouf have been receiving requests to deliver paid training sessions to women in other villages in the area, leading to new revenue streams.

A practical training workshop on Operation and Maintenance of Solar PV Systems was held in Akkar Al-Atika for both villages. Participants were members of the cooperatives, who should, as a result, be able to operate and troubleshoot such systems and technical school students who ended up with improved job prospects upon graduation. Thus, the impact is expected to be lasting.

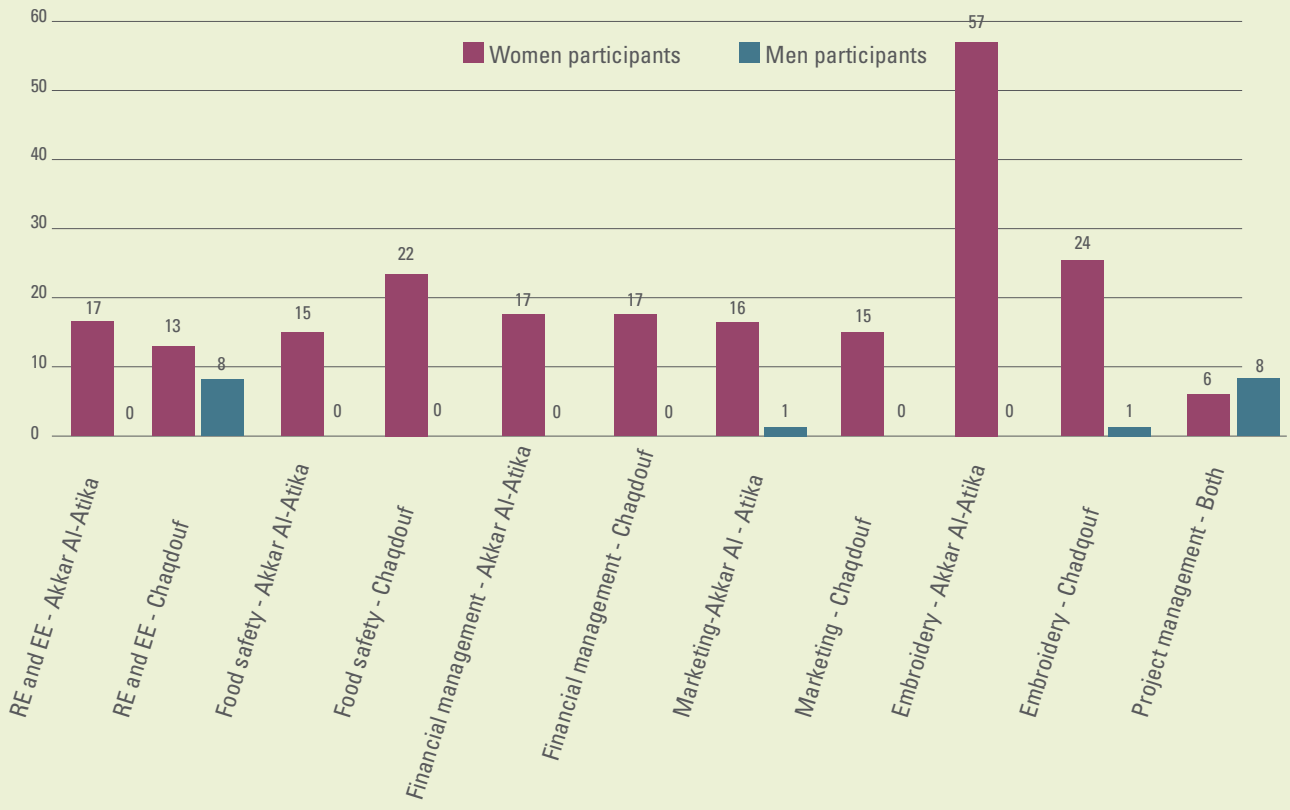
Throughout all workshops, mothers and children were supported and accommodated by designating a specific place for young participants to stay in, curating presentations to be inclusive and clear, and handing out certificates of participation also to the young participants for encouragement. In one case, a young girl, Ms. Sara Nashar, who attended with her parents, was celebrated by naming her Ambassador for Sustainable Energy in Akkar (figures 17 and 18).

The total number of participants was 237. Figure 19 presents participation data by gender and topic.

Figure 17. Ambassador for Sustainable Energy in Akkar, Ms. Sara Nashar, Akkar Al-Atika, Lebanon.

Figure 18. Ambassador for Sustainable Energy in Akkar Certificate

Figure 19. Lebanon Capacity Building Programme participation data



Tunisia

Members of Al-Amal Agricultural Development Group participated in a comprehensive series of capacity building workshops covering a wide range of topics related to production activities for economic empowerment. The workshop on **Improving Performance of the Agricultural Development Group for Rural Women (Al-Amal) and Raising its Efficiency** introduced participants to the legal, financial, and administrative aspects of managing the group and increasing its productivity, thus providing them with valuable skills that would assist in promoting activities.

The workshop on **Marketing Techniques and Mechanisms of Rural-Women Products** explained how to market local products and develop sustainable income streams, and demonstrated available marketing mediums, such as social media and participation in exhibitions and bazars.

The workshop on **Distillation and Valorisation of Materials Extracted from Medicinal and Aromatic Plants** introduced these plants as a possible source of income, and provided a comprehensive guide to manufacturing and packaging various products made from aromatic and medicinal plants.

The workshop on **Packaging, Customised Trademark Adoption, and Labelling of Local products to Improve their Promotion** dwelt upon the importance and basics of packaging and its role in marketing and promotion of products to maximise income. It also emphasised importance of sustainable and environment-friendly packaging practices and provided practical exercises on them.

The workshop on **Cattle Breeding** provided practical knowledge on the basic principles of feeding and caring for cattle and improving production and quality of milk. Most of the workshop was practical and on-site, with participants learning how to measure quantity and quality of hay feed (figure 20).

Figure 20. Workshop on Cattle Breeding in Chorbane

The workshop on **Improving Yield and Quality of Fruit Tree Plantings and Adopting Water-Saving Irrigation Techniques and Renewable Energy Technologies for Pumping, Irrigation, and Water Desalination** provided useful practical information on improving trees, which enabled participants to increase yield and enhance efficiency and productivity. A wide range of types of fruit trees and aspects to consider in cultivating them were covered.

The workshop on **Entrepreneurship in the Agricultural Sector** provided the basics of entrepreneurship, and information on potential funding and financing opportunities. Case studies and success stories from Tunisia were presented to encourage entrepreneurial emulation. Moreover, Enda Tamweel, a microfinance institution, was invited to present its approach and products, which resulted by the time of writing in disbursement of 40 microfinance loans to 40 women entrepreneurs in Chorbane to develop and grow their productive income-generating activities.

All workshops were practical and hands-on to ensure that participants fully grasp all concepts and can subsequently practice them.

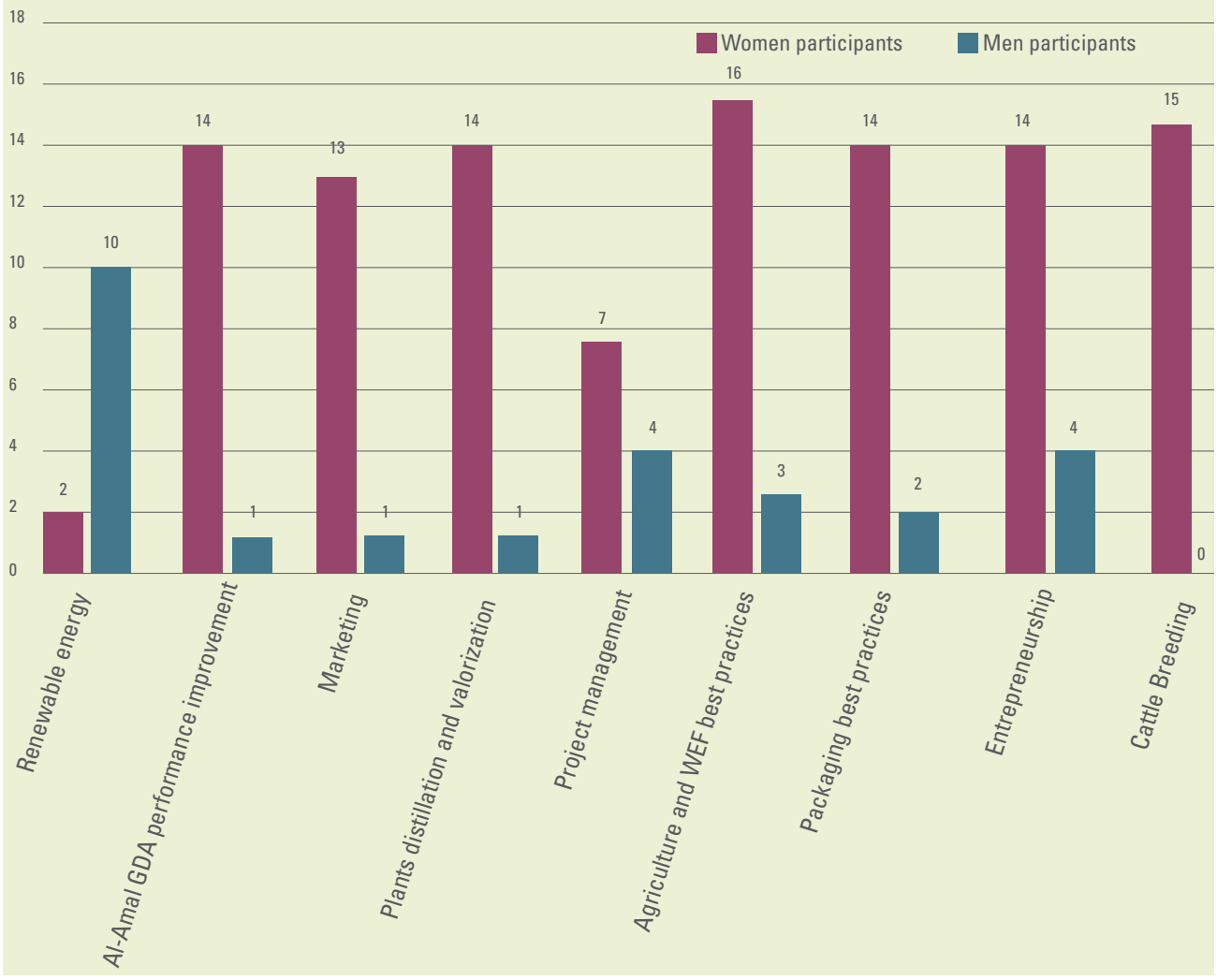
In addition to the capacity building workshops offered to Al-Amal, another was provided to local officials of the municipality of Chorbane. The workshop on **Use of Small-Scale Renewable Energy for Rural Development in Tunisia** provided the necessary knowledge of renewable energy and its potential in empowering the agricultural sector in the country, as well as listing the national stakeholders in the renewable energy sector and the type of support each can offer to rural communities.

Furthermore, the workshop on **Planning, Management, and Finance** was conducted for the elected members of the municipal council and some municipal administrative/financial staff. It provided theoretical knowledge and practical experience of methods and techniques for mobilisation of traditional and non-traditional funds, and promoted the concept of planning and financing for sustainable development.

The last two workshops, which were organised at the municipality of Chorbane, should enable local officials to promote renewable energy and sustainability on a larger scale.

The total number of participants was 135. Figure 21 presents participation data by gender and topic.

Figure 21. Tunisia Capacity Building Programme participation data



09.

Impact of field projects on income-generating activities of beneficiaries

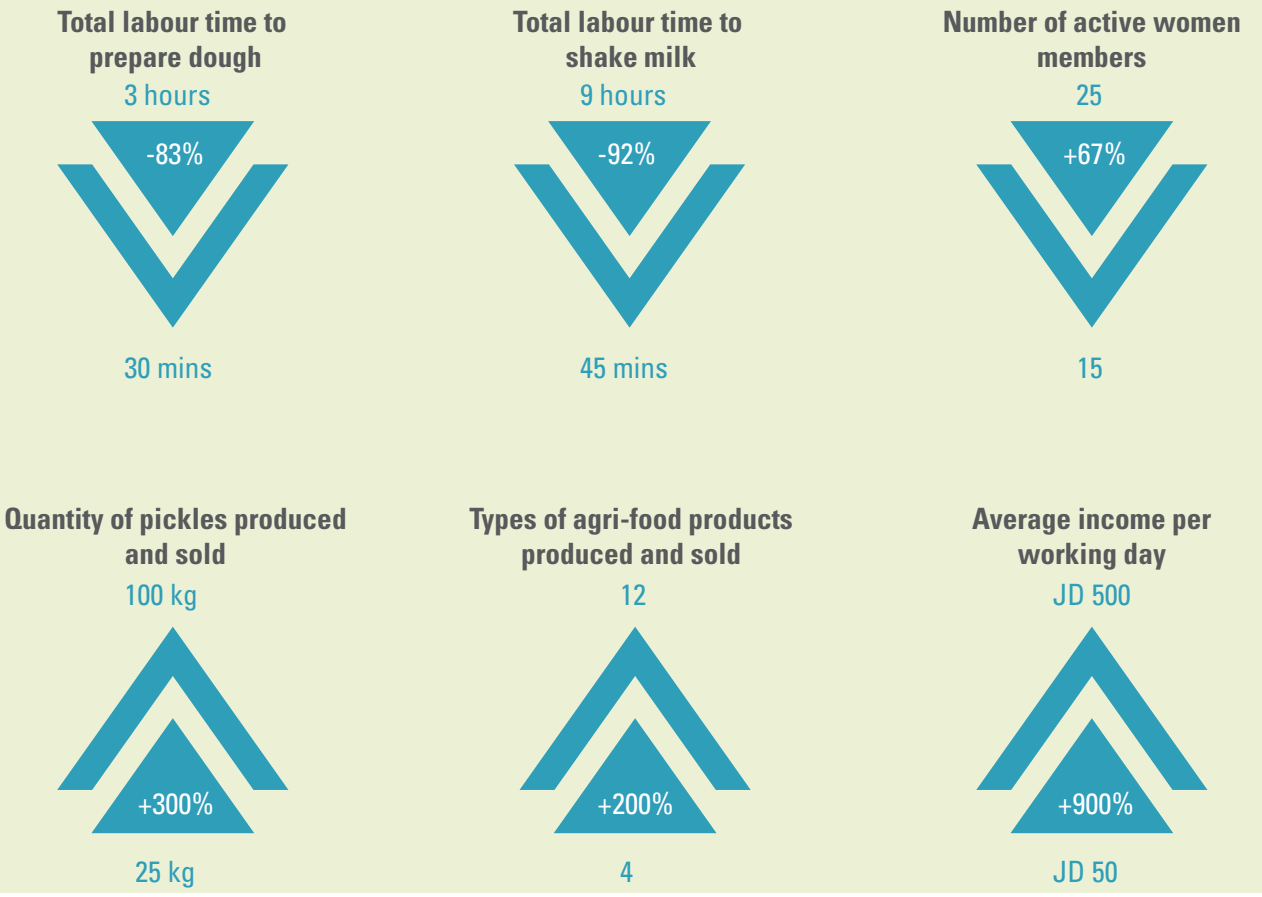
09.
Impact of field projects on income-generating activities of beneficiaries

REGEND field projects, production equipment, and capacity building efforts were combined to match the needs of the beneficiaries. While the capacity building workshops introduced beneficiaries to new methods and techniques for improving and growing income-generating activities, the energy efficient production equipment, powered by the renewable energy systems, enabled sustainable effective growth by reduction of time, effort, and cost, thus enhancing productivity, efficiency, and revenues.

Jordan

The following are some of the results documented so far at the Al-Jawhara CBO.

Figure 22. Documented results at the Al-Jawhara CBO



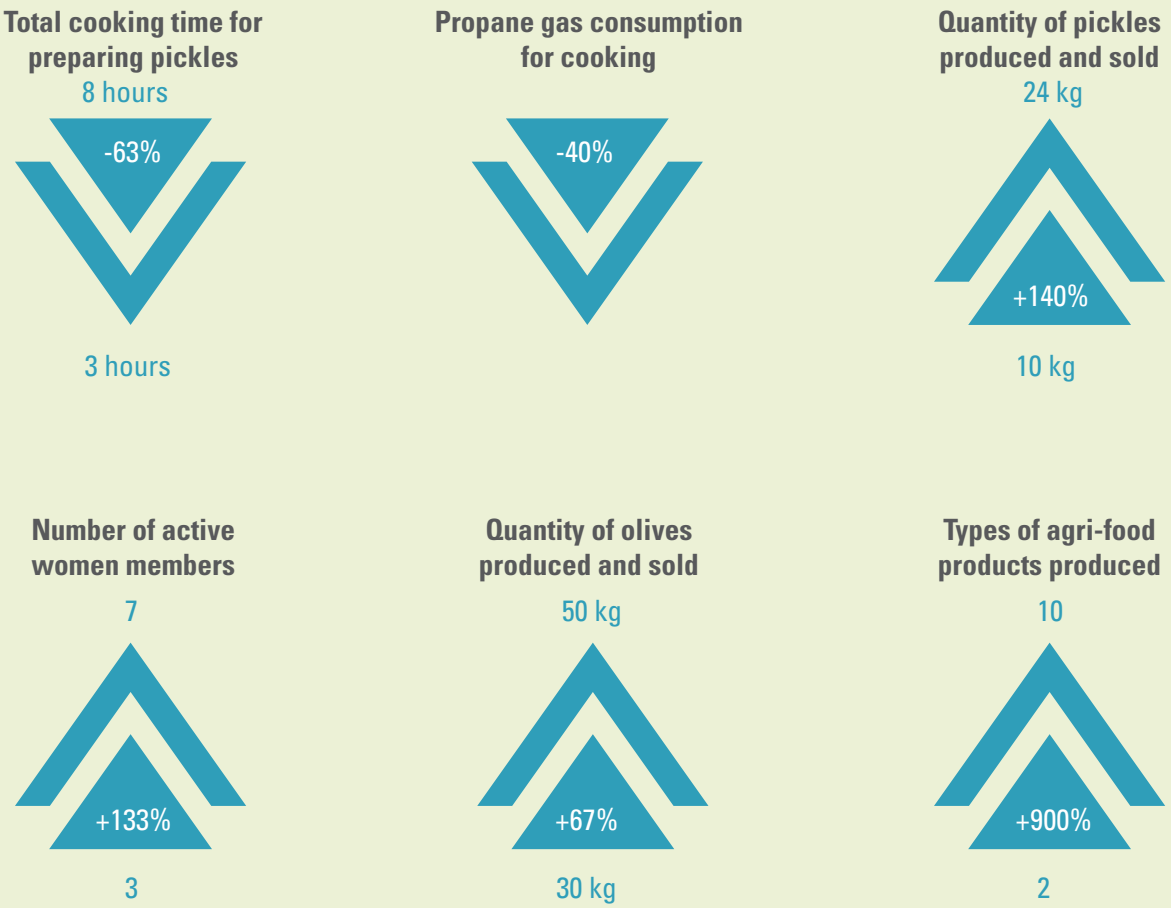
In addition, the CBO ventured into catering, producing a wide variety of foods for events nearby. Moreover, thanks to the production equipment leading to reduced labour times, the quantity of dairy products produced increased significantly, and the knowledge and skills acquired in the first capacity building workshop were used to plant new crops, benefiting from both the solar PV and the drip irrigation systems.

The following are some of the results documented so far at the Shabbat Batir Al-Khayriya CBO.

Quality of dairy products was significantly improved as a result of both the production equipment received and the capacity building. Using the readily available hot water provided by the solar water heater, the need of using propane for heating water for cooking was eliminated and 30 minutes of process time were saved.

Both CBOs also used the knowledge and skills acquired in the third capacity building workshop to better label agri-food and dairy products and market them in exhibitions and bazars, leading to increased sales and revenues. For instance, profits accrued from high sales volumes in Al-Zaytouneh exhibition in December 2021 are planned to be used for buying raw dairy materials to produce in February and March 2022 the local variety of dry yogurt (Jameed). Moreover, sales of both CBOs were boosted through using social media platforms for marketing and advertisement, based on the training received during the same workshop.

Figure 23. Documented results at the Shabbat Batir Al-Khayriya CBO



Lebanon

In Akkar Al-Atika, significant savings in electricity bills enable beneficiaries to market products at lower than regular market prices, which created new markets and revenue streams, leading to higher revenues.

The president of the Union of Beekeepers Cooperative reported a 20 per cent increase in year-to-year revenues, due to growth in demand from existing customers, as well as from new ones in further away places, such as Ras Baalbek in Baalbek-Hermel Governorate and Zahlé in Beqaa Governorate.

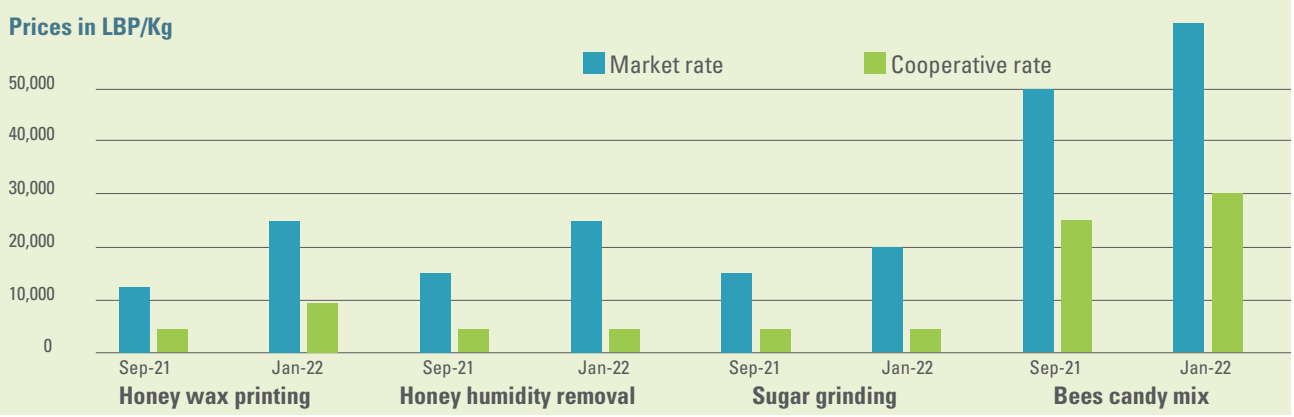
The Cooperative produces and offers various seasonal products and services, such as honey wax printing, honey humidity removal, sugar grinding, and bee candy. For a few hours monthly, melting wax requires steam, which in turn requires electricity produced by a diesel generator, but all other processes are currently powered by the solar PV system.

Electricity cost savings have enabled the Cooperative to sell products at prices that were lower than market prices by 50 to 67 per cent in September 2021 and by 50 to 87 per cent in January 2022. The widening margin is driven by the soaring costs of raw materials and diesel, while thanks to REGEND interventions, the Cooperative has been able to maintain low operating costs. Table 4 and figure 24 present comparisons for both months.

Table 4. Comparison between Akkar Al-Atika Union of Beekeepers Cooperative prices and market prices

	Sep-21			Jan-22		
	Market price (1 000 LBP/ kg)	Cooperative price (1 000 LBP/kg)	Difference (%)	Market price (1 000 LBP/kg)	Cooperative price (1 000 LBP/kg)	Difference (%)
Honey wax printing	10	4	60	20	7	65
Honey humidity removal	12	4	67	20	4	80
Sugar grinding	12	4	67	15	2	87
Bee candy	40	20	50	50	25	50

Figure 24. Comparison between Akkar Al-Atika Union of Beekeepers Cooperative prices and market prices



The Cooperative originally supported beekeepers in the Akkar governorate. However, its low prices have enabled it to attract new customers from Ras Baalbek and Zahlé, approximately 75 km away, notwithstanding high transportation cost. Remarkably, by Fall 2021, gasoline cost had increased 400 per cent year-on-year, yet these customers find it economically viable to take the trip to Akkar Al-Atika to purchase the keenly priced products and services.

The Women Agri-food Cooperative recorded an increase in revenues of approximately 25 per cent, notwithstanding the soaring prices of vegetables and fruits used for agri-food production. For example, the price of apples increased 8-fold since 2019. Yet, low operating costs have enabled the Cooperative to maintain low prices for apple products, leading to increased sales. As shown in table 5 and figure 25, Cooperative prices are lower than market prices by 34 to 62 per cent.

Table 5. Comparison between Akkar Al-Atika Women Cooperative prices and market prices

	Market price (1 000 LBP/kg or 750 ml)	Cooperative price (1 000 LBP/kg or 750 ml)	Difference (%)
Stuffed apples	125	75	40
Apple slits jam	53	35	34
Apple cider vinegar	65	25	62
Apple molasses	112	60	46

Figure 25. Comparison between Akkar Al-Atika Women Cooperative prices and market prices

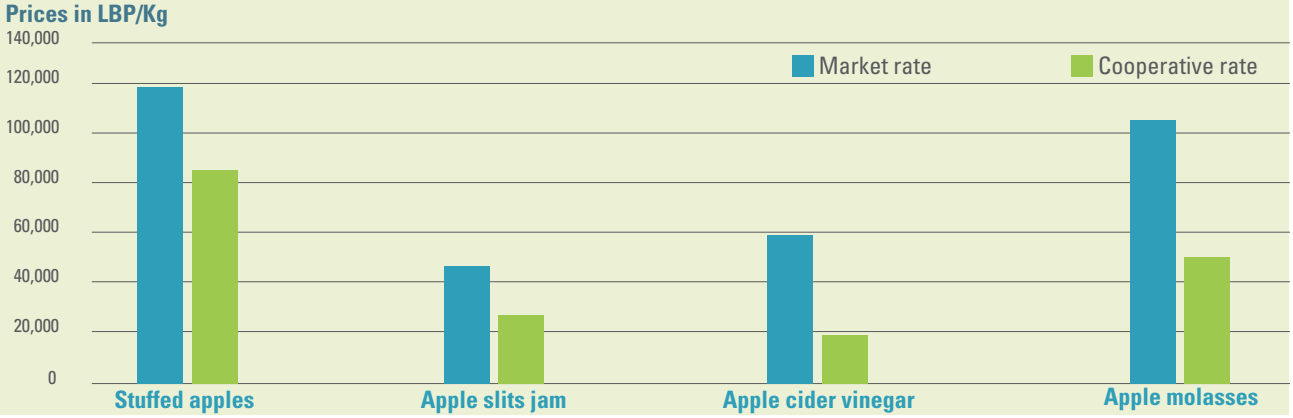
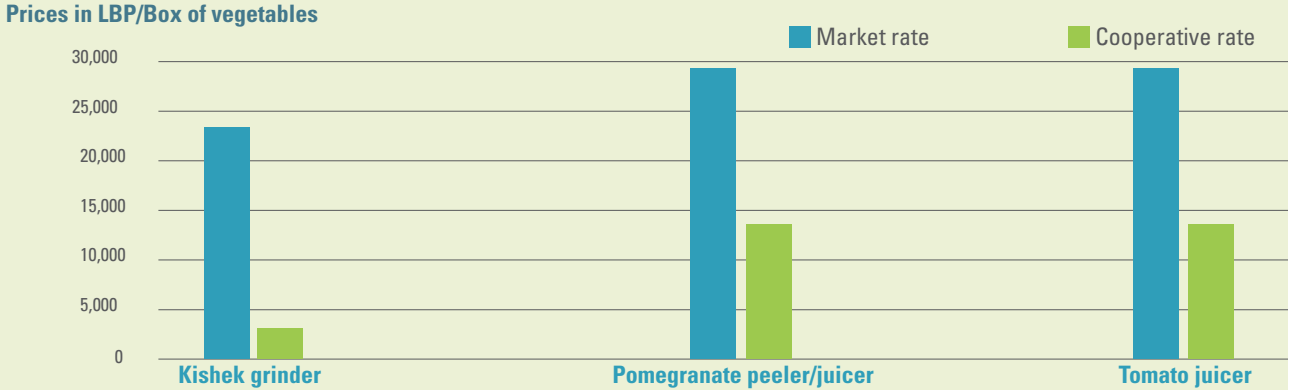


Figure 26. Cost comparison between Akkar Al-Atika new agri-food workshop and local market



Utilising skills acquired in the capacity building workshop on Food Manufacturing, Safety and Best Methods of Food Packaging and Preservation, the Cooperative is now considering introducing new revenue streams, including ones based on new products, such as ketchup and tomato sauce.

Overall, despite successive crises in Lebanon and hikes in prices of raw materials, the solar PV systems ensured for both cooperatives continuous and reliable operation, enabling them to even increase production volumes. The president of the Women Agri-food Cooperative reports that production levels have this season surpassed those of business-as-usual.

For the new agri-food workshop established and run by the municipality, production equipment provided by REGEND has secured continuity of production activities across the village, including those of rural women operating informally from their homes. The workshop is non-profit, with fees for using equipment set at low levels to cover cost only. Figure 26 shows that in comparison with market prices, fees charged by the workshop are 85 per cent lower for kishek grinding and 67 per cent lower for pomegranate juicing/peeling and tomato juicing.

Although newly established, the workshop has already processed 200 kg of kishek, 150 boxes of pomegranate and 50 boxes of tomatoes. Reportedly, the local community feared that services would be unaffordable, but the municipality succeeded in overcoming initial hesitancy through an information campaign using social media and municipal communication channels. The pomegranate juicer has also added value, since it is not commonly available in the market, and the workshop provided an added incentive by including juicing in the price of peeling.

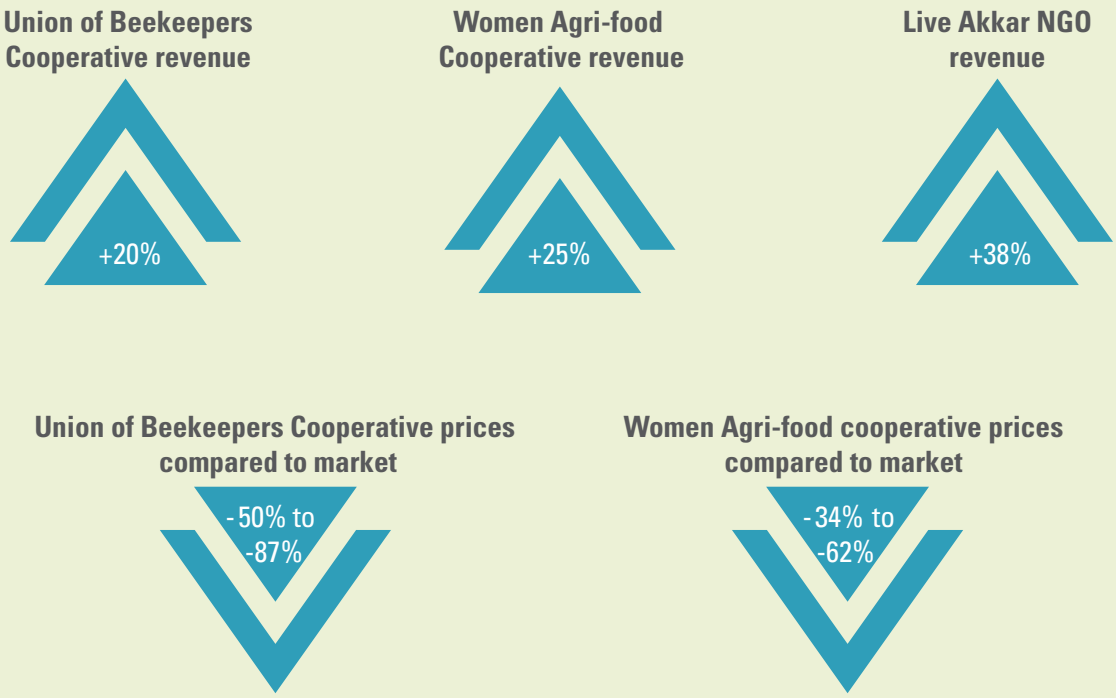
In Chaqdouf, the Live Akkar Women Sewing and Embroidery Workshop has reaped two immediate benefits:

1. The solar PV system has positioned the workshop as the only one in the area having a reliable electricity supply in times of significant outages, with the resulting increased workload leading to revenues increasing by 38 per cent, as well as the addition of eight part-timers to the four full-time employees.
2. The women trained in the workshop on Sustainable and Effective Methods in Embroidery and Weaving have become trainers themselves. The municipality of Menjez, a village in the Akkar region, in collaboration with an international organisation, has hired three Live Akkar workshop full-time employees to **train local women in Menjez** for $150 each over 3 days. Other NGOs across the Akkar governorate have made approaches with a view to conducting similar exercises.

REGEND has also provided the Live Akkar Workshop with an embroidery machine and a buttonhole machine that were not previously available in the area, enabling it to start new production lines and expand into new markets. As a result, revenues increased by 38 per cent, from $240 to $330.

The following is a summary of some of the results documented so far in Lebanon.

Figure 27. Documented results at beneficiaries in Lebanon



At the time of writing, the solar PV lighting kits had not been installed. Reporting on their impact would be possible only some period after they become operational.

Tunisia

The income-generating production activities of beneficiaries in Chorbane are varied. Income from agricultural activities, including arboriculture (e.g., olive, almond, and pomegranate trees) and vegetable crops (e.g., chilis, tomatoes, beans, carrots, mint, parsley and lettuce), is supplemented by various secondary economic activities, such as spice mills and catering services.

Unfortunately, not all beneficiaries keep detailed accounts of their agricultural production. However, some documented positive results are available. For example, Mr. Ben Mansour was able to honour his commitments for the year 2021, producing a large, high-quality crop of cereals in the very difficult context of a severe economic crisis caused by the COVID-19 pandemic.

Availability of additional irrigation water made possible by the solar PV pumping systems has had a tremendous positive impact. Some beneficiaries:

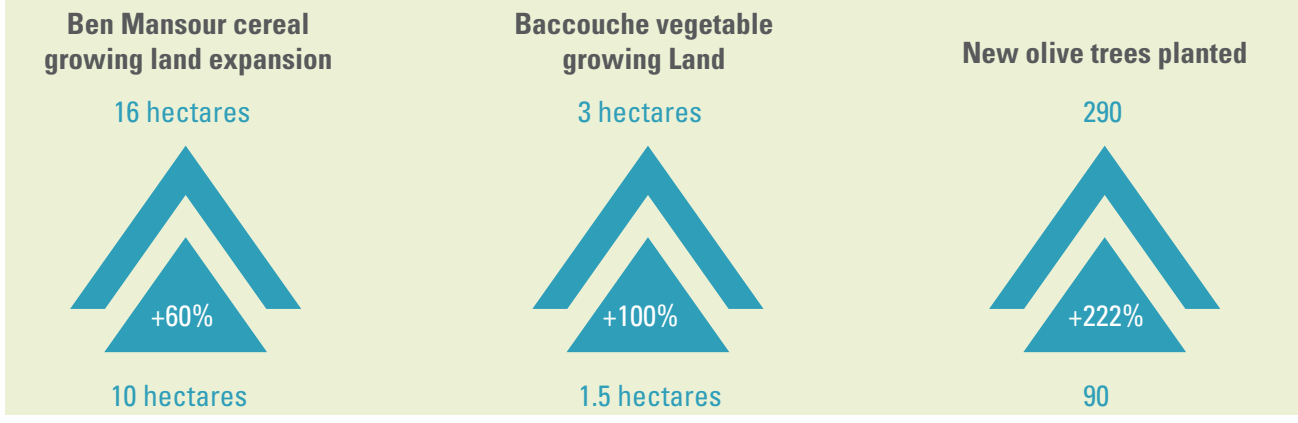
- Expanded their cultivated area, generating higher incomes. For instance, Mr. Ben Mansour expanded his cereal growing area by 60 per cent, from 10 to 16 hectares; Mr. Baccouche doubled his vegetable growing area from 1.5 to 3 hectares; and Ms. Bougtif, who currently cultivates a 4-hectare land, is considering cultivating new vegetable crops in four to eight hectares of neighbouring land belonging to her brothers-in-law, thus engaging her extended family.
- Increased the yield and improved the quality of their crops, which should lead to higher

incomes. For example, Mr. Ben Mansour raised the quality of his cereals; and Mr. Amor that of his agricultural crops, particularly olives and pomegranates.

- Diversified or plan to diversify their agricultural crops, which should enable them to produce and generate income throughout the year. Mr. Ben Mansour diversified his cereal crops and Ms. Bougtif plans to cultivate carrots soon.
- Expanded or plan to expand crops. For example, Mr. Baccouche has planted 200 new olive trees, in addition to the existing 90; and Mr. Amor and Mr. Ltaief intend to plant more vegetables and fruits (e.g., onions, carrots, parsley, lettuce, watermelon, melon, olive, pomegranate) in their 5-hectare and 8-hectare lands, respectively.

The following is a summary of some of the results documented so far in Tunisia.

Figure 28. Documented results at beneficiaries in Tunisia



10.

Impact of field projects on energy

10.
Impact of field projects on energy

REGEND renewable energy field projects (73.26 kWp in Jordan, 35 kWp and 107.7 kWh (battery storage) in Lebanon, and 36.32 kWp in Tunisia) have increased clean energy generation nationally, as well as locally in the beneficiary communities.

Jordan

Based on the average specific generation of 1,560 kWh/kWp, the annual electricity generated from the solar PV systems in Jordan is estimated at 112,000 kWh, while, taking into account degradation of panels over time, the 25-year lifetime electricity generation is estimated at around 2,611 MWh. This translates into estimated annual savings of JD23,254 and an overall net present value (NPV), using the current electricity tariff, of around JD316,138. Table 6 details generation and savings data.

Table 6. Electricity generation and savings data for renewable energy field projects

#	Beneficiary	System Capacity (kWp)	Location	First-year electricity generation (kWh)	25-year lifetime cumulative electricity generation (kWh)	Annual savings (JD)	Overall NPV of savings (JD)
1	Al-Achaari Farm	22.47	Al-Achaari	34 352	800 966	2 061	27 497
2	Al-Jawhara CBO	12.305		18 812	438 624	16 095	223 209
3	Batir CBO	4.28	Batir	6 543	152 565	453	5 834
4	Batir Farm	10.165		15 540	362 342	2 314	29 512
5	Al-Shurafa	4.28		6 543	152 565	453	5 834
6	Al-Hindawi	4.28		6 543	152 565	453	5 834
7	Shayesh Al-Jazi	4.28	Al-Achaari	6 543	152 565	453	5 834
8	Abed Al-Aziz Al-Jazi	2.8		4 281	99 809	243	3 146
9	Falah Al-Jazi	2.8		4 281	99 809	243	3 146
10	Aouda Al-Jazi	2.8		4 281	99 809	243	3 146
11	Ali Al-Jazi	2.8		4 281	99 809	243	3 146
Total		73.26		112 000	2 611 426	23 254	316 138

Prior to installation of the solar PV system at Al-Jawhara CBO, the monthly electricity bill averaged JD40. Subsequent to installation, the bill for the first month dropped to just JD2.5 (of which the fixed cost amounted to JD0.75), i.e., a drop of nearly 94 per cent. Moreover, with net-metering, the CBO will inject electricity into the grid, enabling it to utilise the balance during low irradiance months, which should reduce overall bills further.

The energy savings provided by solar water heaters to each beneficiary will depend on hot water consumption. Based on the rule of thumb of 2,700 kWh per year per system, energy savings for both CBOs are estimated at 5,400 kWh per year and the 25-year lifetime energy savings are estimated at 135,500 kWh. Based on the applicable electricity tariff and gas cost for each CBO, the resulting annual monetary savings amount to JD634 and JD452 for Al-Jawhara and Shabbat Batir Al-Khayriya, respectively, with overall NPVs amounting to JD8,936 and JD6,371, respectively.

The overall savings in irrigation-water quantities due to the drip irrigation system amount to 414 m^3 per year. The Jordan Water Sector Energy Policy 2020–2025 reports the water-energy intensity to be 6.6 kWh/m^3. On that basis, energy savings are estimated at 2,732 kWh (414 m^3 x 6.6 kWh/m^3) per year or 60,113 kWh over the 25-year lifetime. Furthermore, Shabbat Batir Al-Khayriya reduced monthly spending on diesel for irrigation from JD50 to JD5; a drop of 90 per cent. Further operational maintenance savings accrue from using the much more reliable new pump, which has been maintenance-free so far.

Thermal insulation and waterproofing of the Al-Jawhara building and the new thermally insulated caravan for the Shabbat Batir Al-Khayriya should reduce heating and cooling energy consumption throughout the year, while lighting-energy consumption will decrease due to replacement of old lighting fixtures at various locations across the two villages with new LEDs.

The newly supplied air conditioning units, freezers, cooking stoves, washing machine, and IT equipment meet the highest energy efficiency standards. Hence, the additional energy consumption will be limited and will be more than compensated by productivity and output gains.

As pointed out earlier, through collaboration with the Rural Electrification Department at MEMR, the beneficiary farm in Batir was connected to the national grid, as were neighbouring lands.

Lebanon

Recent successive crises have aggravated energy supply and cost problems. The EDL electricity supply is barely available, forcing consumers to rely on neighbourhood generator subscriptions. However, while most wages remained at their previous levels, in Fall 2021, a 5-ampere subscription, which powers only basic electrical appliances, such as a fridge, a few lights, and one machine, had soared 10 times compared with only two years earlier, rendering such an option unaffordable for most consumers.

Thanks to the project, the Agri-food Women Cooperative cancelled its monthly generator subscription, relying solely on the solar PV system.

The two other cooperatives in Akkar Al-Atika had no EDL connection and used to rely fully each on its own diesel generator. Since installation of the solar PV systems, both have relied on them, except for the wax melting process at the Union of Beekeepers Cooperative. Notably, the president of the latter cooperative is convinced that had it not been to the solar system, it would have had to cease operations. This is hardly surprising since the cost of private diesel generation is estimated to have rocketed 16 times since 2019.

Similarly, the Live Akkar Women Sewing and Embroidery Workshop is currently reliant on the solar PV system and batteries for 90 per cent of its electricity needs, having cancelled the neighbourhood diesel generator subscription in Fall 2021. The president of the NGO is of the

opinion that they would otherwise have been out of business. Again, this is hardly surprising since the diesel generator can provide electricity for only about two hours a day and at an unaffordable price, while the EDL supply is barely available. In fact, without the solar system, electricity cost, assuming that 10 per cent of the consumption is provided by EDL, would have surged 11-13 times compared with 2019.

For the 25 kWp system at Akkar Al-Atika, assuming an average specific generation of 1,500 kWh/kWp, the annual electricity generated is estimated at 37,500 kWh, which, assuming a 25-year lifetime and taking into account panel degradation, leads to an estimate of total lifetime generation of 857 MWh. Similar calculations for the 10 kWp system at Chaqdouf lead to an estimate of total lifetime generation of 343 MWh.

Tunisia

In Chorbane, groundwater for irrigation is pumped using either a diesel generator for agricultural lands not connected to the national electrical grid, or by grid electricity. Either way, the cost places a heavy burden curbing agricultural production, and solar pumping constitutes a sustainable alternative.

Table 7 presents electricity generation and savings data for the solar PV water pumping projects. In the case of Mr. Ltaief, savings could have been greater had his agricultural production not increased, raising demand for water and electricity.

Equally important, all farmers also improved crop yield and quality.

For the projects at the SMSA (El Faouz) and the GDA pour l'Eau Potable (El Intilaka) that are still awaiting commissioning, simulations during the design phase indicate estimated annual electricity generation to be 119,000 kWh and 28,000 kWh. Using the usual 25-year lifetime and panel degradation assumption, this translates to around 2,770 MWh and 654 MWh, respectively, which should lead to significant reduction of electricity cost.

Table 7. Electricity generation and savings data for the solar PV water pumping projects

#	Beneficiary	System capacity (kWp)	Electricity generated (kWh) as of 14 Feb. 2022	Average monthly savings
1	Bougtif	4.8	1 495	Reduction of electricity bill from TND225 to TND25 (89%).
2	Mansour	10.4	2 006	Elimination of TND900 diesel bill (100%).
3	Baccouche	7.04	254	Elimination of TND1,800 diesel bill (100%).
4	Ltaief	7.04	56	Reduction of electricity bill from TND600 to TND438 (27%).
5	Amor	7.04	1 519	Elimination of TND200 electricity bill (100%).
Total		**36.32**	**5 330**	

11.

Impact of field projects on empowerment of women

11.
Impact of field projects on empowerment of women

REGEND interventions have helped beneficiaries reduce time, effort, and cost, increasing productivity, efficiency, and revenues, which, in turn, resulted in reduced prices to the benefit of the community as a whole. In addition, due to increased revenues, quality of life of beneficiary households have improved. Moreover, several women who received training have since become trainers themselves, transferring knowledge and expertise to rural women in neighbouring communities.

Jordan

Most direct beneficiaries in Al-Achaari and Batir are rural women. In Al-Achaari, 25 active women members of the CBO and 5 women entrepreneurs working from their homes make up a total of 30 direct beneficiaries. In Batir, the corresponding numbers are 7, 2 and 9, respectively. In both, in crop and farming seasons, additional women are employed at the beneficiary farms on a part-time or seasonal basis.

Overall, the number of indirect beneficiaries is estimated at 800.

Lebanon

Most direct beneficiaries in Akkar Al-Atika and Chaqdouf are rural women. In Akkar Al-Atika, the president of the Women Agri-food Cooperative is assisted by 4 full-time women employees and up to 20 seasonal part-time women employees, depending on needs and revenues. In Chaqdouf, the full-time employees are 5, of whom 4 are women. The increase in workload and revenues has led to recruitment of 8 additional women on a part-time basis. The 30 women who across Akkar Al-Atika informally produce in-house agro-products, such as tomato sauce, pomegranate juice, kishek, are also direct beneficiaries of the new municipal workshop. The 4 full-time and 8 part-time employees at the Live Akkar workshop are also direct beneficiaries of the new sewing machines used in making new products, the reliable electricity produced by the solar PV system, and the continuously available hot water. The full-time employees have also become trainers, benefitting from additional revenue streams. In addition, across Chaqdouf, women who produce in-house agro-products benefit directly through the use of the Live Akkar workshop.

Overall, the number of indirect beneficiaries is estimated at 520.

Tunisia

In Chorbane, rural women are direct and indirect beneficiaries. Ms. Bougtif, a direct beneficiary, employs about 10 rural women during harvest periods, while 2 other direct beneficiaries, Mr. Amor and Mr. Baccouche, employ respectively 3 and 2 female members of their families, and respectively 5-6 and 10-15 rural women during harvest periods. Mr. Ben Mansour and Mr. Ltaief employ during the harvest periods 25-30 and 10-30 rural women, respectively.

Overall, the number of indirect beneficiaries is estimated at 950.

12.

Impact on beneficiaries and rural population

12.
Impact on beneficiaries and rural population

Jordan

Data collection was encumbered by lack of financial records for the CBOs and women entrepreneurs due to lack REGEND capacity building workshops addressed this issue, but it was not possible to establish a baseline income upon which to calculate income growth. Moreover, due to seasonality, some production activities have not started. Nonetheless, it is estimated that, thanks to the new range of products and the newly undertaken catering services, average income per working day at the Al-Jawhara CBO increased from JD50 to JD500 (+900 per cent). Also, on April 1st, 2020, Batir CBO generated from JD1000-worth of dairy products a profit of 30 per cent, which was divided equally between the women entrepreneurs, who worked on producing the batch, and the CBO, which provided equipment and energy.

Benefiting both the CBOs and the women entrepreneurs, the capacity building workshops have enhanced social solidarity among rural residents, mainly women, who as a result engaged in income-generation activities at the CBO or from home. Additionally, several women have become trainers themselves, transferring knowledge and expertise to rural women in local and neighbouring communities. Similarly, the CBOs have hosted women from neighbouring communities in capacity building workshops on various income generation activities. In addition, both CBO presidents were featured on national television during the **REGEND multistakeholder forum** organised in November 2021, and gave excellent feedback on the impact on production activities and lives. Inauguration events of REGEND projects were also milestones. Attended, among others, by municipal council representatives, key CBOs for women in the region, teachers from both boy and girl schools, and beneficiaries and their families, these events were well covered in social media and acknowledged by the communities.

In the medium and long term, it is expected that more CBOs and women entrepreneurs from the community and neighbouring communities will embrace the REGEND business model and come together to exchange experiences and success stories on expansion of income-generation activities utilising renewable energy.

Lebanon

REGENED interventions have ensured continuity and improvement of production activities, resulting in revenue growth for the Union of Beekeepers Cooperative and the Women Agri-food Cooperatives in Akkar Al-Atika and the Sewing and Embroidery Workshop in Chaqdouf of 20, 25 and 38 per cent, respectively, which improved their finances enabling them to grow activities while raising the living standards of the households involved. Moreover, the increase in revenues has enabled the latter two organisations to recruit additional part-time employees.

Through additional revenue streams and product lines and entry into new markets utilising social

media and potential partnerships, which have been significantly impelled by the capacity building workshops, a higher future impact is expected.

Supplying solar PV electricity to the health clinic at Akkar Al-Atika has literally averted a humanitarian crisis. The clinic now charges per consultation fees that are 90 per cent lower than market rates, and offers gynaecology, dentistry, and general medicine services to users whose number has increased three folds as the purchasing power of the local community plummeted. Currently, the PV electricity supply is used for lighting and for powering a single, mostly dental, machine at a time.

Similarly, by powering lights, photocopiers, and desktop computers, the supply of solar PV electricity to Akkar Al-Atika municipality building has enabled the municipality to continue functioning.

The interventions, particularly the capacity building workshops, have enhanced social solidarity, with women motivated to undertake income-generating activities and the broader rural community reflecting on the efficacy of self-help in the absence of assistance from a state that has left them feeling left behind. Indeed, participants valued the critical thinking, dialogue and collaboration opportunities offered to the rural population through the workshops.

The installed solar PV and water heating systems more than have halved the production time of agri-food products at the Women Agriculture Cooperative enabling larger production volumes. According to the President of the Cooperative, a task that used to take four hours, due to electricity interruption and down time, currently takes less than two. In addition, the provision of cold storage has improved product safety and the supply of fans and a heater has enabled faster drying of vegetables and food, leading to more efficient processing.

The experience of Chaqdouf constitutes a success story of training the trainers as an untapped source of income. Additionally, as rural women came together and expressed willingness, the municipality is attempting to develop a small chocolate factory for them to generate revenues.

In the medium and long term, new partnerships and market entries should enable beneficiaries in both Akkar Al-Atika and Chaqdouf to tap into the talents honed through the capacity building workshops. Moreover, other cooperatives and women entrepreneurs from the community and neighbouring communities are expected to embrace the REGEND business model and band together to attempt income-generation activities utilising renewable energy.

Tunisia

REGEND interventions have improved the income generated by the agricultural and agri-food production activities of the beneficiaries. Furthermore, more land is being cultivated and agricultural activities are being diversified and/or intensified, which would provide the rural population, in particular rural women, with more employment opportunities at various times, thus further improving social inclusion and empowerment of rural women.

For Mr. Ben Mansour and Ms. Bougtif, lack of financial records precludes calculation of the rate of increase of income, though both have generated additional income; while for Mr. Amor, Mr. Baccouche, and Mr. Ltaief, none of the crops irrigated by the newly installed solar PV water pumping systems has been harvested, barring quantitative assessment.

On the level of community, by supplying on-farm work, REGEND improved social inclusion and reduced emigration of family members of beneficiaries out of the area; namely, the son of Mr. Ben Mansour avoided having to move away and the husband of Ms. Bougtif needed not return conflict-ridden Libya in search of employment.

In the medium and long term, more farmers and women entrepreneurs from the community and neighbouring communities are expected to embrace the REGEND business model, launching income-generation activities utilising renewable energy. Notably, as REGEND success stories started circulating throughout the community, new farmers became interested in solar PV water pumping systems, and some have already invested in them.

13.

Economic impact of field projects

13.
Economic impact of field projects

The overall impact on the local economies is associated with the direct monetary savings enabled by the renewable energy projects, as well as the direct benefits resulting from the capacity building workshops and the donated production equipment. By reducing operating costs, and boosting sales, revenues, and profits, these savings will provide the beneficiaries with the financial space to invest in growing income-generating activities that also create employment opportunities, as well as to increase spending on education and health and generally improve living standards; all of which will contribute to growing the local economy.

Jordan

Increased output and revenue are trickling down to the local economy. The number of active women increased from 15 to 25 at Al-Achaari CBO, and from 3 to 7 at Batir CBO, in each case involving additional households and improving their purchasing power. In addition, by venturing into catering, the average income of Al-Achaari CBO increased from JD50 to JD500 per working day, while the significant improvement of the quality of the dairy products at Batir CBO enabled it to generate a 30 per cent profit on dairy products sold for JD1000.

Lebanon

At a time of severe crises and soaring inflation, the local community in Akkar Al-Atika gets to purchase the products of the Women Agri-food Cooperative at prices 67-85 per cent lower than market prices, while safeguarding profit margins. Moreover, as indicated by the president of the Cooperative, it purchases the vegetables and fruits from local farmers, creating further value for the local community.

In the case of the Union of Beekeepers Cooperative, the growing gap between its prices and market prices, at a time of increasing electricity and diesel prices, is positioning it ahead of competitors, and its advantage will further expand with the upcoming hike in electricity tariffs.

In Chaqdouf, recruitment of 8 more part-timers at the sewing workshop, in addition to the 5 existing previously, has positively impacted the households concerned in a village of 100 households plagued with unemployment. The new revenue streams of the full-time employees are improving the purchasing power of 13 households in this small village. Moreover, the services offered by the Live Akkar workshop have saved the 15 rural women active in the industry third-party costs, thus increasing their household net income, which bolsters spending within the local community, especially as transportation costs have soared.

Tunisia

In Chorbane, increased output and revenue of the farmers are trickling down to the local economy. Expansion of their cultivated lands by between 60 and 200 per cent, and diversification and/or intensification of their agricultural crops improved the purchasing power of the households of the farmers and women workers. In addition, demand for labour, in particular that of rural women, will rise and work periods will be longer and better distributed over the year.

14.

Environmental impact and reduction of greenhouse gas emissions

14.
Environmental impact and reduction of greenhouse gas emissions

Jordan

Calculations of CO_2 emission reduction are based on the emission rate of 0.4585 kg CO_2/kWh adopted in Jordan's **Second Biennial Update Report 2020**, assuming also that it remains constant throughout lifetime. Table 6 presents system capacity, first-year electricity generation, and 25-year lifetime cumulative electricity generation.

Table 8 presents data for Batir.

Table 8. CO_2 emission reductions data in Batir

CO_2 emission reduction (kg)		
System owner	**First-year**	**25-year cumulative**
Batir CBO	3 000	69 951
Batir Farm	7 125	166 134
Al-Shurafa	3 000	69 951
Al-Hindawi	3 000	69 951
Total	**16 125**	**375 987**

Table 9 below presents data for Al-Achaari.

Table 9. CO_2 emission reductions data in Al-Achaari

CO_2 emission reduction (kg)		
System owner	**First-year**	**25-year cumulative**
Al-Achaari Farm	15 750	367 243
Al-Jawhara CBO	8 625	201 109
Shayesh Al-Jazi	3 000	69 951
Abed Al-Aziz Al-Jazi	1 963	45 762
Falah Al-Jazi	1 963	45 762
Aouda Al-Jazi	1 963	45 762
Ali Al-Jazi	1 963	45 762
Total	**35 227**	**821 351**

For the solar water heater in each of Batir and Al-Achaari, with the estimated annual electricity savings of 2,700 kWh, the annual CO_2 emission reduction is estimated at 1,238 kg.

With all figures combined, the overall CO_2 emission reduction is estimated at 1,259,236 kg over a 25-year lifetime.

Lebanon

The solar PV systems were commissioned only recently. Hence, actual data cover only a limited period, between August 2021 and the first week of February 2022.

The calculations are based on:

- A ratio of 90/10 of private diesel generator supply to EDL supply.
- Emission rates[5] that remain constant throughout lifetime of 0.669 kg CO_2/kWh for EDL and 0.712 kg CO_2/kWh for private diesel generators, and
- Estimated electricity generation by the solar PV system annually and over a 25-year lifetime.

In Akkar Al-Atika, the annual CO_2 emission reduction would amount to about 26,000 kg annually, and about 606,000 kg over a 25-year lifetime. The corresponding figures for Chaqdouf would be about 10,000 and 242,000, respectively; and for the two combined, the figures would amount to about 36,000 and 849,000, respectively.

Tunisia

REGEND field projects have reduced pollution and CO_2 emissions in Chorbane.

Mr. Ben Mansour and Mr. Baccouche no longer need diesel generation, thus eliminating all associated emissions, while Ms. Bougtif, Mr. Amor, and Mr. Ltaief, reduced emissions by lowering consumption of national grid electricity.

Table 10 presents CO_2 emission savings data in Chorbane, based on a grid emission rate of 0.374 kg CO_2/kWh.

Table 10. CO_2 emission reductions data in Chorbane

#	Beneficiary	Annual CO_2 emission reduction (kg CO_2)
1	Bougtif	559
2	Mansour	750
3	Baccouche	95
4	Ltaief	21
5	Amor	568
Total		**1 993**

For the projects at the SMSA (El Faouz) and the GDA pour l'Eau Potable (El Intilaka), which have not been commissioned, the estimated annual electricity generation figures are used to estimate annual CO_2 emission reductions to be 44,506 kg and 10,472 kg, respectively. Assuming that the grid emission rate remains the same over the 25-year lifetime, the estimated 25-year lifetime CO_2 emission reduction then amounts to about 1,036,000 kg and 245,000 kg, respectively.

15.

Partnerships

15.
Partnerships

REGEND identified key local stakeholders and formed LFTs that supported the initiative throughout, from baseline review, to selection of beneficiaries, to implementation of field projects and capacity building programmes.

These strategic partnerships added important value, enabling REGEND to formulate and design solutions and deliver key messages that are adapted to the national and local context of each targeted country and community. The result has been enhanced ownership by stakeholders and beneficiaries, creating a strong spirit of solidarity and synergy in the drive towards the common goal of improving livelihoods, economic benefits, social inclusion and gender equality of rural communities, by addressing energy poverty, water scarcity and vulnerability to climate change and other natural-resource challenges.

Jordan

Since completion of the capacity building programme, the CBOs have increasingly participated in local and national exhibitions, selling more at higher prices. The new economic partnerships they have formed will constitute a pivotal point in their path towards growth and prosperity. Equally important, the training workshops and events jointly organised with and for neighbouring communities and CBOs have also resulted in new partnerships for exchange of knowledge and experience, as well as for joint participation in exhibitions to increase volumes and magnify presence.

Additionally, Al-Jawhara CBO established itself as a caterer, regularly serving banquets and events in the community organised by local, national, and international entities, with which it has formed useful new economic partnerships.

On the national and regional levels, the partnerships formed with AOAD and ARABFFI for capacity building will facilitate development and organisation of new capacity building programmes and workshops using REGEND knowledge products and training content, which will be hosted on ESCWA's educational platform and made accessible online.

Lebanon

Joint activities by Akkar Al-Atika and Chaqdouf, such as planning meetings and capacity building workshops, have cemented relationships between the two villages. Akkar Al-Atika Women Agri-food Cooperative and the Live Akkar Women Sewing and Embroidery Workshop could potentially collaborate in, inter alia, mutual promotion of products and activities and co-organisation of exhibitions and events.

The Live Akkar Workshop is also approaching schools in the area and the Lebanese Army to secure contracts for supply of embroidered products, from uniforms to hats and bags, and the women full-time employees are being approached by various NGOs to deliver the Sustainable and Effective Methods in Embroidery and Weaving Workshop, sharing their experience with a larger audience of rural women.

Furthermore, it is envisaged that new partnerships will be developed through the improved digital access and social media marketing, which would create new markets for the beneficiaries.

Tunisia

On the national level, the strategic partnership among ANME, CGDR, and APIA, which was initiated and facilitated within the framework of REGEND and formalised by memoranda of understanding, will extend beyond the scope and timeline of the initiative and will significantly contribute towards adoption of a participatory and nexus approach in planning and implementation of small-scale renewable energy and sustainable development policies, programmes, and activities for rural areas.

Beneficiaries of REGEND solar PV water pumping projects were unable to develop new economic partnerships due to the travel and movement restriction enforced by the Tunisian authorities in response to the COVID-19 pandemic in 2021. However, they believe that, thanks to the increase in and diversification of their agricultural production, they will be able develop such partnerships in the future.

Endnotes

1 ESCWA, **REGEND Assessment Report of Prevailing Situations in Rural Areas in Lebanon**, 2020.

2 ILO, Jordan Young women's employment and empowerment in the rural economy, 2018. **https://www.ilo.org/employment/areas/youth-employment/WCMS_622766/lang--en/index.htm**

3 ESCWA, Study on Gender Mainstreaming, Social Inclusion, Human Rights Processes and Outcomes of Access to Energy in Targeted Local Communities in Jordan, 2020. **https://www.unescwa.org/publications/gender-mainstreaming-social-inclusion-jordan**

4 ESCWA, Study on Gender Mainstreaming, Social Inclusion, Human Rights Processes and Outcomes of Access to Energy in Targeted Local Communities in Tunisia, 2020. **https://www.unescwa.org/publications/gender-mainstreaming-social-inclusion-tunisia**

5 Since the electricity mix of each country is made up of different technologies with varying capacities and resulting emissions, the CO^2 emission rate for each country will be different.

Through implementing projects that address energy poverty, water scarcity and vulnerability to climate change, as well as other natural-resource challenges for marginalized groups in the rural communities in Jordan, Lebanon, and Tunisia, ESCWA's Regional Initiative to Promote Small-Scale Renewable Energy Applications in Rural Areas of the Arab region (REGEND) aims to improve livelihoods, boost economic benefits, and to promote social inclusion and gender equality.

Within the framework of the initiative, solar energy field projects and capacity building programmes have been implemented to reduce or even eliminate the cost of energy while developing skills and knowledge relating income-generating activities among the beneficiaries. In addition, the initiative included the procurement and donation of production equipment to rural women to facilitate production activities, reduce production time, and develop new production lines.

This report seeks to assess the social, economic, and environmental impact of REGEND's activities in such rural communities. It presents REGEND's sustainable impact on income-generating activities, energy consumption, women empowerment, and the environment.

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