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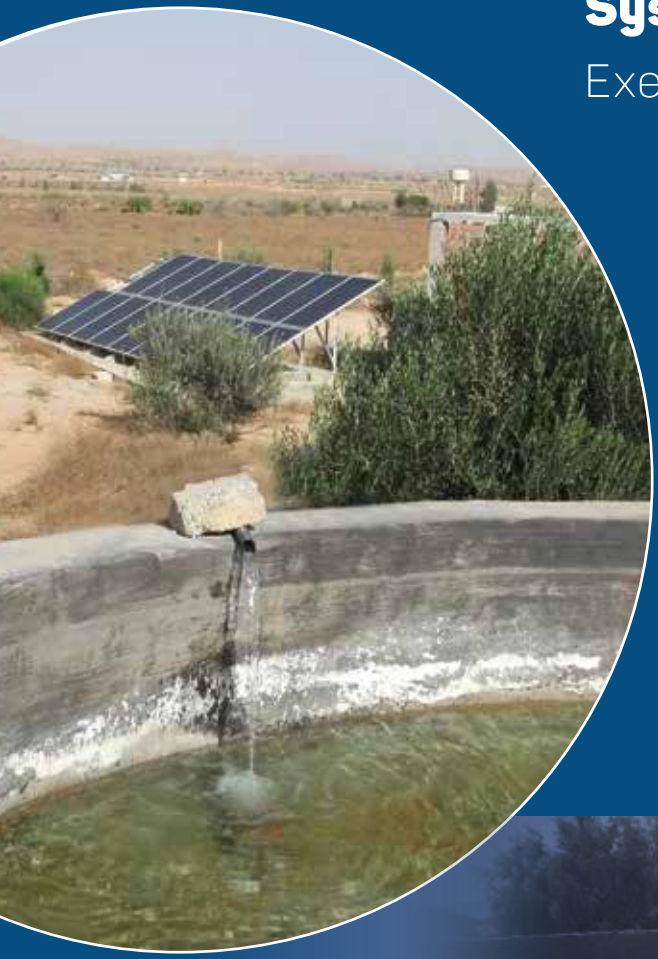
# Impact of Solar Pumping Irrigation Systems in Tunisia

## Executive Summary



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**Headquarters:** Bonn and Eschborn, Germany

**Global Nexus Secretariat**
c/o Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH
Dag-Hammarskjöld-Weg 1-5
65760 Eschborn, Germany

+49 6196 79-1878
nexus@giz.de
@NEXUSPlatform #Nexusplatform
www.facebook.com/nexusresourceplatform/
www.nexus-dialogue-programme.eu
www.water-energy-food.org

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**Authors**
Tarek Keskes (GFA), Hakim Zahar (GFA), Abdelkarim Ghezal (GFA), Khaled Bedoui (FAO)

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# Context of the Study and Methodological Approach

This case study analyzes the impact of solar-powered irrigation systems (SPIS) on the groundwater use as well as its impact on a socio-economic level in Tunisia. It is based on interviews with a sample of Tunisian farmers and provides recommendations to promote the sustainable use of the technology.

The study is part of an evaluation mission of the Water-Energy-Food Nexus (WEF Nexus) in Tunisia commissioned by the "Nexus Dialogue in the MENA region", co-funded by the European Union and the German Federal Ministry for Economic Cooperation and Development (BMZ) and jointly managed by EU DEVCO and GIZ. This study has been carried out in close collaboration with the Food and Agriculture Organization of the United Nations (FAO), through its project "Realising the potential and managing the risks of solar irrigation in the Near East and North Africa".

The preparation and execution of the study during its various phases were carried out in consultation and coordination with several Tunisian institutional partners: the Ministry of Agriculture, Hydraulic Resources and Fisheries (MARHP), in particular the Directorate General for Rural Engineering and Water Operations (DGGREE), the National Agency for Energy Conservation (ANME), the Agricultural Investment Promotion Agency (APIA), the Agricultural Extension and Training Agency (AVFA) and the Tunisian Union of Agriculture and Fishery (UTAP). All stages of this work were discussed and approved these partners. In addition, two larger workshops were held to consult further stakeholders and follow a participative approach.

The study is based on a desktop data analysis and field survey. The latter was carried out on 24 farms of which 20 benefited from subsidies to install their SPIS and had thus authorized wells, while 4 had non-authorized wells and did thus not benefit from any subsidies.

A data analysis and sample of subsidized systems for the survey were built on the database of the National Agency for Energy Conservation (ANME). Between 2010 and 2017, ANME granted subsidies for 124 solar powered irrigation systems. Three criteria were used to take the sample of 20 farms: geographical distribution, installed capacity and period of operation.

### A total of eight governorates were visited:

Gabes, Gafsa, Kairouan, Kebili, Sfax, Sidi Bouzid, Sousse and Tataouine. The sample of systems is quite limited, but leads, however, to certain trends and assumptions. Nonetheless, it is advised to further study the impact by monitoring campaigns over a longer period (before and after installation) as well as looking at a larger sample of non-authorized systems.

# The Situation of Solar-Powered Irrigation Systems in Tunisia

Irrigated agriculture plays an important role for Tunisia's economy, its trading economy and food security. It is highly related to the availability of groundwater, in particular in the central and southern areas of the country. The cost of off-grid pumping is increasing due to the continuous fade-out of diesel subsidies. The use of SPIS has thus become economically viable compared to diesel systems.

Due to a highly subsidized electricity tariff for pumping, grid-connected SPIS still have long payback periods and are thus not economically feasible.

The photovoltaics (PV) market has registered an important evolution since 2009 after the adoption of a respective promotional framework. Two funds grant subsidies to enhance the installation of SPIS: the Energy Transition Fund (FTE), managed by the ANME, and the Tunisian Investment Fund (FTI), managed by the APIA for investments in the agricultural sector.Improving their economic viability further, these subsidies made SPIS a reliable option for irrigation far from the national electricity grid.

All farms selected for the field survey received FTE subsidies prior to a reform in 2017 that set out revised caps and conditions. The impact of the reform could thus not be measured in this study.

# Water situation in the Southern and Central Areas of Tunisia

Large parts of the central region of Tunisia are characterized by a critical water situation. The strong exploitation of groundwater resources in Kairouan and Sidi Bouzid is putting a strain on water resources. In Sousse and Sfax, on the other hand, rainfed agriculture is practiced and has a crucial share in the development of the regional economy, in particular in the production of olive oil.

Tunisia's southern region is prone to the depletion of groundwater resources. The water extracted is mainly used for the production of dates in Kebili, and for a new intensive, irrigated agriculture scheme in Gabes.

In Tataouine, irrigated agriculture is a recent activity and groundwater resources are estimated to be not yet intensively exploited.
The number of SPIS, however, increases steadily.

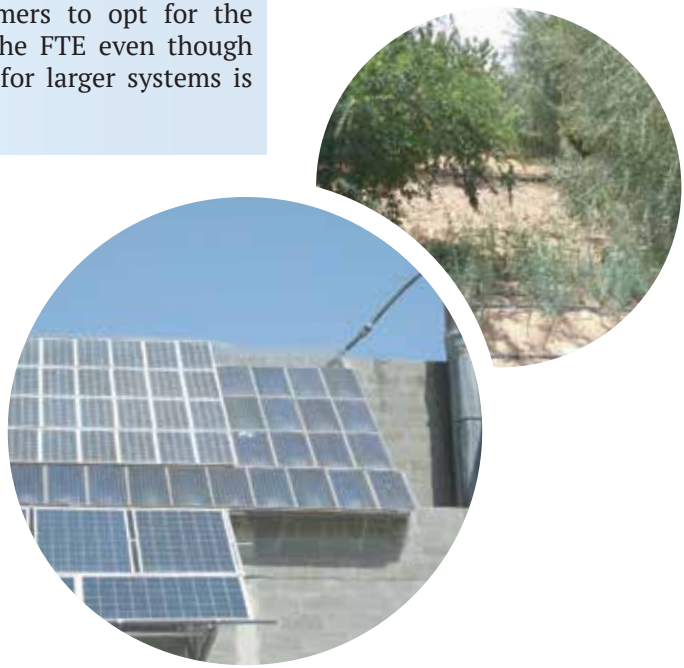
# Results of the Study

## REGULATORY FRAMEWORK AND INCENTIVE SCHEME FOR SPIS

A desktop analysis of converter imports implies that the number of SPIS actually installed is significantly higher than estimated in national statistics. Between 2015 and 2018, 1 340 SPIS converters benefitted from tax privileges at import. The large number of systems installed beyond the subsidy schemes vvchallenges the necessity of investment subsidies for off-grid SPIS in place and leads to the assumption that a large number of systems has been installed at non-authorized wells.

SPIS benefit from high subsidies. However, slow administrative procedures are a major constraint and indirectly promote the achievement of SPIS outside the incentive system.

As for the FTI, the complexity of administrative procedures and terms and conditions encourage some farmers to opt for the subsidy granted by the FTE even though the amount granted for larger systems is generally higher.



## FINANCIAL AND SOCIO-ECONOMIC PARAMETERS

The main motivation for installing SPIS, especially for farms using diesel systems, is to save energy costs. The investment costs of SPIS are considered to be high. The fragmentation of agricultural holdings considerably limits the large-scale dissemination of SPIS as small-holders cannot stem the investment. The major part of systems was installed at larger farms with higher revenues. These farms financed their SPIS foremostly through equity. Some of them, mostly larger farms, benefitted from instalment plans over two to three years offered by the installing companies. None of the farms gained access to a bank loan to finance the system.

The sizing of the solar installation is generally proposed by the installer following the farmers' observations and indications related to the intended water exploitation. In one out of four cases, the capacity of the SPIS was downsized due to lack of budget or for the investment to remain under the cap of the FTE subsidy.

All farmers were satisfied with the technology installed. Almost all of them intend to reinvest in the technology.
Experiences of neighboring farmers are an important factor in decision making.

## WATER USE AND MANAGEMENT

Access to SPIS has enabled a third of the surveyed farmers to start exploiting arid or unused agricultural land. SPIS thus support the expansion of agricultural activity, but lead to an increase in water consumption. Almost 90% of farmers pump more water than prior to the installation of the system. Farmers tend to believe that water resources are free and inexhaustible. They are widely not aware of the water stress level in their regions and do not pay their water fees as set out in the Water Code.

Subsidy schemes in place require specific prerequisites that include installing a water meter and the use of authorized equipment. During on-site visits prior to the authorization of the subsidy payment, the systems are checked regarding these conditions. After these on-site visits, a major part of the farmers deinstall water meters or do not use them at all to verify the extracted amounts.

Farmers strongly believe that an intensified water supply for the plant subsequently improves the yield. Nonetheless, SPIS partly enhanced the value of water by encouraging farmers to choose higher value crops.

According to the Water Code, authorized wells have to be equipped with water-saving irrigation systems. All visited farms used drip irrigation systems. However, only two thirds of farmers use water storage systems. Given the additional cost on top of the high upfront investment of the SPIS, the other third does not intend to invest in a storage system at all or prefers to postpone the construction. Moreover, two thirds of water storage systems installed are undersized due to budget constraints.

None of the individual well owners would change towards a collective system. Most of them fear problems in managing common property and a limited availability of water.

## RECOMMENDATIONS

Based on the results and conclusions of the study, a set of recommendations was developed. These concern the incentive scheme, research and development as well as the areas of capacity development and awareness-raising.

## REGULATORY FRAMEWORK AND INCENTIVE SCHEME

### Ensure compliance with the law:

It is necessary to apply the law, in particular the national Water Code, and to sanction those who do not comply with these regulations. The Water Code regulates the payment of extraction fees for irrigation that are largely not applied today. Therefore, SPIS lead to operation costs close to zero. Without a price tag on the cubic meter pumped or electricity used, there is thus no budgetary limiting factor for the extraction of water.

### Ensure the means of control:

Controlled access to water must precede the introduction of high-tech irrigation. Promoting high-tech upgrading in the absence of control mechanisms will necessarily lead to overexploitation. The role of control and enforcement needs to be clearly passed on to institutions in place that should carry out regular checks and penalize illegal actions. These checks could be carried out on a random sample basis.

### Non-authorized wells:

It is essential to identify, investigate and close illicit wells equipped with SPIS in close coordination with various actors. The adoption, publication and enforcement of the new Water Code would limit the expansion of nonauthorized wells. Furthermore, it is recommended to control the sale of variable speed drives, which should be exclusive for authorized wells.
A register should be set up and on-spot-checks carried out to prevent violations.

### Set regional SPIS caps and develop a holistic planning tool for SPIS:

Authorities should set caps for the expansion of SPIS by region. Comprehensive planning tools are needed to take into account the links between energy, water and agricultural production, as well as finance, technology and policy. It is recommended to develop a holistic planning tool that integrates both: solar pump and irrigation technology.

### Adapt the technical reference system of the incentive scheme:

The technical reference framework for SPIS subsidies should demand system sizing based on the authorized flow rate and agricultural activity. Furthermore, the installation of a water storage system and sustainable water management plans should become mandatory. ANME and APIA should include these parameters in their demand verifications.

### Strengthen cooperation between ANME and APIA:

A close cooperation between the two institutions in the verification of FTE and FTI subsidy applications and the coordination of on-site checks ensures the compliance of systems installed.

### Reduce the duration of the subsidy procedure:

It is recommended to increase the number of ANME staff to accelerate the procedure of granting subsidies. Speeding up the process would be beneficiary for farmers in the light of their financial situation.

### Encourage collective SPIS:

Subsidies should favor collective management of SPIS to limit the number of wells. This initiative could be promoted by granting preferential subsidy rates to farmers wishing to switch from individual to collective pumping.

## RESEARCH AND DEVELOPMENT

Encourage and foster the implementation of electronic control devices that transmit real-time information on reservoir levels, pump flows and drilling water. This information can be used to make regulatory decisions, remote control of the amounts pumped and anticipate excessive water use.

### Perform geodetic identification of all wells in operation:

It is recommended to develop a map of operating pumps.
These maps can be used to raise awareness of farmers and avoid the over-exploitation of common water resources.

### Encourage audits of large farms equipped with SPIS:

It is recommended that incentive tools are put in place to promote audits of large farms in order to assess the impact on energy, water and agriculture, and to identify measures to improve the sustainability of the farm.

## CAPACITY DEVELOPMENT

### Raising awareness for technology and agricultural options:

Knowledge of SPIS technologies and their adaptability to different agricultural systems, sizes and crops is limited by the lack of training of installers, agricultural agents and farmers. Targeted training measures can contribute to a better use of SPIS' potential and to the management of its risks.

### Strengthen the capacity of agricultural supervision and extension:

In order to raise awareness among farmers and provide them with guidance on irrigation techniques and the determination of the need and frequency of irrigation, it is recommended to revitalize local agricultural agencies.

### Show good practice:

A series of demonstration projects in strategic regions could improve the situation by providing examples of good practice. Some of these projects could be dedicated to research and development to test and demonstrate the advantages and added value of innovations.

Global Nexus Secretariat
**C/O** Deutsche Gesellschaft für Internationale
Zusammenarbeit (GIZ) GmbH
Dag-Hammarskjöld-Weg 1-5
65760 Eschborn, Germany

+49 6196 79-1878
nexus@giz.de
www.facebook.com/nexusresourceplatform/
@NEXUSPlatform #Nexusplatform
www.nexus-dialogue-programme.eu
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