

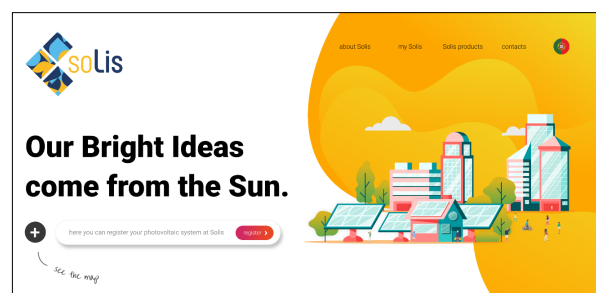
CASE STUDY



Lisbon Solar Platform

SOLIS will support the development of an inclusive solar community in Lisbon (Portugal)!

“As an alternative to fossil fuels, Lisbon has potential for capturing solar energy as few other capital cities in the European scene” José Sá Fernandes, Deputy Mayor for Environment, Green Structure, Climate and Energy, Municipality of Lisbon



Using appealing graphics and intelligible key figures, SOLIS offers citizens, local authorities, investors and businesses, three different mapping products, at three different zoomable levels – the city, the parish, the building:

- an updated solar radiation map ², delivering the impinging amount of solar energy in the city's roofs (fig. 2);
- a solar electricity generation map, both potential and (estimated) actual energy, with the additional functionality of estimating key self-consumption figures at building level for a specific citizen profile;
- an informative map of PV installations in the city and its evolution over time.

In addition to solar mapping functionalities, SOLIS further offers:

The Summary

Lisboa E-Nova, the Energy and Environment Agency of Lisbon, is launching in 2019 SOLIS, the Lisbon Solar Platform ¹ (fig. 1). SOLIS has the mission of promoting a wider acceptance and massive adoption of PV systems in the city towards an inclusive solar community and is a central instrument in attaining the goals of Lisboa Cidade Solar®, Lisbon's Solar Energy Strategy for 2030.

¹ In the scope of the project “SOLIS - Solar in LISbon”, co-promoted with Municipia, S.A. and co-funded by the Portuguese Environment Fund (Fundo Ambiental)

² In 2012, Lisboa E-Nova delivered the first Lisbon's Solar Radiation Map in the scope of the European Intelligent Energy Europe project

POLIS “Identification and mobilisation of solar potentials via local strategies”. In SOLIS the radiation map has evolved, considering the new city form and delivering higher spatial and time resolutions.



- Means for the Lisbon community to participate and source the solar dynamics of the city – by registering their own systems, by participating in the digital social market delivered by SOLIS.app, by giving their testimony;
- Insightful information on market rules and dynamics;
- Educational content and media, including appealing infographics and an animated short-film.



Extract of the Solar Radiation Map of Lisbon

The Context

Lisboa Cidade Solar® is Lisbon's solar strategy and an integral part of the Sustainable Energy and Climate Action Plan (SECAP), approved by the municipality in June 2018 and subsequently submitted to the Covenant of Mayors³. Departing from the national legal framework in force, that sets the rules for licencing self-consumption PV systems, as well as creating the grounds for an incentive to renewable electricity-fed electric public transport, the following goals are established in Lisboa Cidade Solar⁴:

- By 2021, a cumulative PV capacity of 8 MW installed in buildings;
- By 2021, a capacity of 2 MW installed in a centralized power plant feeding the public fleet of electrical buses and waste management trucks, promoted by the municipality;
- By 2030, a cumulative capacity of 103 MW installed in the city.

The strategy builds upon the theoretical grounds of the diffusion of innovations⁵, thereby recognizing that the rate at which PV will be diffused to the city is a function of the nature and attributes of the technology, of the nature and origin of the channels used to communicate it over time to a given social system, and of the efforts of the change agent, a role that the municipality appropriates.

In this context, SOLIS emerges as a central strategic piece, that will lead the city stakeholders through the decision-making process, reducing the perceived risk and inducing the willingness to adopt PV. SOLIS has therefore the mission of promoting a wider acceptance and massive adoption of PV systems in the city towards an inclusive solar community and is a central instrument in attaining the goals of Lisboa Cidade Solar®.

The first stage of the adoption process implies acquiring knowledge about the technology being diffused. The lack of widely available and high quality legal, market and technological information about PV in Portugal sets the motivation for uniting in one platform several information layers that are appealingly communicated, while establishing the channels for feedback loops and community participation.

SOLIS builds upon social innovation and transdisciplinary approaches, involving many stakeholders and strategic partnerships, such as local authorities, investors, entrepreneurs, marketers, companies, installers, distributors, consumers, universities and research centres.

The Challenges

Lisbon is a fast evolving city, with many new urban developments being planned and implemented, changing profoundly the city landscape and as such its potential to receive and capture solar energy. The first challenge was then to access updated cartography that delivers a meaningful snapshot of the city solar radiation map. In

³ http://www.cm-lisboa.pt/fileadmin/VIVER/Ambiente/Alteracoes_Climatericas/Relatorio_PAESC.pdf

⁴ http://ec.europa.eu/environment/europeangreencapital/wp-content/uploads/2018/07/Indicator_11_Lisbon_EN.pdf

⁵ Rogers, E. M. (2003). *Diffusion of Innovations* (5th Edition ed.). New York: The Free Press.



addition, an ambition was set to derive hourly radiation maps on every surface of the city, enabling future studies on the aggregation of consumers and on the establishment of positive solar communities. Both were successfully accomplished.

Mapping and characterising solar PV installations in Lisbon is another significant challenge. The PV systems installed in the city have been put in place in the framework of three distinct licencing regimes⁶ for which asymmetries exist regarding the information publicly available, or otherwise accessible through official sources (e.g. the Directorate-General for Energy and Geology, DGEG). Although the overall installed capacity in each licensing regime is known at city level, geo-referencing information is only available for the legal framework currently in force (self-consumption). Further, system characteristics are limited to the interconnection power, with no further information on its configuration, such as PV panels and inverters installed. This challenge is still being tackled, not only by working together with the national authorities but also recurring to tools sourced through SOLIS, such as the SOLIS.App and the system registration functionality.

Furthermore, another significant challenge arises when trying to devise a reliable way to estimate the self-consumption performance figures of rooftop PV systems. Ideally, the hourly radiation profile impinging on the selected roof would be used to deliver the hourly PV electricity production, which would further be compared with the hourly consumption profile of the citizen interacting with SOLIS, subsequently delivering the investment economics and performance. Both the electricity and consumption profiles are nonetheless hard to obtain – the first being presently the subject of a PhD thesis, the second not being widely metered and communicated at low-voltage consumer level. To overcome these difficulties, a simplified empirical model has been developed, that makes use of a set of metered data of residential prosumers. This tool will inform the citizen about expected ranges of self-consumption and self-sufficiency rates,

investment and environmental performance, thereby answering the following most common questions:

- Does my rooftop have high solar potential?
- How much does the PV system cost?
- Will the return of investment be long?
- What are the monthly or annual savings?
- Am I avoiding significant CO₂ emissions?



The Model

The method followed in SOLIS to develop the solar radiation map makes use of high-resolution airborne photogrammetry and GPS /INS data. This input data allows for the characterization of the surface's altimetry through the creation of a Digital Surface Model (DSM). The DSM can be adjusted and/or crossed with vector data in the building cadastral plan to determine the orientation and slope associated with each intersection point; using either custom numerical algorithms or a solar analysis tools in Geographical Information System (GIS) software, the incident radiation on the buildings can then be estimated. Specific solar parameters for the local analysis and the shadowing effects from the surroundings must be included given their potential to reduce solar availability.

The solar electricity generation map makes use of the average productivity (i.e. kWh/kW installed) observed for the micro and mini-generation installations, which can be derived from officially available information. The estimated annual

⁶ The three licensing regimes are the microgeneration (2008-2014), minigeneration (2011-2014) and self-consumption (2014-present).

The first two regimes offered a feed-in tariff incentive scheme, whereas self-consumption is market based.



electricity production is then derived based on the installed capacity in the city for a given year.

The self-generation estimation tool targets the residential consumers and uses an empirical model based on a set of metered data of residential prosumers – namely total solar electricity production, total electricity consumption and total solar electricity exported, allowing for the derivation of self-consumption and sufficiency rates – and of metadata available for the same prosumers – in particular contracted power and installed PV capacity. The SOLIS user selects a rooftop and inputs information on its contracted power, annual electricity consumption and on occupancy characteristics. The model then outputs expected ranges of self-consumption and self-sufficiency rates, investment and environmental performance.



Credits: Fulvio Ambrosanio, Unsplash

The People Behind

SOLIS Project was carried out by a multidisciplinary team of experts in Solar PV technologies, Geographic Information Systems, Cartography, Business models and Communication and Marketing.

The Clients

Many will benefit from the content offered by SOLIS:

- Lisbon Municipality and parish Councils will have an instrument for evaluating the solar potential in the city as well as the evolution of the installed PV capacity, providing insightful information for the policy and decision-

making process. SOLIS can be further integrated with other management platforms from the municipality;

- Central public administration will have an instrument that will allow the evaluation of the actual potential of the capital city to contribute to the National 2050 carbon neutrality vision and provide information on how to best design policies and support instruments to promote the energy transition strategy inscribed in the National Energy and Climate Plan;
- Consumers will be given the possibility to estimate the electricity production from their rooftop and the associated investment and revenue. Also, a sense of place and belonging is introduced by inducing competition between parishes over the total installed capacity and its characteristics. The educational dimension is intrinsic to the SOLIS platform so that citizens acquire information, knowledge and willingness that will potentially lead to adoption of PV systems;
- Investors, financiers and entrepreneurs will ensure the synergies that allow the technological scalability of the project and its future sustainability;
- Energy traders and the DSO will be able to access data to identify areas of critical potential for the investment in solar energy solutions and/or areas that present challenges to the grid management;
- Other market agents will also become aware of the most interesting areas to promote business activity and to foster a market place for future commercial development;
- Universities and research centres will be provided with open data for their projects in the municipality, creating an opportunity for articulation with local companies.

The Money

SOLIS was developed by Lisboa E-Nova in partnership with Municipia and co-financed by Fundo Ambiental, Portuguese Ministry Environment, 2018.



Since the SOLIS project is mainly an innovation technological project and a tool to support the solar policy in Lisbon, the business model behind was designed exclusively to support the platform maintenance and to create an investment reserve for further improvements of the project. In the future two main sources of revenue are identified and will be explored – a qualification system of companies that provide solar services in the city and advertising.

The Replication Potential

With the SOLIS digital platform, Lisboa E-Nova presents a new integrated approach with high potential for reproducibility. Virtually it is replicable in any municipality willing to proactively act and be empowered when paving the way in this energy transition era.

The Impact

SOLIS is a central element in the strategy inscribed in Lisboa Cidade Solar® and in the SECAP. It is expected that it will be the driving force for the city to deliver in 2030, 103 MW of cumulative installed PV capacity towards carbon neutrality in 2050, the vision that underlies the SECAP.

The Figures

- ✓ Lisbon is sunny! The total solar radiation impinging in the city rooftops represents an amount of energy equivalent to **7 times** the city's electricity consumption in 2016.
- ✓ **44%** of Lisbon's roof area has good or very good solar exposure (irradiance higher than 1400 kWh/m²).
- ✓ If all available roofs had PV, the solar electricity produced would represent **95%** of the city's electricity consumption in 2016.
- ✓ Presently there are **4 MW PV** installed in Lisbon, of which 23% were licenced under the microgeneration regime, 42% under the mini-generation regime and 35% in the self-consumption regime.
- ✓ The 4 MW PV installed capacity corresponds to **322 systems**, of which 78% are

microgeneration systems, 3,68 kW being the most common interconnection capacity declared per system.



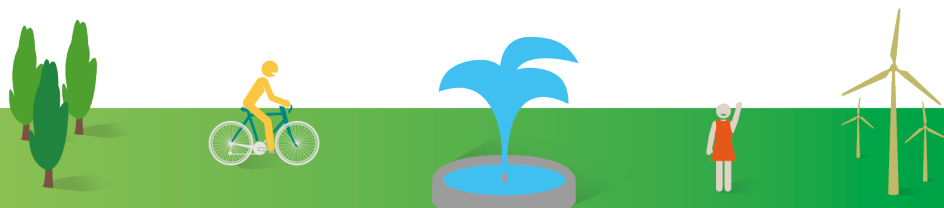
The Next Steps

For the launch of SOLIS (April 2019), a marketing campaign has been planned, including various public events and activities for the citizens of Lisbon to inform about solar communities' potential and to challenge them to find and photograph PV systems in the city, in exchange of crypto currency and to contribute to the installation of a PV system in a building of the parish selected by the citizens.

In order to increase social acceptance and confidence in the technology, SOLIS-CERT-PRO, a voluntary certification system for PV systems' turnkey-providers, is being devised. When in place, the certified companies will be listed in SOLIS as the recommended entities in the marketplace.

Several developments are foreseen in the future. With regard to solar radiation potential, it is envisioned that in the future façades will be included in the maps, for which a 3-D functionality will have to be introduced.

With regard to PV electricity production potential, an evolution is expected from the now available theoretical potential to the technical and market potentials. The technical and market potentials represent limitations to the theoretical potential by including in the estimates constraining



parameters such as building construction and structural data, listed building preservation orders, geometric limitations for siting PV arrays in the available rooftop surfaces, consumers' purchasing power, among others.

The model behind the self-consumption estimation tool is also expected to evolve to a more deterministic one, an endeavour that will be open to the academic community in Lisbon.

Also, further improvements are expected to be developed regarding SOLIS interoperability, in order to allow exchanges of information with other platforms and other services, as well as the possibility of integrating open data that will constitute new levels of information complementary to those offered by SOLIS. It is an example of interoperability, the future need to integrate the SOLIS platform with the open data portal of the Lisbon City Hall (<http://dados.cm-lisboa.pt/>), thus reinforcing the potential synergies between the two platforms.

Finally, a vision exists for integrating in the future online data acquisition of the PV systems in the city. The municipality PV installations will constitute a pilot for these developments, as well as selected members of Lisboa E-Nova.

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