the celebrated *portugaises* oysters (*Crassostrea angulata*) form the Tagus, which once served as Europe's largest natural bank for these mollusks, may be harvested again. Perhaps, even the river nymphs - the *tágides* sung by the Renaissance poet Luís de Camões, in his epic poem "Os Lusíadas" (*The Lusiads*) -, shall swim its waters one more time, at the mouth of the Iberian Peninsula's longest river, on the westernmost point of Eurasia - where they once welcomed Ulysses.

38 Assessing Impacts of Urban SUNstainability

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ABSTRACT

This paper discusses the concept and how to evaluate Urban SUNstainability. Generically understood as a process for attaining sustainable development in urban areas, via the intense production and use of solar energy, Urban SUNstainability is presented as a convincing urban policy strategy for a greener, sustainable and prosperous world. Based on existing experiences in areas with abundant levels of solar radiation, it was found that, by now, the use and production of solar energy in urban areas starts to be economically viable and should be regarded as an adequate solution to implement a greener and sustainable territorial development process in urban areas. As a way to assess the potential and current levels of Urban SUNstainability in urban areas, the paper proposes a multi-dimensional policy evaluation framework, based on five crucial aspects: the solar energy generation capacity, the direct and indirect environmental, economic and social benefits from implementing Urban SUNstainability strategies, and the soundness and effectiveness of the urban planning and governance processes related to the implementation of this process.

Keywords: SUNstainability, Sustainable Development, Territorial Development, Urban Development, Solar Energy

1. Introduction

The purpose of policy evaluation is to verify the *raison d'être* of an intervention (European Commission, 1999). Unlike the assessment of mere outputs or results, however, impact assessment looks to answer the 'big' evaluation questions. In essence, impact evaluation consists of judging the effects of the evaluated intervention in crucial development trends, such as the quality of life of citizens, the reduction of environmental footprints, improvements in governance or spatial planning processes, or increasing employment in a certain territory, for example (European Commission, 2008). Although impact assessment can focus on a specific dimension of development, such as the economy (economic impact assessment), or the environment (environmental impact assessment), recent policy impact evaluation trends have brought to the fore the advantages of a more holistic and comprehensive approach which focus on more than one dimension of territorial development (Medeiros, 2019). These impact assessment methodologies as often calleted Territorial Impact Assessment (European Commission, 2013; Medeiros, 2020a).

Following from the above remarks, this paper presents a methodological approach to assess the main Impacts of Urban SUNstainability, which is generically understood as a 'process of attaining sustainable development via the intense production and intense use of solar energy within urban areas' (Medeiros, 2020b). By entailing a multi-dimensional and multi-governance development perspective, the proposed conceptual policy evaluation framework can be applied to assess urban areas' SUNstainability capacity. Methodologically speaking, this 'Urban SUNstainability conceptual framework' is designed based on a wealth of literature, namely on sustainable and smart cities, and also on the use of solar energy in urban areas.

Profoundly preconditioned by an age of global warming and increasing vulnerability to climate related hazards, mankind has a choice to mitigate and invert the potential negative resulting impacts by replace the use of fossil fuel energy sources by renewable sources of energy, towards a more sustainable development (United Nations, 2016). In an increasing urbanized world (Urban Agenda, 2016), cities need to make choices about the use of green sources of energy and infrastructure in order to improve quality of life of their citizens, maximize economic opportunities, and minimize the impact of the population on the natural environment (Sachs, 2015). Indeed, by now, the majority of carbon emissions and the bulk of energy consumption occur in urban areas (Vesco and Ferrero, 2015). Under this scenario, the use of solar energy is increasingly seen as a viable and clean energy source to power cities, through solar thermal systems (solar water heating, solar refrigeration) and photovoltaic (PV) systems (Govada et al., 2017).

Substantially, solar energy can be an important component for promoting sustainable or green urban communities (Zahran et al., 2008). Analogous ideas emerge in

point out several advantages for using solar related technologies in urban areas: (i) can be efficient in large areas of the world; (ii) require no special skill set to generate or provision power; (iii) need no security measures (Stimmel, 2016); (iv) can perform without excessive maintenance costs for prolonged periods (Pelton and Singh, 2019); (v) can help to reinforce national security, economic growth, climate stewardship, sustainable land use, and economic development (Zahran et al., 2008); (vi) contribute to an urban energy transition towards experimentation in sustainability governance (Quirós et al., 2018); and (vii) have the potential for the creation of new green jobs (Park and Eissel, 2010). In addition to environmental and cost benefits, reducing demand for energy in buildings has three direct positive effects: (i) eliminating or requiring smaller mechanical service systems; (ii) making the buildings themselves more robust and resilient, in that they require less heating or cooling; and (iii) reducing the number of new power stations required to generate electricity (Bothwell, 2015).

In sum, SUNstainable cities can be seen as a concrete solution to embracing zero carbon footprint green urban systems and zero carbon buildings (Govada et al, 2017); a vehicle to promote integrated sustainable urban development strategies (Medeiros and van der Zwet, 2020a, 2020b); and ultimately, sound territorial planning (Faludi, 2018) and development (Warf and Stutz, 2012). In order to be successful, however, SUNstainable cities should create partnerships with the academic and business arenas, and stimulate city dwellers in implementing solar energy solutions in their activities. From a governance standpoint, cities supported by solar energy systems can allow for the mitigation of over policy centralization, as they can become semi-independent in providing electrical power to the grid on an as-needed basis (Pelton and Singh, 2019).

The article is organized as follows. The next section will address the Urban SUNstainability conceptual framework for policy evaluation. The following section summarizes the policy support to renewable energy and the potential Urban SUNstainability in Portugal. The final section concludes the article.

2. The multi-dimensions of Urban SUNstainability

As previously mentioned, generically speaking, the concept of 'Urban SUNstainability' can be understood as a process of attaining sustainable development via the intense production and intense use of solar energy within urban areas. As such, a fully SUNstainable urban area would not need to rely on any other energy source than solar energy, in an ideal scenario. For certain areas of the globe with wide solar exposure and intensity, that is not a far cry scenario. Emanating from our previous discussion, it is also clear that the notion of SUNstainability is multi-dimensional, as it does not solely regard the assessment of the solar energy generation capacity of the analysed urban area, but also other development dimensions related to planning and governance, environment, social

and economic aspects. Hence, and reflecting an integrated and interdisciplinary approach, from a methodological standpoint, the proposed Urban SUNstainability conceptual framework is supported by five analytic dimensions (Figure 1):

Fig. 1 – The key dimensions of the SUNstainability concept. Source: based on (Medeiros, 2020b)

1. Solar energy generation capacity: this dimension is crucial to assess the degree of SUNstainability since this process largely depends on availability and intensity of solar radiation. Hence, one way of assessing this solar energy generation capacity is by calculating the solar radiation values in a specific urban area, for example, via the use of a Geographical Information System (GIS) software. The end result of this analysis would identify if the urban area can be fully powered by solar energy.

2. Urban planning and governance processes: the sound implementation of 'Urban SUNstainability' processes require appropriate urban planning and governance instruments, which can regulate and stimulate the use of solar energy by all interested stakeholders. In this light, the assessment of Urban SUNstainability should take into account in what measure the incorporation of regulations into urban plans are stimulating the use of solar energy use and production in the city. Likewise, it is fundamental to analyse if and how dedicated institutional capacity to coordinate stakeholders in implementing Urban SUNstainability governance processes is taking place.

3. Environmental benefits: in the end, Urban SUNstainability should be a key driver for achieving environmental sustainability processes within urban areas. As such, the analysis of this process requires the assessment of its direct and indirect impacts in improving environmental conditions (reduction of air and water pollution, and CO2 emissions, etc.).

4. Economic benefits: Urban SUNstainability processes should entail positive impacts in stimulating a greener economy, both via the creation of indirect and direct green jobs and business activities, and also by stimulating the reduction of the use of carbon-related energy sources in transport and economic activities across the urban area.

5. Social benefits: the analysis of Urban SUNstainability processes requires the analysis of the direct and indirect social benefits from the production and dissemination of solar energy related practices. In the end, these practices should contribute to improving the quality of life of urban dwellers, for instance in their health and income status.

As can be seen, the proposed methodological approach is innovative in a sense that is goes beyond the purely technical perspective on the use of solar equipment in cities (see Pitt et al., 2018; Chow et al., 2016; Ko et al., 2017) and the regulatory settings to promote their use (see Steffen et al., 2019). Instead, the Urban SUNstainability conceptual framework is intended not only to unveil the detailed solar energy capacity of each case-study, but also to shed light on existent or non-existent municipal planning/governance processes (regulatory and financial instruments) which aim to support Urban SUNstainability processes. Moreover, the proposed framework is completed by collecting information on the potential economic, social and environmental benefits of such strategies in urban areas.

3. The policy support to renewable energy and the potential Urban SUNstainability in Portugal

Portugal is known to be a sunny country. Yet, whist the exploration of eolic energy has been largely explored in many parts of the country, the full exploration of its solar energy production is still largely unexplored (Table 1). Having an ambitious goal to use 31% of energy from renewable sources by 2020, 10% in the transport sector, by 2017, Portugal has reached 27.3%, whereas the share of electric energy based on renewable sources reached 53.7% in 2018, against 38.5% in 2010 (Agência Portuguesa do Ambiente, 2019). These numbers show a clear tendency in Portugal for an increasing use and production of renewable sources of energy, in overall terms, as the data from Table 1 shows. However, the steady increase of eolic-based energy contrasts with the irregular production of hydroelectric-based energy, since Portugal has a quite variable weather system, prone to dramatic yearly changes in precipitation values. Then again, as previously mentioned, it is also clear that Portugal has not been capable of harnessing its tremendous photovoltaic energy production potential (Fig. 2), unlike other south European countries (Quirós et al., 2018).

Table 1 – Annual production of renewable sources of energy (GWh) in Portugal (2010–2019)

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Hydroelectric	16,547	12,114	6660	14,868	16,412	9800	16,916	7632	13,628	8814
Eolic	9182	9162	10,260	12,015	12,111	11,608	12,474	12,248	12,617	12,894
Biomass	2226	2467	2496	2516	2578	2518	2481	2573	2558	2624
Biogas	100	161	210	250	278	294	285	287	271	245
Urban solid waste	577	592	490	571	481	584	610	632	573	587
Geothermic	197	210	146	197	205	204	172	217	230	206
Photovoltaic	215	282	393	479	627	799	871	993	1006	1248
Total	28,754	24,692	20,411	30,610	32,453	25,514	33,503	24,309	30,637	26,366

Source: (Medeiros, 2020c).

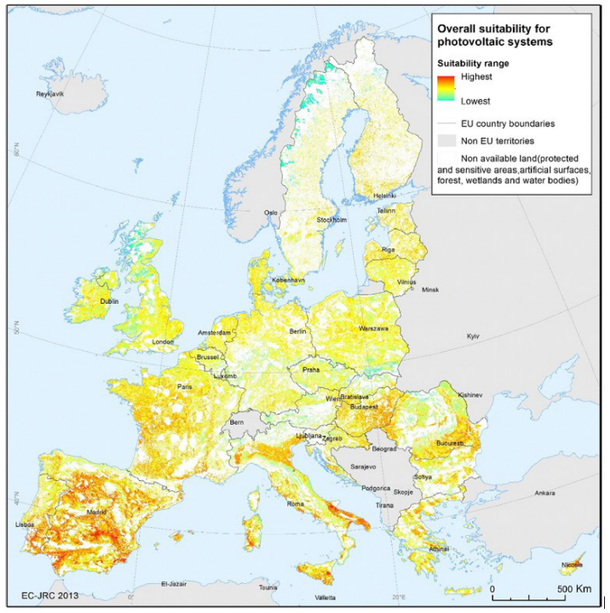

Fig. 2 – Spatial distribution at grid cell level (1km resolution) of the suitability for the installation of large-scale PV systems in Europe. Source (Castillon et al., 2016: 91).

This solar energy potential is extensive to the urban areas, which have an advantage of the presence of a myriad of roofs, many of them with a high exposure to solar radiation in parts of the day. In this stance, Lisbon engaged on the POLIS project, which joins six European cities (Lisbon-PT, Vitoria-ES, Lyon-FR, Paris-FR, Munich-GE, and Malmö-SE), in a quest to implement strategic town planning and local policy measures to utilize the solar energy capability of structures. In sum, the aim of the POLIS project is to "identify and evaluate current practices in solar urban planning, and unite the key responsible parties of this process to create a

more cohesive planning and legislation practice for solar developments. The physical structure of a building and its position within the urban pattern is clearly integral to its solar energy capabilities. Availability and orientation of external surface area is a crucial factor in the design of active solar systems and also important for the reception of passive solar energy. More than any other renewable energy, integrated solar energy relies on the qualification of the built environment".

This POLIS project is particularly interesting since it makes available to all interested stakeholders several instruments to promote solar energy in urban areas, such as: (i) municipal agreements or private law commitments; (ii) a best practice guide for solar urban planning in Europe; (iii) the presentation of solar action plans; and (iv) the presentation of several software programmes for analysing and simulating sun irradiation in a given urban area. In the end, the promotion and mobilisation of solar urban potential is engaged through the cooperation of cities that are currently engaged in solar urban planning.

Lisbon, as one of the cities integrated in the POLIS project, has created an Energy and Environment Agency (Lisboa E-Nova), which "seeks to contribute to sustainable development of Lisbon by mainstreaming good practices among political decision makers, major urban stakeholders and citizens. Lisboa E-Nova's objectives are met through projects and communication actions that promote the adoption of innovative concepts and actively contribute to the definition of new policies and development frameworks. By incorporating measures to adapt to climate change and actions to mitigate it, as well as supporting innovation and the development of projects that enable greenhouse gas (GHG) emissions to be reduced, Lisboa E-Nova is working towards achieving a low carbon city and one that is less vulnerable to the effects of the future climate. A city that is an example to follow on the path to decarbonization, while focusing on the welfare of the citizen[s] and future generations. Lisboa E-Nova is a key player in the city in the pursuit of national and international energy and climate goals for 2030 and 2050, and is active in three broad areas".

Most importantly, however, from this E-Nova initiative, was the creation of the SOLIS instrument, which includes the development of a two-component platform: (i) the update and improvement of a solar potential chart for Lisbon (Figure 3); (ii) and the development of a virtual space, capable of gathering and sharing technological solutions associated with the production of solar energy. In synthesis, the solar potential chart for Lisbon was developed in 2012, and serves as a support tool to assess the solar potential of edifices and other surfaces in Lisbon. With this chart, the city of Lisbon expects to establish appropriate goals and policies when it comes to the adoption of solar energy. Additionally, this tool will allow the owners of the buildings and other spaces to compare their electric consumption profile with the photovoltaic potential of their location, in order to obtain the optimal solar photovoltaic system.

The good news is that, at the national level, Portugal has recently approved the expansion of its capacity to explore the production of solar photovoltaic energy, mostly in the south of the country (Fig. 4). On the bigger picture, however, the main source of regional development investment in Portugal (EU Cohesion Policy Funding for 2014-2020 - Portugal 2020) has only allocated (by 2019) around 15% of its total investment to measures associated with the sustainable development goal, against an expected 25%. Worse still, the share of the allocation of funds for the production of renewable sources of energy is particularly low in view of the country's potential in this domain. Here, hydroelectric is, by far, the most financed source of renewable energy, in a project located on the island of Madeira (Calheta). surprisingly, not a single project was dedicated to exploring the country's potential to be one of the world's leaders (as it is with the production of wind energy) in exploring solar sources of energy (photovoltaic, thermal), namely in the southern part of the country and in urban areas. In sum, the Portugal 2020 contribution to improving the use and production of renewable sources of energy is limited and insufficient, taking into account the untapped potential of the Portuguese territory in this domain. Additionally, and this is extensive to the use of EU funding in Portugal, the policy intervention logic is one of fuelling pinpoint project proposals instead of supporting a clear development strategy which boosts the territorial development potential of the country. In this regard, and in our opinion, Portugal 2020 looks to be another lost opportunity to place Portugal in the group of the most developed European countries, in particular, by smartly exploring its main territorial sustainable development potential, especially in the renewable energy policy cluster. To achieve this, there is a need to ring-fence EU funding to key territorial sustainability development areas, such as the promotion of urban sustainability development strategies [75] and off-shore wind and tidal related energy production.

Fig. 3 – Solar potential chart for Lisbon. Source: http://80.251.174.200/lisboae-nova/potencialsolar/

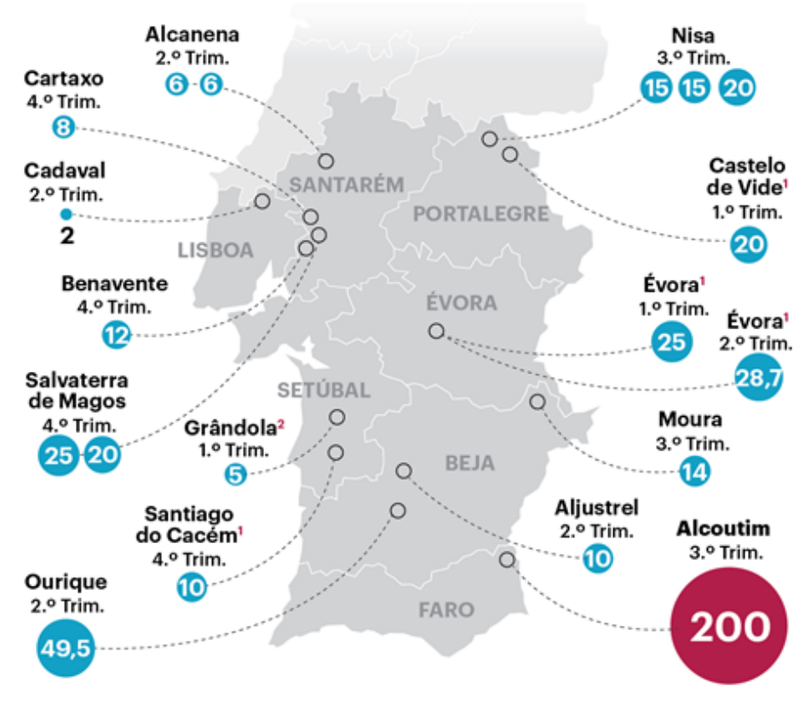

Fig. 4 – Solar photovoltaic projects implemented in Portugal in 2019. Source: https://www.dinheirovivo.pt/economia/portugal-estreia-19-centrais-solares-em-2019-com-um-investimento-de-350-milhoes/

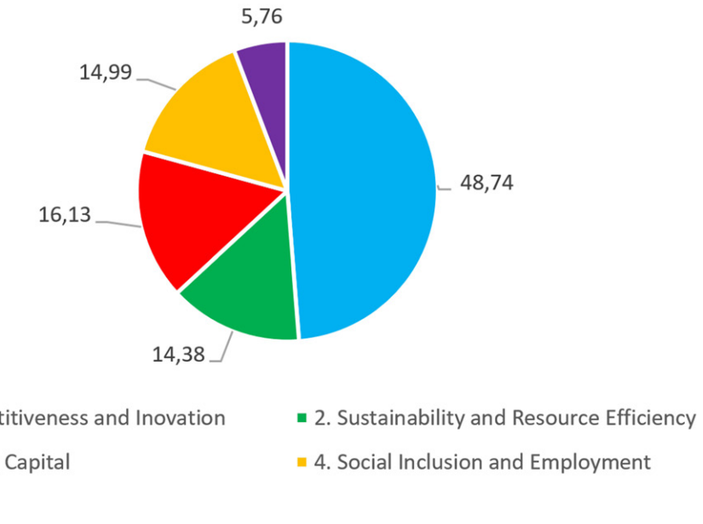

Fig. 5 – Portugal 2020 main intervention axis executed fund distribution (%) by September 2019. Source: (Medeiros, 2020c)

4. Conclusion

In this article, a case is presented on how urban areas, in particular those located in territories with abundant solar radiation, can significantly contribute to promoting sustainable territorial development policy agendas, by exploring their untapped solar energy potential, towards a carbon-free economy. Based on a wealth of literature, it is possible to conclude that, as we speak, these potential Urban SUNstainability policy agendas, supported by the idea that an urban area can be gradually self-sufficient in covering all its energy needs via solar energy, with indirect and direct social, economic and environmental beneficial impacts, is very much realistic..

In order to assess the current Urban SUNstainability process, and also to assess its potential, this article presents a conceptual framework based on five analytic dimensions. First and foremost, the solar energy generation capacity needs to be assessed, since this process largely depends on the availability and intensity of solar radiation. In future research, there is a need to assess existing urban planning and governance procedures which can stimulate and consolidate the implementation of Urban SUNstainability policy strategies. Lastly, the analysis of the potential effectiveness of this process needs to find causalities of its implementation to provoke positive social, economic and environment development trends, and in particular to the implementation of a greener and circular economy, higher standards of living, and a cleaner environment.

As could be seen, Portugal had still a huge unexplored potential to explore the production of solar energy. Surprisingly, the national and regional public investments on environmental sustainability have not favoured investment on untapping the solar energy potential, despite positive initiatives to support its exploration in many parts of south of Portugal, in past years. As regards the case of Lisbon, one could expect that a path towards an increasing use and production of solar energy, towards a smarter and more sustainable city, would require policy measures, at the urban level, which could attract the urban population to become both producers and consumers of solar energy. Likewise, this intended sustainability path requires experimenting with novel multi-level governance models, which can embrace a whole-of-society approach in view of increasing the administrative capacity of urban government structures, as well as the awareness of the positive transformative nature that the use and production of solar energy can provide to all urban dwellers.

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56 Seeing, pausing, inhabiting the riparian limits

Urban Projects Bound To the Tagus Estuary Hydrographic System

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ABSTRACT

In urbanised areas historically marked by watercourses, riverfronts and green or blue corridors seem to be the places for an appealing and winning urban regeneration formula. This work aims to highlight how water is becoming a support for landscape and urban interventions; hence, watercourses turn into a primary resource and a tool for the city's project that tends towards an urban habitability.
Now more than ever, we recognise that riverside promenades and green paths attract inhabitants, tourists, and new residents. While water has become a generator of new urban facades and a trigger of territorial habitability, it has also become the place and the way towards improved inhabitants' and visitors' well-being, and social cohesion. Among urban projects that seek solutions towards thriving in a world increasingly sensitive to the 'good health' of the planet and its inhabitants, this work focuses on regeneration interventions along the Tagus Estuary humid system.
Beyond the well-known cases of the Lisbon Municipality, the case studies of this research are realised regeneration projects located in the city settled along the Tagus Estuary hydrographic system – dubbed as the City of the Tagus Estuary (Lisbon Metropolitan Area).
At this moment of the ongoing research, through a critical view on the answer given to the specific characteristics of the place by the selected interventions, the work investigates the context-based design processes that supported them. The work concludes that, regardless of whether they are natural or artificial / visible or invisible (because they are currently canalised and buried), the estuarine waters are today, again, a resource for the city's project that has the potential for becoming a 'sensitive territorial intervention'. This is to say, the estuary's humid system has to be considered as a key term of the metropolitan city's habitability, promotion, and adaptation.

Keywords: Water landscape, regeneration projects, City of the Tagus Estuary, Lisbon Metropolitan Area.