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Fostering photovoltaic technologies in Mediterranean cities: Consumers' demand and social acceptance

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ABSTRACT

This paper provides an analysis of six Mediterranean countries as regards public acceptance of Photovoltaic (PV) and Building Integrated Photovoltaic (BIPV) technologies. The analysis considers both the private dimension (i.e. willingness to install a specific PV system) and the public dimension (i.e. acceptability of BIPV applications in the urban context where the individual resides). As regards the latter, we propose simulations of BIPV applications in residential buildings representative of each city, and elicit preferences for different technological and aesthetic solutions, conditional on different levels of information on the cost effectiveness of each option. The results show that awareness of the benefits arising from the PV installation and attachment toward the city are important drivers in both the public and private dimensions. A comparative analysis across countries suggests that Italian, Tunisian and Jordanian respondents seem the most interested in BIPV technologies, either when considering a possible investment for their household, and when evaluating applications in the buildings presented in the experimental scenarios.

1. Introduction

The total demand of primary energy in the Mediterranean countries is steadily increasing, with an estimated growth rate of about 2.8% per year since 1970. This trend has a significant impact on the fossil fuel consumption in the region, raising concerns of import dependency, pollution, and climate change issues, which can be addressed by orienting energy policies more decidedly toward renewable energy sources. Southern European countries, in accordance with the Climate-Energy Package – the so-called "20-20-20" package, have undertaken this path, and are on average close to the 20% target of renewable energy in gross energy consumption, to be reached by 2020 [12]. By contrast, the Middle East and North Africa (MENA) countries rely for over 95% of their energy needs on oil and natural gas [14,28], and this seems at odds with the fact that the region is abundantly endowed with renewable energy sources. In particular, the Mediterranean basin is considered to be one of the world's best locations for solar energy, although its enormous potential is still unexpressed [17,32]: the investments in renewables in the Mediterranean region have been mainly directed to large power plants (see Refs. [19,21,28,32]) rather than to micro-generation at a domestic level, and a change of direction in public policies is called for to promote the diffusion of photovoltaic technologies in the residential sector.

This paper draws from a project funded by the European Union (ENPI CBC MED - FOSTEr in MED: "Fostering Solar Technologies in the Mediterranean area": [16]), with the purpose of informing public decision making on these issues. The aim was to design strategies for the promotion of innovative Photovoltaic (PV) technologies in the Mediterranean area, with a specific focus on the residential sector. The research involved six Mediterranean partner countries (Spain, Italy, Tunisia, Egypt, Jordan and Lebanon) in a multidisciplinary framework. A core task entailed a pilot project of Building Integrated Photovoltaic (BIPV) in five cities, one for each partner country (except for Spain). As a preliminary step before the pilot projects activities, a survey was administered in each city, in order to get insights on the level of awareness that residents in different cities/countries have with respect to innovative PV technologies, and on the social acceptance of BIPV applications in such different urban environments. The present paper reports on the results of the survey.

Our research presents some innovative aspects with respect to previous literature. First, it presents a comparative analysis of

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Southern European and MENA countries as regards the attitudes, opinions, and preferences on energy production, energy efficiency, and solar technologies; previous studies on social acceptability of these technologies were mainly based in countries (US and Northern European), characterized by different climate conditions. Second, it analyzes the social acceptance of PV technologies both in the private dimension (i.e. willingness to adopt a specific PV system) and in the public dimension (i.e. acceptability of specific BIPV applications in the urban context where the individual resides), with the aim to identify common or specific factors underlying the individual behavior in the two domains. Finally, we designed an experiment to assess the relative importance of aesthetic and economic/technical considerations in shaping the social acceptance of technical innovations in the built environment.

The paper is structured as follows: the second section presents a review of the literature and a description of the main facts about renewable energy policies in the involved countries; afterwards we present the case studies and the survey instrument; the fourth section deals with the methods, while the following presents the results of the estimations. Finally, a conclusion highlights main results and policy indications.

2. Review of literature

MENA countries are characterized by an excess of demand of fossil fuels, and difficulties in matching national electricity needs. Fattouh and El-Katiri [14] identified some critical elements in the energy policies applied in these countries: in particular, the high level of subsidization of fossil fuels, though constituting an important social safety net for the poor and achieving some important economic goals such as promoting industrialization, has produced many unintended adverse consequences. First, an uncontrolled growth of energy consumption: in all MENA countries the demand for primary fuels and electric energy has been far above the world trend. Second, a discouragement in the development of alternative energies, an increase in greenhouse gas emissions and an exacerbation of local air pollution problems. Third, underinvestment in the infrastructures: because of the cap prices imposed on electric utilities, revenues often do not fully cover investment costs, and the result is the provision of low quality services to end users, with recurring power outages which characterize electricity provision throughout wide parts of MENA countries.

As a consequence, there is a growing necessity to increase the share of renewables in order to relax the dependence from fossil fuels. As discussed by Hadjipanayi et al. [20]; the potential of the PV market development in the MENA region, though still at an early stage, is developing. Griffiths [19] argues that in MENA countries the PV technology has become cost competitive against conventional power generation for three primary reasons: 1) solar equipment costs have plunged in the last decade, and further reductions are forecasted; 2) solar power generation fits well domestic demand patterns in countries where electricity demand is driven by air-cooling needs; 3) some MENA countries have increased their dependence on expensive imported LNG and/or oil-based fuels for power generation, hence decreasing the opportunity cost of solar energy with respect to fossil fuels. Yet, Kinab and Elkhoury [24] argue that PV electricity generation is still a new and expensive technology, and that its main use arises when the national grid does not reach rural areas. As reported by Fattouh and El-Katiri [14], Hawila et al. [21] and Hadjipanayi et al. [20], different government plans and subsidy programs have been designed to promote the transition to renewables; however, as pointed out by Hawila et al. [21]; their implementation and communication has often been unsatisfactory.

The picture is quite different in European countries, where specific targets have been set for renewable energy. Italy and Spain introduced a generous system of incentives (feed-in tariffs) to promote the diffusion of PV technologies (see Ref. [20]; and [8]; for reviews of subsidies in some European countries). The economic incentives have been effective to achieve the required EU targets: in 2014, solar energy accounted for about 5% of electricity produced in Spain[1] and about 8% in Italy.[2] However, in the last three years, both the Italian and the Spanish governments decided to drop the feed-in tariffs and modify the tariff structure (see Ref. [3]; and [1] for the Italian case [11]; and [17] for Spain). The reduced economic advantages could be an obstacle to further PV deployment, unless other considerations act as a counterbalance. It is therefore important to understand which factors, besides subsidies, could influence the adoption decision: social and psychological factors may play a role, along with other economic elements, in the willingness to adopt a renewable energy technology.

The literature on the social acceptability of technologies for production of renewable energy is extensive for large scale projects, but not so rich for adoption at household level. The last part of this section presents a short overview of studies in this area of research.

Jager [25] and Faiers and Neame [13] analyze the elements that could influence the choice of adopting a PV technology. They found that the financial aspect is only one of a variety of important elements, which include also aesthetic concerns and the perception of technical, operational and bureaucratic barriers, which can be lessened by providing information and support. Moreover, the so-called peer or network effect is an important psychological factor in explaining innovative technology adoption. Bolligher and Gilligham [6] find strong evidence of causal peer effects in their studies on PV adoption in California cities: an extra installation in a zip code increases the probability of an adoption in the zip code areas. The neighborhood effect works in two ways: first, viewing the panels stimulates interest, and second, the social interactions lead to better information and produce imitation effects. This result is in line with Jager [25]; who indicates the important role of social networks and the influence of people who have already installed a PV system to induce people to adopt the technology.

Claudy et al. [9], and Michelsen and Madlener [27] enquire on the determinants of adoption of different micro-generation technologies, respectively in Ireland and Germany. They find that the subjective perception of the technologies' characteristics, in terms of environmental friendliness, compatibility with routines, social risk, social support, etc., can be an important factor, with different effects across technologies. A similar research has been conducted by Balcombe et al. [5] in UK. They find that adopters are characterized by stronger environmental attitudes, which include a green social image; while a stronger perception of economic risk, and lower perception of environmental benefits is mainly associated with rejecters (people not interested in adopting a micro-generation technology).

The studies reported so far were based in North Europe or US, characterized by cooler climate conditions than Mediterranean countries. An application in hot climate countries is presented by Taleb and Pitts [31]; who survey homeowners, academics, building developers and architects in the Gulf Cooperation Countries (Saudi Arabia, Bahrain, United Arab Emirates, Kuwait, Oman, Qatar) to assess acceptance of BIPV technologies. They find that perception of

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[2] TERNA, Dati statistici sull'energia elettrica in Italia, anno 2014, 2016, Available at: http://download.terna.it/terna/0000/0607/85.PDF.

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