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Extended Abstract | The 1st Research Innovations in Sustainable Marketing: A Global Virtual Symposium

Nanoroll: Developing an Innovative Product to Improve the Efficiency of Photovoltaic Panels

Rodoula H. Tsiotsou[a*] | Yiannis Kyanides[a] | Vaggelis Saprikis[b] | Ioannis Samos[a]

[a] *School of Business Administration, University of Macedonia, Thessaloniki, Greece*

[b] *School of Economic Science, University of Western Macedonia, Kozani, Greece*

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Extended Abstract: The goal of the European Green Deal is for Europe to become the world's first climate-neutral continent by 2050. This extremely ambitious package of actions should enable European residents and companies to benefit from a sustainable green transition. Stopping our reliance on energy derived from fossil fuels - the leading driver of climate change - is the key to resolving this issue. Numerous potential benefits are associated with the usage of renewable energy, such as a reduction in greenhouse gas emissions, a diversity of energy supply, and a decreased reliance on fossil fuel markets (in particular, oil and gas). Thus, renewable energy has a significant and rising part in the European Union's energy system, especially now during the energy crisis. The Europe 2020 strategy set an aim of achieving at least 32% of gross final energy consumption from renewable sources by 2030. In 2020, the EU27 achieved 22% of renewable energy consumed, up from 9.6% in 2004. Renewable energy sources include wind power, solar power (thermal, photovoltaic and concentrated), hydro power, tidal power, geothermal energy, ambient heat captured by heat pumps, biofuels and the renewable part of waste.

Solar energy is a primary Renewable Energy Source (RES), with a share of 59% of the total energy from RES in 2019 (International Energy Agency, 2020). As a result, significant investments in photovoltaic (PV) system installations have been made worldwide. The PV sector is considered an area with extremely promising potential. This can be attributed to the continuous improvement of PV features performance, the economies of scale, and the national and international incentives to achieve energy and environmental goals. All of these factors have significantly reduced the cost of PV systems expenses and increased the investment interest worldwide simultaneously. As a result, the annual global growth rate amounted to 35% from 2010-2019 (Philipps & Warmuth, 2023), and the total installed PV capacity reached 627 GW at the end of 2019 compared to 100GW in 2012 (International Energy Agency, 2020). Additionally, the performance of new PV system installations exceeded 100GW worldwide for the 3rd year in a row (International Energy Agency, 2020). Given their importance in RES, this research aimed at developing and testing a new product that can improve the efficiency of PV panels.

To this end, two studies have been conducted. The first study examined the PV maintenance and cleaning services offered and identified the best practices for improving PV panel efficiency using a qualitative research approach. We collected data through in-depth interviews with 99 PV service providers

Corresponding author:
Rodoula H. Tsiotsou | rtsiotsou@uom.edu.gr | School of Business Administration, University of Macedonia, Thessaloniki, Greece.

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in Greece. The study's results identified six types of services developed in the PV sector: contract/-maintenance services, contract/consultancy services, contract/maintenance/PV equipment suppliers, PV equipment suppliers, contract/PV equipment suppliers, and consultancy services. Then, we asked service providers their views concerning the PV sector, its present, and future. About the current situation, although there was an increase in the market before 2018, there has been a decline over the last few years due to its concentration on a few large companies that determine the selling prices (oligopoly) and often delay payments. Regarding future opportunities in the sector, respondents consider energy storage, large projects (PV parks), maintenance, installation, and net metering. In the next five years, the respondents believe that energy production via PV will increase and the sector will significantly develop, meeting the European standards for green energy production. The most frequently identified obstacles in the development of the sector are bureaucracy and delays in the licenses, frequent changes in the laws, lack of bank financing, the marginalization of small producers, problems with the distribution channels, and lack of qualified staff. Regarding their services, the majority of the service providers (85.9%) offer PV operation and performance checks once (22.6%) or twice a year (37.1%), and only 6.5% conduct checks daily. PV service providers either offer only maintenance (54%) or cleaning services (4.8%), or both (30.2%). About the PV maintenance methods, the respondents indicated Visual inspection (cable inspection, broken panel, rust, camera), Electrical inspection (operation, thermal camera, and efficient operation of the inverter), and Cleaning (washing - spraying or mowing). The respondents answered that they carry out all the necessary maintenance (46.9%), while 32.8% carry out optical-electrical-sprinkling-grass cutting.

The second study examined the reactions of various possible users (producers of photovoltaic energy, maintenance service providers, installation service providers, and sellers of photovoltaic panels) to a new nanotechnology-based product called Nanoroll. Nanoroll is a thin, transparent film that can be installed on PV panels to improve efficiency. With the help of nanotechnology, Nanoroll is hydrophobic and oil-repellent and, at the same time, hydrophilic, therefore, to a certain extent, self-cleaning. Therefore, the accumulation of dust, salts, oxides, inorganic deposits, and organic residues (pollen, insects, bird droppings), elements that reduce both the efficiency of the PV panels and their lifetime, is significantly prevented. Specifically, mechanical degeneration, i.e., corrosion due to contact with various particles, which causes gradual aging, does not exist from their application onwards, while chemical degeneration, i.e., corrosion of the glass due to contaminants that have been absorbed into the glass and do not they are cleaned with chemical cleaners, thus leaving a light haze that grows over the years, is completely reversible and is completely eliminated with the application of the Nanoroll. A questionnaire, including a video of Nanoroll and its installation on photovoltaic panels, was sent to 1003 companies. 136 companies responded to the questionnaire (13.56% response rate). Participants' responses were positive toward the new product while assisting in developing the marketing mix of the new product. In sum, the green energy sector is developing while new supporting products and services are surfacing to increase the efficiency and operation of RES.

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ORCID

Rodoula H. Tsiotsou
| https://orcid.org/0000-0003-2035-0334
Vaggelis Saprikis
| https://orcid.org/0000-0002-4947-3699

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