FOURIER

END OF PROJECT STATEMENT

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Fourier Project: achievements and future challenges as told by the leading researchers

The FOURIER Project (Efficient photovoltaic facade for the near future of the electricity grid) represents a significant step forward in the development of building-integrated photovoltaics and the transition toward sustainable energy. In September 2021, FOURIER was selected as the winner of the call for proposals promoted by CSEA (Cassa per i Servizi Energetici e Ambientali), aimed at funding research projects dedicated to technical and technological innovation of interest to the electrical sector.
The project brought together major industrial and academic players, focusing on the design and development of high-efficiency photovoltaic cells integrated into building facades. The goal was to combine high technical and aesthetic standards with large-scale applicability, thus contributing to the advancement of innovative and sustainable energy solutions.

One of the distinctive features of FOURIER is the creation of a fully Italian supply chain, which brought together the best expertise in the country into a synergistic ecosystem. The group consists of: Camlin Italy (leader), a company specializing in the monitoring of infrastructure and the electrical grid, working in close collaboration with Henesis Srl – Focchi Group, specialized in the construction of facades for large buildings – Applied Materials Italia, a leader in the supply of machinery for the production of solar cells – IMEM-CNR, a research institute at the forefront of the development of photovoltaic cells based on chalcogenides – Eurac Research, an organization dedicated to the study of the reliability of photovoltaic systems, solar resource analysis, and supporting the integration of these technologies into buildings and electrical grids – and GruppoSTG, a company that contributed to the design and production of photovoltaic structural glazing with insulated glass units. The joint effort between these top-tier companies has led to the creation of innovative solutions.

Years of collaboration between Camlin Italy (Henesis) and IMEM-CNR have created a concrete synergy between fundamental research and industrial R&D. "*This partnership has led to significant results in several areas of innovation, including photovoltaics,*" says Konstantin Koshmak, MicroFabrication Lead at Camlin Italy. "*It transformed the initial ideas of the FOURIER project into functional prototypes by its conclusion. The collaboration with other prestigious Italian partners also allowed us to explore potential market solutions, validate the prototypes under real operational conditions, and conduct scale-up studies and assess the applicability of the proposed technology.*"

This strategy allowed for a response to market needs through effective communication between the partners. It has also led to "*A fully Italian supply chain guaranteed several advantages, such as high product quality and a strong enhancement of the skills and excellence of our country in the renewable energy sector,*" says Laura Vandi, Innovation Manager at Focchi Group. "*Furthermore, the motivation and synergy among the partners were key elements, strengthening the sense of belonging and the shared commitment toward the project's goals.*"

The success of FOURIER was made possible by an integrated design vision that optimized every phase of the development of photovoltaic modules, allowing for a balanced combination of aesthetic requirements, essential for a glazed facade, with technological requirements related to energy efficiency. "*The research focused on creating a product that met market needs, with particular attention to aesthetics, sustainability, maintenance, and the potential for industrialization,*" emphasizes Laura Vandi.
Martina Pelle, a researcher at Eurac, explains the importance of an integrated approach to design, highlighting how "*One of the very first activities of the project involved identifying, together with the architects and facade designers, both the technical and aesthetic requirements of the integrated product. This allowed us to develop photovoltaic modules with specific features, such as the coloration of the front glass to hide the photovoltaic cells, and certain glass treatments to facilitate the housing of technical components and wiring, ensuring easy integration into the facade system and meeting the aesthetic requirements necessary for architectural use.*"

From a technological standpoint, the project introduced significant innovations, including:

- The development of solar cells using cutting-edge techniques, carried out by the joint laboratory "Σinergy lab" of IMEM, in collaboration with Camlin Italy, is one of the key technological innovations. Edmondo Gilioli, Research Director at IMEM, states, "*There are no analogous processes on the market. The production of a stable ink of the absorber material (chalcogenide) allows solar cells to be made using various liquid-phase deposition techniques, drastically reducing the need for investment in vacuum physical deposition machinery typically required for the production of traditional inorganic thin-film solar cells.*"
- The use of "shingling" technology, in which the cells are overlapped and bonded together with conductive adhesive, is another key innovation. "*This allows for the creation of photovoltaic strings with superior aesthetic performance due to the absence of front interconnections, greater flexibility in terms of size compared to standard strings, and improved reliability and durability, thanks to the bonding with conductive adhesive,*" explains Marco Galiazzo, Process and Lab Manager at Applied Materials.

The integration of photovoltaic modules into facades, which the FOURIER project has made particularly virtuous from both a technological and aesthetic standpoint, offers significant functional advantages. "*The integration of photovoltaic strings into a facade allows the building to become energy-autonomous or at least reduce its energy dependence on fossil fuels," states Marco Galiazzo, "Specifically, the FOURIER facade represents an excellence in terms of aesthetic integration and photovoltaic efficiency.*"

Martina Pelle highlights that "*Integrated photovoltaic technologies offer promising prospects, as they allow renewable energy to be produced in a widespread manner, directly where it is needed. Vertical installation on facades, especially with an east-west orientation, presents an additional advantage: unlike south-facing installations, these can generate energy during peak demand periods, that is, in the early and late hours of the day, substantially contributing to the energy self-sufficiency of buildings.*"

The project addressed the development of innovative technologies for integrating photovoltaics into buildings. Konstantin Koshmak explains: "*In the lab, we made significant progress in producing a photovoltaic ink capable of transforming glass surfaces, used in building construction, into semi-transparent photovoltaic panels. At the same time, the integration of the silicon module into the facade and the analysis of its performance allowed us to test a similar application in its relevant field of interest, enabling us to validate the chosen technological solution in advance.*"

With the completion of the project, the Italian supply chain is ready to expand the market for building-integrated photovoltaics (BIPV), offering innovative solutions for new constructions and renovations. As Laura Vandi emphasized, "*The solution developed in the FOURIER project has the potential to be further analyzed and advanced. Future developments will need to focus mainly on optimizing energy performance and expanding aesthetic customization possibilities, two key aspects for enabling large-scale use. It will also be important to further explore the industrial scalability of the solution, with the goal of making it competitive and accessible to the global market.*"

The first step toward the future will be the scale-up of the technology developed in the lab, with the goal of increasing both the application area of the photovoltaic ink and the efficiency of the cells produced. To make it industrially viable, further investments will be required (currently, the product has been developed at the prototype level and is not yet commercially available). "*The next steps involve the development of 'tandem' photovoltaic modules,*" specifies Konstantin Koshmak, "*combining the cells developed in the FOURIER project with silicon or perovskite-based cells, for applications in BIPV and automotive sectors that require high photovoltaic module efficiency.*"

Finally, Marco Galiazzo adds: "*Certainly, the direction for the integration of photovoltaics into facades has now been set. The enabling factors for the widespread use of this technology will be the awareness and innovative drive of architects and designers, as well as appropriate legislation. The combination of active facade modules and energy storage systems within an energy community will allow for the massive utilization of both technologies' potential, through the optimization of load throughout different phases of the day.*"

FOURIER demonstrates how innovation and sustainability can go hand in hand, placing Italy at the forefront of the transition to renewable energy, and towards a future where buildings not only consume energy but also produce it.

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