ART / ECOLOGY / DISTRIBUTED ENERGY / DIY RESEARCH

# Biomimetic Solar

An artistic and technological investigation into solar panels made through biomimetic design, organic material experimentation and community-oriented DIY production.

JOFRE OLIVERAS

PROJECT ABSTRACT

The project rethinks the solar panel as a functional device, an art object, and a pedagogical tool. Drawing from plant morphology and natural growth processes, it explores how solar technologies can be reimagined through alternative forms of design and production.

By applying electrochemical coatings to diverse surfaces, the work expands from screen-printing techniques to architectural-scale mural interventions. It focuses on reproducible fabrication methods, enabling photovoltaic structures to emerge from accessible, low-cost processes rooted in DIY culture and collective experimentation.

## 01 **Study Process**

The project unfolds as a process of theoretical research through artistic practice. It is a long-term proposal that evolves at every point of its structure in a non-linear way, where theory, practice, and critical reflection are constantly intertwined. The process is not conceived as a closed succession of productive phases, but rather as an open work diary, where each experience or moment of work generates new questions that reorient and expand the development of the project.

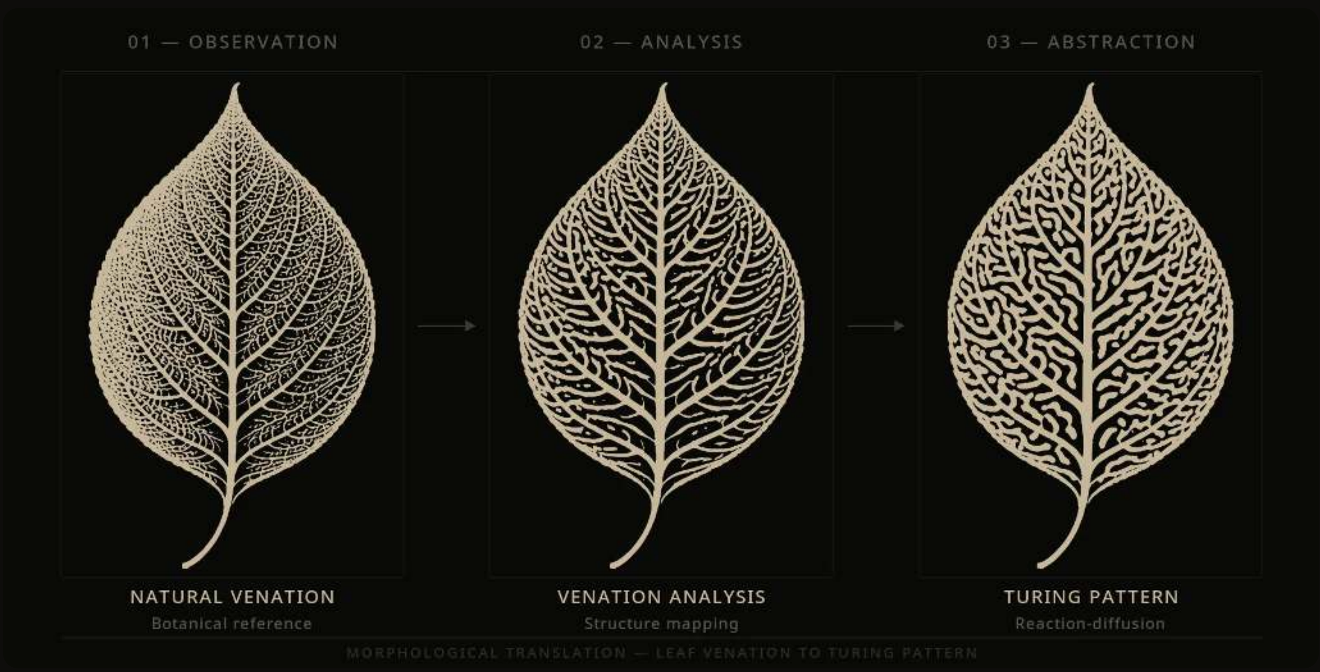
Patterns present in nature constitute a fundamental starting point for visual study and artistic creation within biomimetics. These patterns not only respond to functional and physiological needs — such as the optimization of space, light capture, or nutrient distribution — but also generate geometric and repetitive structures that can be reinterpreted as visual elements. Understanding them makes it possible to construct a formal language that connects science and creation.

Leaf venation, branching systems and surface organisation are understood as optimised solutions developed through evolution. These morphologies are not arbitrary; they emerge from the need to maximise efficiency with minimal material. Through biomimetics, these principles are translated into the design of solar systems: instead of relying on flat, standardised panels, the project explores alternative geometries that could improve energy distribution, light capture and spatial integration — questioning the sterile, purely industrial construction of conventional solar technologies.

## Physarum / Turing

Reaction-diffusion patterns described by Alan Turing in 1952 explain how simple chemical interactions generate stripes, spots or labyrinthine forms on animal skin. Visual complexity emerges from very simple rules — a reference model for the generation of textures on natural surfaces. In Solar Biomimetics these patterns cease to be a visual reference and become a method of spatial distribution: if the panel is an organism managing photons and dissipating heat, labyrinthine configurations avoid hot spots and optimise current collection. If part of the panel is shaded, the electron flow finds alternative low-resistance routes, mimicking the resilience of vascular systems.

Physarum polycephalum offers the biological counterpart: an adaptive network that optimises paths between resources, strengthening frequently used routes and abandoning inefficient ones — approximating solutions to complex spatial problems such as shortest paths or optimal connectivity.




MORPHOLOGICAL TRANSLATION — LEAF VENATION TO TURING PATTERN

## 02 Application

The study of natural patterns integrates temporality and adaptation into the artistic object. An animal's skin is not a static surface; the pattern grows and deforms with the organism. Translated into the screen printing of organic solar cells, interfaces stop being perfect grids and become "living" networks that respond to the topography of the support.

Serigraphy enables precise, layer-by-layer deposition of functional materials, closely mirroring the stratified construction of photovoltaic devices. Expanded to mural scale, the technique acquires an architectural dimension: the wall becomes an active surface where energy-generating layers are embedded into the visual structure of the work.

The application shifts from manual screen printing toward spray-based deposition, maintaining the same layered logic across façades, infrastructures or irregular constructions — the stencil expanded, mobile, or replaced by masking systems.

The mural operates as an integrated system of energy capture, storage and emission: sprayed photovoltaic layers collect solar energy by day, channel it through embedded conductive patterns into storage, and return it at night through LEDs or electroluminescent layers — the mural illuminates itself and reveals its internal structure. Stored energy can also feed external outputs such as device-charging points. Storage itself takes a sculptural dimension: battery units conceived as artefacts — classical vessels containing organic components functioning as large-scale bio-batteries.

BIOMIMETIC MURAL — ARCHITECTURAL SCALE STUDY

## 03 **Fabrication**

Each layer plays a role in energy conversion: the substrate provides structural support; the anode collects positive charges; the hole transport layer (HTL) facilitates charge movement; the active layer absorbs light and separates charges; the electron transport layer (ETL) guides electrons toward the cathode. Layers are deposited sequentially by screen printing, controlling mesh density, squeegee angle and pressure.

Three material models are explored in parallel: a laboratory-grade model based on MIT cellulose solar cell research; a DIY model optimised for serigraphic efficiency with accessible compounds; and an organic/sustainable model using bio-accumulated silica, anthocyanins and lignin extracted from plant matter.

At architectural scale, silver busbar networks distribute current across large formats; an ETFE fluoropolymer varnish protects organic molecules from UV degradation and oxidation. Estimated production cost: ≈152 €/m². As a counterpart, organic LED structures perform the inverse conversion — murals that generate energy during the day and return light at night.

SOLAR CELL LAYERS — MATERIAL STUDIES

| LAYER | R MODEL (LAB) | DIY MODEL | ORGANIC MODEL |
|---|---|---|---|
| **Substrate** | Transparent cellulose nanofiber | Cellulose acetate / bioplastic | Flax / hemp cellulose |
| **Anode** | ITO | Silver / copper ink | Oak charcoal (pyrolysis) |
| **HTL** | PEDOT:PSS | PEDOT:PSS (solution) | Purified lignin |
| **Active** | DBP + C60 | DBP + C60 (solvent) | Anthocyanins (blackberry) |
| **ETL** | BCP | $TiO_2$ | Equisetum silica (ash) |
| **Cathode** | Evaporated silver | Silver mesh | Graphite / soot mesh |
| **Encapsulation** | Protective ETFE varnish — UV and oxidation barrier | | |

## 04 Participation

One of the purposes of this project is to build a participatory archive. People can use the experiments published here; visitors are invited to leave reflections, ideas, further experiments, observations or notes — a network of people and ideas around distributed, self-built energy.


BIO-BATTERY VESSEL


BATTERY SECTION DIAGRAM

JOFRE OLIVERAS — JOFREARCHIVE.COM/PROJECTS/BIOMIMETIC-SOLAR