



## Valldaura Self-Sufficient Labs

### *The 'green' campus of the Institute for Advanced Architecture of Catalonia (IAAC)*

**Valldaura Labs** is a centre belonging to IAAC directed by **Vicente Guallart**, co-founder of the Institute and former chief architect of the Barcelona City Council (2011-2015), who has been working since 2008 on the development of a new concept of habitability that places people at the centre of all actions. Valldaura campus encourages local self-sufficiency in the use of the environment and promotes the expansion of knowledge through participation in global information networks to share and generate progress. The centre is a large park and innovation laboratory located in the Natural Park of Collserola in Barcelona, which has the latest technologies in the field of energy, information and manufacturing.

Valldaura has three laboratories: the **FoodLab**, the **EnergyLab** and the **Green Fab Lab** which aim to investigate the specificities of the production of key elements related to self-sufficiency: food, energy and sustainable ideas, combining ancestral knowledge that connects us with nature and the latest advanced technologies. Valldaura Labs has developed a series of initiatives and projects in recent years that aim to contribute to a more sustainable, self-sufficient society and offer solutions to the most urgent challenges of our environment linked to the scarcity of resources for the population (energy, food, living space...) and climate change.

- **IAAC's Master in Advanced Ecological Buildings (MAEB) headquarters**

The Master in Advanced Ecological Buildings (MAEB) is a 12-month immersive academic programme with a hands-on approach to training professionals with advanced experience in the design and construction of green buildings. The programme takes place in ValldauraLabs and begins its first edition in October 2018.

During the first six months in Barcelona, students will embark on a series of intensive and cumulative modules and workshops that will address all fields interrelated with the design and construction of advanced green buildings, including thermal and metabolic materials. Students will collectively create the design concept, strategies, manufacturing techniques and plans for a prototype green building to be built during the last three months of the program.

The master's degree is aimed at engineers, architects, artists, creators, designers and graduates of any discipline related to the creation of the built environment. The program will be developed with the collaboration of companies and industry, leading experts from around the world with the aim of training new professionals interested in leading the design of green buildings worldwide.

#### **More information**

<https://iaac.net/educational-programmes/master-advanced-ecological-buildings/>



## Open Source Beehives

The **Open Source Beehives** project is a collaborative response to the threat facing bee populations in industrialized countries around the world. The Open Source Beehives (OSB) initiative is a project that allows anyone concerned about the decline of bees to become an active contributor to finding a solution.

Anyone can download the plans to build open source hives for free and the pieces can be cut from a single sheet of wood 1.5 x 2.5 meters by a computer-controlled cutting machine called a CNC milling machine. These machines are found in most woodworking shops. The hives take minutes to assemble and do not require nails or glue.

The project, promoted by **Jonathan Minchin** (coordinator of the **Green Fab Lab** at the IAAC Campus in Valldaura), Aaron Makaruk and Tristan Copley-Smith, **addresses the problem of the collapse of bee colonies** (*Colony Collapse Disorder, CCD*) a mysterious global epidemic in which honey bees disappear or die suddenly, and which has destroyed more than 10 million hives since 2007 in North America alone. Few ecological problems are as critical to the future of humanity as the decline in bee population. The UN has reported that of the 100 staple crops that provide 90% of the world's food, 70 require bees to pollinate them.

**Open Source Beehives** allow any beekeeper to connect their hive to the Internet and record the data, which can help determine the causes of the honey bee's disappearance. The data collected from each hive is published along with geolocations that allow for comparison and analysis of the hives.

The project proposes to design hives that can support bee colonies in a sustainable way, to monitor and track the health and behavior of a colony as it develops. Each hive contains an open source sensory kit, **Smart Citizen Kit**, developed at the **Fab Lab Barcelona** of the Institute for Advanced Architecture of Catalonia (IAAC), which transfers the information collected to an open data platform: **Smartcitizen.me**.

**Smart Citizen kit allows beekeepers to know when their bees are in danger.** The idea is to bring these low-cost "smart" hives into gardens around the world, with the aim of helping to rebuild the bee population and develop an online network of real-time hive data that researchers can use to find out why bees are disappearing. The project currently has more than 60 remotely constructed or commissioned hives in more than 20 countries.

### More information

<https://iaac.net/research-projects/self-sufficiency/open-source-beehives/>



## **Biophotovoltaic Panel System**

In 2014, students from the Master's Degree in Advanced Architecture at the Institute for Advanced Architecture of Catalonia (IAAC) designed and installed a bio-photovoltaic wall on the Valldaura campus that acts as a battery that collects natural and continuous energy from the bacteria that constantly flow under our feet.

Biophotovoltaic Panel (BPV) describes the energy use process naturally produced by the bacteria in the soil. When plants undergo photosynthesis, they produce nutrients in the soil as a by-product that soil bacteria metabolize. As the bacteria digest nutrients from the soil, they release electrons. Created at the IAAC's Green Fab Lab in Valldaura, the team's BPV device extracts these electrons by placing an anode and a cathode inside the ground. Then, by connecting the circuit to a capacitor, the harvested energy can be stored and used to power household appliances and other electronic devices.

Each of the components that make up the LVA has certain parameters that can be changed to control production processes and efficiency - the type of plant that grows, whether edible or decorative, the soil characteristics that allow microbial growth, the type of soil that makes up the electron transfer, and the materials and composition of the battery help determine the efficiency at which electrons are collected and transferred.

Although the energy produced is not yet as powerful as wind or solar energy, it can still power many small appliances. Through their calculations the team estimated that a LVA panel can charge a mobile phone, 8 could power a microwave and 16 a radiator. LVA cells do not constantly require sunny weather, blowing wind or flowing water. Instead, they absorb the natural energy that is produced throughout the year, underground.

### **More Information:**

<https://iaac.net/research-projects/self-sufficiency/bio-photovoltaic-system/>



## **Moss Voltaics**

Moss Voltaics is a project carried out at the IAAC by the researcher Elena Mitrofanova and the biochemist Paolo Bombelli, capable of creating energy from mosses, a technology known as biophotovoltaics (BPV).

It is a prefabricated, hollow panel with cells that house the biological material and create the ideal conditions for its correct development and maintenance. The "container", made of porous clay, is capable of absorbing rainwater, and at the base of the cavities there is a hydrogel capable of storing it for prolonged use over time, which provides the necessary moisture for the growth of the moss, which is deposited on it, with the most suitable arrangement for its proper development.

Moss, during photosynthesis, releases organic compounds into the soil, including bacteria that metabolize the photosynthetic residues, releasing electrons during the process. In this case, carbon fibres are arranged, which attract the electrons and act as an anode to generate electricity.

The prototype created has a profile designed for dry joining, allowing the creation of a single electrical circuit without the need for complex connections. With a set of 16 modules they have been able to generate 3 volts, so they ensure that with 2 square meters of facade could illuminate a LED bulb.

One of the most outstanding aspects of this new technology is the ability to create energy without the need for direct sunlight, a great advantage in countries with adverse weather conditions and few days of sunshine a year, where conventional solar panels are not efficient enough.

### **More Information:**

<https://iaac.net/research-projects/self-sufficiency/moss-voltaics/>



## Aquapioneers

Aquapioneers is an initiative born in the Green Fab Lab of IAAC in Valldaura Labs, which has had the support of IAAC and Fab Lab Barcelona. Aquapioneers creates an open-source urban farming system that saves 90% of water consumption and allows soilless cultivation through the aquaponics system.

The initiative aims to revolutionise urban agriculture and promote food self-sufficiency through aquaponics, an innovative urban sustainable agriculture method designed for cities that uses the remains of fish to obtain plants. In particular, through an aquarium located underneath the orchard, the fish fertilize the vegetables in the orchard (with their remains) and this allows them to grow herbs and vegetables without soil, throughout the year and with much greater water savings than in a traditional orchard. In addition, the plants clean the tank and a closed cycle is created, 100% organic, without chemical fertilizers or pesticides and completely local.

Guillaume Teyssié and Loic Le Goueff are the founders of this project that aims to develop urban and sustainable agriculture to revolutionize food production in cities. In collaboration with the crowdfunding financing platform Ulule obtained 30,000 euros to consolidate its project in Barcelona. With this total amount, the Aquapioneers initiative is promoting and producing locally and the "Aquapioneers Ecosystem", a kit that combines an aquarium and a garden in a compact wooden design.

This initiative, together with its popular collective funding campaign, has been covered by the local and international press and media with great interest. Journalists from the main media such as **El Mundo, El País, PlayGround, El Periódico de Catalunya, Via Empresa and Betevé** have presented this initiative as an innovative and revolutionary project for Barcelona thanks to the collaboration of IAAC.

### **More Information:**

<http://aquapioneers.io>



## **ROMI – Robotics for MicroFarms**

Since 2017, the Institute for Advanced Architecture of Catalonia has been coordinating the European project Robotics for MicroFarms (ROMI), within the framework of the H2020 project, which has a budget of approximately 4 million euros. IAAC is part of a consortium formed by an interdisciplinary team of experts in IT (Inria, Sony), robotics and electronics (UBER, Sony, IAAC), crop monitoring and agronomy (CNRS, Inria), as well as micro-agriculture (Châtelain) who will be in charge of developing the ROMI initiative, an open and lightweight robotic platform for small agricultural areas.

By implementing robotics on farmland, ROMI will help in weed reduction and crop monitoring and also help reduce manual labor, saving farmers 25% of their time. The technology applied in this project will allow the acquisition of detailed information on the sample plants and will be coupled to a drone, developed by Noumena, which acquires more global information on the crop level.

Micro-farm robotics will produce an integrated, multi-scale image of crop development that will help the farmer monitor crops to increase crop efficiency. The objective of this project is to adapt and expand the most advanced aerial and ground monitoring tools to handle small fields with complex designs and mixed crops. IAAC, in collaboration with an international consortium, will develop and market an affordable, ground-based multifunctional robot that will develop comprehensive 3D plant analyses for detailed crop monitoring, a NERO drone for multiscale crop monitoring and test the effectiveness of this technology in real field conditions.

### **More Information:**

<https://iaac.net/iaac/european-projects/romi-robotics-microfarms/>