Living Architecture

The goal of project LIAR is to design and build a proof-of-concept 'living architecture' whose targeted breakthrough is to transform our habitats from inert spaces into programmable sites.

Living Architecture (LIAR) is a next-generation, selectively-programmable bioreactor. It is envisioned as an integral component of human dwelling, capable of extracting valuable resources from sunlight, waste water and air and in turn, generating oxygen, proteins and biomass through the manipulation of their interactions.

A freestanding partition is composed of bioreactor 'building blocks' which are conceived as standardized building segments or 'bricks' that can be incorporated into common building construction methods.

The bioreactor LIAR unit is being prototyped based on the operational principles of Microbial Fuel Cell (MFC) technology and Synthetic Microbial Consortia (SMC). The outcome will be two building blocks: one, a programmed and configured MFC to produce electricity, the SMC to purify air and water.

An array of bioreactor units will act in parallel to a computer that is capable of both SENSING local conditions within a building and CONTROLLING the bioreactor system to optimize the building's environmental impact.

In the future, the LIAR unit can become a form of customizable, programmable micro-agriculture for installation in domestic, public and office environments. The technology could potentially address global scale challenges of urban sustainability and resource management.

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MODULAR / PROGRAMMABLE / ECOSYSTEM

LIAR BRICK

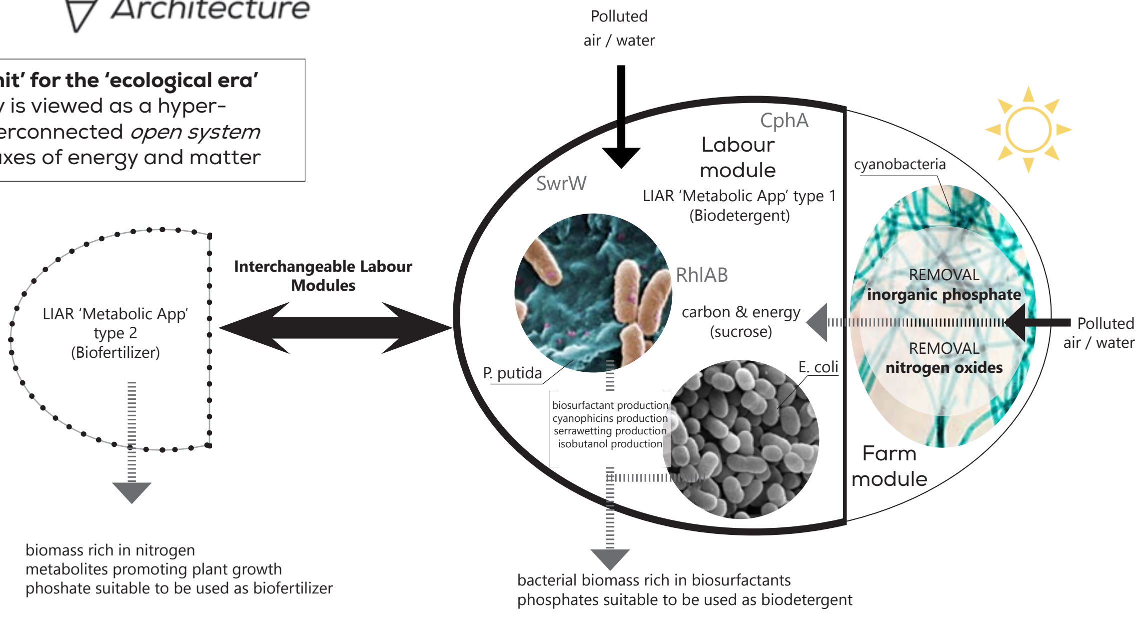
Living Architecture

an 'ecological unit' for the 'ecological era' where reality is viewed as a hyper-complex and interconnected *open system* with constant fluxes of energy and matter

LIAR exploits one experimental and two well established bioreactor-platforms as its foundational technologies. Standard principles of both **Photobioreactor** and **Microbial Fuel Cell (MFC)** are adopted by LIAR and combined into a single sequential hybrid bioreactor system. Furthermore, LIAR develops a **Synthetic Module Consortia (SMC)** that will work synergistically, but separately from the new LIAR MFC. During operation, both systems together, will polish wastewater, generate oxygen, electrical power and potentially usable biomass (fertiliser).

Interchangeable Labour Modules each is a "metabolic app" that performs a specific task

Synthetic Metabolic pathways
Pit/Pkk: Inorganic Phosphates / PolyP accumulation
NirS/NorB/NosZ: Nitrogen oxides removal
RhlAB: Rhamnolipids
CphA: Cyanophicins
SwrW: Serrawetting
IsoB: Biofuel

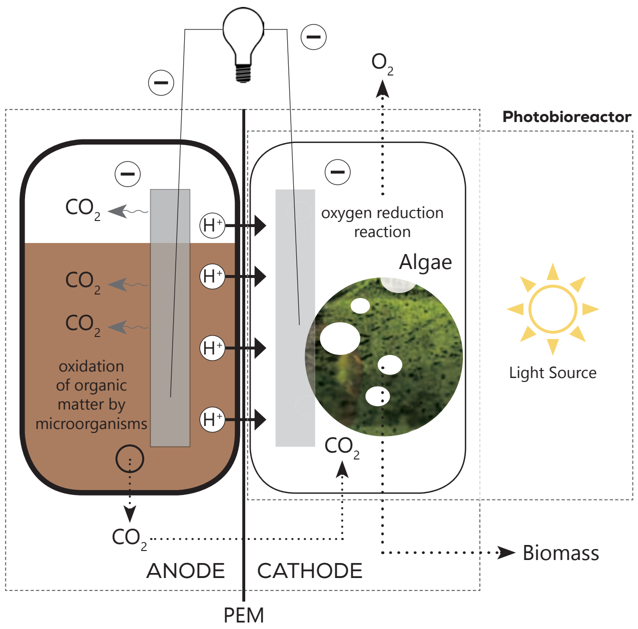


LIAR Synthetic Microbial Consortia (SMC)

LIAR envisages the design of a Synthetic Microbial Consortia (SMC) composed of two types of modules:

(1) **a cyanobacterial-based farm module** exposed to the facade. The farm module will supply easily metabolised carbon as an energy source for the labour module.
and
(2) **bacterial-heterotrophic-based labour module(s)**, placed in the interior of the building. LIAR develops at least two different and interchangeable labour module(s), also called 'metabolic app(s).' Each are capable of performing a target biotechnological function and add value to the whole system. A set of related synthetic metabolic pathways when introduced into the workhorse strains (E. coli, P. putida) constitute a specific „metabolic app."

Both farm module and labour-type module(s) are amenable to Systems metabolic engineering. Using synthetic biology, the design and optimisation of different and unrelated functions are allowed, including phosphate cleaning and NOx-removal from gray water and polluted air, as well as the production of biodetergents and biofertilizers using just CO_2 and sunlight. LIAR envisions the design of a large set of highly customizable Labour Modules to be used in the home to add value to domestic waste.



LIAR Microbial Fuel Cell (MFC)

MFCs are bioelectrochemical devices that convert the chemical energy of organic feedstock into electricity, via the metabolic processes of microorganisms, which act as biocatalysts.

MFCs consist of two compartments, the **anode** and the **cathode** separated by a proton-exchange membrane (PEM). In the anode chamber, bacteria anaerobically oxidize the organic substrate (fuel) generating electrons and releasing protons. The electrons travel via an external circuit and the protons flow through the PEM, to recombine at the cathode, and react with oxygen (oxidising agent) to produce water. Oxygen is potentially the most effective electron acceptor for a MFC due to its high redox potential, availability, low cost and zero chemical waste products (the only by-product being water).

It is proven that algae can thrive in a MFC cathodic environment, photosynthesise and produce oxygen as a byproduct. The photosynthetically evolved oxygen is utilised at the cathode to enhance the oxygen-reduction-reaction, for improved power generation and longevity.