Using sunlight for high-value chemicals production: sustainability analysis of FlowPhotoChem System

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INTRODUCTION & OBJECTIVES

The chemical industry contributes to a significant amount of GHG emissions due to the production of chemicals from fossil fuels. The EU 2030 Climate Target Plan is committed to reduce GHG emissions by 55% by 2030 and climate neutrality by 2050. **These targets cannot be achieved by current fossil fuel-based technologies**.

The objective of FlowPhotoChem (FPC) project is to develop **new materials** and **flow reactors** which can use **non-fossil fuel resources, i.e., sunlight, H_2O and CO_2 to produce chemicals**. To ensure the sustainability of FPC, two specific objectives are addressed: **i)** to **provide environmental information** on the design of materials and reactors and **ii)** to perform a **comprehensive sustainability assessment** of the FPC system (Fig. 1. Integrated single reactors) and comparison with current technologies.

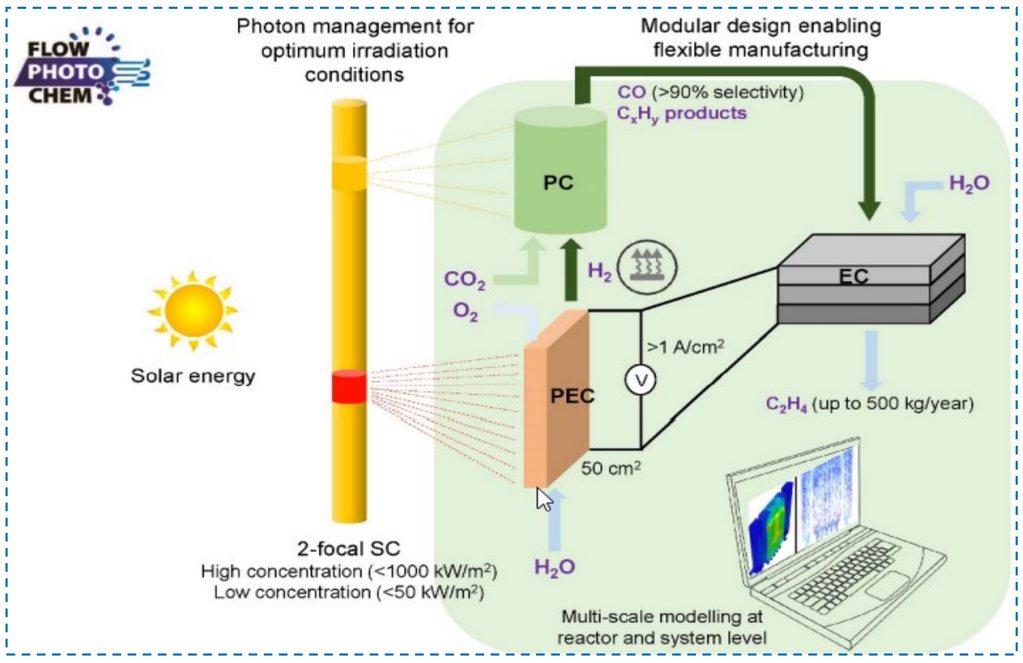

Fig 1. FlowPhotoChem concept showing the FPC system (light green) with 3 modular reactors: PC (Photoelectrochemical), PEC (Photocatalytic), EC (Electrocatalytic). *Source: FPC Grant Agreement.*

MATERIAL & METHODS

The following methodologies are being used: **(Prospective) Life Cycle Assessment (LCA)** for the environmental assessment and **Social Life Cycle Assessment (S-LCA)** and **Life Cycle Costing (LCC)** for the socio-economic assessment.

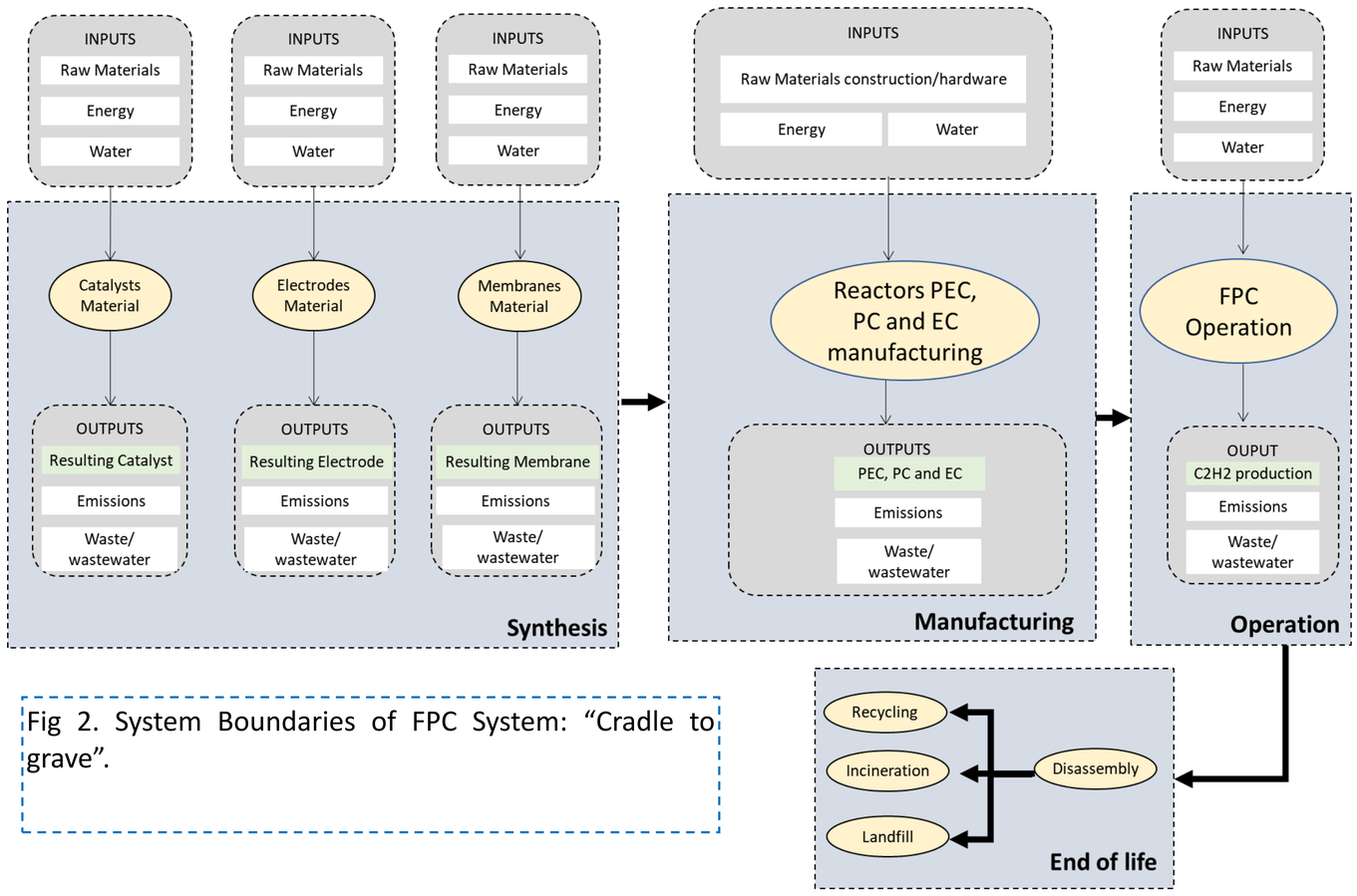

Fig 2. System Boundaries of FPC System: "Cradle to grave".

PRELIMINARY WORK & RESULTS

Goal and scope: To assess the environmental and socio-economic performance of the FPC system whose **function** is to produce ethylene.

- **Functional Unit**: 1 kg of ethylene produced.
- **System boundaries** (Fig 2.): the synthesis of components, individual reactors manufacturing and operation, FPC integrated system operation and end of life
- **Scenarios established** (three production levels):
  - Sc1) Lab scale*
  - Sc2) Medium scale (150kg/year)
  - Sc3) Large scale (500kg/year)

Hotspots of the most promising early catalysts for PEC reactor have been identified at lab scale*.

*Simapro v9.1, ecoinvent 3.7.1 and EF (adapted) LCIA method.

NEXT STEPS

1. **Sc1. Lab scale, *Ongoing***: continue to provide environmental information for the development of new materials and reactors.
2. **Sc2, Sc3. Medium** and **Large-scale**: scale-up of individual reactors and integrated FPC demonstrator.
3. **Prospective LCA and sustainability analysis** of FPC System using prospective data based on simulations and predictive scenarios.
4. **Comparison of FPC with competing commercial technology**, identifying associated impacts and benefits.

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