

Pilot Plants and Demonstration Units

PSDI is equipped with 8 pilot plants units towards the production of clean fuels and energy. These units include:

1. Synthesis gas production Unit
2. Methanol reforming unit
3. Hydroprocessing unit
4. Regenerative PEM fuel cell
5. Control unit for PEM and MEPR electrochemical systems
6. Unit of Single Solid Oxide Fuel Cells
7. Electrode production unit
8. Laboratory unit for controlling electrochemical process

Synthesis Gas Production Unit (SYNGAS)



The synthesis gas production unit was designed and manufactured within PSDI, aiming to convert natural gas, hydrocarbon gases and oxygenated liquids to synthesis gas. The SYNGAS unit consists of a fixed bed and a spouted bed reactor which may operate in parallel or individually. The SYNGAS unit is a fully-automated unit.



Methanol Reforming Unit

The goal of this unit is the power production of 10 kW, using autothermal reforming steam reforming of methanol and utilizing the produced hydrogen in PEM fuel cells. The steam reforming of methanol is considered a superior methodology over the other two alternatives (partial methanol oxidation and methanol reforming), as it is a combination of the other two. The proposed methodology causes less catalyst sintering and does not require additional reactor heating.

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Hydroprocessing unit (HDS)



A large pilot-scale hydroprocessing unit has been used for a variety of projects including hydrotreatment catalyst evaluation, hydrotreating and hydrocracking of heavy refinery streams, hydrocracking of Fischer-Tropsch wax, etc. It consists of two fixed bed reactors in series ($D=2.8\text{cm}$, $L=48\text{ cm}$), and is fully automated. It has capacity of ~ 14 lit/day processing feedstock and combines all the sections of an industrial scale hydroprocessing unit.

Control Unit for PEM and MEPR Electrochemical Systems (SOFCU)

This unit is sufficiently equipped in order to study and control the operation of a single or a cluster of PEM fuel cells. Furthermore it is utilized for Monolithic Electrochemically Promoted Reactors (MEPR) in high temperatures or Solid Oxide Fuel Cells (SOFC). The unit includes an integrated flow control system, gas IR analyzers, potentiationstat, high temperature furnace and operating control system. The main goal of this unit is the basic study of the electrode yield for the aforementioned fuel cell assemblies.



Regenerative PEM Fuel Cell

This unit consists of an integrated system for the operation and study of operating parameters of a regenerative PEM fuel cell (RPEMFC) system. It consists of a of PEM fuel cells' cluster and an electrolytic assembly of PEM type for the production of hydrogen and oxygen, an integrated

flow control and electrical control system of the cluster. The unit is equipped with the necessary automation to allow continuous operation for extended periods of time. The unit is at the final stage of its construction.

Unit of Single Solid Oxide Fuel Cells (BUTTON CELL)

This unit enables research studies on single fuel cells and of the materials they incorporate for their SOFC application. It consists of an advanced arrangement (button cell) with the advantage of automated control of the atmosphere of both anode and cathode. It further includes a cylindrical furnace for allowing operations at high temperatures (up to 1200°C). The operation of this unit is temporarily supported by the SOFCU unit (see above).

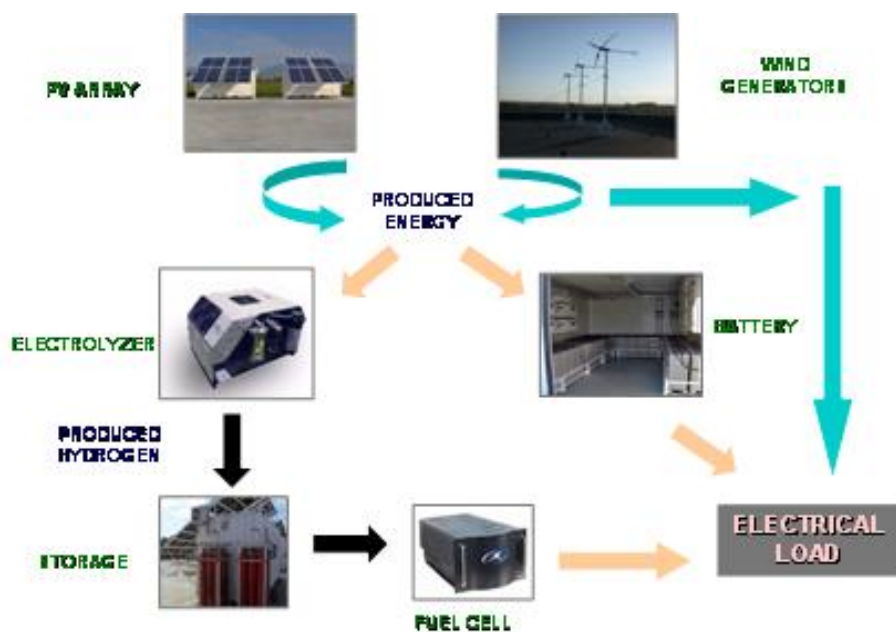
Electrode Production Unit

This includes two autonomous units. The first one involves production of membrane electrode assemblies for PEM, and it consists of a press which can operate up to 300°C. The second one is a spray printing device for catalyst deposition in the form of electrodes.

Laboratory Unit for Controlling Electrochemical Process

This unit enables the study of the aforementioned electro-catalytic processes and the electrochemical characterization of the solid electrolyte catalyst. The unit includes an intergraded flow control system, a gas chromatograph, a potentiationstat/galvanostat and a high temperature furnace.

Stand alone power system based on solar and wind energy with hydrogen



PSDI has developed a stand alone power system which is based on solar and wind energy in order to produce hydrogen. The 10 kW_p power system includes an energy storage facility which enables the autonomous power production throughout the year. This power system is part of an ongoing collaboration with a private company in Xanthi, Greece.



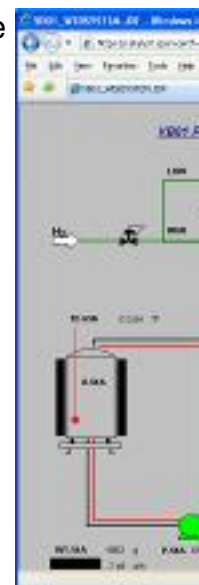
Machine Shop and Calibration Room

This Machine Shop includes all necessary machinery infrastructure to support the construction and maintenance of the laboratory pilot plants. The machine shop includes mechanical and electrical equipment for supporting the laboratory needs.

PSDI is further equipped with specialized infrastructure which enables the calibration of instrumentation equipment including pressure transmitters, temperature transmitters, mass flowmeters.

Informatics

The PSDI employs and also develops informatics tools in order to support the needs of the



affiliated laboratories and to provide third-party services. These tools include:

1. Informatics infrastructure for providing various services via internet
2. Infrastructure for remote monitoring and data safety via internet
3. Laboratory Information Management System (LIMS)
4. Process Information Management System (PIMS)

5. Control and data management system of pilot plant units



Other facilities within CPERI.

PSDI works closely with other laboratories of CPERI which provide additional services that support the research programs PSDI is involved with. Within CPERI there is a modern and fully equipped analytical laboratory involved in fuel quality control (analyses on crude oil, petroleum

fractions, products and lubricants) as well as quality control of hydrocarbon gaseous mixtures. Furthermore PSDI collaborates with another independent laboratory which allows detailed physical, chemical and morphological characterization of materials.