

Current Status and Future Perspectives of Clean Energy Research in Cinvestav

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1. Introduction

Mexico had been a top world producer of oil until the early 2000's. Hence, heavily dependent on fossil energy resources such as oil, gas, and coal for its primary energy supply. However, the use of fossil energy resources led to important pollution problems in the largest cities in the country. Consequently, Mexico adopted a strategy to increase the use of renewable energy achieving almost 23% of generation of electricity in 2018. In accordance to this strategy Mexico became signee of the Kyoto protocol (1997), the Doha amendment (2012) and the Paris agreement (2018). However, during this year there has been an emphasis by the Mexican Government through the Ministry of Energy on revitalizing the use of fossil sources, in order to strengthen the economy of regions of the country dependent on oil production. With this development R&D activities in renewable energies have been placed in Research Centers with more general research missions and Universities.

2. R&D activities related to clean energy technology

Cinvestav is the largest research center in Mexico with 650 faculty and 5000 graduate students, operating in a similar way as a research university, with a fundamental mandate of generating the scientific manpower of the country. Consequently, all research programs, including those related to renewable energies have associated masters and doctoral programs, which have served as the basis of other research groups in Mexico.

Through our academic campuses in the Southeast, Center and North of the country Cinvestav promotes new technologies, related to storage, use and conservation of clean energies. The main research themes of these campuses are materials and devices related to more efficient utilization of solar power generation and production and utilization of hydrogen energy carriers.



Renewable Energies Program Site in Cinvestav-Salttillo in Northern Mexico

3. Specific research activities in hydrogen and solar cells

The utilization of hydrogen is a top choice clean energy source as it does not generate CO₂. In this sense, the production of hydrogen in a CO₂ free procedure is critical to achieve a process that does not have a carbon signature. Our research is focused on producing carbon-free hydrogen from renewable energy resources by electrolyzing water using electricity generated with other renewable resources. This is conducted in our Applied Physics

Department in Cinvestav-Mérida (Southern Mexico) and our Chemistry Department in Cinvestav-Mexico City and Cinvestav-Salttillo. On the storage side, our Chemistry Department is working on the development of solid-state hydrides as MgH_2 . Finally, in the specific use of fuel cells, the research effort envelopes the process to create catalyst nanoparticles, used in fuel cells to power small vehicles, which are built as prototypes in Cinvestav-Mexico City.

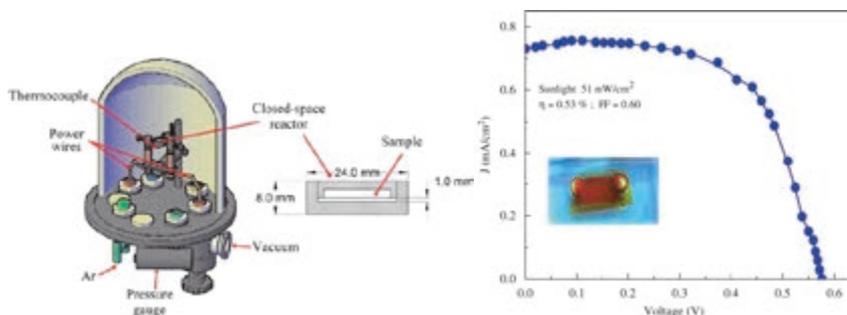


Prototype Vehicles propelled by fuel cells built in Cinvestav-Mexico City

Related programs/projects conducted by Cinvestav

Electrolysis of water using solar energy. (2017-2020)
 Development of fuel-cell propelled prototype vehicles for use in Mexico City Project (2016-2021)

We have current projects in fourth-generation green solar cells in the Applied-Physics Department in Cinvestav-Mérida, specifically the role of structural defects in increasing efficiencies in Cu_2ZnSnS_4 and $CdS/CdSe$ based cells. Also, in the same department we currently have projects in increasing the efficiency of dye-sensitized ZnO and TiO_2 cells. With current projects running until 2020.



Reactor for production of Cu_2ZnSnS_4 cells, Dye sensitized cell, both produced at Cinvestav-Mérida

4. International collaboration

4-1 International alliance/networking development

Cinvestav has signed five comprehensive and specific MOUs with oversea institutes in the area of clean energies, in general currently Cinvestav holds more than 200 agreements with

institutions outside Mexico. These agreements include activities as joint projects, researcher exchange, student mobility and dual degree granting. These collaborations are important for carrying out and accomplishing research as 83% of the papers published by Cinvestav are done in collaboration with another institution. Also, the presentation of different projects to international funding agencies requires the partnership with several institutions at the same time. Such collaborations among the research institutes in G20 members are important for carrying out innovation in clean energy technologies.

4-2 International joint R&D activities

Although not directly in the field of green energy, Cinvestav has specific joint activities with the CNRS in France, as we are the site of one of the International Units of Research of CNRS outside France. Also, we have direct agreements with the CNR in Italy to support joint Italy-Mexico research which is open to joint research groups.

5. Future perspectives

At this moment is very important for Mexico to increase the share of power generated by renewable energy such as solar and wind as both sources have an unexploited potential due to the geographical and climate situation of the country. Although for immediate economical and development issues, the support for use of fossil fuels has been increased, this situation will have a short span, after which the country is expected to retake the growth if renewable energies in order to comply with the commitments set in the Paris agreement for 2035. Cinvestav is interested in creating research groups in CUC technologies, as is one of the areas not currently represented in the whole country. As a representative Mexican institution we are very much interested in creating possible alliances to achieve this goal. We have the advantage of hosting a selected group of doctoral students that have help us in the past to consolidate research projects due to the possibility of increased mobility,

Jose Mustre

2014 Director-General, Cinvestav-Mexico (current)
2012 Visiting Professor, University Nice-Sophia Antipolis University, France
2004-2007 Deputy Director for Research, Cinvestav-Mexico
2003 Visiting Scientist, Laboratorio Nacional de Luz Sincrotrón, Campinas, Brazil
2000-2001 Visiting Scientist Los Alamos National Laboratory, USA
1997 Visiting Scientist, Argonne National Laboratory, USA
1992- Professor of Physics, Cinvestav-Mexico (current)
1989-1992 Postdoctoral Fellow, Los Alamos National Laboratory, USA



Research Biography

2016- Quaternary semiconductors for solar cells
2010- Atomic structure and water ordering of ions in solution
1997-2002 –CdTe based solar cells
2008- Fe-based superconductors
1997-2002 – II-VI semiconductors for use in solar cells
1989-2017- High temperature Superconductivity in copper-oxides
1983-1989 Ab initio Methods of X-ray Absorption

Academic Background

1989 Ph.D. in Physics, University of Washington, Seattle, USA
1984 Master of Science, Physics, University of Washington, Seattle, USA
1982 Master of Science, Cinvestav-Mexico City, Mexico