R&D in Clean Energy Technologies at the National Institute of Industrial Technology

Eng. Javier Ibañez
President
National Institute of Industrial Technology – INTI (Argentina)

1. Introduction

Argentina represents less than 1% of GHG emissions within the CMNUCC´s countries, but in terms of per capita contribution that number climbs to 10 tons of carbon dioxide equivalent[1], that has located us between the first 30 countries.

In recent years, in accordance with the provisions of the Third National Communication[2] Argentina has carried out plans, programs and actions directly and indirectly with the mitigation of GHG in various productive and consumer sectors.

The main contribution to GHG emissions is the generation and use of energy: combustion of fossil fuels to obtain electric and thermal power and transportation. In that order, there were actions implemented in two fundamental axes: energy diversification including the participation of renewable energy in the matrix and the promotion of rational and efficient use of energy.

With that aim, the Law N° 27.191 was held in 2015, forcing the large consumers of electric power to consume incremental percentages of energy from renewable sources, which turns the electric power in a tradable product between privates companies and between them and the government. From this milestone, the RenovAR Program begins, through which the argentine government bid electric power for 44.666,5 megawatts (147 projects) until now and there were 1164,8 megawatts (50 projects) commercialized between privates companies.

Nowadays the maximum contribution of electrical energy from renewable sources reached approximately 8%, and will continue to grow as the renewable parks are commercially enabled and can supply electricity to the grid. Besides, great efforts are being made in order to replace the fuels for biomass to industrial heat operations.

On the other hand, the distributed generation law is being regulated and fomented through financial incentives for equipment that generate their own energy or to reduce the energy consumed.

The National Institute of Industrial Technology (INTI) is a public decentralized institution created in 1957 that is part of the National Science and Technological System. Today under the National Ministry of Production and Labor, its mission is to promote industrial development through innovation and technological transfer. INTI is also the national reference in Metrology, to strengthen the metrological capacities to spread industrial quality all over national industry. INTI has technological centers across the country dedicated to various industrial sectors.

2. R&D activities related to clean energy technology

The Technological Development and Innovation Management through its Energy and Mobility Deputy Management (soeym@inti.gob.ar) works for the strength of the competitiveness and sustainability of companies, specially SMEs, through development and appropriation of

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1 https://www.infobae.com/tendencias/innovacion/2018/05/09/argentina-entre-los-30-paises-que-mas-contaminan-la-atmosfera-en-el-mundo/, visited 09/14/2019.

2 https://www.argentina.gob.ar/ambiente/sustentabilidad/cambioclimatico/comunicacionnacional/tercera, visited 09/14/2019.

innovative products and processes that contributes to reduce the GHG emissions and collaborate with the Government in order to rules dictations.
The main technologies we address are:

BioEnergy, Solar Collectors for residential use, Photovoltaic panels, Low Power Wind Turbines
Storage
Smart Grid Integrations
Movility
Energy Efficiency

3. Specific Research activities in hydrogen, CCUS, and related technologies

Electrolyzers. Fuel cells fed by low-carbon hydrogen produced by water electrolysis are a good alternative for renewable energy storage. Alkaline electrolyzers are currently developed, including liquid and zero gap devices. A project in portfolio is a microbial electrolysis device, which performs an effluent treatment in a microbial anode along with H2 production in a photo cathode.

Nanostructured Materials for Energy. With the increase in energy consumption, new and more efficient materials for energy generation and storage are required. Moreover, the increasing use of portable electronic devices requires the development of new or more efficient energy storage technologies. Green, environmental friendly energy sources, which are intermittent, in some cases, like sunlight, tides, wind and waves, present the necessity to store the energy produced.

In our group, different nanostructured materials are developed and characterized.

Mesoporous carbon (MC) with well-defined porous size distribution to assess its effect as electrode support for fuel cell catalysts and supercapacitors is obtained by polycondensation of resorcinol and formaldehyde (RF) on silica nanoparticles as hard template agents, and subsequent carbonization in an inert atmosphere. The obtained mesoporous carbon products with a high specific surface area (> 400 m2g-1) were used as support for Pt and PtRu catalysts nanoparticles. The modification of the surface allowed 30% reduction of the diameter of the metal particles deposited over the support and a 10% increase of power density of membrane electrode assemblies compared with state of art of DMFC PtRu/carbon supported catalyst.

On the other hand Ni-Mo alloys electrodeposited over Ni substrate were tested as electrocatalysts for the hydrogen evolution reaction in alkaline media, and the influence of the electrodeposition conditions in composition, morphology and HER activity was analyzed.

TiO2 Deposition on Carbon Substrates with Tailored Mesoporous Structures for Fuel Cells.

Anion Exchange Membranes. Low carbon footprint hydrogen, a near-zero emission energy carrier, plays a key role in many applications such as road transport, micro co-generation and de-carbonization of several industrial processes. Most of these applications involve fuel cells (FCs) to convert hydrogen to power, though other fuels like natural gases, methanol or ethanol are employed to feed FCs as well. It is worth mentioning that hydrogen technologies footprint depends on its method of production, and in this sense, electrochemical water splitting is a very favored option.

Despite their potential, one of the main barriers to the widespread adoption of these technologies is the current costs of fuel cells and electrolyzers. Therefore, alkaline systems, which do not require precious metals as electrocatalysts or demand corrosion-resistant components, are a good option for low temperature, membrane-based devices. Consequently anion exchange membrane fuel cells (AEMFCs) and zero-gap liquid alkaline water electrolyzers (LAWEs) have gained interest recently, demonstrated by the significant increase in the number of publications, particularly since 2010.

In our group, we prepare anion exchange polymer membranes based in polybenzimidazole, including polymer synthesis, blend with PVA, crosslinked with PVBC/quaternized, hybrid membranes with functionalized graphene oxide and electrospun nanofibers. The membranes are characterized and evaluated in alkaline water electrolysis devices liquid and zero gap.
Actually new applications are explored for the membranes developed, like salinity gradient power or redox flow batteries.
Patent INPI-ARG: 180.100-013/2018: Preparation method of a polymeric proton exchange membrane.

Biomass Gasification Technology. In Argentina, the bioenergetic sector it is made up of many agro industrial companies that generate waste, primary producers who waste crop residues, and a sub sector of support that are the SMEs manufacturers of machines and equipment. To achieve the industrialization of these wasted resources are required innovations and developments in both physical and chemical products and processes and Biological in the industry dedicated to the use of biomass, as in the existing machinery to achieve profitable industrialization processes (collection, densified, storage, conditioning, pre-treatment, etc.).
From the NETWORK and with the support of the industry, it seeks to identify opportunities for development of new bioproducts including biofuels as well as innovation opportunities in machines and equipment that allow reaching new and improved degrees of biomass industrialization.

Utilization of pellets of agricultural harvesting and forestall activities residues in biomass combustors. Many of the agricultural crop residues are suitable to transform to solid biofuels with a correct management. This valorization technique for these mostly unused residues can help the different agriculture industries to diversify their conventional activities and to replace the natural gas for thermal energy. During the validation process, the previous data was compared with the newest Standard approved in Argentina for solid biofuels (IRAM-ISO 17225) to establish a quality basis for the industrial process.

Materials for the Off Shore generation and storage of renewable energy. The development of advanced materials and prototypes for sustainable energy production (solar, wind, wave and tidal) including energy storage through batteries and hydrogen technology in off-shore platforms. It is also included the salinity gradient energy applications in argentine lagoons of high salt concentration (reverse electro dialysis) and in oil wells.

Investors Interoperability. The interoperability system is a photovoltaic inverter data acquisition system that takes the data and integrates them into a dedicated IoT (internet of things) platform. The main problem that this system solves is the incompatibility of data that comes from multi-brand inverters. If all the photovoltaic systems were from the same manufacturer, the communication protocols and the way in which the data is shared would be homogeneous among all, with which it would be possible to observe them in the same place; however, this situation is not in practice.

Grid Network with Renewable Energy. In Amstrong, Santa Fe Province a 11.000 habitants city, a integrated network of renewable energy (200 kW photovoltaic floor plant, 60 solar roofs in homes and 10 small wind turbines located in the city) with conventional grid system was established. With wireless equipment installed in a thousand homes in the city, they can monitor the local electricity service and obtain information remotely to determine the quality of the service, the user load curve, and the different conditions of the network or consumption characteristics of each residence.

Non conventional vehicle performance. Argentina is one of the highest biofuels producers and the proportion included in our gasoline is high too (12% of bioethanol and 10% of biodiesel). It is also a very common practice to utilize a 100% biofuel in some farm equipment, public transportation and private vehicles. On the other hand, the argentine electric car is a reality. With this aim, we explore the biofuels quality.

CCUS Technologies. As a national institute, we assist companies to improve their technologies to achieve environmental objectives.

Related programs/projects conducted by the institute (further information on programs/projects are found in the template)

- Grid Network with Renewable Energy (2016-2019)
- Investors Interoperability (2019 – 2021)
- Development of electrodes for the electrolytic production of H2 (2018 – 2021)
- Development of mesoporous C material applied to fuel cell components and super capacitors (2017 - 2020)
- Development of low-cost hybrid membranes in PVA and chitosan materials cross linked with graphene oxide for electrolyzes and H2 cells (2017 – 2020)
- Development of alkaline membranes based on polybenzimidazole for storage system (2016 – 2019)
- Development of PBI - PVA membranes with fibers produced by electrospinning (2018 – 2021)
- Utilization of pellets of sugar cane harvesting residues in biomass combustors (2018-2020)

4. International collaboration

4-1. International alliance/networking development

INTI has three strategies to promote international collaboration:

1. Industrial Technology Transfer
   Productive knowledge, innovative technologies and transfer promotion to countries with equal or less industrial development with the aim of contributing to strengthen their productive and industrial network.
2. Scientific and Technology Cooperation
   Improve technological knowledge.
   Participate in joint innovation processes.
   Promote industrial competitiveness and productiveness.
3. Internationalization of Local Companies
   Contribution to the incorporation of technological innovation that favors the generation of employment and the increase and diversification of the exports of the national SME sector.

We carry out these strategies through the following cooperation activities:

- Technology Transfer
- Institutional Strengthening
- Training & Development
- R&D&I Projects
- Short Term Mobilities in the frame of Projects
- Scientific International Workshops and Meetings

4-2. International joint R&D activities

Among different activities in energy field below main remarkable cooperation activities with worldwide institutions

- JICA (Japan): Development program for Energy Efficiency technologies and best practices.
- Surrey University (UK) & TECNALIA (Spain) & Naples University (Italy) &

Technion Institute (Israel): Workshop Clean Energy through innovative materials: off shore Energy (October 2019). Sustainable energy developing is essential to reduce greenhouse gas emissions and climate change, and the energy storage challenges need to be solved in order to enable the evolution towards a global renewable energy matrix. This Workshop focuses on the development of advanced materials for sustainable energy production (involving solar, wind, wave, tidal and salinity gradient energy) and energy storage through batteries and hydrogen technology in off shore platforms.

- CENER (Spain): Renewable Energy Technology transfer program including formation of our professionals and consultancy services for infrastructure build up.
- TNO (Netherlands): Biomass technology and services development.

5. Future perspectives

In accordance to the Argentinian Third National Communication, our next challenges are aimed at the appropriation, generation and transfer of technology in order to reduce GHG emissions in two different aspects:

- Thermal Energy technologies for industrial activities:
  - **Solar Concentrators** for fluids heating or steam generation aimed at SMES located in regions beneficial for this technology
  - **BioGas - BioEnergy**: energy recovery of the organic fraction of urban solid waste
  - **Biofuels**, obtain from all kinds of agricultural and forestry industrial residues. The generation of an industrial and public market is aimed, through process standarization
- Electrical Transportation
  - Production and Reuse of **Lithium Batteries**: Technological assistance to battery manufacturers in component development (separators, electrodes, cells). Spent batteries disposal and recycling, engine testing laboratory for different fuels and electricity.
  - **Engine Testing Laboratory**, for the performance evaluation of different biofuels, gasoline cuts for the evaluation of introduction of more biofuels to the regular one and electrical power.

Eng. Javier Ibañez

President

Industrial Engineer-University of Buenos Aires

Since December 2015 he is serving as President of INTI.

He has experience at Government level in Management positions in four Ministries related to economic development, strategic management, digital services and control of the city of Buenos Aires activity. His performance is oriented to the management of changing work paradigms in governmental institutions.

Management experience in the development of commercial offers and management of orders in multinational companies with local presence and abroad. Solid knowledge in the areas of commercial and operational management, logistics, planning and production control. Trained to carry out tasks of supervision and control of operations, with characteristics of leadership, self motivation and teamwork. Results-oriented performance, innovation and risk.