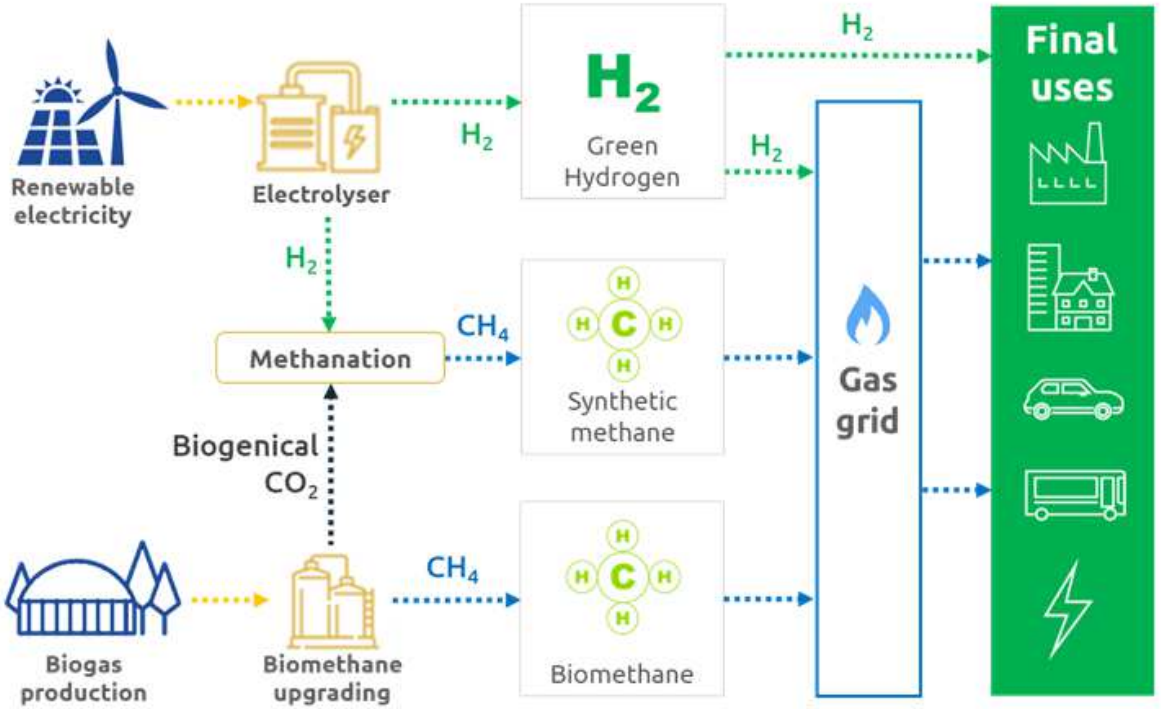
IDOM references on Renewable Gases



About IDOM

We are **an association of independent professionals**
working in the fields of Consulting, Engineering and Architecture,
sharing common objectives and work practices, at the service of our clients.

330 M€
annual turnover

63
years

125
countries

45
offices

3.800
professionals

866
partners

Our pillars

We believe in **excellence**. We strive for excellence in everything we do.

We believe in the **power of human relationships** as a motivating force to overcome difficulties.

We are **passionate about resolving problems** that no one has solved before.

Innovation is present in all our activities.

Our soul

The Client

The centre of our activity.

Our people

The basis and foundation of IDOM.

Professional development

Highly qualified people who seek excellence in the development of their work.

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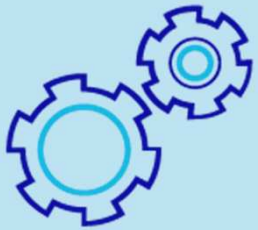
Our activity

IDOM

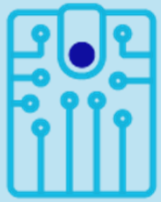
Cities



Industry

Public sector

Energy



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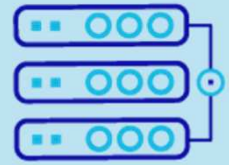


Electronics & Communications

Our Activity

IDOM

Architecture

Transport Systems

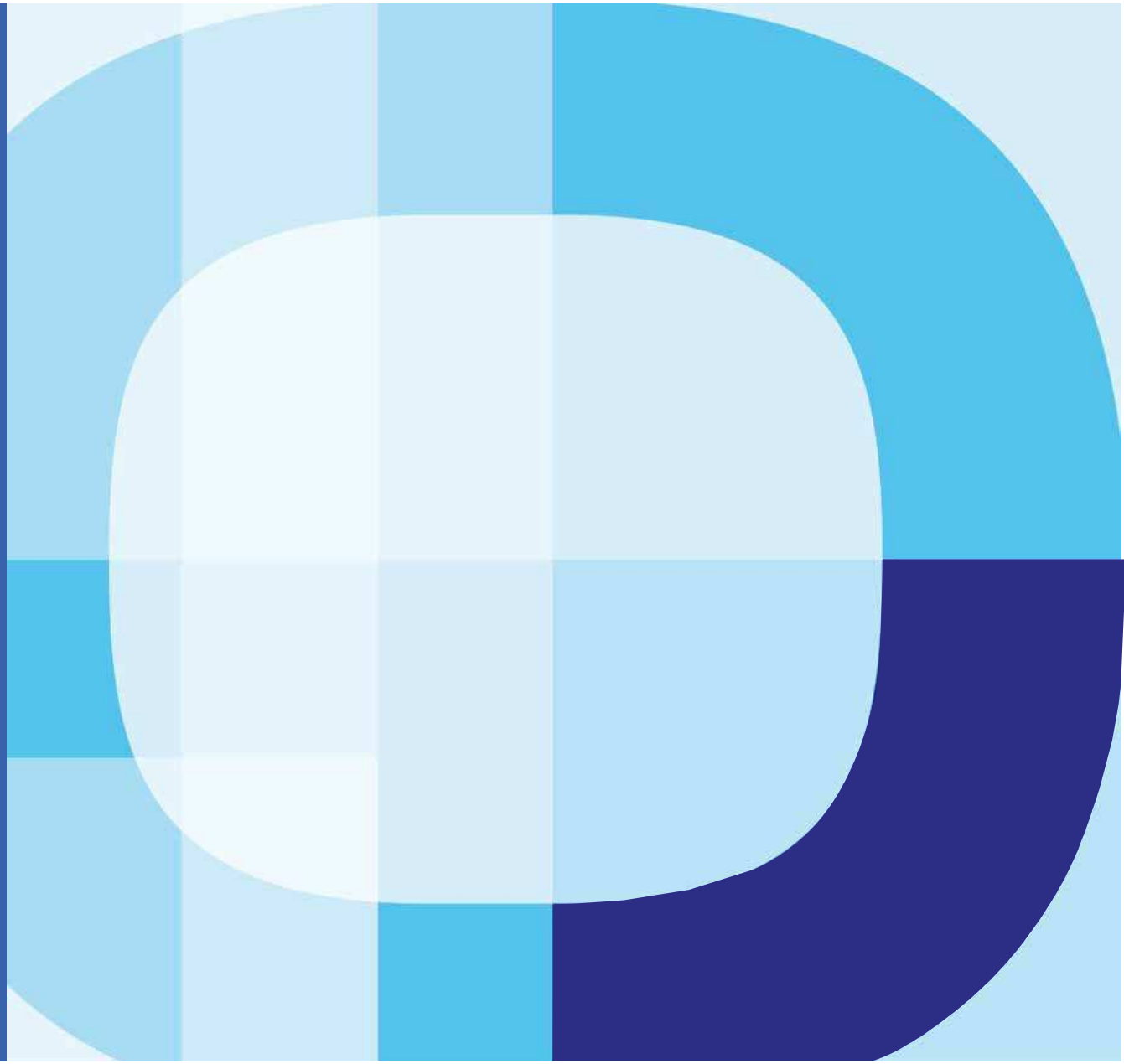
Science & Astronomy

Health

Water Cycle

Environment

IDOM background on H2



Looking back

IDOM has been involved in hydrogen projects since 14 years ago, with a long back up on consulting and engineering developments, with multidisciplinary teams, adding knowledge, experience and innovation

The experience accumulated starts at the Zaragoza office, a leading Province that has been betting hard on this gas for almost 20 years

General Description on Services related to H2

IDOM

R&D / Specific studies

- Definition, support and management of R&D projects
- Facilities for laboratories and test benches
- Safety studies

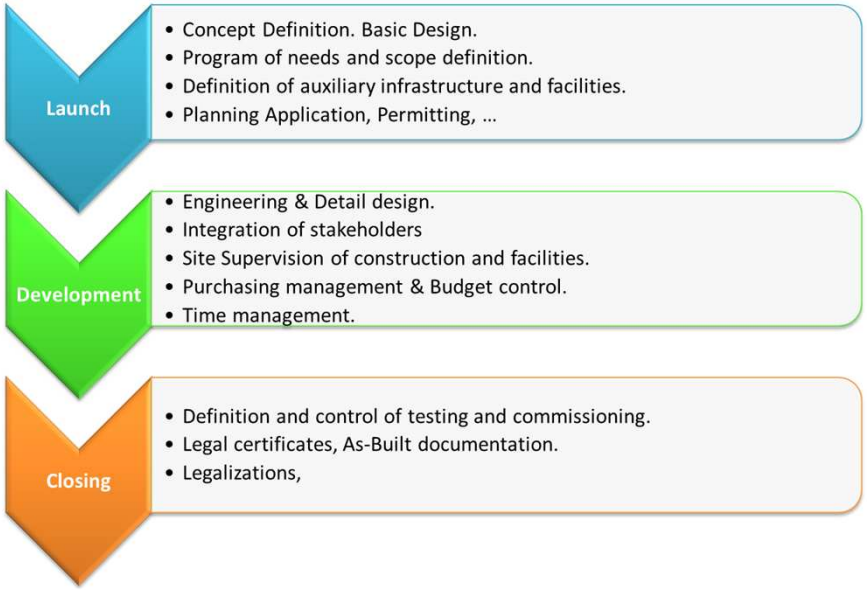
Consultancy

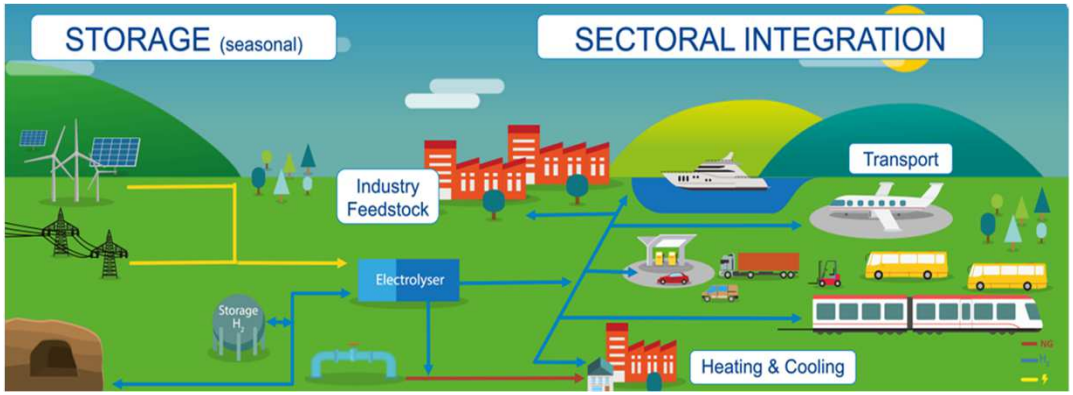
- Definition of master plans and strategies on deployment of new hy-technologies
- Specific studies for business development and business cases
- Logistics and distribution of H2

Project Development

Project management, Construction management, permitting and commissioning of H2 facilities like:

- Green Hydrogen and renewable energy integration projects
- Hydrogen filling stations and H2 storage facilities
- Hydrogen for Power Plants





Permitting (Spain)

Reference codes/normative/legislation specified for hydrogen utilities facilties

Green production
- Real Decreto 815/2013: Anejo 1. (Cap. 4.2a)

Methane reformer & Haber-Bosch
- Real Decreto 815/2013: Anejo 1. (Cap. 4.2a)

$$H_2O \rightarrow H_2 + O_2$$
$$CH_4 + O_2 \rightarrow CO + H_2$$
$$CO + H_2O \rightarrow CO_2 + H_2$$
$$H_2 + N_2 \rightarrow NH_3$$

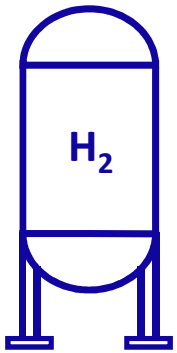
Natural gas pipeline
- Ley 34/1998, de 7 de octubre, del sector de hidrocarburos (Artículo 64. El Gestor Técnico del Sistema)
- EN 16726 Gas infrastructure. Quality of gas.

Hydrogen gas pipeline
- UNE 60309: Pipelines for gaseous fuels. Minimum wall thickness for steel pipes.
- B 31.12 Hydrogen Piping and Pipelines

Tank transportation
- ADR: European Agreement concerning the International Carriage of Dangerous Goods by Road

Pressurized storage
- APQ 5: Almacenamiento de gases en recipientes a presión móviles
- Real Decreto 2060/2008: Reglamento de equipos a presión y sus instrucciones técnicas complementarias.

Ammonia storage
- APQ 4: Almacenamiento de amoníaco anhídrido



Turbine
- Real Decreto 1042/2017 sobre la limitación de las emisiones a la atmósfera de determinados agentes contaminantes procedentes de las instalaciones de combustión medianas.

Automotive
- Real Decreto 919/2006: Reglamento técnico de distribución y utilización de combustibles gaseosos y sus instrucciones técnicas complementarias ICG 01 a 11
- ISO 14687-2: Hydrogen fuel — Product specification — Part 2: Proton exchange membrane (PEM) fuel cell applications for road vehicles
- UNE-ISO/TS 20100: Gaseous hydrogen. Fuelling station

Permitting (Spain)

IDOM

Timeline

Pre-construction

Document	Agent / Ministry / Goverment
Urbanistic inform	City council
Obtainment of business activity and work license.	
Application for Integrated Environmental Authorization from competent authority (Regional Level) when H2 production is at industrial scale.	Regional goverment
Authorization from the Provincial Industry Service regarding all projects of the H2 Production Facility.	
Authorization for electricity and water supply.	Utility companies

Post-construction

Document	Agent / Ministry / Goverment
Comissioning permits	Regional goverment
Start-up license	City council

Involvement with H2 Stakeholders

IDOM

Participation on H2 Entities

FUNDACIÓN PARA EL DESARROLLO DE LAS NUEVAS TECNOLOGÍAS DEL HIDRÓGENO EN ARAGÓN

AeH2 ASOCIACIÓN ESPAÑOLA DEL HIDRÓGENO

Cluster Energía BASQUE ENERGY CLUSTER

Clients

Redexis

PETROPERU

ÇALIK ENERJi

enhol

ecoTRANS

MINISTERIO DE CIENCIA E INNOVACIÓN · CDTI Centro para el Desarrollo Tecnológico Industrial

EXPO ZARAGOZA 2008

شركة بمكو العربية للمقاولات ARABIAN BEMCO CONTRACTING CO.

GS Engineering & Construction

ОБЩЕСТВО С ОГРАНИЧЕННОЙ ОТВЕТСТВЕННОСТЬЮ СЛАВЯНСК ЭКО

FUNDACIÓN PARA EL DESARROLLO DE LAS NUEVAS TECNOLOGÍAS DEL HIDRÓGENO EN ARAGÓN

IDOM references on H2

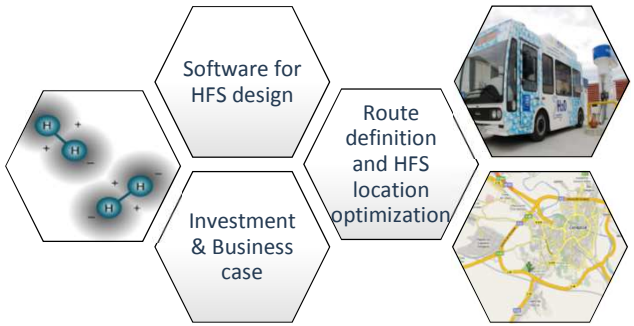
R&D / Specific studies

"Walqa" Green H2 Filling Station & Electrolizing System Prototype (Fundación del H2 de Aragón)

SCOPE OF THE PROJECT	IDOM ACTIVITIES
Design of hydrogen facilities for storage and production.	Detailed Design
Design of hydrogen filling station	Site Supervision and Project Management
Laboratory hydrogen network	Permitting and legalizations

CENIT ECOTRANS – Environmental Technology for urban transportation

ecoTRANS



PROJECT SCOPE

- Develop technologies required to provide passengers with more appealing public urban transport (comfortable, punctual, fast, safe, reliable) with less environmental impact (low power consumption, low visual impact, low noise impact)

IDOM ACTIVITIES

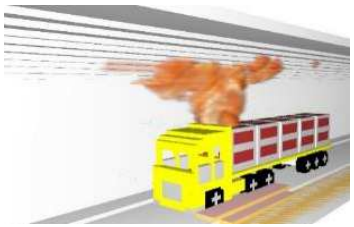
- "Logistics study associated with metropolitan transport by hydrogen"
- Total IDOM budget: 0,8 MM€
- Duration: 2008 – 2011

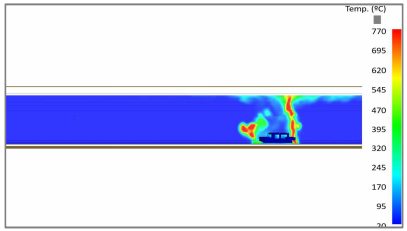
RESEARCH CENTRES involved

- The Foundation for the Development of New Hydrogen Technologies of Aragon (Fha) support the Hydrogen technologies and its development
- University of Zaragoza, Research Team for Transport and Logistic (GITEL)

R&D / Specific studies

Project INSTUNH2: Improving safety inside tunnels facing the chance of new hydrogen vehicles.





- Study of the impact of a hydrogen fire in road tunnels
- Development of a model for the discharge of pressured hydrogen tanks
- CFD simulations of passenger cars and heavy vehicles
- Study of the influence of ventilation

- Study the different options for conducting a real fire test.
- Design ofgathering information system (sensoring) that allows evaluating the test results.

Partners and founding:

CALVERA

IDOM

GOBIERNO DE ESPAÑA · MINISTERIO DE ECONOMÍA, INDUSTRIA Y COMPETITIVIDAD

[AEI] agrupaciones empresariales innovadoras

minetur

IDOM

GOTOR comunicaciones

Consultancy

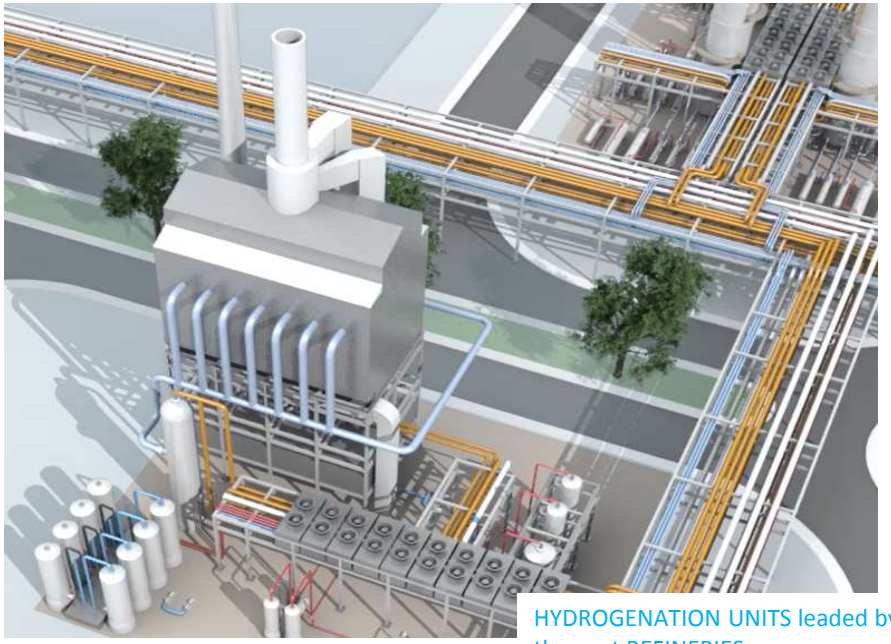
Technical Assistance for Aragon Hydrogen Master Plan 2011 to 2015 and 2016 to 2020.

- Definition of the new structure of the Master Plan
- Implementation of the participatory process, workshops with the main regional and national stakeholders, with following topics:
  - H2 Production
  - Storage, logistics and transportation
  - Applications of H2
  - Transfer of technology, protection and economic impact
  - Training,& enforcement
  - Definition of the monitoring system of the Master Plan
- Document writing and supervision
- Executive Summary

FUNDACIÓN PARA EL DESARROLLO DE LAS NUEVAS TECNOLOGÍAS DEL HIDRÓGENO EN ARAGÓN

Project Development
Hydrogen Generation at Refineries

IDOM is working with his refineries clients towards the Refinery of the Future. We are working in several paths and particularly in the incorporation of blue hydrogen to the process.



HYDROGENATION UNITS leaded by IDOM at the next REFINERIES:

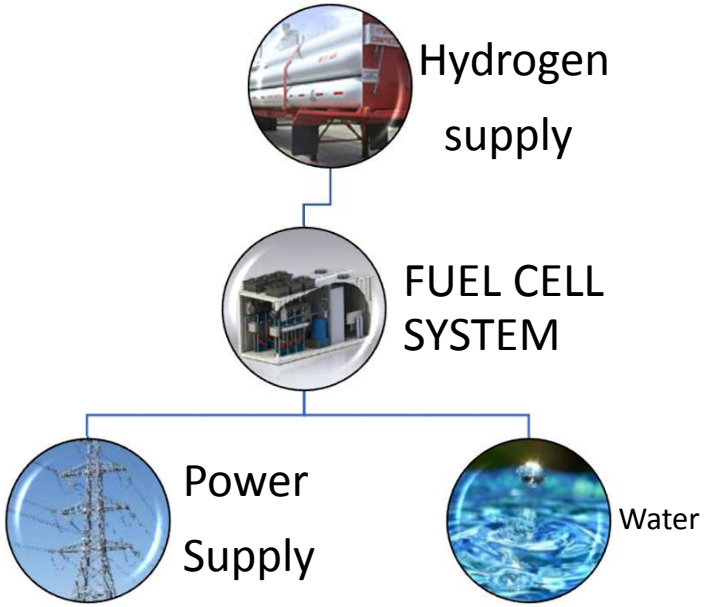
TALARA (PERU)

LUBA (GUINEA)

SLAVYANSK (RUSSIA)

Project Development

On-site electric production from H2 for off-grid building supply (500kW)



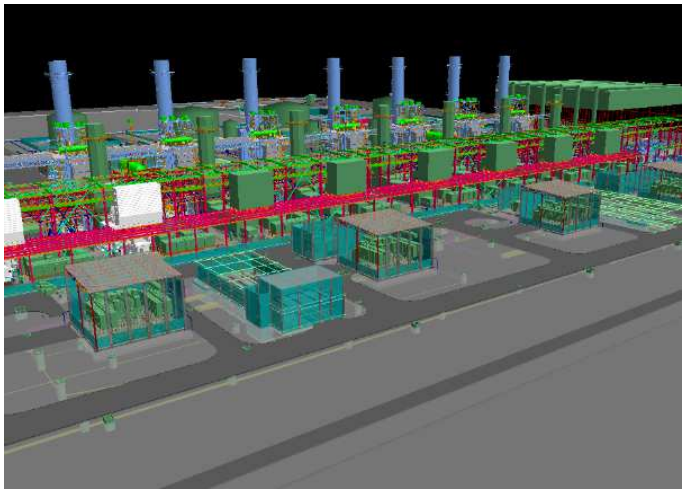
SCOPE OF THE PROJECT	IDOM ACTIVITIES
Design of electric main power supply system from Hydrogen	Concept design
Onsite Hy-storage.	Market investigation
FC BoP system for electric power supply	Detailed Engineering
Implementation req's & auxiliaries	Procurement process

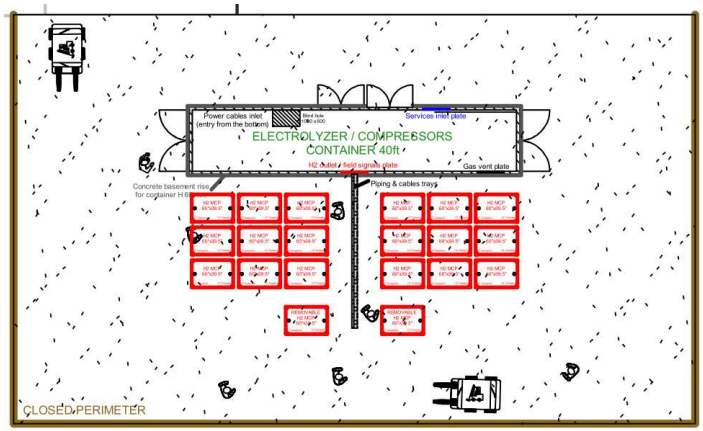
Project Development
Hydrogen Generation at Power Plants

On-site H2 production facilities (with around 20 Nm3/h) at CCPPs

(e.g. PP12 2000MW, in Saudi Arabia, and KHOMS 400MW, in Libya), with the next scope:

- Definition and calculation of H2 needs
- Specification of the On-site H2 Production System
- Bids Comparison
- Supplier Documentation Follow-Up and revision
- Integration within the General Lay Out considering normative constraints
- H2 Storage system design
- Hazard evaluations



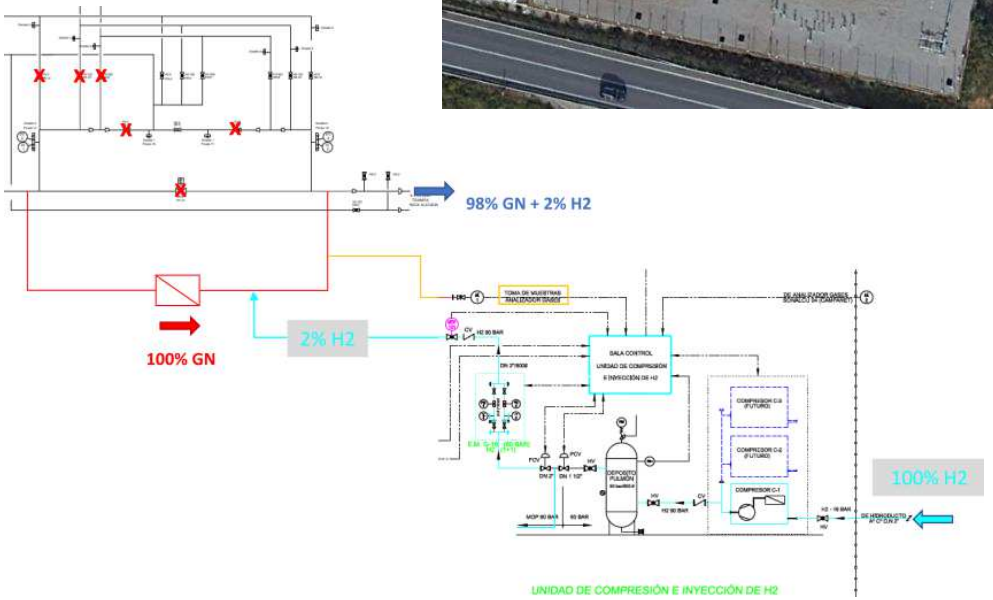


Project Development

Green H2 Pipeline (35 km) & Injection System into NG Network

Preliminary studies for a H2 pipeline evacuating the Green H2 production from a PV + Electrolizing facility covering:

- Analysis of alternative configurations for the injection into NG Network (2.500 Nm3/h of H2)
- Lay Out assessment
- Pipeline sizing (35 km)
- Preliminary CAPEX



Project development

Technical Assistance for new Hydrogen HUB and Hydrogen Filling Stations. (Europe – Confidential)

- Analysis of client concept design.
- Development of basic design including:
  - Hydrogen HUB
  - Purification stage
  - Storage of Hydrogen
  - Distribution strategy to HFS
  - HFS definition
- Technical definition for tender process
- Market engagement
- Procurement process management
- Regulation assistance & lobbying

Hydrogen HUB

- Production
- Purification
- Compression
- Storage

- scenario from 600 kg/day to 10,000 kg per day

Hy Distribution

- Study of best suitable hydrogen carriers.
- Study of logistic transport to HFS according demand scenarios

Hy Filling Stations

- Scenario from 3 to n HFS
- External supply
- Multi-vehicle
- Multi-pressure system (350bar & 700 bar)

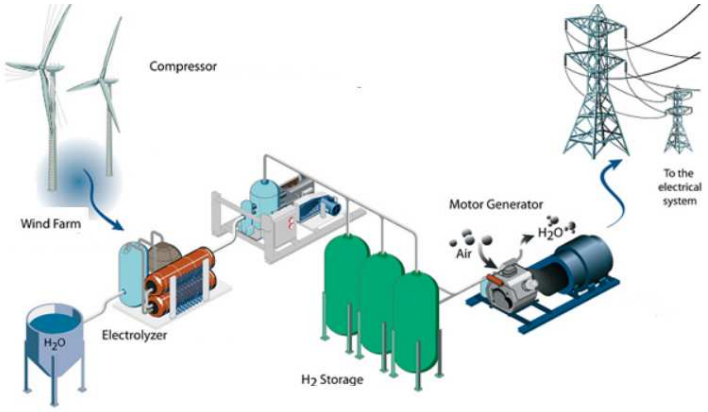
Project Development

Project Management of Hydrogen vehicles and Hydrogen Filling Station in Expo Zaragoza 2008

SCOPE OF THE PROJECT	IDOM ACTIVITIES
Full project management	Hydrogen Service Station Design
Design & Build an hydrogen filling station	Integrated Management to fleet cell vehicles acquisition
Searching and managing a fleet of fuel cell vehicles	Site Supervision & permitting
	Operation and maintenance control
	Project Management

Project Development

Green H2 Energy storage from Wind Farm (CONFIDENTIAL)



SCOPE OF THE PROJECT

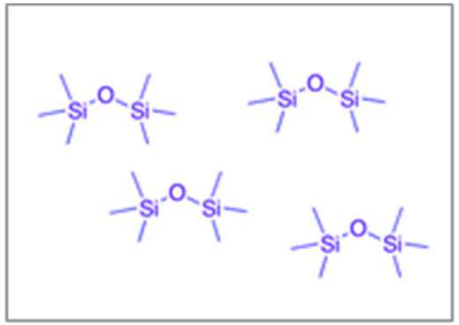
- Production of hydrogen by electrolysis with surplus power.
- Storage and compression of hydrogen gas.
- Conversion of hydrogen into power and fed into the electricity grid

IDOM ACTIVITIES

- Facilities design
- Selection of suppliers
- Detailed Engineering
- Procurement process

IDOM references on Biogases

Siloane elimination from Landfill Gas to fuel for Gas Engines



Client: GUASCOR I+D, 2001

DESCRIPTION

IDOM developed a theoretical study on the presence of siloxanes in the LFG.

This study was the base for the design of an installation for elimination of this damaging compound.

Several potential suppliers were consulted for economic evaluation of the designed system.

Study for heat utilization from LandFill Gas for Heating Greenhouses

Client: BEHEMENDI, 1997

DESCRIPTION

Feasibility study for the utilization of the residual heat obtained from gas engines running on LFG in San Marcos Landfill (San Sebastian). Heat from the cooling system of the engines is used to warm the air inside three greenhouses placed over concrete slabs in the upper platform of the closed landfill.

R&D / Specific studies
Study of the use of Biogas as Automotive fuel

Client: JAR BIOGAS, 2012

DESCRIPTION

The objective of the study was to determine the feasibility of using biogas obtained from the anaerobic digestion of agricultural and livestock waste, as well as biogas from a landfill as fuel for vehicles. The biogas is treated to obtain a gas basically consisting of methane (biomethane).

In its development, technological alternatives developed at an industrial level, its applicability, technical and environmental requirements, the adaptation needs of a fleet of vehicles and an estimation of investment and operation costs were studied.

Technical specifications for biogas extraction networks

Client: JUNTA DE ANDALUCÍA

Year: 2009

DESCRIPTION

Technical specifications for biogas extraction network facilities in non-hazardous waste landfills and waste water treatment plants (from Anaerobic Digestion tanks). The work involved the development of a template to be used by landfills and waste water treatment plants operators in Andalusia for outsourcing the services of operations of biogas facilities

IDOM Scope

The study included the following:
- Regulatory framework and procedures to be considered.
- Technical requirements for biogas extraction network facilities and utilization.
- Criteria and maintenance programs.
- CAPEX and OPEX.
- Methodology for calculating energy yield using landfill biogas.

Consultancy

Due Diligence of the Project for the Degasification of the Bordo Poniente LandFill (México)

DESCRIPTION

Bordo Poniente is one of the largest landfills in the world, and in its 412 hectares it is estimated that more than 80 million tons of MSW, generated for decades by the inhabitants of Mexico DF, are stored.

The work of IDOM consisted in the review and validation of the technical documentation prepared by the concessionaire of the exploitation: Sistemas Eléctricos Metropolitanos (SEM), through its subcontractors (ELECNOR, ACCESGAS, and others), for the collection and use of the biogas produced at the landfill, In order to generate electricity (installed capacity: 72 MW), as a step prior to the financial approval of the banks and public institutions involved.

The technical due diligence included the assessment of:

- Proposal for sealing and closure works
- LFG extraction and treatment system
- Electricity generation system with Internal Combustion Engines
- Transformers, cabins and electricity transport
- Auxiliary systems (water supply, air instrument, system control

In addition to the technical aspects, the due diligence included in the review and evaluation of other aspects, such as: environmental, social, administrative (permits, licenses...) and the financial model.

Consultancy

Technical assistance for AL AWEER Biogas Power Plant (from Sewage Treatment) in Dubai

TECHNICAL ASSISTANCE FOR DESIGN OF A BIOGAS POWER PLANT (SEWAGE TREATMENT PLANT). TENDERING DESIGN

Client: BLUE LLC. (Alserkal Group) (UAE)

(2017)

DESCRIPTION

Dubai Municipality and the Government of Dubai launched a BOT tender to turn biogas generated at the WWTP of Al Aweer into electricity. The minimum biogas flow is set to 30,000 m3/day.

The Consortium team comprised of Blue LLC and Lara Central de Tratamento de Resíduos LTDA, and Idom as Technical and Financial consultant, worked in the technical and economical proposal based on efficient Facility which enables to recycle the biogas generated by the Anaerobic Digestion of sludge from wastewater treatment plant operations at Al Warsan being the net electricity production of 25.6 GWh/year.

IDOM Scope

- Assessment of site allocated for the plant
- Preparation of the Technical and economic proposal
- Preparation of design documents and Financial Model
- Project Execution The engineering tasks were focused on a power plant using biogas form the anaerobic digesters of the Sewage Treatment Plant of Al Aweer (Dubai)
- Design of the biogas treatment and conditioning system, boosting unit and energy generation (CHP). Plant layout.
- Draft of specifications and request of proposals for the elements of the plant.
- Technical description, mass&energy balances, cost estimate for construction (CAPEX) and for operation (OPEX).
- Assessment of alternatives: heat recovery, extension of the power plant, upgrading and compression of biogas (CNG) for vehicle fuel.

Consultancy
Biomethanization (Anaerobic Digestion) plants feasibility in Andalusia (Spain)

Technical Assessment of the Anaerobic Digestion technology in Andalusia (Spain)

Client: AGENCIA ANDALUZA DE LA ENERGÍA - JUNTA DE ANDALUCÍA

(2009 – 2010)

DESCRIPTION

Study of the potential application of the technology of Anaerobic Digestion in Andalusia for the treatment of by-products and bio-waste.

IDOM Scope

The scope of study was:

1) State of the art in Europe; situation and business models in accordance with the type and origin of the waste and the size of the plant.
2) Existing plants in Andalusia: technology and generation of green employment.
3) Identification of areas with high potential for the installation of new Anaerobic Digestion plants in Andalusia and assessment of the potential for generation of biogas;
4) Ratios of investment by plant size and operating and maintenance costs; employment generated.
5) Proposal and location of new Anaerobic Digestion plants in Andalusia.

Consultancy

Biomethanization (Anaerobic Digestion) plant enlargement feasibility study (Chile)

Feasibility study for the enlargement of a Biomethanization (Anaerobic digestion) Plant for the treatment of manure and agricultural waste

(CHILE)

Client: IIC INTER-AMERICAN INVESTMENT CORPORATION - IDB GROUP

Year: 2012

DESCRIPTION

The purpose of the project was to expand the energy production capacity from 2MW to 4MW of a currently operating biogas-fueled power generation plant, by adding two extra generation units with their associated anaerobic digestion ponds and equipment in order to increase the availability of biogas. The main inputs for the plant are cow manure and corn silage, as well as other agricultural organic wastes. In addition, the project uses the associated heat in annexed greenhouses to produce hydroponic tomatoes. The project facilities are located near to several sources of manure and agricultural products that are used to feed the plant.

IDOM Scope

Study included:

1. Technical analysis
2. Project Cost Estimate and Implementation
3. Financial conditions and Projections
4. Environmental and Community constraints management

Consultancy

Biomethanization (Anaerobic Digestion) plant for Poultry Manure and co-substrates

Feasibility Assessment. Anaerobic Digestion Plant for Poultry Manure and co-substrates

Client: Client: JAR BIOGAS S.L.

Year: 2011-2012

DESCRIPTION

Technical and Economic Feasibility assessment of an Anaerobic Digestion facility to treat poultry manure and other co-substrates from the agro-forestry sector and food processing factories:
- Assessment of availability of the main waste (poultry manure).
- Assessment of availability of co-substrates.
- Assessment of alternatives for the feedeing mix to the Anaerobic Digestion system.
- Preliminary calculations for biogas generation to produce 500 kWe.

Three well-known technology suppliers for the Anaerobic Digestion process were contacted in order to compile the necessary technical and economic (investment, operation and maintenance) requirements for the Anaerobic Digestion plant.

IDOM Scope

IDOM has prepared a full dossier with the requirements of quantities and quality of the feedstock for an AD system based on Poultry dejections and other co-substrates (pig manure, vegetable waste, glycerine, market green waste…). Average organic waste treatment capacity 25.000 t/year.

In a second stage, IDOM carried out a preliminary design to assess the BOP and general costs of the plant and the project. Economic feasibility is assessed in the light of the applicable legislation in Spain and taking into consideration the expected tendencies in the energy sector.

Alternatively, within the scope of the study, it was considered the feasibility of an upgrading facility for turning the biogas into bio-CNG (bio compressed natural gas) to be used in fueling a vehicle fleet.

Consultancy
Feasibility studies on LandFill Gas

ALTERNATIVES STUDY ON FEASIBLE USES OF LANDFILL BIOGAS (GONGORA LANDFILL, SPAIN)

Client: MANCOMUNIAD COMARCA DE PAMPLONA (Union of Municipalities), 2011.

IDOM undertook the assessment of the alternatives evaluation to define the most adequate system to use landfill gas produced in Gongora Landfill as an energy resource. Feasibility has been considered from several points of view: technical, economy and environmental conditions have been assessed for that particular site.

Technologies evaluated have been: fuel for heating (industry and district heating), fuel for electricity production with gas engines and gas turbines, biogas upgrading for gas network injection, biogas upgrading for fuel for vehicles, biogas for use in fuel cells.

IDOM prepared the model for biogas production foreseen in order to determine the size of the installations.

DEGASIFICATION TEST AND FEASIBILITY STUDY IN IGORRE LANDFILL AND JATA LANDFILL (BASQUE COUNTRY, SPAIN)

Client: GARBIKER, 2001-2003.

IDOM designed the installations to develop a pilot campaign for the assessment of the energy production capacity of the LFG generated in the two mentioned landfills: wells (distribution and technical features), pipe network, pumping system and flaring station, measurement and testing means (for composition, flow, temperature) and in situ tests.

IDOM supervised the works to build the infrastructure in both landfills, supervised two sampling campaigns and dealt with the leachate problems in the wells. IDOM prepared a final report, including LFG production estimation, and established the basic design of the two LFG to Energy plants.

Capital investment and production cost estimates were prepared. Feasibility Study included Financial Rate of Return (FRR) and Net Present Value (NPV) calculations.

FEASIBILITY STUDY FOR FOR LFG EXTRACTION AT CA NA PUTXA LANDFILL (IBIZA-BALEARIC ISLANDS, SPAIN)

Client: HERBUSA, 1999.

IDOM carried out the Feasibility study for LFG extraction and energy production in the principal waste landfill of Ibiza.

IDOM performed “in situ” assessment of the landfill situation, LFG generation estimation, LFG extraction network, equipment and facilities definition. Use of liquified natural gas was assessed as a supporting fuel.

Capital investment and production cost estimates were prepared. Feasibility Study included Financial Rate of Return (FRR) and Net Present Value (NPV) calculations.

FEASIBILITY STUDY IN FOUR SMALL LANDFILLS FOR ENERGY USE (BASQUE COUNTRY, SPAIN)

Client: Basque Agency for Energy, 1998.

Feasibility study for LFG extraction and energy production in four small Municipal Solid Waste landfills located in several areas of the Basque Country. Tasks developed by IDOM included “in situ” assessment of the landfill situation, LFG generation estimates, LFG extraction network, equipment and facilities definition.

Capital investment and production cost estimates were prepared. Feasibility Study included Financial Rate of Return (FRR) and Net Present Value (NPV) calculations.

FEASIBILITY STUDY FOR CURVA DE RODAS LANDFILL (MEDELLÍN, COLOMBIA)

Client: Basque Agency for Energy (Spain) & EE.VV. de Medellín (Colombia), 1998.

Feasibility study for LFG extraction and energy production in the biggest landfill in the metropolitan area of Medellín.

Tasks undertaken by IDOM included “in situ” assessment of the landfill situation, LFG generation estimates, LFG utilisation alternatives (gas engines, gas turbines, boilers, purification and automobile use, household use).

IDOM designed the LFG extraction network (40 wells and a pumping station for 1.500 Nm3/h), and the equipment and facilities required to use the LFG as fuel for gas engines (3 engines x 535 kWe).

Capital investment and production cost estimates were prepared. Feasibility Study included Financial Rate of Return (FRR) and Net Present Value (NPV) calculations.

AGRICULTURAL AND LIVESTOCK SECTOR WASTE MANAGEMENT PLAN IN GALICIA.

Client: XUNTA DE GALICIA
Year: 2000

Development of an agricultural and livestock waste inventory in Galicia (Spain), focused on the regional production of manure from cow and pig farms.

Treatment systems assessed for manure management included: manure injection into the soil as a fertilizer and waste treatment technologies.

IDOM developed the design of selected alternatives for manure management: construction of manure storage ponds, elaboration of manure injection guidelines for the diverse types of soils, Anaerobic Digestion plants for biogas generation and equipped with CHP units.

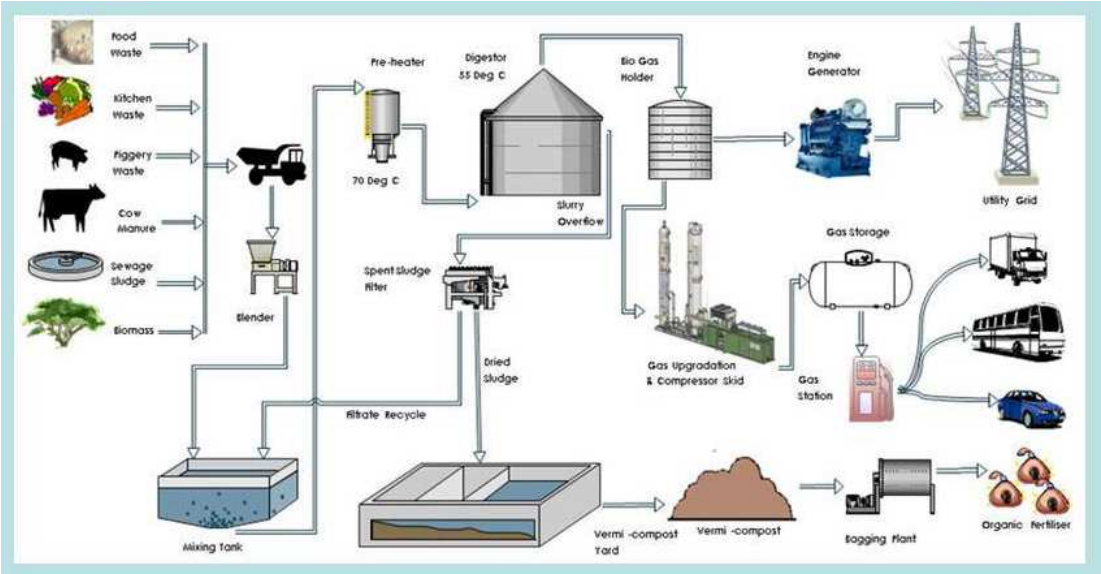
FEASIBILITY STUDY FOR OIL EXTRACTION WASTES (ALPERUJO) GENERATED IN JAEN (SPAIN)

Client: APAJ (ASOCIACIÓN PROVINCIAL DE ALMAZARAS DE JAÉN)
Year: 1998

Feasibility Assessment for the most effective treatment for the solid waste generated in the milling process of olives to produce olive oil.

“Alperujo” is a semi-solid waste that is traditionally stored in large open ponds causing many disturbances and environmental troubles.

The preliminary design considered the construction of several closed storage tanks and the transportation system of the waste, the construction and operation of an Anaerobic Digestion plant to obtain biogas that was used in a CHP plant to generate electricity and heat.



Project Development
Biomethanization (Anaerobic Digestion) Plant in Mexico City

Biomethanization (Anaerobic Digestion) Plant

(Mexico City)

Client: TECMED Mexico 2016

DESCRIPTION

Anaerobic Digestion Plant fed with on-source segregated organic waste. The plant is designed to a capacity of 2,000 tpd and the footprint is approx. 6.5 Ha in a plot located next to Mexico City Food Market.

Installed power, based in reciprocating engines running on biogas, is 30 MWe.

IDOM scope

The Project comprises the provision of engineering services for the development of a layout and 3D model of all equipment and facilities.

For the conceptual design, Idom experts had to consider not only technical aspects but also architectural integration within the existing urban landscape.

Following with this assignment IDOM as carried out the engineering design of all the facilities and infrastructures in order to prepare the documents required for the tendering process. The final deliverables also include a bill of quantities and quotation for the cost of the plant.

Project Development Property Engineering
Biomethanization (Anaerobic Digestion) and composting plant in Alava (Spain)

Works Supervision for the biomethanisation (Anaerobic Digestion) and composting plant

Alava (Spain)

Client: VITORIA-GASTEIZ MUNICIPALITY (SPAIN) 2004-2007

DESCRIPTION

The Plant treats the municipal waste produced in the Alava Province (325.000 inhab.) including its capital, Vitoria-Gasteiz City (250.000 inhab.).

The waste treatment plant has a capacity of 120,750 tpy covers an area of 30,000 m2 and includes the following facilities:
- Waste reception area
- Pretreatment and material separation and recovery
- Anaerobic Digestion for biogas production to be used in a CHP system
- Composting Plant
- Warehouse

FCC and CESPA were the companies responsible for the construction and operation of a treatment plant servicing the entire county of Alava.

IDOM scope

IDOM was hired by the City Hall of Vitoria Gasteiz to act as his technical assistance during the three years of the project.

Project Development, Construction & Operation
Landfill gas and power generation System in Areosa (Cerceda - A Coruña, Spain)

LANDFILL GAS TO ENERGY PLANT IN AREOSA LANDFILL

(CERCEDA - A CORUÑA, SPAIN)

Client: SOGAMA (Environmental Entity of Galicia).

DESCRIPTION

The LFG Plant main characteristics are:

- Present population served: approx. 600.000 inhabitants.
- MSW deposited in the site: 250.000 metric tons per year.
- Collection wells network: 64 units (from 15 to 40 m depth)
- Flare: pilot flame (continuous functioning). Max. capacity 600 Nm3/h.
- Cooling system for LFG dewatering.
- 3 gas engines x 760 kW (electric).

IDOM scope

IDOM undertook engineering tasks for the LFG plant construction from the very beginning, and was in charge of Plant construction and operation of the LFG to Energy plant up to September 2008.

The tasks developed for IDOM are:

- Feasibility Study for energy recovery from LFG (1999). Including LFG sampling and analysis, and LFG production estimation for ten year span.
- Basic Engineering for LFG collection network and Energy Plant (2000)
- Plant Purchasing (2001).
- Detailed project for construction (2001) and permitting.
- Plant construction and start-up (2002).
- LFG plant operations supervision and technical assistance (May 2002-September 2008), including design for the LFG collect network extension, maintenance procedures for LFG generators and other plant equipment, inventory of Greenhouse Gases Emissions for the landfill, optimization of flare unit operation, engine exhaust gases control.

Project Development
Plants (3) for swine manure treatment in Aragón (Spain)

BASIC ENGINEERING DESIGN OF THREE PLANTS FOR SWINE MANURE TREATMENT

(ARAGÓN, SPAIN)

Client: SODEMASA - SOCIEDAD DE DESARROLLO AMBIENTAL DE ARAGÓN 2008

DESCRIPTION

One of the strategies of SODEMASA is to solve pollution caused by dumping and accumulation of animal manure in various areas of Aragon. In this context, SODEMASA undertook the implantation of three plants of treatment for 60,000, 120,000 and 180,000 m3 per year of liquid manure.

IDOM scope

IDOM developed Basic design and the study of economic feasibility of the three plants, and designed the following processes: **anaerobic digestion**, cogeneration with biogas from digestion, biological treatment of liquid fraction and composting of solid fraction

Project Development
Plastic packaging waste thermalysis plant in Cerceda-Galice (Spain)

Plastic packaging waste thermalysis plant in Cerceda

(Cerceda-Galice, SPAIN)

Client: TECNOAMBIENTE GALICIA, S.L.

2009

DESCRIPTION

The Cerceda thermalysis plant allows the transformation of plastic wastes into a fuel (synthetic biogas and synthetic diesel fuel) with high heat value.

IDOM scope

IDOM was responsible for the following tasks:
- Preparation of all necessary documents to obtain the IPPC permit
- Detailed design
- Procurement support
- Technical Assistance during the construction works and commissioning

Project Development
Plasma gasification plant

Preliminary design for a plasma gasification plant (tender process)

Client: CESPA 2008

DESCRIPTION

Preliminary design for the plasma gasification plant (tender process) to obtain a synthetic gas fuel (biogas)

IDOM scope

- Design of major installations.
- Study of mass and energy balances. Sizing of the electromechanical equipment.
- Definition and architecture of process buildings: foundations, structure, walls and roofs.
- Definition of electrical installations.
- Cogeneration system
- Flue gas treatment system specifications.
- Instrumentation and Control system. Definition and evaluation of the system.
- Definition of the distribution of drinking water, sanitation and fire protection facilities.
- Communications network.
- Integration of data, drawings and description of process systems.
- BoQ: civil works, facilities, specific equipment, machinery, etc

Project Development
Landfill gas and power generation System in Amman (Jordan)

LANDFILL GAS AND POWER GENERATION SYSTEM AND THE OPERATION OF GHABAWI LANDFILL

(AMMAN, JORDAN)

Client: GREATER AMMAN MUNICIPALITY (GAM), 2011-2021

DESCRIPTION

- Average from 2,500 t/day (initially) up to 4,200 t/day (currently) deposited in the landfill.
- Environmental supervision: LFG migration network, landfill settlement,leachate extraction (Leachate extraction wells and peripheral network).
- The degasification and biogas treatment facility is compatible for the development of a Clean Development Mechanism in accordance with Greenhouse Gas compensation policies.

IDOM scope

IDOM was awarded to develop engineering services for the DBO contract that will lead to the construction and operation of a LFG to Energy system in Ghabawi Landfill in Amman, Jordan.

Services, started on February 2011 and will be developed until 2021, including 2 extensions of the original contract.

The project is finally developed in 4 stages, including technical assistance for leachate treatment and recirculation facilities to enhance the LFG generation.

Project Development
LFG Gas to Energy Plant in Valdemingómez (Madrid-Spain)

DETAILED PROJECT FOR LANDFILL GAS TO ENERGY PLANT IN VALDEMINGÓMEZ LANDFILL

(Madrid Spain)

Client: CESPA, SUFI, S.A, VERTRESA, 2001-2003

DESCRIPTION

Valdemingómez Landfill was the biggest landfill in Spain for decades, before it was closed in 2002. Its surface is more than 100 hectares and there was a network of about 280 gas extraction wells. The plant is able to produce 18,9 MWe of electricity running on LFG and natural gas (up to 10% of the landfill gas).

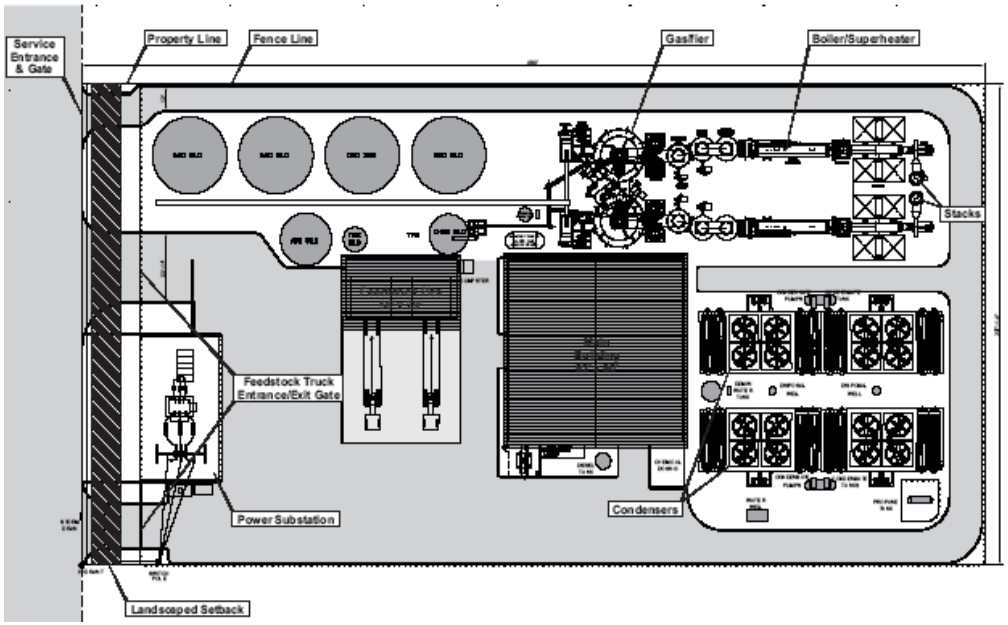
The project consisted in:

- Gas cleaning system: hydrogen sulphide elimination (double scrubber system with base-acid system).
- Cooling system for LFG dewatering.
- Landfill gas pumping, storage (double membrane gas holder) and distribution system.
- Natural gas cofuelling (up to 10% of LFG energy content).
- 8 gas engines x 2124 kWe plus boiler and 1 steam turbine x 1960 kWe.

IDOM scope

IDOM received a contract for the detailed engineering of the LFG energy recovery by means of gas engines and steam turbine.

Project Development
Biomass Gasification Power Plant



HONUA POWER

8.5 MW BIOMASS GASIFICATION POWER PLANT

Oahu, Hawaii - USA

DESCRIPTION

Basic design of a new gasification to energy facility in Campbell Industrial Park, ‘Ewa, O‘ahu, Hawaii (USA). Fuel includes mostly construction & demolition debris.

Gasification technology will be utilized to produce the syngas fired in the boiler, whose steam will be employed in the steam turbine generator.

Year: 2009-2010

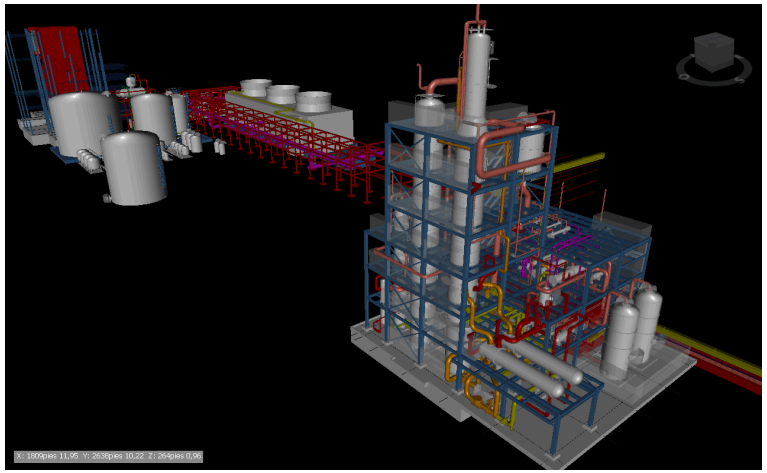
MAIN CHARACTERISTICS

- Fuel: Mostly C&D debris
- Gross electrical power: 8.5 MW
- Technology: Gasification

WORK PERFORMED

- Basic engineering covering all the disciplines (process, mechanical, civil, structural, electrical, I&C) and including, among others, heat and mass balances, design criteria, P&IDs, layout, single line diagram, system descriptions, control architecture, etc.
- Technical specifications of main equipment

Project Development
Direct (Bioethanol) and indirect (Evaporated stillage) cofiring Power Plant



ABENER GHENOVA, INC.
23 MWe Biomass Cogeneration Power Plant
25 MG/y Ligno-Celluloscic Bioethanol Plant
Hugoton – Kansas (US)

DESCRIPTION

Abengoa Bioenergy (Abengoa Group) facility in Hugoton, Kansas.
Abener Ghenova Engineering (Abengoa Group) developed, jointly with AEC Idom, the detailed engineering for the entire plant.
Project partially financed by US Department of Energy.
Year: 2011-2012

MAIN FEATURES

- 25 million gallon based on 365 operating days
- Third generation bio-ethanol facility using ligno-cellulosic feedstock materials, initially agricultural residues (corn stover and wheat straw) and in the future, switch grass and other warm season grasses will be the source of feedstock
- Residues from the distillation process, whole stillage, is separated into a liquid stream, thin stillage, and wet-cake. The thin stillage is evaporated to produce syrup which is burned in the on-site biomass burner along with the wet-cake. The biomass boiler system provides steam and power to the entire plant
- Steam conditions: 750F @ 900 psig 330 kpph
- Fuel: Wastes streams of the plant
- Gross electrical power: 23 MWe
- Fluidized bed biomass boiler

WORK PERFORMED

- Detailed engineering for 3 of the 6 plant packages:
    - 23 MW biomass cogeneration plant
    - Ethanol storage
    - Distillation unit

Project Development

Direct (Biomass) and indirect (SYNGAS) cofiring Power Plant

ENDESA GENERACIÓN

DIRECT (BIOMASS) AND INDIRECT (SYNGAS) COFIRING POWER PLANTS

Spain

DESCRIPTION

Direct biomass - coal cofiring / indirect syngas (coming from biomass and coal gasification) cofiring studies for the currently operating coal fired power plants of Endesa Generacion in Spain.

Biomass storage, pretreatment and drying plant to be used for cofiring in the 'Litoral' power station of ENDESA in Almeria, Spain.

Year: 2008-2009

WORK PERFORMED

- Basic design for the EPC process of the biomass storage, pretreatment and drying plant
- Technical assistance in the development of simulation studies of biomass direct cofiring in the Litoral 1 (Carboneras, Almeria, Spain), Teruel (Spain) and As Pontes (La Coruña, Spain) power plants
- Technical assistance in the development of simulation studies of biomass indirect cofiring (gasification) in the Litoral 2 (Carboneras, Almeria, Spain) and Los Barrios (Algeciras, Cádiz) power plants

IDOM representative references on other Biofuels

Project Development (Other Biofuels)
Bagasse Power Plant

ISOLUX CORSAN

43 MW BIOMASS FIRED CHP PLANT

Meta - Republic of Colombia

DESCRIPTION

Biomass CHP plant in Meta (Republic of Colombia), included in a new bioethanol production plant for the company Bioenergy.

The biomass plant utilizes a mobile grate boiler that fires bagasse. The steam coming from the boiler is expanded in a steam turbine to generate electricity. Low pressure steam is used in the bioethanol production process.

The biomass CHP plant has been designed to operate in four possible scenarios: Normal operation, Maximum power, Maximum extraction and Off season mode.

Year: 2011-2014

MAIN CHARACTERISTICS

- Steam conditions: 70.2 bar, 520ºC, 180 t/h
- Fuel: Bagasse (100%)
- Gross electrical power: 43.5 MW for maximum power mode
- Expected annual operation: 5,000 h/y

WORK PERFORMED

- Conceptual engineering for FEED
- Basic design of the plant
- Technical assistance
- Detail design of the plant

Project Development (Other Biofuels)
Bioethanol Plant

ABENGOA BIOENERGÍA NUEVAS TECNOLOGÍAS (ABNT)

BASIC ENGINEERING AND PMC SERVICES FOR THE ABSL 2G BIOETHANOL PLANT IN SAO LUIS (PIRASSUNUNGA, BRASIL)

DESCRIPTION

Abengoa Bioenergy proposes the construction of a Line of 2G (2nd generation) ethanol plant in Sao Luis (Pirassununga, State of Sao Paulo) inside of the existing factory of ABSL (Abengoa Bioenergía Sao Luis).
New Line of 2G will be able to a name plate capacity of 15 million gallons of fuel ethanol that will be reached using lignocellulosic feedstock materials, such as biomass from sugar cane, as a source of fermentable sugars. This process will operate in campaign with sugar cane straw (SCS).

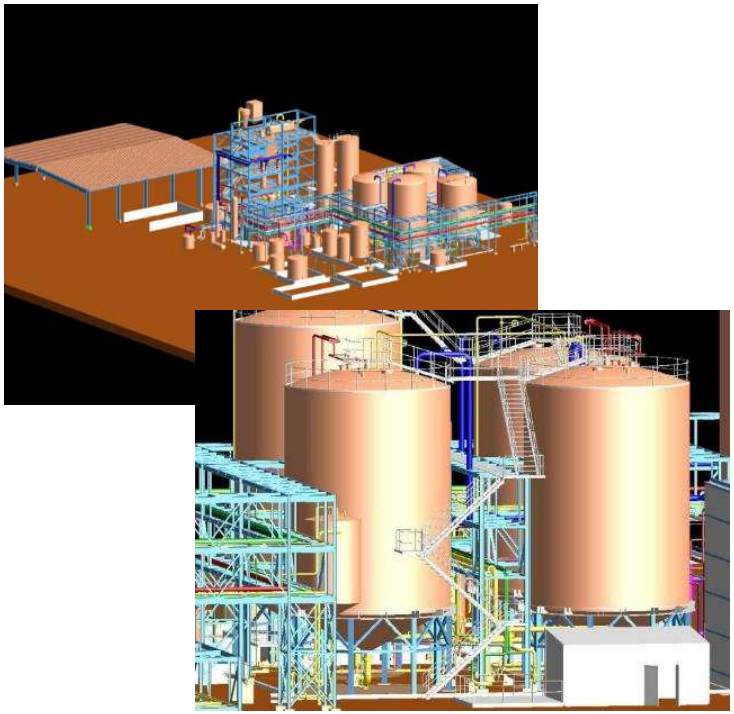
MAIN FEATURES

- Nominal capacity: 15 million gallons bioethanol
- Working days: 332 days/year

SCOPE OF WORK

- Review of the basic engineering package provided by ABNT, including design basis, process descriptions, mass and energy balances, process flow diagrams, equipment data sheet, electrical consumer list, lines and instrument lists, preliminary layout and preliminary piping specification.
- Update and improve basic engineering package.
- Complete basic engineering package with those detailed documents needed for quote an EPC solution (basic layouts of all process sections, MTO's, single line diagrams, P&ID's, main pipes and electric trays routing, technical specifications and data sheets for all equipment, including instrumentation, specification for geotechnical works, building's definition).
- CAPEX estimation for the project
- Conduct a HAZOP & SIL studies over the final basic engineering.

Project Development (Other Biofuels)
Bioethanol Plant



ABENER

5.000.000 l/year Bioethanol Plant

Babilafuente (Salamanca, Spain)

DESCRIPTION

BIOCARBURANTES DE CASTILLA Y LEON (company owned by ABENGOA BIOENERGY R&D) has developed a plant to obtain 200.000.000 l/year of bioethanol from cereal fermentation in Babilafuente, Salamanca (Spain).

ABENGOA BIOENERGY R&D will install attached that cereal plant a commercial plant to get 5.000.000 l/year of bioethanol from lignocellulasic biomass (wheat straw) in order to demonstrate the feasibility of biomass-to-ethanol technology.

The process is based on the following operations:

- Biomass preparation in order to adequate the size of the straw chips.
- Biomass pretreatment with sulphuric acid and steam to obtain cellulase.
- Cellulase hydrolysis to glucose by enzyme addition.
- Glucose fermentation and beer production.
- Beer distillation from the fermentors in order to obtain ethanol.

ABENER, EPC contractor by ABENGOA BIOENERGY R&D has ordered to IDOM the Detail Engineering of the plant, including civil works, mechanical installations, electrical installations and instrumentation and control.

Project Development
CHP Plant for manure treatment (Spain)

"ENERCOR XXI" CHP Plant for manure treatment

Langa de Duero-Soria (Spain)

Client: ENERCOR 2004-2007

DESCRIPTION

The manure treatment plant is based on a biological system plus a CHP plant to complete the treatment of the manure:

- 1st step of biological treatment of the manure
- 2nd step of solid (sluge) -liquid separation.
- 3rd step for biosolids recovery form the liquid phase of the treated manure (triple-effect evaporator).
- 4th step for composting the residual solids, transforming them into a fertiliser.
- Energy section based on 5 gas engines (14.9 MWe), heat recovery boilers, steam turbine (2 MWe), coolong towers and the necessary facilities for electrical grid connection.

IDOM scope

IDOM has carried out the Detail Engineering services, works supervision and quality control and assurance.

IDOM representative references on Ammonia Facilities

/ REFERENCES /

Revamping of Annaba Ammonia (Kellogg Unit) Plant (Annaba, Algeria)

2015/18

FERTIAL

- PMC Services
- Capacity: 1500 t/d

IDOM

/ REFERENCES /

Revamping of Arzew Ammonia (Kellogg and Chemico Units) Plants (Arzew, Algeria)

2015/18

FERTIAL

- PMC Services
- Capacity: 1500 and 1000 t/d

IDOM

/ REFERENCES /

Syngas Compressors revamping Puertollano Factory (Puertollano, Spain)

2018/19

FERTIBERIA

- FEED Engineering
- Capacity: 600 t/d

IDOM

/ REFERENCES /

Camargo Petrochemical Complex Revamping for Ammonia Plant (Chihuahua, México)

PEMEX

- Revamp preliminary studies
- Capacity: 132,000 t/y

IDOM

/ REFERENCES /

Ammonia Storage upgrade of the Arzew FERTIAL Plant (Argelia)

2019/20

FERTIAL

- EPCM services of the ammonia storage system (new ammonia tank of 32.000m3 and a new system to the gas recovery for the new and old tank, flare system…)

IDOM

IDOM representative references on Gas Facilities

/ REFERENCES /

FEED for TENDRARA Gas Processing Facility (Morocco)

2018/19

ENAGAS / SOUND ENERGY MOROCCO

- 2.000.000 Sm3/d Central Processing Facility (CPF) for gas treatment to pipeline
- Gas Treatment in Well pads and Clusters
- Flowlines from Clusters to Central Processing Facility (CPF)
- Rehydration, CO2 removal and reclamation units. Bi-phase, three-phase separators and condensate hydrocarbons stabilization..

IDOM

/ REFERENCES /

EUSKADOUR natural gas compression station (Irun, Spain)

2015

ENAGAS

- Project Management of the whole executed construction works and facilities
- A two way Natural Gas Compression for the connection pipeline between France and Spain
- 65.000 Nm3/h – 210.000 Nm3/h

IDOM

/ REFERENCES /

Natural Gas Compression and Conditioning Unit as part of SIDDHIRGANJ 340 MW CCPP (Dhaka, Bangladesh)

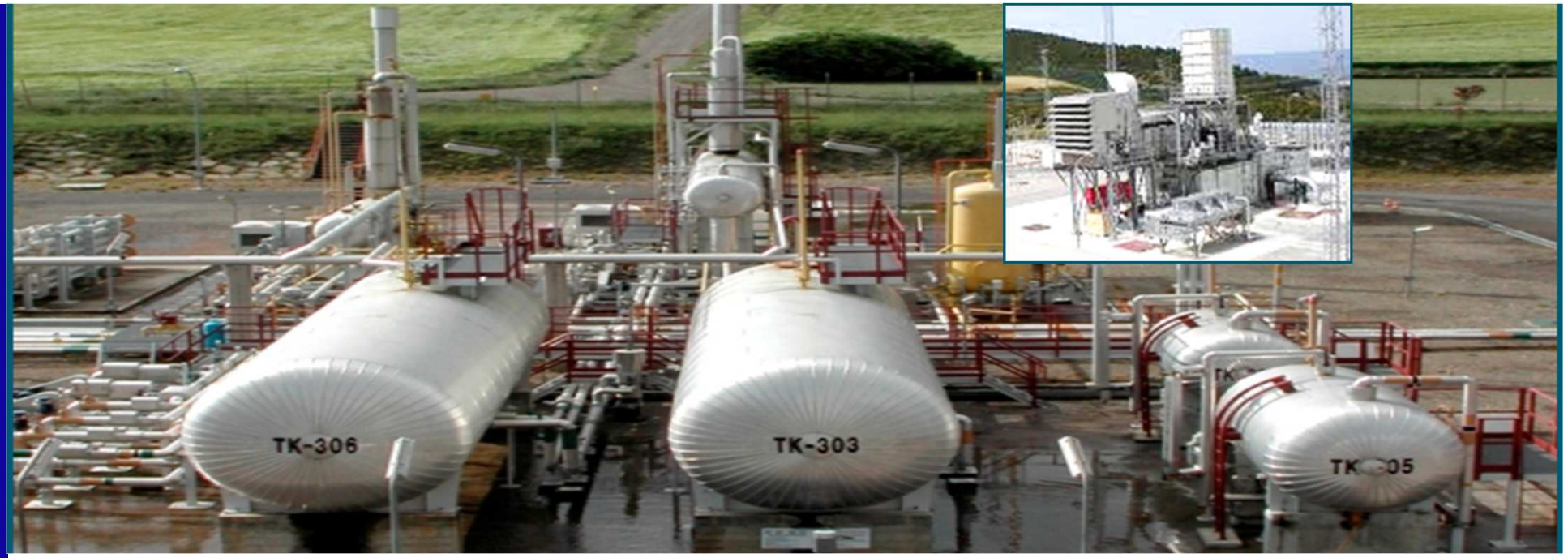
2012/19

ISOLUX

- Flow Capacity: 52.000 Nm 3 /h
- Pressure rise : 5 – 30,6 bar

IDOM

/ REFERENCES /



Serrablo Natural Gas Underground Storage with centrifugal turbo compressor (Serrablo, Spain)

ENAGAS

- Electrical Revamping of the complete station

IDOM

/ REFERENCES /

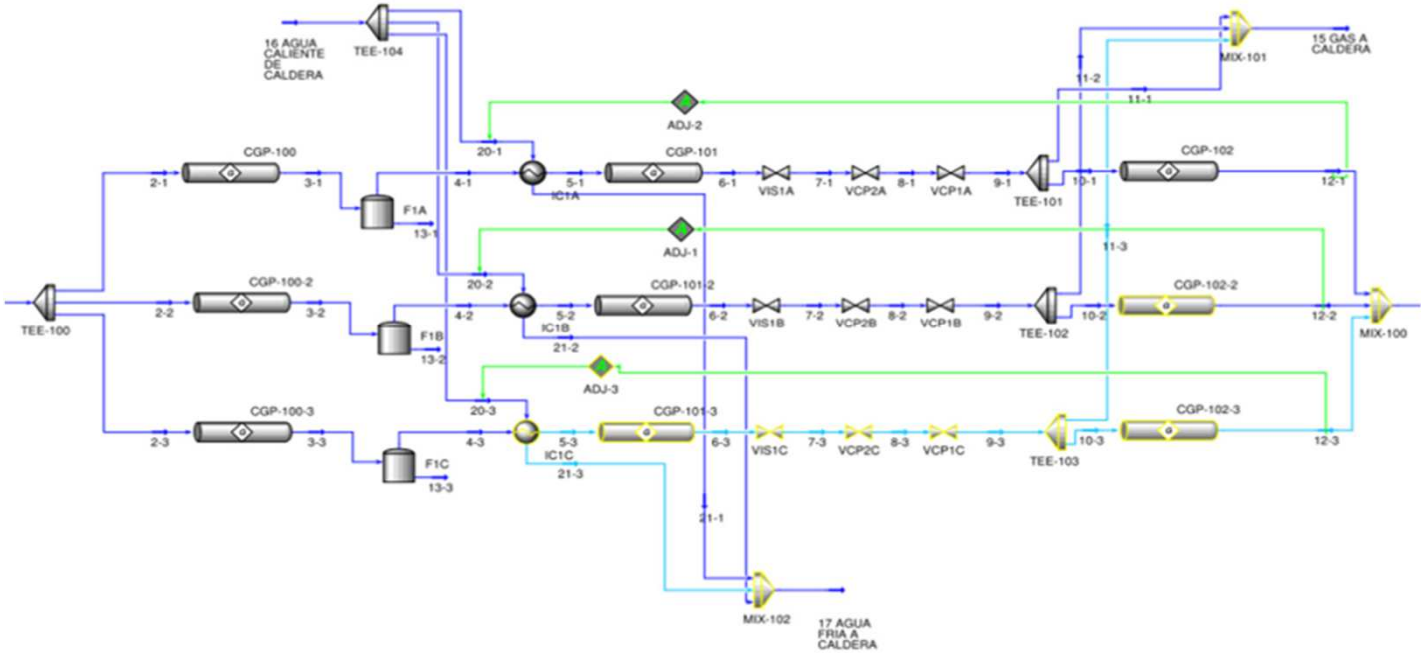
Natural Gas Enrichment and Conditioning Unit of the CCPP of Skopje (Skopje, Macedonia)

GAMA Power Systems Engineering

- 35 t/hour

IDOM

/ REFERENCES /



Optimization of High Pressure Regulation and Measuring stations Standard Designs (Spain)

ENAGAS

- Optimization analysis, Basic Design, FEED, Specification for Contractor and Detailed Design
- Main Sections:
    1. Separation
    2. Regulation
    3. Heating
    4. Auxiliary Facilities, Installations and Buildings

IDOM

/ REFERENCES /

Ampliação 55 km da Rede de Distribuição de Gás Natural Canalizado (São Paulo, Brazil)

COMGAS

- Elaboração de Editais e Orçamentos para Execução de Obras.
- Planejamento, Programação de Obras e Ramais.
- Elaboração e Gestão do Sistema de Controle Administrativo.
- Gerenciamento da Autorização de Execução de Obras.

IDOM

/ REFERENCES /

New Liquefaction Line (Beasain & Madrid, Spain)

PRAXAIR

- Detailed Engineering
- 55m height Distillation Column
- 6 MW air compressor and two cryogenic tanks one for N2 (1.250 m3) and other for O2 (200 m3).

IDOM

/ REFERENCES /

Compression and Transport of the Gases from Salvador's City Metropolitan Embankment for Combustion in Boilers (Camaçari, Brazil)

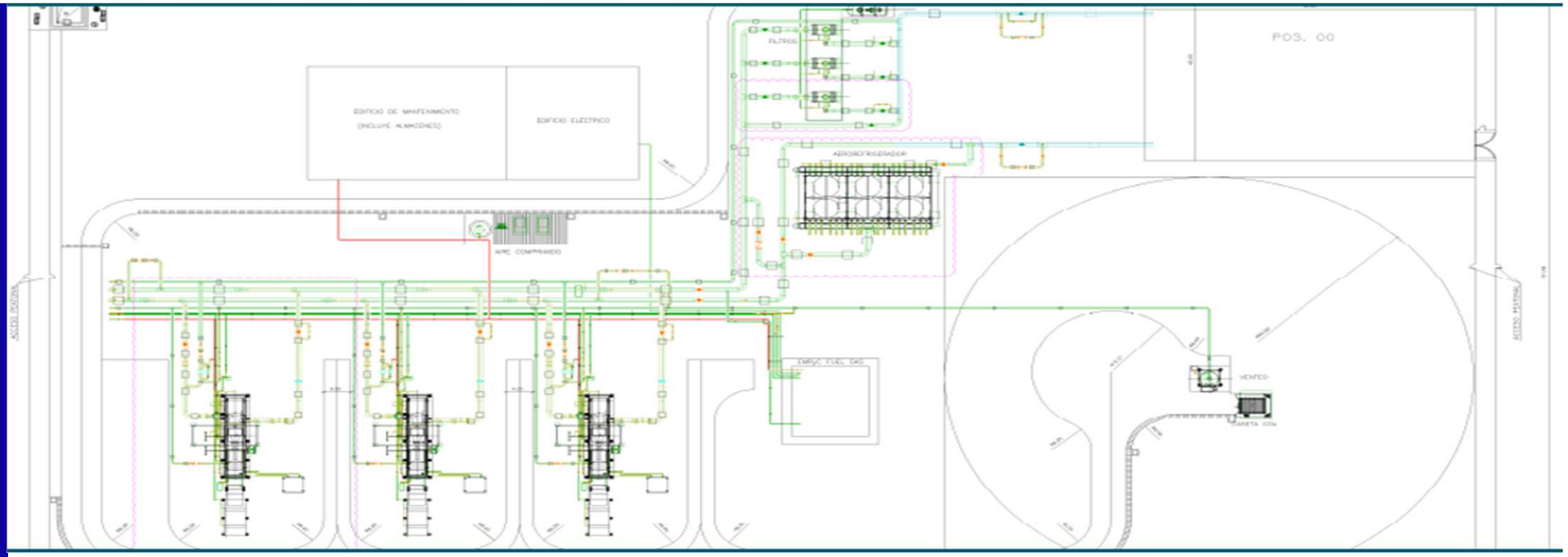
BRASKEM

- Technical and Economic Feasibility Study

IDOM

IDOM representative references on Gas Pipelines

/ REFERENCES /



Natural Gas Pipeline South Texas (USA) to Tuxpan (Mexico)

ENAGAS - ELECNOR

- Concept design of the compression station and cost for the BOO tender
- Compression Station
- 48” 800 km (subsea and onshore) 2.6 million cubic feet per day (3.2 b$ investment)

IDOM

/ REFERENCES /

Gas treatment plant, LNG Terminal and liquefaction (Brazil)

2019

ACCIONA

- Procurement Management
- Tender Engineering

IDOM

/ REFERENCES /

Naucalpan-Tlaneplanta Gas Pipeline (México)

ENAGAS

- Engineering contractor
- Works management and civil works supervision
- Diameter 24"/ Pressure 21 bar/ 11km

IDOM

/ REFERENCES /

Cartagena-Lorca Gas Pipeline (Spain)

ENAGAS

- Engineering contractor
- Works management and civil works supervision
- Diameter 20"/ Pressure 72 bar/ 25km

IDOM

/ REFERENCES /

Bermeo-Lemona (Boroa) Gas Pipeline (Spain)

ENAGAS

- Engineering contractor
- Equipment and materials, connection points selection, alternative routing
- Diameter 16"/ Pressure 72 bar

IDOM

/ REFERENCES /

Matosinhos (Leixoes) Gas pipeline (Portugal)

PORTGAS

- Engineering contractor
- Diameter 8"/ Pressure 72 bar

IDOM

/ REFERENCES /

Marinha Grande-Leiria Gas pipeline (Portugal)

ENAGAS

- Engineering contractor
- Diameter 10"/ Pressure 72 bar

IDOM

/ REFERENCES /

Arrigorriaga-Saturtzi Gas Pipeline (Spain)

GAS DE EUSKADI

- Engineering contractor
- Works management & civil works supervision
- Diameter 30"/ Pressure 72 bar / 24 km

IDOM

/ REFERENCES /

APA and MPB Gas Pipeline (Spain)

GAS DE EUSKADI

- Engineering contractor
- Works management & civil works supervision
- Pressure 16/4 bar

IDOM

/ REFERENCES /

Bergara-Irún (Bilabona) Gas pipeline (Spain)

2013

GAS DE EUKADI

- Engineering contractor
- Diameter 16"/ Pressure 72 bar

IDOM

/ REFERENCES /

Granada-Motril Gas Pipeline (Spain)

ENAGAS

- Engineering contractor
- Works management and civil works supervision
- Diameter 10"/ Pressure 72 bar/ 80km

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For further information
IDOM.com