18 th November 2021

WORKSHOP ON SUSTAINABLE ENERGY AND CIRCULAR ECONOMY
Canada-Italy Business Forum on Artificial Intelligence

Spark talk #3 - Itelyum Regeneration SpA

Ing. Francesco Gallo (Operations Director and R&D responsible)

CIRCULAR ECONOMY CASE OF USED OIL RE-REFINING DIGITAL TRANSFORMATION

ITELYUM

The mark of circular economy

Itelyum is the Italian player with more than half a century of history, internationally recognized for its technology, expertise and quality in the regeneration of waste oil, purification of solvents and chemical streams, and environmental services for the industrial sector.

Thanks to **23 companies**, **26 operating sites** and **850 people**, Itelyum offers sustainable solutions to over **30,000 customers** in more than **60 countries**.

% circularity over the total waste (more than 1 million t) and raw materials (~40.000 t) managed by the group

Vision

Producing responsibly, trading sustainable products and providing the market with efficient and integrated solutions is only the starting point.

We want to be inspiration and example for all those who understand **people**, **intellectual capacities**, **social relations**, and **natural**, **technological** or **financial resources** as **capitals** that cannot be neglected or wasted, but that must be **valorized**.

Mission

We help save natural resources and improving the quality of life, with sustainable processes, products and solutions for waste management and the optimization of served markets, sharing **creation of value** with our **business partners**, the **society** and the **environment**.

Sustainability, within an outstanding model of circular economy

Itelyum provides a growing integrated and sustainable offer of products, solutions and services, adopting a model of circular economy that **extends the life cycle** of products and **creates partnerships** in the market segments served.

A CIRCULYTICS™

Itelyum has received the score "A" with the help of **Circulytics**, the most comprehensive circularity measurement tool created by the Ellen MacArthur Foundation to allow companies assessing their material flows and service models via a broad set of metrics.

UN Global Compact e SDGs

Itelyum adheres to the **United Nations Global Compact** and actively supports its **10 Principles** of Human Rights, Labour, Environment and Anti-Corruption; it is also one of the founding members of the Global Compact Network Italia Foundation.

With its activities, it contributes to the achievement of five **SDGs (Sustainable Development Goals**) through its commitment to material recovery (**SDG 12**), water purification (**SDG 6**), and decarbonisation (**SDG 13**) with a view to innovation (**SDG 9**) and growth (**SDG 8**). It also focuses on health and safety protection (**SDG 3**), continuous training and the dissemination of a culture of sustainability (**SDG 4**) and promotes diversity as a lever for competitiveness (**SDG 5**). It bases its relations on a supply chain approach and builds strong partnerships with its stakeholders (**SDG 17**).

It reports annually on its integrated performance and progress in supporting the Global Compact through a **Sustainability Report**, which follows the latest GRI standards.

Processes, products and integrated services

REGENERATION SOLUTIONS

Leader in the production of regenerated base oils, used by the main lubricant manufacturers in the world and with performances equivalent to those of base oils obtained from virgin raw materials.

PURIFICATION SOLUTIONS

Leader in the production of high purity solvents from virgin fractions and in the purification of chemical streams and used solvents from the chemical and pharmaceutical industry.

ENVIRONMENT SOLUTIONS

Provider of integrated services to industrial waste producers: collection, storage, transport, pre-treatment, intermediation, consulting, chemical analysis and treatment of industrial wastewater.

RESEARCH AND DEVELOPMENT

- transform environmental and waste disposal chains into industrial processes, thanks to the chemical knowledge, process and the ability to manage technologically complex plants.

- innovate technologies and processes for continuous improvement in efficiency, sustainability and quality of products and regenerated resources;

- consolidate new regeneration chains that allow to expand the types of waste to be regenerated and to accompany the ecological transition of production systems

850+ people / 23 companies / 26 operating sites

A solid but flexible industrial network

REGENERATION SOLUTIONS

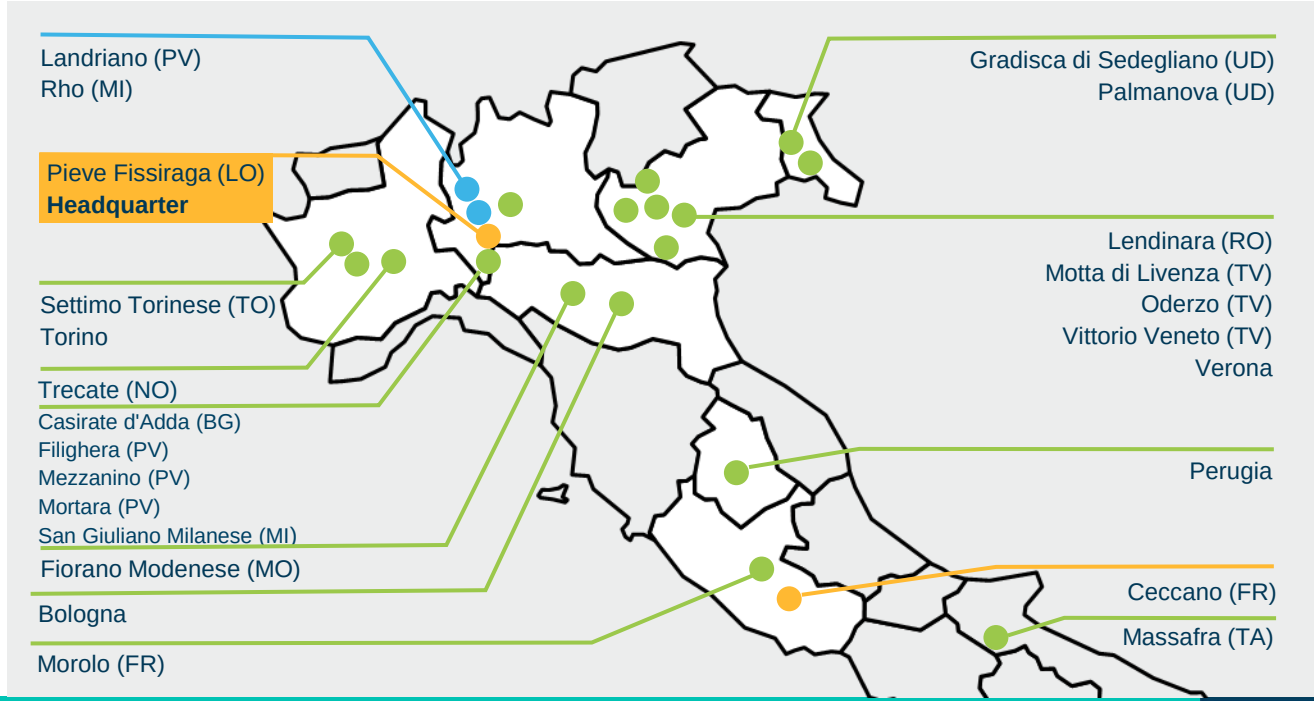
process
180,000 t/year waste oil
products
120,000 t/year base oils
40,000 t/year other recycled products

PURIFICATION SOLUTIONS

process
100,000 t/year used solvents and chemical streams
40,000 t/year solvents and virgin chemical streams
produce
70,000 t/year solvents and other recycled chemicals
30,000 t/year solvents and other pure chemicals

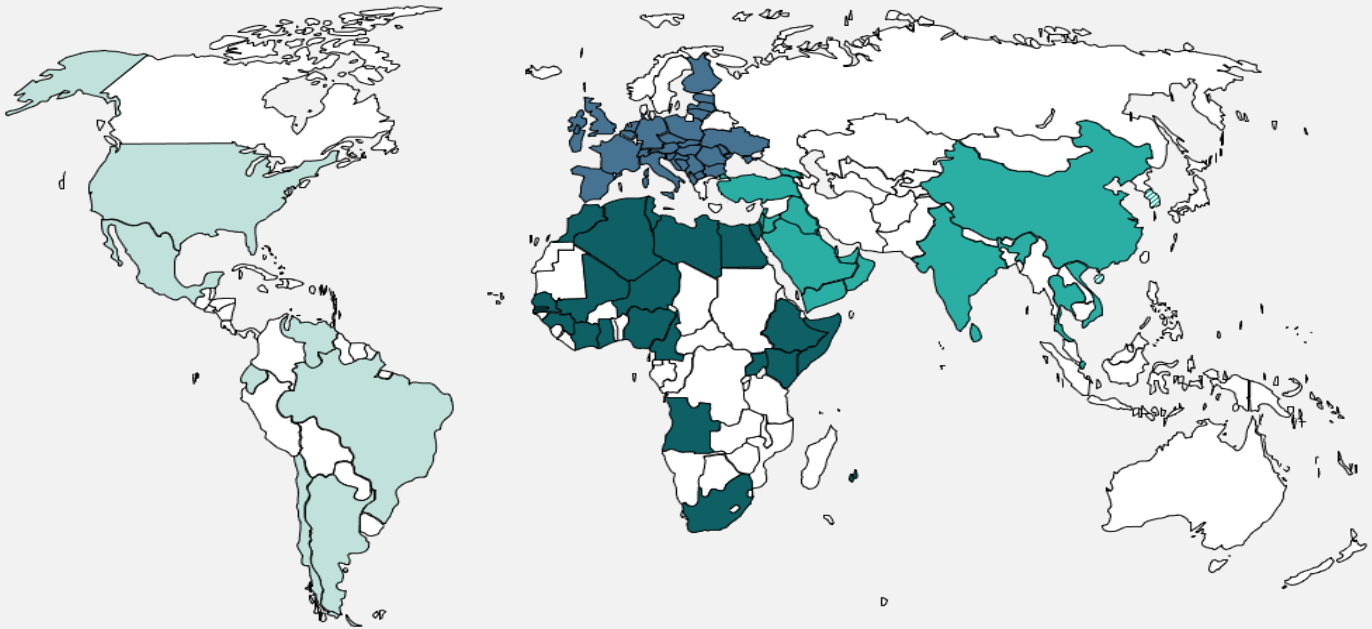
ENVIRONMENT SOLUTIONS

manage
1,500,000 t/year industrial waste (handling and industrial services 500,000 t/y)



400+ M€ revenues / 30.000+ customers / 60+ countries

Our world



Regeneration of waste oil
Circular excellence

Two plants for the regeneration of waste oil, with advanced technologies and proprietary processes, capable of producing high quality base oils.

The base oils produced are ideal for the different applications in the automotive and industrial sectors, matching the most demanding performances and environmental requirements.

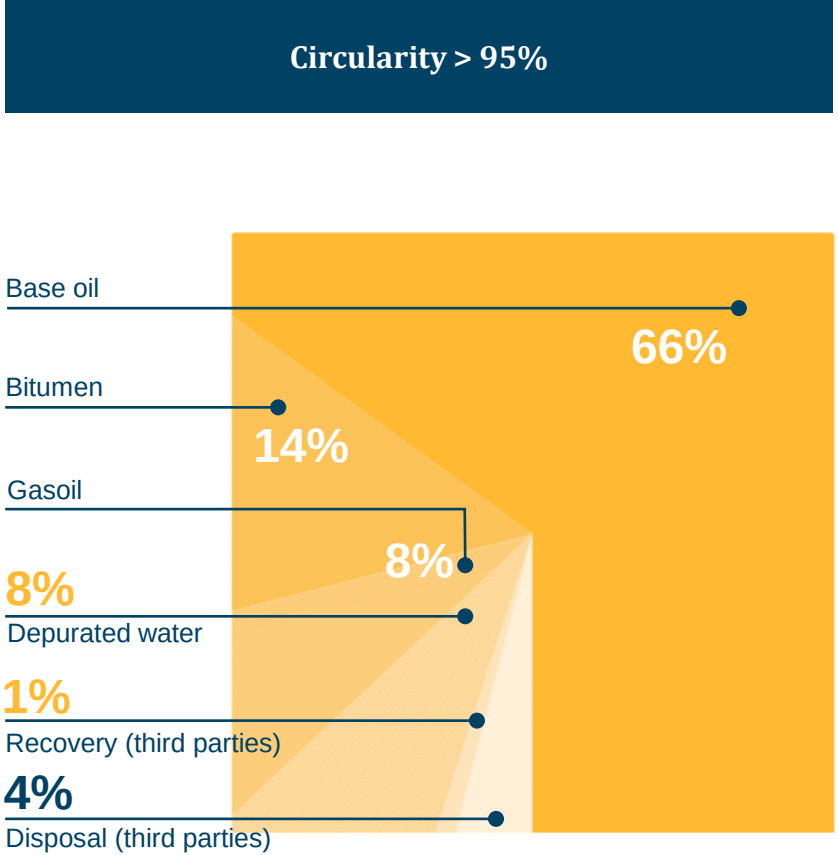
The reduced environmental footprint of the regenerated base oils creates sustainable value for the market.

Regeneration of lube oils
Circular excellence

The base oil regeneration process, compared to the virgin ones, allows:

- **half** emissions of CO_2
- **4 times less** emissions of fine dusts
- **5 times less** emissions of acidifying substances (NO_x, SO_2 and NH_3)

Moreover, at least **95%** of the waste oil processed is transformed into products, returned to the environment as purified water or recovered by third parties.



% of total lube oil procesed

Regeneration of waste oil
Group I+ and II+

- Itelyum re-refined base oil Group I+ and Group II+, obtained through a high pressure catalytic hydrogenation process, presents **ideal chemical-physical and compositional features** for use in the different applications of lubrication, either in the automotive or industrial sector.

- The very low sulphur and aromatic components content and the high viscosity index favour the choice of formulation solutions within **a wide viscosity interval**, able to meet the most severe performances and the environmental requirements demanded from modern lubricants, thus allowing also a saving in the use of additives in the formulations.

- The properties of Itelyum re-refined base oil enable to use it **in several industrial applications** such as rubber and compound manufacturing and, in general, it can be used as efficient process oil.

Regeneration of waste oil

New Group II+, another step beyond

With our leading technology in re-refining base oil and further implementation of the hydrofinishing process, Itelyum has launched **HG Series Group II+,** a step towards the future customers' needs.

Why Itelyum HG Series Group II+:

- ✓ More demanding engine tests and new OEMs Specifications ask for HG Group II+
- ✓ HG Group II+ blends can perform better than Group I/III mix
- ✓ >75% of Engine Oil Demand could be blended using HG Group II+
- ✓ >95% of industrial oils could be formulated with Itelyum HG Group II+
- ✓ Optimized for Low/Mid SAPS
- ✓ Reduce complexity
- ✓ Cost savings

Driving innovation and sustainability
Approvals

- Thanks to the technological excellence of the Itelyum processes we have recently achieved, in partnership with **INFINEUM**, the American Petroleum Institute qualification API CI-4 for a SAE 15W-40 formulation containing our Gp II+ base oils.

- In partnership with **LUBRIZOL**, we have obtained the qualification of a 100% Itelyum Gp I+ base oils formulation ACEA E7-2016 (as well as related OEM's approvals) and API CI-4.

PURIFICATION SOLUTIONS

Purification of solvents and chemical streams
Circular partnership with pharmaceutical industry

A complex industrial structure, specialized in the production and distribution of solvents, in the recovery and purification of organic solvents and in chemical synthesis. Possibility to operate also on behalf of third parties, thanks to flexible process lines and variable layout depending on the input and production programs.

A logistics site, with automated bottling capacity.

A multi-purpose organic synthesis facility.

Circularity > 95%

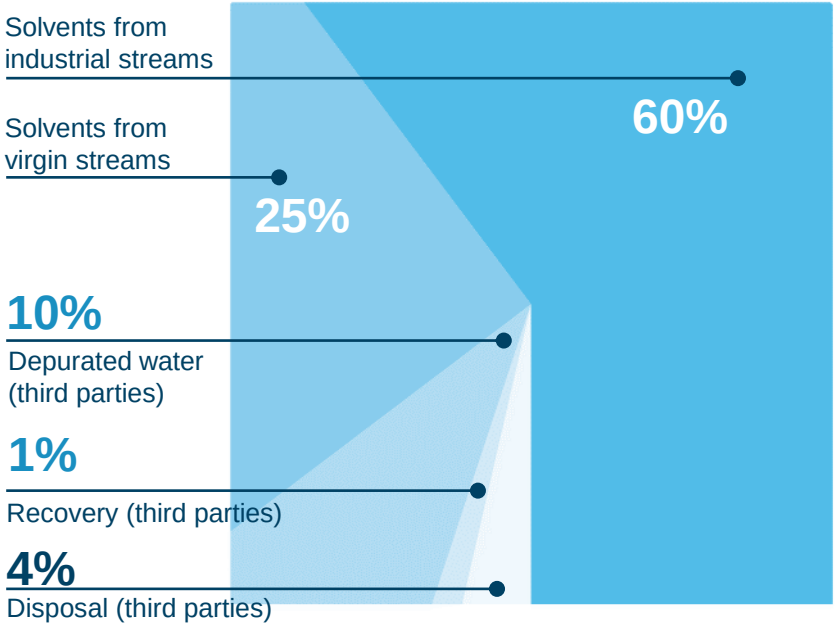
Purification of solvents and chemical streams

Circular partnership with pharmaceutical industry

Benchmarked against primary production, the mix of purified solvents produce:

- **5 times** less CO_2 emissions
- **reduced** emissions of fine dusts and acidifying substances (NO_x, SO_2 and NH_3)

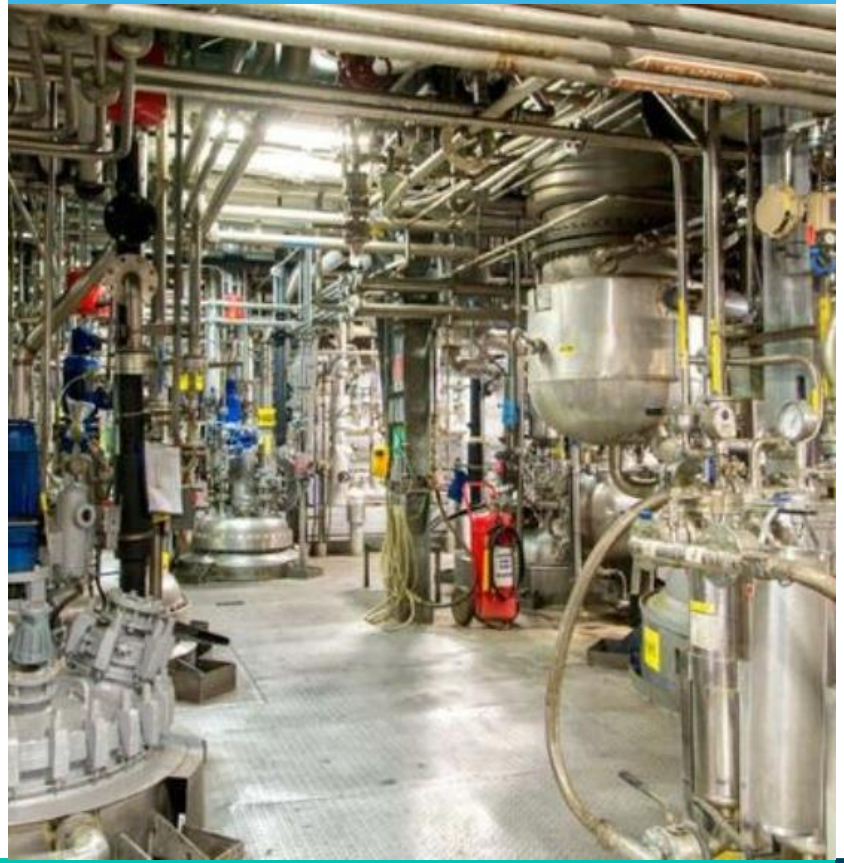
Moreover, at least **95%** of the industrial streams and raw materials processed is transformed intro products or, by third parties, returned to the environment as purified water or recovered.



% of total industrial and virgin streams processed

Multi-purpose synthesis plant

In 1997 Itelyum Purification (formerly Bitolea) decided to build a "multi-purpose" fine chemical and pharmaceutical plant in order to support the same chemical-pharmaceutical companies in their production.
Today, the Itelyum Purifcation plant stands as a reliable partner able to meet the different needs of its customers. The plant has a capacity of 220 m3 with reactors of different sizes both in stainless steel and glass-lined, capable of operating from -197 ° C up to 200 ° C, as well as thin film evaporators, distillation columns, centrifuges and filter dryers.



PURIFICATION SOLUTIONS

Know-how

In over 20 years of production, a consolidated know-how has been gained in the following reaction of organic chemistry : acetylation, halogenation, alkylation, condensation, cyclization, epoxidation, esterification, hydrolysis, oxidation, reactions with organometals (Grignard reagents directly produced on site) and reductions.
This was made possible thanks to the help of a pilot plant for process scaling-up, a dedicated laboratory of analysis and quality control, and an R&D department, as well as by highly qualified staff from leading pharmaceutical companies.

Environmental services for the industry
Responsible efficiency

A comprehensive wide range of integrated environmental services for the industrial sector.

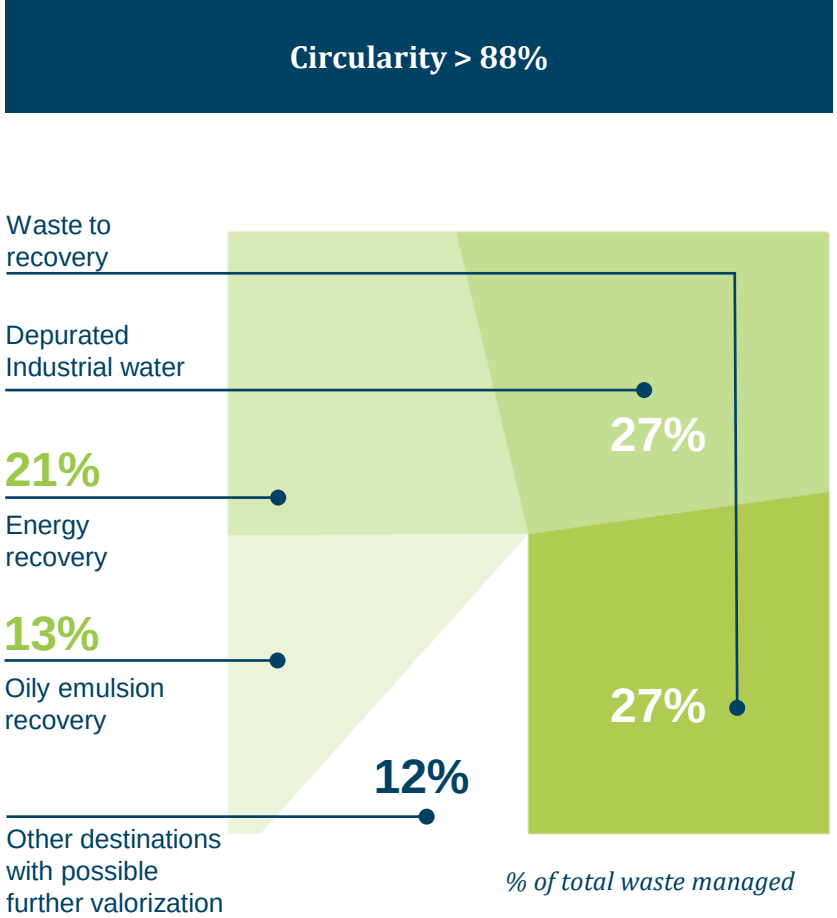
Over 1,500,000 t/year of industrial waste responsibly managed from collection, to storage, pre-treatment, until recovery or disposal.

Competence and professionalism in the related services, such as chemical analysis, water treatment, transport and HSE consultancy.

Environmental services for the industry
Responsible efficiency

A comprehensive wide range of **integrated environmental services** for industrial and hazardous waste

Sustainable value for the market, maximizing recycling and recovery options versus the other forms of disposal: almost **88%** of waste managed are returned to the environment as depurated water or sent to recovery operations, managed by the group or authorized third parties.



530+ people / 20 companies / 24 operating sites

Integration and presence on the territory

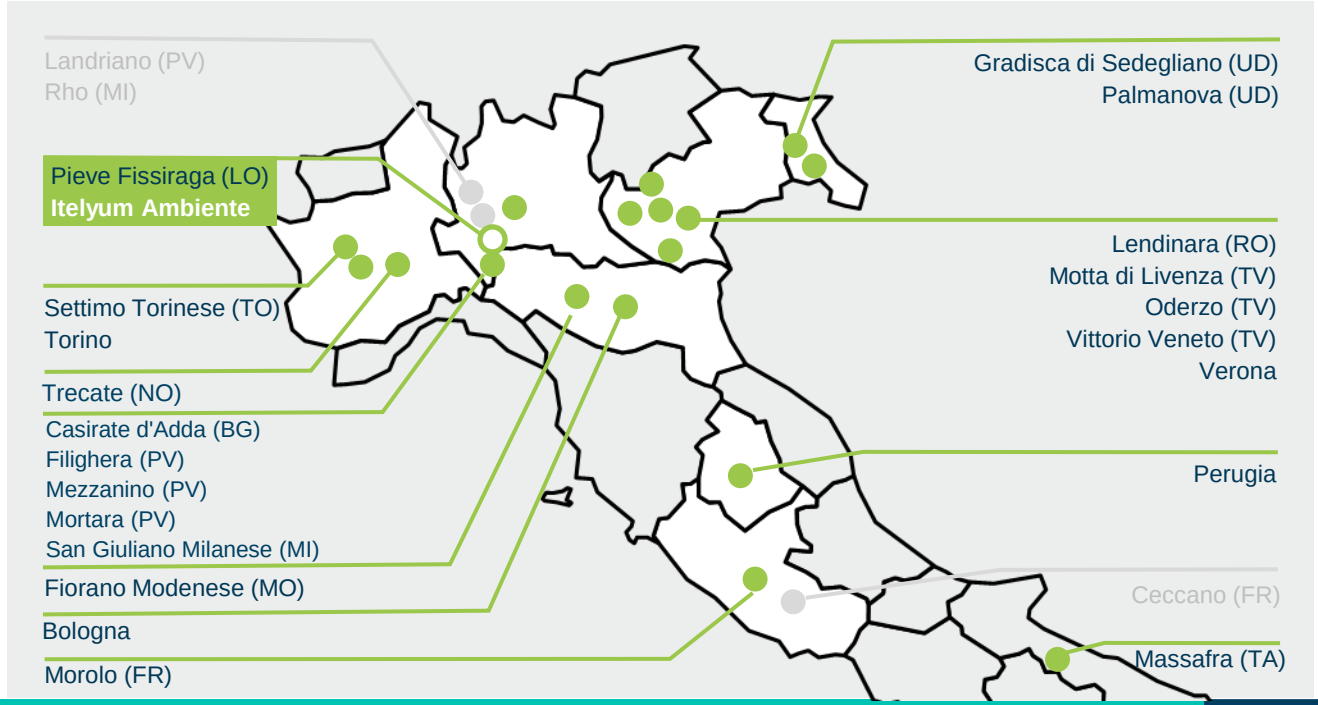
Plants, expertise and transparency

ENVIRONMENT SOLUTIONS

A network of companies and operating sites in Italy, connected to the acitvity of valorization of used oil and solvents
by Itelyum Regeneration and Itelyum Purification.
Thanks to a significant plant capacity and to wide-ranging authorizations **Itelyum Ambiente** can cover the whole national territory through integrated services.

Main services:

- Collection, transport and treatment of hazardous and non-hazardous industrial waste;
- Trading of industrial waste, hazardous and non-hazardous;
- Project and implementation of environmental remediation;
- Facility management for plant and industrial sites waste management ;
- Health and safety consultancy in the workplace;
- Chemical and environmental analysis;
- Assistance for transbondary movements.



Supply chains

1 Liquid waste Treatment

- Processing capacity of more than 220,0000 ton/y
- Advanced chemical-physical-biological treatment

2 Solid waste preparation

- Processing capacity of more than 200,0000 ton/y
- Selection, screening, homogenization, volume reduction through grinding and pressing

3 Emulsion treatment

- Processing capacity of more than 50,0000 ton/y
- Chemical-physical treatment by Tricanter, 2 evaporators and a final biological and active sludge treatment plant

4 Micro collection

- Plants that offer micro collection services to small and medium-sized enterprises

5 Auxiliary services

- Itelyum offers specific auxiliary services of sector (storage hub, transport, environmental consultancy)
- Itelyum trades more than 400,000 ton/y of hazardous and non-hazardous waste
- Itelyum manages sludges coming from waste water treatment plants; global service for industry; maintenance of water networks and aqueduct systems; demolitions, remediations and revamping of industrial plants; jetty and terminal services

6 Analysis Laboratory

- 2 accredited laboratories
- Working on different matrix: water, soil, waste etc…

Itelyum: the mark of circular economy

REGENERATION SOLUTIONS

Itelyum Regeneration SpA

PURIFICATION SOLUTIONS

Itelyum Purification SpA

ImTraS Srl

ENVIRONMENT SOLUTIONS

Itelyum Ambiente

Aeco Srl
Agrid Srl
Area Srl
ASMia Srl
Carbo-Nafta Ecologia Srl
Castiglia Srl
Centro Risorse Srl
De Luca Servizi Ambiente Srl
Fer.Ol.Met Srl
Idroclean Srl
Innovazione Chimica Srl
Intereco Srl
Keoma Srl
Labio Lab Srl
Neda Ambiente FVG Srl
Nuova Satro Srl
Rimondi Paolo Srl
RiRAEE Srl
SAM Srl
Sepi Ambiente Srl

Technological development pillars of Itelyum's strategy

Make happen circular economy through the concept of extended regeneration developing parallel verticals Waste to finished products - End of Waste and integrated/interconnected : bridges crossing different waste management supply chains

1) Starting from the consolidated used oil re-refining and solvents regeneration open platforms develops new EoW :

- From rubber powder from used tyres to rubberized asphalt production from used oil;
- From plastics waste to hydrogen and lubricants (Plasbreaker);
- From H_2S & CO_2 to obtain H_2, syngas & sulphur (AG2S process);

2) **Open Innovation** with italian universities: Politecnico di Milano, Università della Calabria, Università Federico II di Napoli, Università di Milano.

3) **Digital Transformation**:

- IoT e Cloud implementation
- business platformization
- digital twin

La Tecnologia AG2S™

Da emissioni acide a syngas: la trasformazione è sostenibile

A seguito dei promettenti risultati ottenuti nelle fasi sperimentali e pilota e nonostante il rallentamento dovuto alla pandemia, Itelyum Regeneration ha avviato il "Laboratorio Dimostrativo Permanente (LDP)" presso lo stabilimento di Pieve Fissiraga (LO), che permetterà di affinare la tecnologia Acid Gas to Syngas™ (AG2S™) utilizzando direttamente le stream industriali di campo.

DI ANNA DELL'ANGELO[1], MASSIMO BARBIERI[2], FRANCESCO GALLO[3], FLAVIO MANENTI[1]

[1] POLITECNICO DI MILANO, DIPARTIMENTO CMIC "GIULIO NATTA", CENTRE FOR SUSTAINABLE PROCESS ENGINEERING RESEARCH (SUPER)
[2] POLITECNICO DI MILANO, TECHNOLOGY TRANSFER OFFICE
[3] ITELYUM REGENERATION SRL

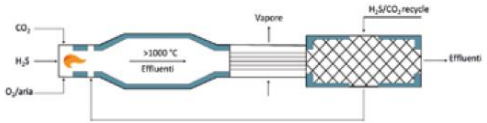
AG2S™, UNA TECNOLOGIA PROMETTENTE

La tecnologia AG2S™ nasce abbinando in maniera sinergica il potenziale rispettivamente riducente e ossidante di queste emissioni acide per la produzione di syngas, senza l'utilizzo di alcuna nuova fonte fossile, ma nemmeno rinnovabile, e in maniera energeticamente autosostenibile.

La tecnologia si applica a qualsiasi impianto in cui sono co-presenti emissioni di H_2S e CO_2. Gli esempi più classici sono i processi di idrodesolforazione presenti nelle raffinerie che oggi, attraverso il processo Claus, convertono l'H_2S in zolfo elementare ed acqua, prodotti di scarso interesse economico.

Sono in corso anche progetti nell'ambito del gas naturale, con conversione dei gas acidi a bocca di pozzo, dello shale oil, della geotermia, dl trattamento degli oli esausti e della produzione del gas naturale sintetico.

In particolare, si segnala il progetto "CO_2-free coal-to-methanol process" secondo cui la tecnologia AG_2S sarà in grado di recuperare tutte le emissioni CO_2 dell'intera filiera di sintesi.



AG2S™ TECHNOLOGY: SCHEMA DI PROCESSO

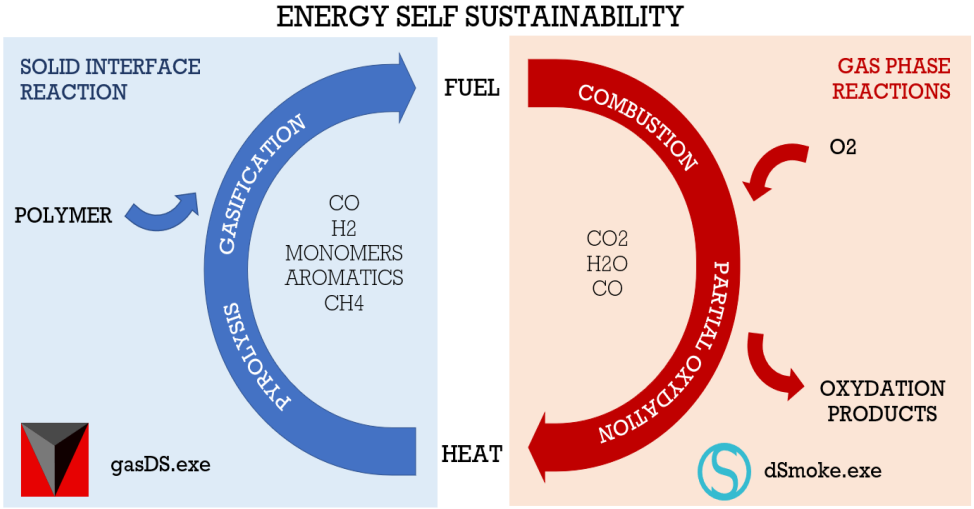
FIGURA 3 - LE FACILITIES DEDICATE AI LABORATORI PERMANENTI DEL POLITECNICO DI MILANO PRESSO ITELYUM REGENERATION. A DESTRA, VISTA ESTERNA DEI LABORATORI IN CUI OPERERANNO RICERCATORI DEL CENTRE FOR SUPER DEL POLITECNICO E DI ITELYUM REGENERATION. A SINISTRA, VISTA INTERNA CON I REFERENTI DI RICERCA E SVILUPPO, IL PROF. FLAVIO MANENTI (POLITECNICO DI MILANO,) E L'ING. FRANCESCO GALLO (ITELYUM REGENERATION)

Laboratorio permanente del Politecnico di Milano nell'impianto Itelyum a Pieve Fissiraga

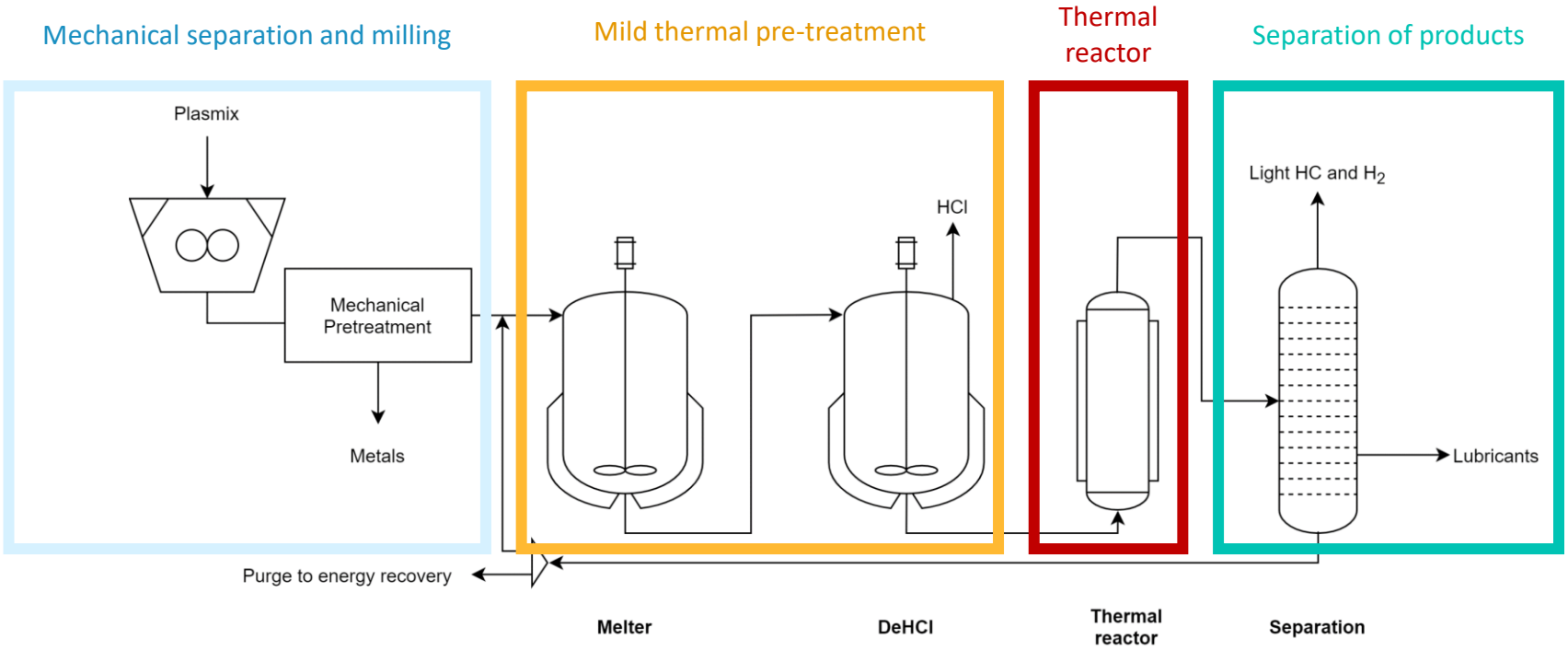
La Tecnologia PLASTBREAKER

Pyrolysis is the process of plastic thermal cracking thanks to rapid heating in the absence of oxygen, reducing the plastics long polymer chains into shorter hydrocarbons. The process takes place in four stages, namely initiation, transfer, decomposition and termination, resulting in the production of vapours and char. Pyrolysis vapours include both condensable and non-condensable gases. The condensation of the condensable vapours forms the pyrolysis wax/oil, which is a complex combination of the thermal cracking. Inter-reactions between these primary thermal cracking products results in the production of secondary products and char and non-condensable gases as by-products of the pyrolysis process.

The pyrolysis process occurs in a thermal reactor, in inert atmosphere, at atmospheric pressure and at a fixed reaction temperature. Usually, thermal cracking of plastics occurs within the temperature range of 300 – 650°C, depending on the heating rate and plastics type with the reaction temperature strongly influencing the pyrolysis product yields.



La Tecnologia PLASTBREAKER



IPCEI Hydrogen – Project Overview

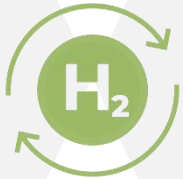
Development of a **blue/green hydrogen production specific hub** in Itelyum Regeneration refinery in Pieve Fissiraga, Lodi, Italy

Hydrogen production initiatives

- **Steam-reforming unit, with CO2 capture plant**, producing 1000 Nm3/h of Hydrogen from natural gas and. Capturing CO2 emissions will allow to reduce the environmental impact of the hydrogen produced enabling its classification as blue hydrogen

- **Plastbreaker unit**, which converts plasmix material into green hydrogen and lube base using an innovative technology:
  - pilot unit with annual treatment capacity of ca. 1000 t of plastic, for the production of more than 150 t/year hydrogen, is already in place on Itelyum facilities;
  - The project includes the industrialization of the unit with an annual treatment capacifit of ca. 80.000 t of plastic, for the production of more than 12.000 t/year hydrogen production;

- **Electrolysis unit**, with a capacity of 20MW allowing for more than 2.000 t/year hydrogen production. The electrolysis unit will be fed with 100% renewable electricity, sourced with specific PPAs and origin certificate, to produce green hydrogen



Hydrogen use destinations

Replacement of current natural gas as a fuel for boilers and cogeneration units of the production site;`

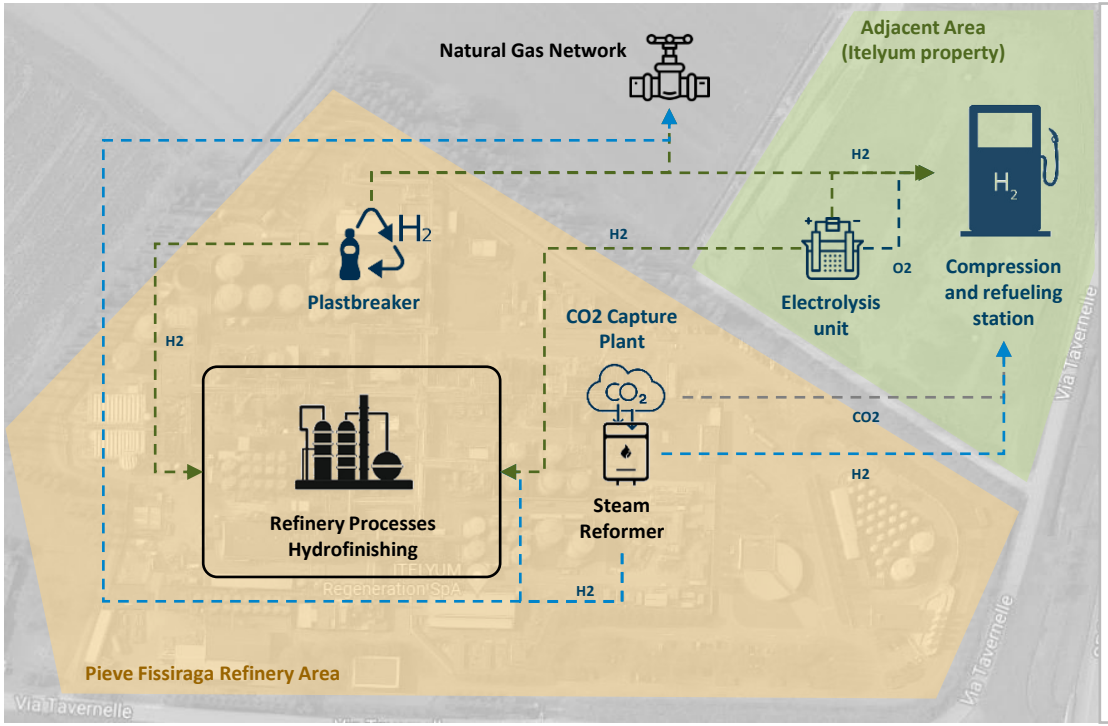
Use as a process feed to the hydrofinishing unit of the used mineral oil re-refinery unit on-site

Hydrofinishing of vegetable used oil, to produce sustainable 2nd and 3rd generation biofuels

Injection into national natural gas network

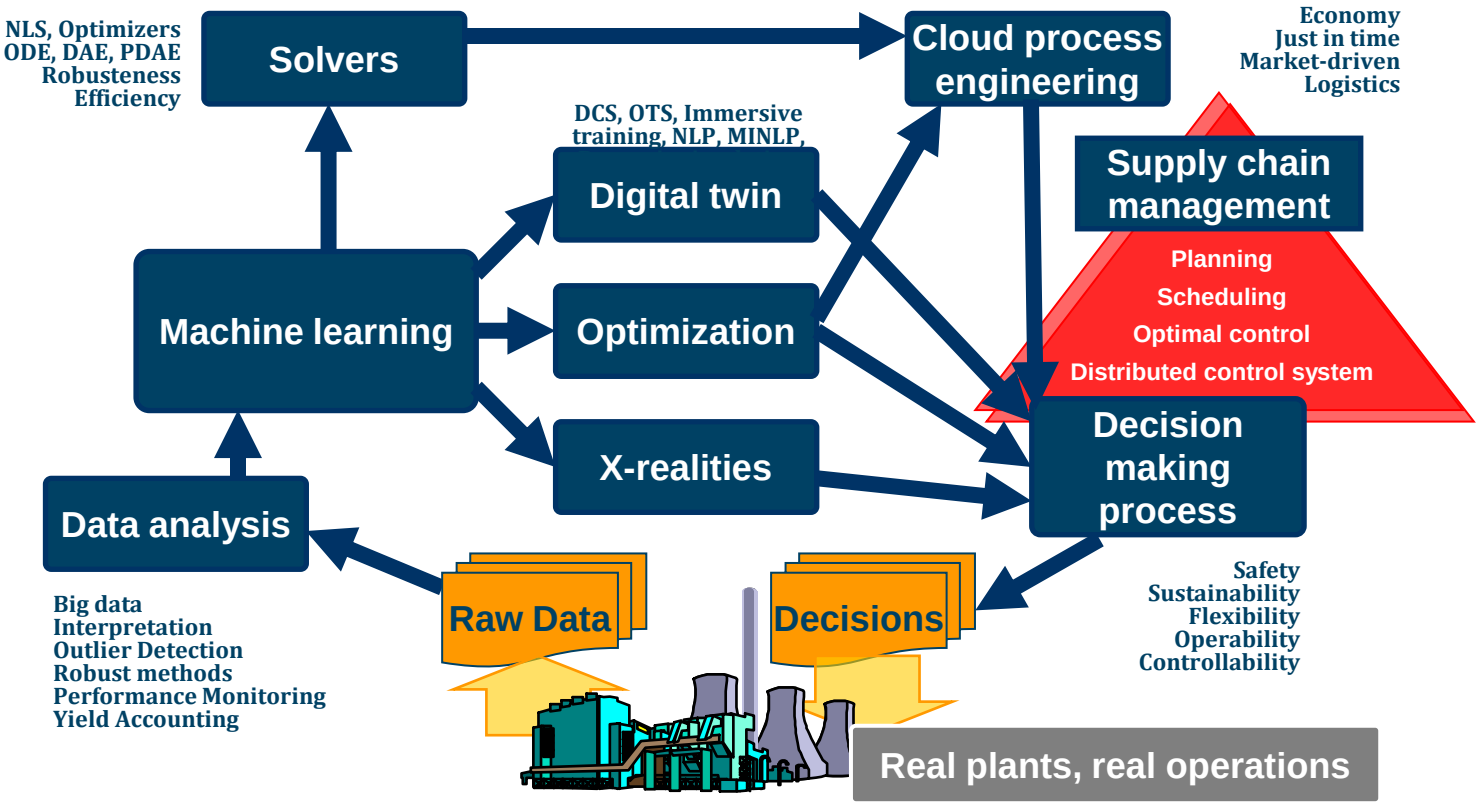
Bottling, together with CO2 and O2 (byproducts of the project), in a specific **bottling and refuelling station** to be realized on-site

Project Conceptual Scheme and key metrics

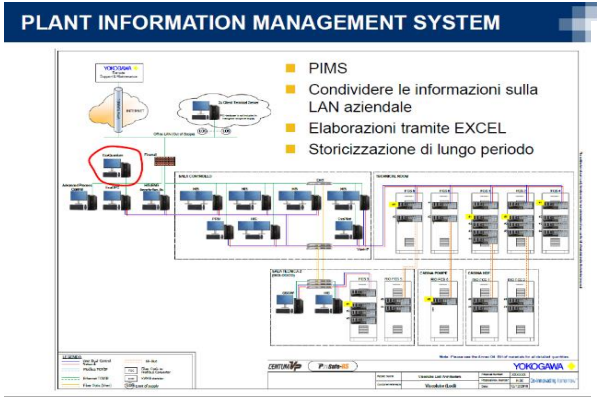


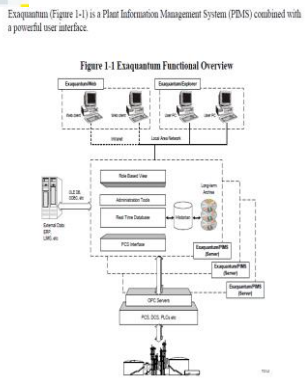
- Plasmix treatment capacity: ca. **80.000 t/year**
- Hydrogen Production ca. **14.000 t/year**:
  - ca. 2.000 t/year from electrolysis
  - ca. 12.000 t/year from plasmix
- Byproducts from continuing treatments:
  - Biolubricant: **8.000 t/year**
  - 2nd and 3rd generation biodiesel: **8.000 t/year**
  - Base lube (group II, group III, white), ultra-low sulphur gasoil and bitume: **48.000 t/year**
- CO_2 impact abatement **126.000 t/year**:
  - 85.000 t/year from complete switch of Itelyum facility from natural gas to hydrogen combustible, which of 5.000 t/year from steam reformer CO2 capture
  - 41.000 t/year from plastics wastes treatment compared to incineration

Process Operations Management



DIGITALIZATION STRATEGY





YOKOGAWA CENTUM VP- EXA QUANTUM

DIGITALTRANSFORMATION PROJECTS CARRYING OUT BY ITELYUM BEING PART OF THE CIRCULAR PLATFORM :

FROM DATA RESISTANT AND CLOSE PROCESS MANAGEMENT TO **DATA DRIVEN** NETWORKING DATA (EXA QUANTUM).

DIGITALIZATION STRATEGY

In the frame of the digital transformation project the following actions are carrying out:

- Terminal Server new (model VP6H1150)- Visible on LAN (new rack station, SW standard operation/monitoring function, licence « Server for Remote Operator allowing 3 client stations to working on company LAN, installation of a Firewall, installation antovirus, installation of licences Whitelistening)
- Move the communication net from current Vnet (10 Mbps) to Vnet/IP (1 Gbps) achieving also the increase of the quantity of data on the net
- Replacing existing CPU models with Vnet/IP;
- Move the communication net between remote I/O ER-bus (2 Mbps) to ES-bus (128 Mbps)
- Installation of PRM (Plant Resource Manager) ;
- Installation of PIMS (Plant Information Management System)- EXA QUANTUM ABLE TO MANAGE 1000 tag/ 3 clients and allowing : sharing on factory LAN, data management and report construction with MS Excel, long period data recording and storage

The technical advantages will be :

- Increasing of calculation's capability ;
- Increasing of function blocks for interface of instrumentation in the field (foundation fieldbus)
- Allowing the architecture of the system ready to exchange data with higher systems like PIMS (plant information management system)

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