GRANIT TECHNOLOGIES

GRANIT

COMPANY PRESENTATION

Water, Waste & Energy related Technologies
and Engineering capabilities

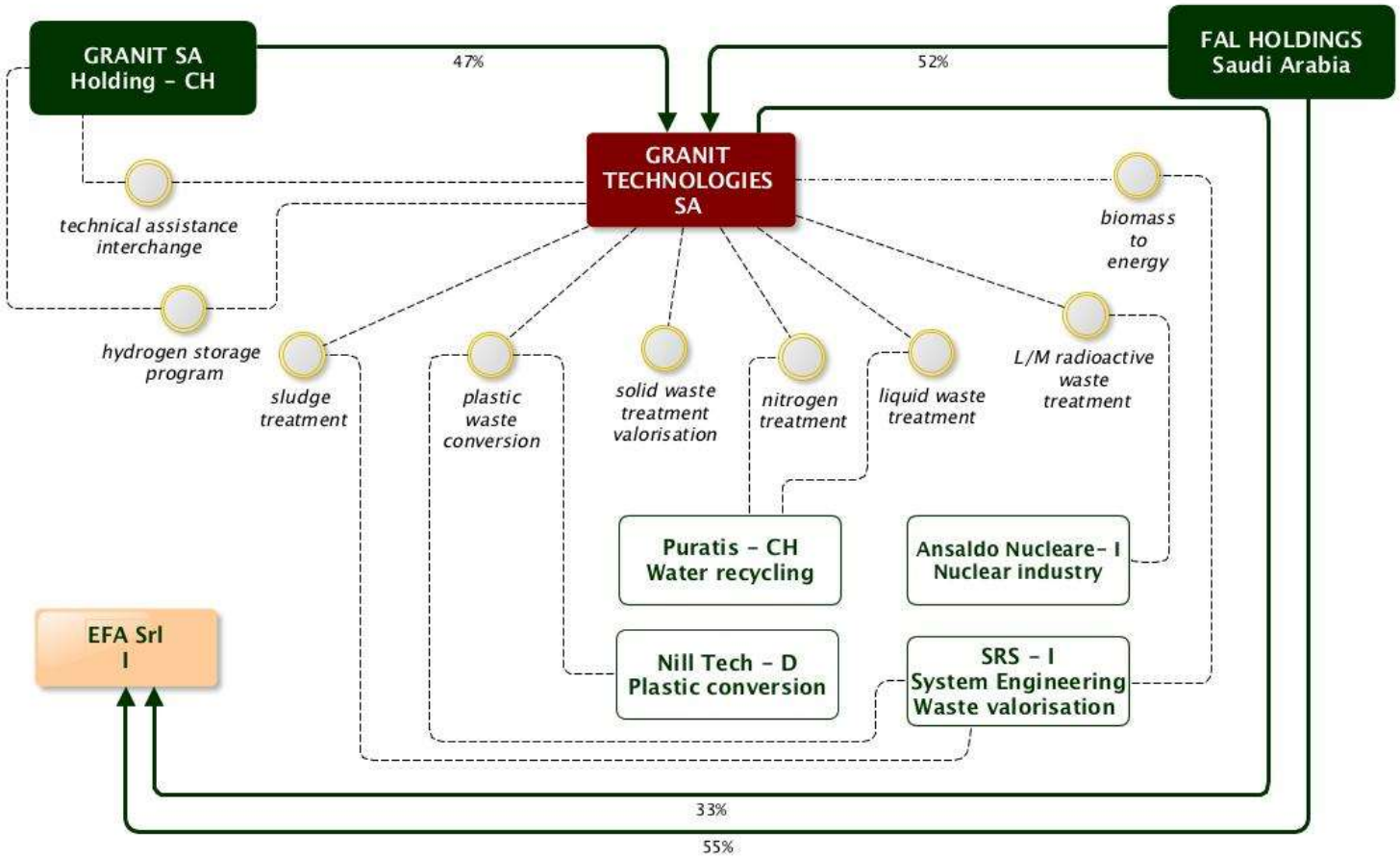
Science, Environment, Health & Industry

Granit Technologies SA (GRT), based in Orbe (Switzerland), was formed in 1981 to encompass the achievements of the Swiss research group Granit SA, a real pioneer in the environmental sciences. The focus of Granit SA was on the fields of **water, waste and energies** and its mission was to link science and industry, always protective of the environment and of the health.

In 2003 GRT retained the Granit SA technical resources and tools and started to operate as an advanced conceptual and system **engineering organisation**, pursuing the application, both at demonstration and at industrial level, of **advanced technological packages** in the fields of the treatment and valorisation of waste.

As of today, GRT proposes state of the art solutions, backed by adequate references, for:

- The **treatment of "non-recyclable" plastic waste** and the relevant valorisation of such waste into quality diesel fuel.
- The treatment of waste containing high percentages of "non-biodegradable" organic material: **civil as well as industrial sludge and liquid effluents**
- The treatment/reduction of **low and medium level radioactive waste** produced by the nuclear energy industries and by some activities in the health fields



A multifaceted network, with a common aim: sustainability

Partnering on one side with qualified technologists, research centres and universities and, on the other side, with reputed engineering organisations and industrial operators, has been so far a GRT distinctive and strategic rule.

This approach, and the interaction with other Group companies, have permitted to progressively enhance the GRT competences (therefore the GRT offer potential).

Furthermore, the compatibility of the GRT action plans is the result of well refined corporate communication procedures, but does not limit the company freedom in reacting to the market dynamics. On the contrary, the strength of the shareholders adds substance to the GRT rating.

Alone and/or in cooperation with other qualified parties, GRT has built a **strong pool of original technologies**, mostly patented, which are all fully marketable.

- **In-house wet oxidation technology** (WOx) for the treatment of organic, non-biodegradable, material.
- **Original biological protocol** for the process of nitrogen in waste water treatment plants. Such protocol has a broad range of applications but has been already tuned to integrate the WOx.
- **Integrated plastic waste conversion** systems, often referred as "plastic-to-fuel", which in fact turn non-recyclable plastic waste into quality fuel (diesel oil and kerosene).

As opportune, GRT markets also technologies developed by its strategic partners, such as:

- The Puratis SA original bio-process that, by leveraging on selected microbial strains, addresses to mainstream water treatments, side stream water treatment and **micro pollutant removal**
- A novel high efficient **biomass gasification system** set up by the Italian company SRS
- A **wood torrefaction system** conceived by the Swiss HEIG-VD (Yverdon) and developed at the pre-industrial stage with the extensive involvement of GRT
- A **hydrogen storage program** developed under a licence granted by the EPFL (Ecole Polytechnique Fédérale de Lausanne).

Technical servicing

- Engineering services for captive projects
- Engineering services for 3rd parties in domains always strategic for Granit
- Engineering services and construction of pilot plants and pre-industrial stage units for 3rd parties
- R&D Services for captive programs
- R&D Services based on Granit know-how and sold to 3rd parties

Liquid waste treatment and valorisation

- Wet Oxidation technologies for civil sludge treament
- Wet Oxidation technologies in industrial fields
- Wet Oxidation technologies to treat low radiactive waste
- Wet Oxidation technologies in batch for the treatment of hazardous waste
- Ammonia treatment with novel, in house, protocols and technologies

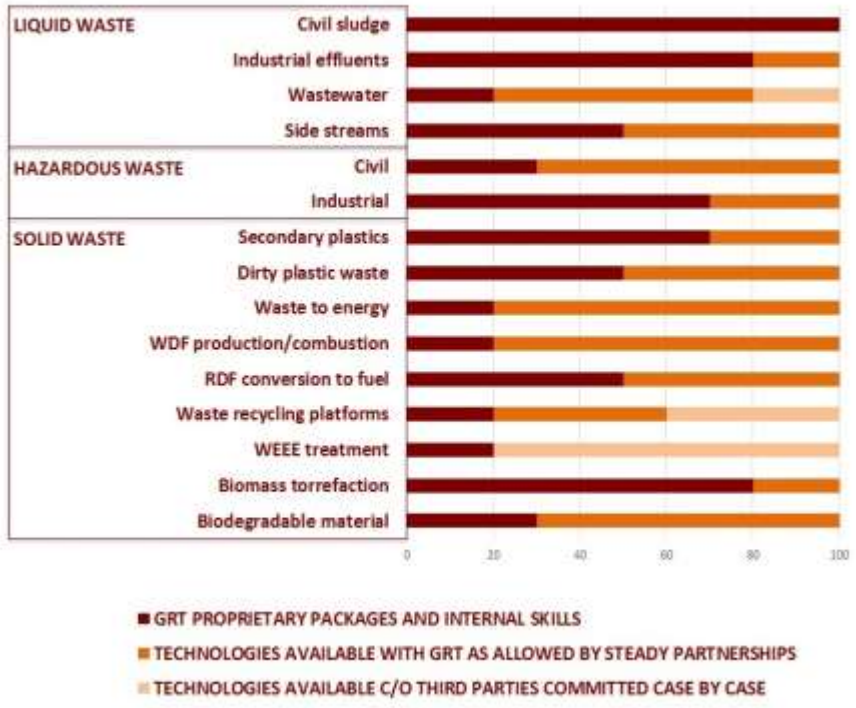
Solid waste treatment and valorisation

- Non-recyclable waste plastic conversion
- Novel conversion processes (fluff, e-waste, car tyres)
- Solid waste valorisation by means of new packages as alternative to incineration
- Biomasses to energies

Focusing on the environmental challenges of today and tomorrow

Merging its proprietary technologies and internal skills with technological assets made available by diverse partners, Granit Technologies can grant added value contribution to a vast array of projects in the waste management fields.

Composition of the GRT panel of advanced waste handling technologies



Wet oxidation plant for the effluent from a pulp and paper industry

Added value services

The GRT servicing potential is granted by the use of internal resources, as well as external professionals, mostly derived by contractual commitments with academic bodies.

When the operations provide also for detailed engineering and general procurement activities, Granit operates in contractual partnership with the qualified engineering company SRS Srl, based in Italy (Rome and Torino) but with a fixed technical antenna in Orbe, within the Granit premises.

The GRT engineering activities leverage also on the use of proprietary technical including:

- Two small scale pilot wet oxidation units in Orbe
- Two fully equipped laboratories in Orbe, one allowing basic chemical and physical analyses, the other devoted to research and pre-project activities
- An extensive library of case studies, recording the GRT various experiences and, as admitted by specific agreements, also such of GRT partners and clients.

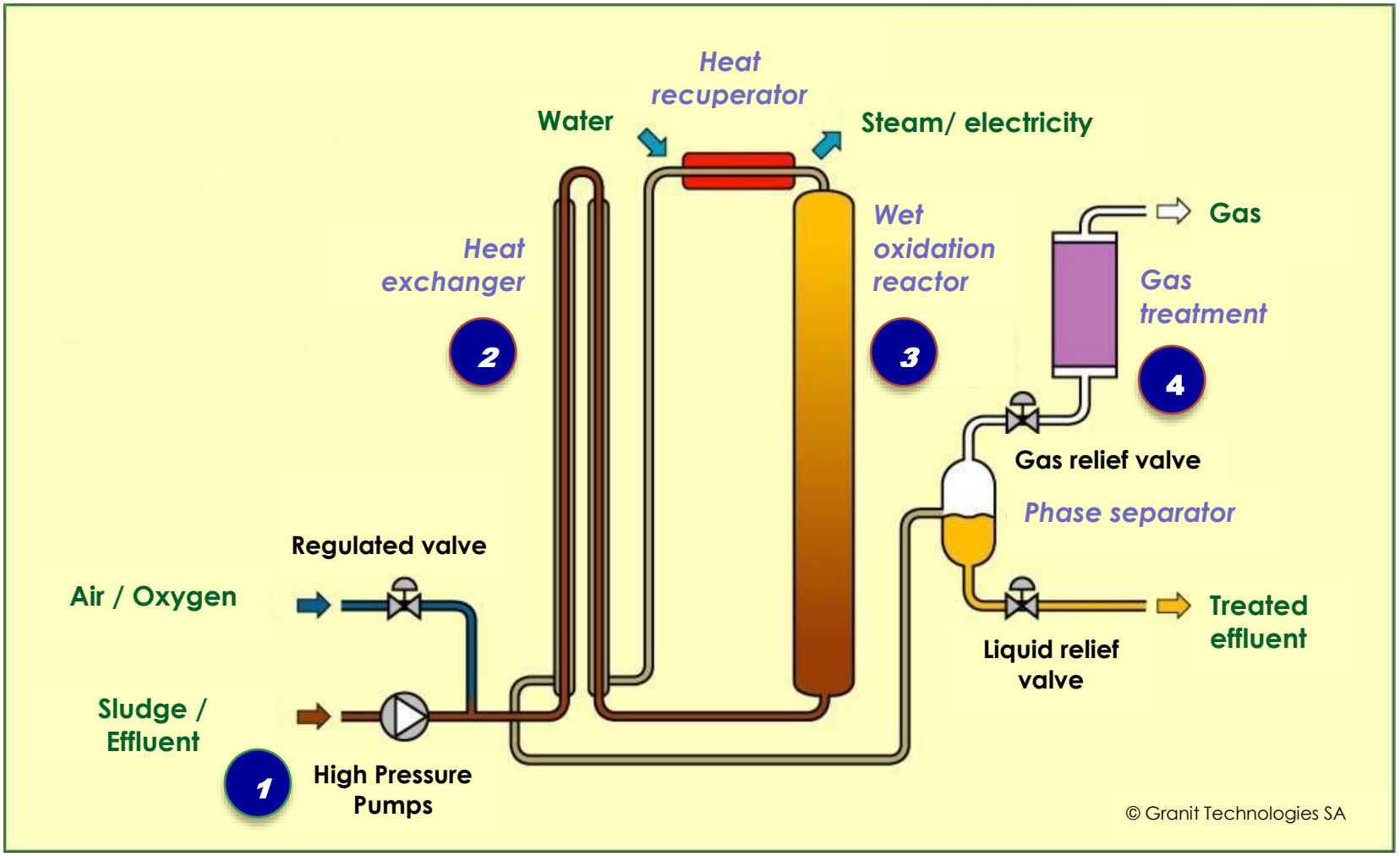
Because GRT is positioned in the TecOrbe area, according to actual needs it can easily widen its collaborative framework to other competences, and reflect them within its projects. TecOrbe is a Swiss techno-park launched and co-managed by a GRT sister company and fully devoted to the environmental sciences.

Treating the “untreatable”

GRT has gained significant experience in the broad area of **sludge and effluent treatment**. In such frameworks, GRT can first of all account on its proprietary “wet oxidation” technology to treat aqueous wastes containing organic non bio-degradable components. Shortly this method allows the elimination by oxidation (or combustion) of the organic components in the liquid phase, at high temperature and pressure.

Wet oxidation (WOx) is a reaction in liquid phase between organics and oxygen at elevated temperature and pressure. Organic compounds content expressed as COD (Chemical Oxygen Demand) entering the unit should be comprised between 70 and 120 gO_2/l. Out of this range, the effluent has to be concentrated or diluted. Dry solids content cannot be higher than 15%.
Compressed air or pure oxygen can be used for the reaction. If the organic content of the sludge or effluent is high, the excess heat can be valorised by the production of industrial steam, hot thermal oil, hot water or electricity.

WOx is a serious, trustable, efficient and environment protective alternative to the landfilling: a practice which is, in fact, under banning in many countries. Furthermore it has also become an as well valid and economic alternative to incineration.



1 *High pressure pumps*

2 *Heat exchanger*

3 *WOX Reactor*

4 *Gas treatment*

Applications

WOx has been already successfully applied to various civil and industrial waste, including sludge from WWTP, effluents from P&P industry, agro-industry, fine chemical industry, special hospital waste and, really promising, refinery and petrochemical industry.

In addition, WOx has already proven its validity for the treatment of low radioactive waste, such as spent ion exchange resins from the nuclear industries and other contaminated material from scientific labs and from the health sector.

Civil

- sludge from WWTP

Industrial effluents

- pulp & paper
- fine chemical
- alcohol distilleries
- olive oil industry
- textile

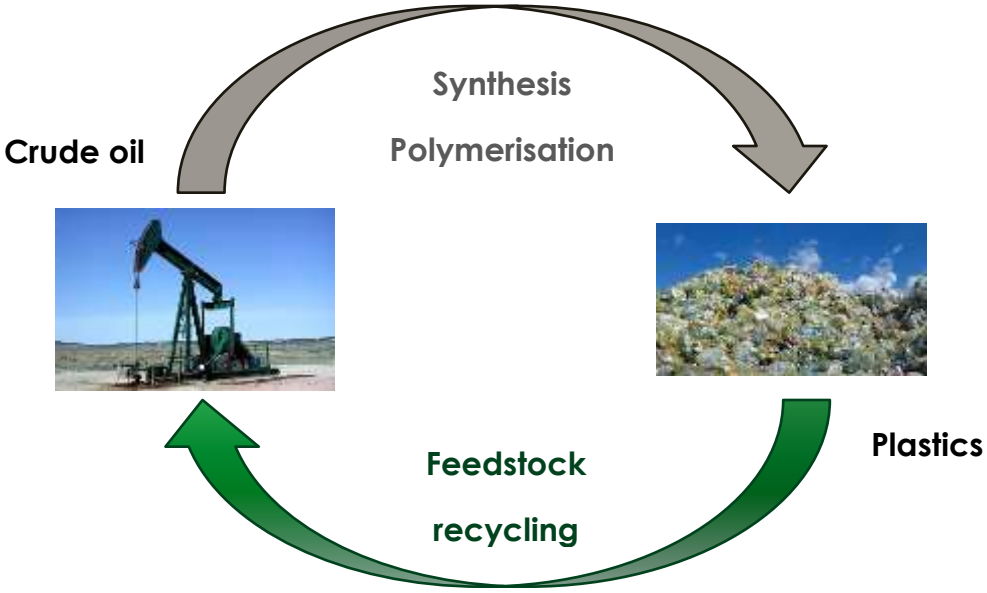
Hazardous

- hospital waste
- low radioactive waste
- spent caustic & red oil from refinery and petrochemical
- metal finishing
- pesticide industry

GRT Intellectual property and references

Patent n.	Date	Description	Notes
10 2007 039 887.7-44 PCT/EP07/07419	2007 2009	Plastic depolymerisation	German application US application
CH 700 665 10711820 PCT/CH2010/000070	2009 2010 2015	Method and device for the Wet Oxidation treatment of liquid waste laden with mineral matter	Swiss patent Europe application US application
00493/12 13/00821	2012 2013	Method and device for the Wet Oxidation treatment of liquid radioactive materials laden with various matter	Swiss application French application
00596/12 PCT/CH2013/00099	2012 2013	Process for cementation and storage of radioactive materials	Swiss application International application
01117/13	2013	Wet oxidation for hazardous waste	Swiss application
PCT/CH2013/000034	2013	Method for producing hydrogen gas from formic acid	International application

References & experiences	Country	Start-up Year	Type of waste	Type of treatment	Capacity	Oxidant
Monthey (CIMO)	Switzerland	1994	Chlorinated organic compounds	WOx for chemical industry	10 m^3/h	Air
Thonon-les-Bains (PDL)	France	2004	Black liquor	WOx for pulp & paper industry	2.5 m^3/h	Air
City of Orbe	Switzerland	2006	Digested sludge	WOx for sludge from WWTP	500 tDS/y	Oxygen
Spontex	France	2007	Production refusal	WOx for raw material regeneration	10 l/h	Oxygen
PDU- Basel	Switzerland	2007	Non-recyclable waste plastic	Waste plastic conversion	50 kg/h	-
Rovereto (Ladurner)	Italy	2011	Digested sludge	WOx for sludge from WWTP	4500 tDS/y	Oxygen
Sogin	Italy	2012	Spent ion exchange resins	WOx for the nuclear industry	1 l/h	Oxygen
Ecofuel Apulia – System Engineering	Italy	2012	Non-recyclable waste plastic	Waste plastic conversion	15 000 t/y	-
Sogin	Italy	2013	Spent ion exchange resins	WOx for the nuclear industry	0.5 m^3/h	Oxygen
Confidential client	Italy	2014	Production refusal	WOx for raw material regeneration	5 l/h	Oxygen/Air
Torplant - Orbe	Switzerland	2015	Wood residues & green waste	Torrefaction	100 kg/h	-
Confidential client – Basic Engineering	Italy	2016	Non-recyclable waste plastic	Waste plastic conversion	15 000 t/y	-



Using the "unusable"

The GRT main focus is on the realisation of projects that provide for the **valorisation of plastic waste into diesel oil**.

As a matter of fact, plastic waste is either recycled into second quality plastic (clean recycled plastic valued up to 400€ per ton), incinerated (cost: 50 to 150€ per ton) or, finally, land filled (similar cost). Recycling is only possible for clean and pure waste plastic while the capacity for incineration and land filling is limited and new sites are difficult to develop. The **plastic-to-fuel** solution is a valid alternative both to landfilling and incineration.

The best products from plastic waste conversion can be obtained by:

- low density polyethylene (LDPE) used in plastic bags, cling film, flexible containers;
- high-density polyethylene (HDPE) used in piping, shampoo and detergent bottles, oil bottles, milk crates;
- polypropylene (PP) used in food containers, battery cases, bottle crates, automotive parts and fibres;
- polystyrene (PS) used in dairy product containers, tape cassettes, cups and plates.

PET and PVC are not suitable and must be attentively pre-sorted.

input

end-of-life plastics
(PE, PP, PB, PS)

reactor 1

melting and separating
liquid/solid

reactor 2+3

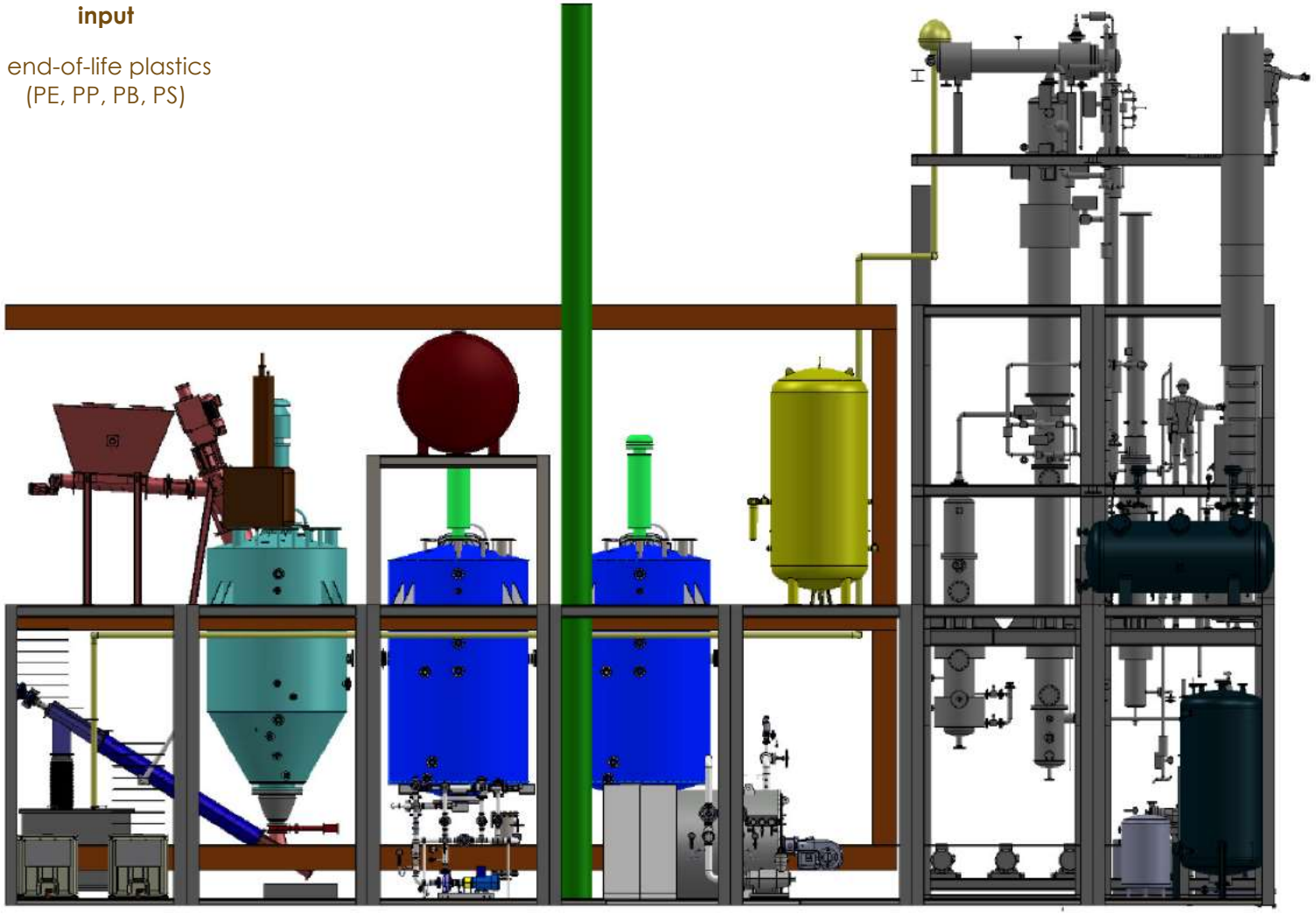
cracking and
evaporating

rectification

separating into customer
specific liquid products

output

quality gasoil and kerosene or
fuel oil



By use of the GRT proposed technologies, a blend of pre-treated waste plastics is converted into product oil suited for various applications.

In its composition and its properties the product oil is similar to fuel oil or diesel respectively.

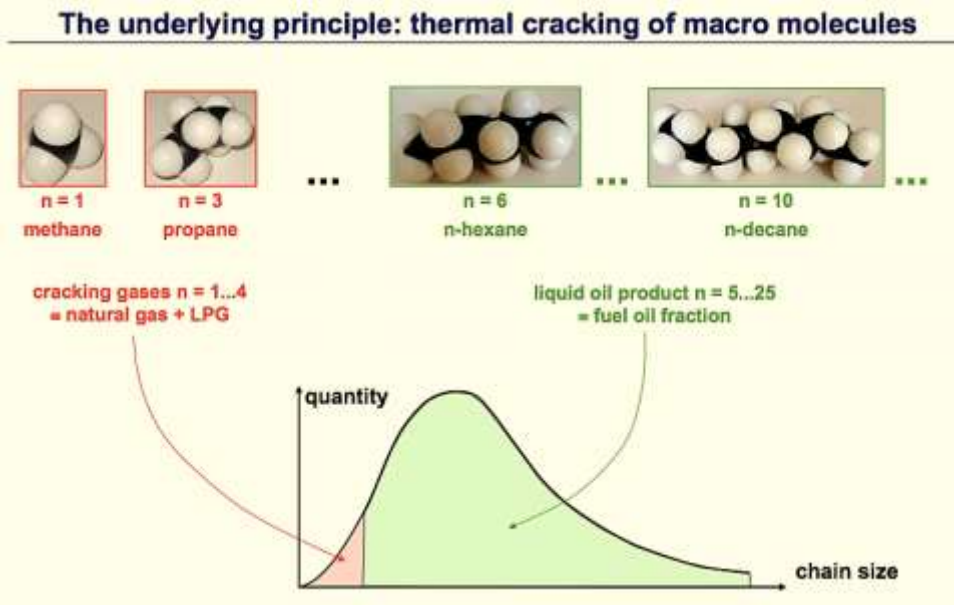
With the help of this efficient recycling procedure, plastic waste can at last return as feedstock for a second usage.

Basically, the proposed conversion process provides that the plastic is shredded roughly, then sorted and afterwards reduced to a grain of about 1 to 30 mm. Within three in series connected reactors the input material is heated onto different temperatures and melted around 400° C. The gases resulting from the cracking step are then condensed.

At the end of the process a mix of hydrocarbon is available. The tests by independent survey-specialists state that the product fulfils the technical requirements of conventional heating oil as per DIN 51603-1.

Out of 1000 kg plastic waste about 850 litres of quality-oil are won, which is usable, next to the application as heating oil, as basic material in the chemical industry. Within the process nearly 10 % burnable gasses arise, which are recovered for the heat-supply of the facility.

The efficiency is around 90% and the residue is inert (sulphur poor slag).



Specification of the end product (Eco-fuel)

- Global calorific value 40-42 MJ/Kg
- Cetane value 45-55
- Density at 15°C 750-850 kg/m^3
- Viscosity at 40°C 1.0-5.0 mm^2/s
- Flash temperature > 50°C (mixture C10 to C24)
- Halogen compounds < 1 ppm
- Sulphur compounds < 20 ppm
- Heavy metals < 10 ppm

Giving value to "residues"

Torrefaction is a thermal pre-treatment process that enables to concentrate the calorific energy of woody biomass in a smaller volume, and guarantees a constant heating value to the torrefied product.

This makes possible the upgrading of low quality feedstock into a solid fuel of high added value.

Low quality feedstock (such as forest residues, green waste, residues from fruit growing) is transformed into a fuel with good storage properties that is well suited for combustion or gasification and also for densification and transport in the form of pellets.

Woody biomass, once torrefied, offers the following main advantages:

- High efficiency fuel with a constant calorific value
- Combustion with lesser fouling
- Hydrophobic fuel, allowing storage in outdoor conditions
- Favourable grinding costs
- Facilitated packaging
- Favourable transport costs.

Torplant unit in Orbe (CH) based on the HEIG-VD concept and co-financed by the Canton of Vaud in the framework of the program "100 million for renewable energy and energy efficiency"

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