



polyn**SPIRE**

Innovative technologies for plastic recycling

Demonstration of Innovative Technologies towards a
more Efficient and Sustainable Plastic Recycling

Nelson R. García-Polanco,
Head of Industrial Technologies
CIRCE Foundation



About the Project



- ✓ CIRCE
 - ✓ Facts & Figures
 - ✓ polynSPIRE and Circular Economy
 - ✓ Main Objective
 - ✓ Goals
 - ✓ Consortium Layout
-



CIRCE is energy

25 YEARS OF R&D&i SERVICE TO COMPANIES,
THE SOCIETY AND THE ENVIRONMENT

We are a technology centre funded in 1993, seeking to provide innovative solutions for a **SUSTAINABLE DEVELOPMENT**.

Our research centre consists of a highly qualified and multidisciplinary team, composed by **more than 185 professionals**.

We work towards improving the competitiveness of enterprises through **generation of technology transfer** by means of R+D activities and market-oriented training within the field of resource sustainability and effectiveness, energy grids and renewable energies.



MISSION

To improve the competitiveness of **companies** by generating and transferring **technology** through market-oriented R&D&i and training activities in the field of sustainability and resource efficiency, energy networks and renewable energies.



VISION

- International **reference** in energy.
- Investment **multiplier** in R&D&i.
- Focus on **talent**.
- Generator of ideas and **solutions**. Innovative and competitive.



VALUES

- **Quality** and agility
- **Commitment** and responsibility
- Passion for challenge and **innovation**
- **Transparency**
- Enthusiasm for **collaborative** work
- **Vocation** for economic, social and environmental sustainability



Research

LEADERS IN APPLIED COLLABORATIVE R&D



14 National projects
> Funded by Spanish Government

66 Horizon2020 Programme and FP7
> 21 Coordinated

Participation in other European Projects
> Interreg SUDOE
> Interreg MED
> Art. 185 EMPIR

+100 million €

*for our partners in the 7FP
and H2020 projects that we coordinate*



Activity lines

INNOVATION FOR THE INDUSTRIAL SECTOR



01

RENEWABLE ENERGY

WIND
SOLAR
BIOMASS
RENEWABLE ENERGY
INTEGRATION IN GRID

02

FUTURE ELECTRIC GRIDS

ELECTRIC NETWORKS
ICTs
SMART GRIDS
POWER ELECTRONICS
& ENERGY STORAGE

03

SMART MOBILITY

ELECTRIC VEHICLE
SUSTAINABLE
MOBILITY

04

INDUSTRY 4.0

COMBUSTION
ICTs
MONITORING

05

ENERGY EFFICIENCY

INDUSTRIAL ENERGY
EFFICIENCY
SUSTAINABLE
CONSTRUCTION
SOCIAL ENERGY
RESPONSIBILITY

06

CIRCULAR ECONOMY AND SUSTAINABILITY

EFFICIENT USE OF THE
RESOURCES
WASTE & EMISSIONS
REDUCTION
SUSTAINABLE ECONOMY
ENVIRONMENTAL,
ECONOMIC AND SOCIAL
IMPACT ANALYSIS



International positioning

PARTICIPATION IN MORE THAN 30 ASSOCIATIONS AND PLATFORMS



Spanish Biomass
Technology Platform



European Association of
Renewable Energy Research
Centres



European Technology
Platform for Zero Emission
Fossil Fuel Power Plants



European Association
for Storage of Energy



European Academy
of Wind Energy



District Heating & Cooling
European Technology Platform



Spanish Biomass
Energy Valorization
Association



European Energy
Research Alliance
**Partners of the Smart Grids
& Wind Energy
Joint Programmes**



Energy Efficient Building
Committee European
Construction Technology
Platform



Spanish Technological Platform
of Electrical Grids
Technical Secretariat



European Technology and
Innovation Platform –
Batteries Europe



SPiRE – Sustainable Process
Industry through Resource and
Energy Efficiency
Funding Members



Bio-Based Industries
JTI members



European Association of
Research and Technology
Organisations



International
Energy Agency



European Technology and
Innovation Platform Smart
Networks for Energy
Transition



Spanish
Wind Energy
Association



Spanish
Energy Efficiency
Technology Platform

**Co-coordinates the Storage
Group and takes part in
other three groups**

The project has received funding from the European Union's Horizon 2020
research and innovation programme under grant agreement no 820665



polynSPIRE: Facts & Figures



Full title: Demonstration of Innovative Technologies towards a more Efficient and Sustainable Plastic Recycling

Start date: 01.09.2018

Duration: 48 months

Number of partners: 21 including research/academic institutions, governmental organization, industries and SMEs

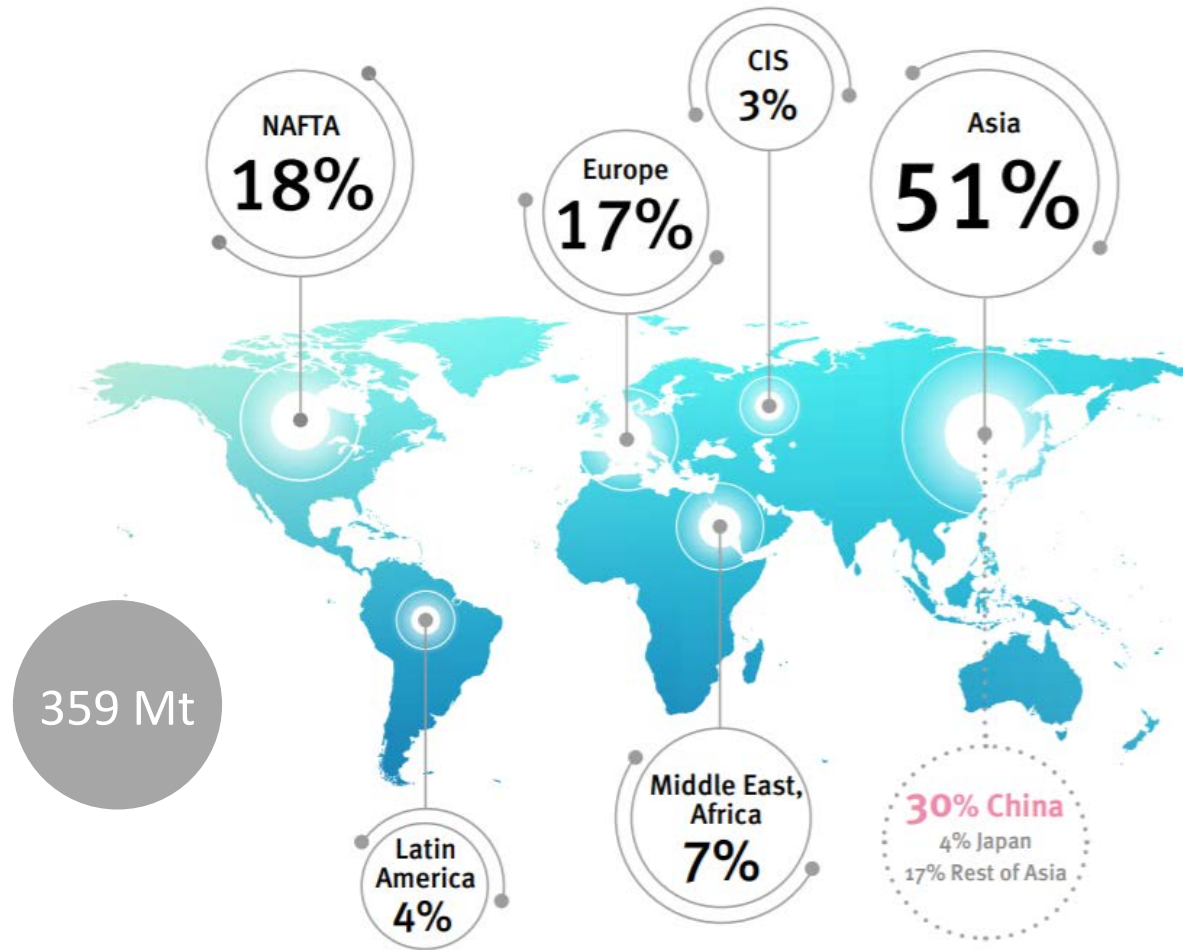
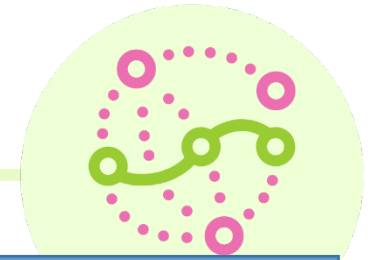
Budget: €9.95 Million

EU contribution: €7.94 Million

TRL at the end: TRL 7 (system prototype demonstration in operational environment)



Plastic: Where is the problem?

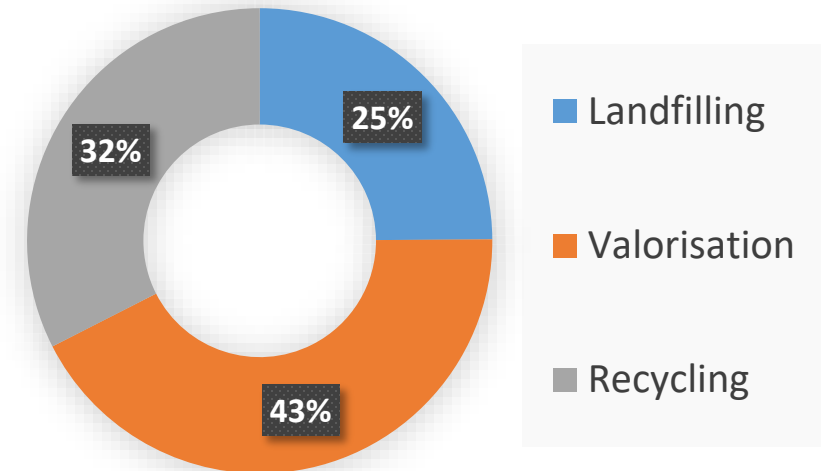


Worldwide production
(Source: Plastics the Facts 2019, PlasticsEurope)

Consumption in Europe: 51.2 millions of tons
(14% of worldwide production)



29.1 Mt of plastic waste



The project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement no 820665



Plastic: Where is the problem?



Plastics use per sector



polynSPIRE and Circular Economy Package



- In 2018, the European Commission adopted a new set of measures, that will help transform Europe's economy to become more sustainable and that will support existing Circular Economy Action Plan
- The new measures include a wide EU Strategy for Plastics in the Circular Economy that will help to transform a smart, innovative and sustainable plastics industry, where design and production fully respects the needs of reuse, repair and recycling.
- polynSPIRE is supporting this effort by introducing a set of novel approaches to recycling and usage of raw materials



Main Objective (I)



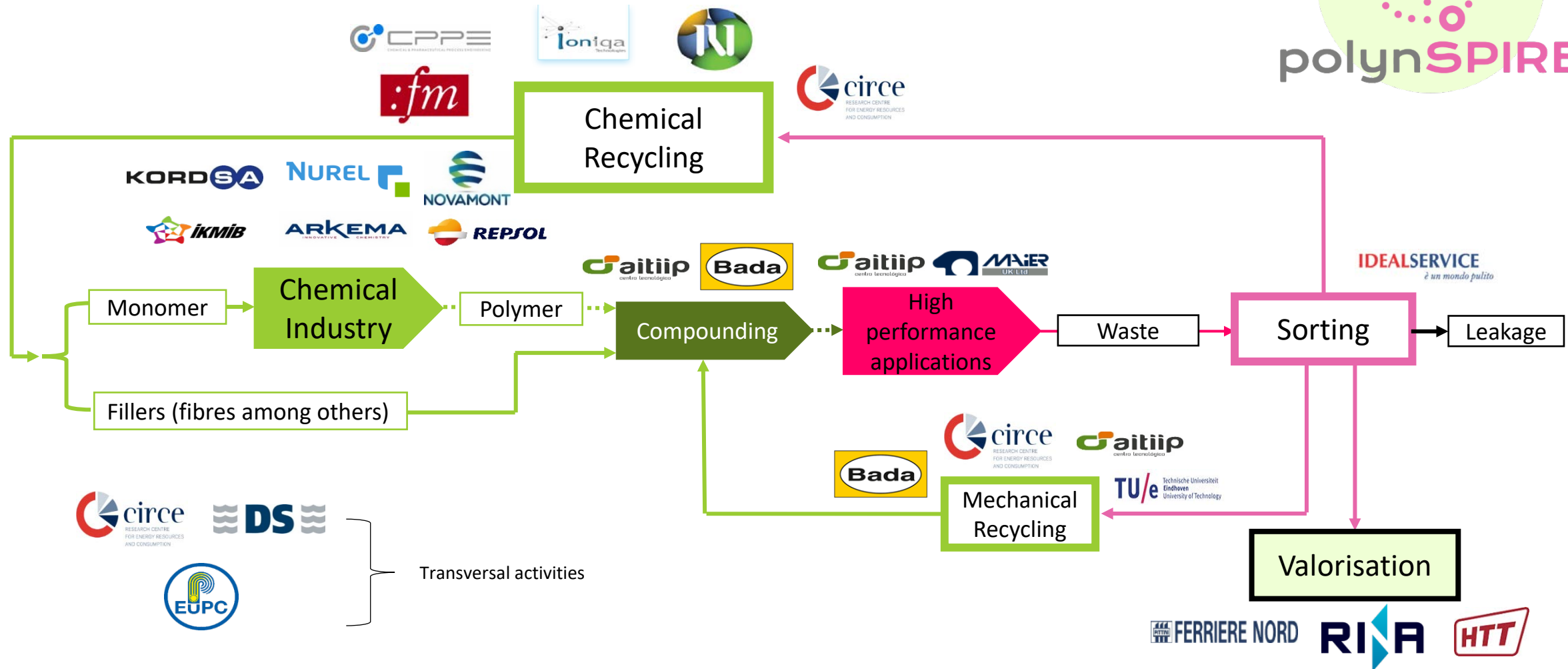
Demonstrating at TRL 7 a set of **innovative, cost-effective and sustainable solutions with an aim to improve the energy and resource efficiency** of plastic recycling processes for materials containing at least 80% plastic.

The project is focused on following plastic containing materials:

- **postconsumer** (after products' end of life)
- **post-industrial** (produced during transformation processes from raw materials to final product)



Main Objective (II)



The project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement no 820665



Our Goals Contribute to the SPIRE Roadmap (I)



polynSPIRE Goals

- **Enhance plastic recycling** through a higher and more flexible usage of heterogeneous plastic waste
- **More efficient energy usage** by reducing energy use up to 68% during chemical recycling
- **Decrease the utilisation of primary fossil resources** at least 32% in the polyamide and polyurethane sectors and reduce landfilling 25% in polyolefin sector
- **Decrease CO₂ equivalent emissions** in the plastic sector between 30% and 40%



SPIRE Roadmap

- Optimal valorisation of waste, residues streams and recycled end-of-life material as feedstock
- Development of more efficient systems and equipment
- Process monitoring, control and optimisation



Our Goals Contribute to the SPIRE Roadmap (II)



polynSPIRE Goals

- **Develop an optimisation and upscaling methodology** based on life cycle studies
- **Create roadmaps of cross-regional and cross-country strategies** for plastic waste management **and analyze the EC barriers** on waste management (including non-technological barriers such as legislation and standardization)



SPIRE Roadmap

- Deeper knowledge of the processes at system level
- A life cycle and costs perspective
- Create efficient business models
- Widespread dissemination of the results



Consortium



The project involves all relevant actors along the value chain

| | |
|--|--|
| <p>Technology Developers</p> | |
| <p>Waste Managers and Providers</p> | |
| <p>End Users and Validators</p> | |
| <p>Technology Providers and Manufacturers</p> | |
| <p>Dissemination, Communication and Standardisation Experts</p> | |

The project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement no 820665



Our Approach



- ✓ Challenge
 - ✓ Solution
 - ✓ polynSPIRE Innovation
 - ✓ Business Plan
 - ✓ Expected Impact
-



Challenge (I)



- Plastics materials (e.g. PE, PP, and PET) are mainly produced from raw materials of fossil origin, and are used in a wide range of applications, thus creating a huge amount of plastic waste
- In 2016 over 27 MT of plastic waste was collected for further treatment
- Although the recycling efforts in the EU improved, landfill is still the first or second option of treatment for post-consumer plastic waste in most Member States

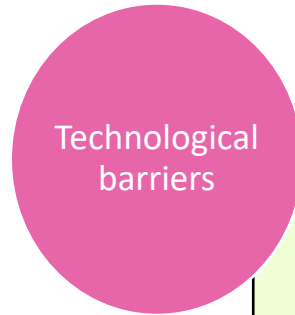


Challenge (II)

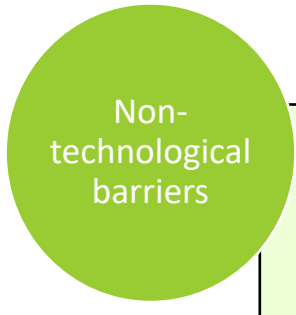


- There are different technological and non-technological barriers for plastic waste recycling

- **Recycling and redesigning the plastics value chain are essential in reusing plastic waste material and avoiding landfill**



| |
|---|
| The existing sorting and waste management systems not able to separate plastics blends and composites |
| The lack of efficient and flexible valorisation technologies |
| The heterogeneity of plastic difficult the mechanical recycling of these plastic materials |



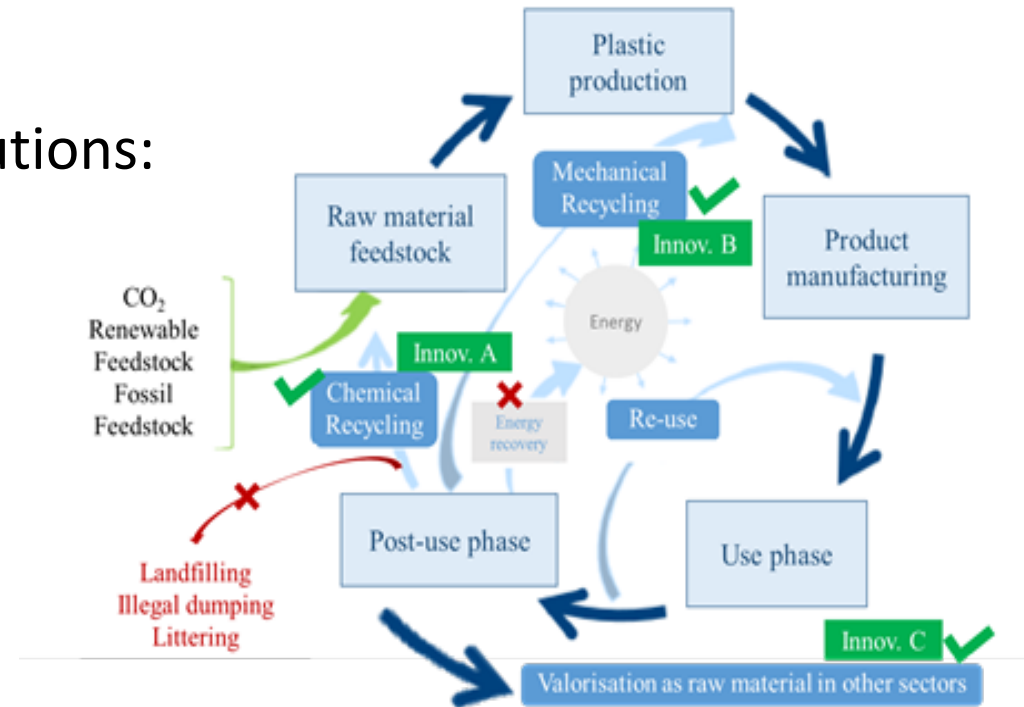
| |
|--|
| Plastic waste is generated at different points of the value chain |
| Existing standards are not homogeneous along Europe (e.g. Waste Directive and End of Waste Criteria) |



Our Solution (I)



- A cost-effective transformation of plastic waste into raw materials through its recycling and valorisation
- polynSPIRE contains three innovative solutions:
 - Chemical recycling (Innovation A)
 - Mechanical recycling (Innovation B)
 - Valorisation (Innovation C)



Our Solution (II)



- Comparing the different approaches will reveal best technical, environmental and economic fit for the different materials depending on waste source (post-industrial or post-consumer), composition, contaminants or other relevant parameters
- The economic and environmental benefits of the approaches will be analysed by carrying out Life Cycle Assessment (LCA) and Life Cycle Cost (LCC) to recycling/valorisation process of the different materials



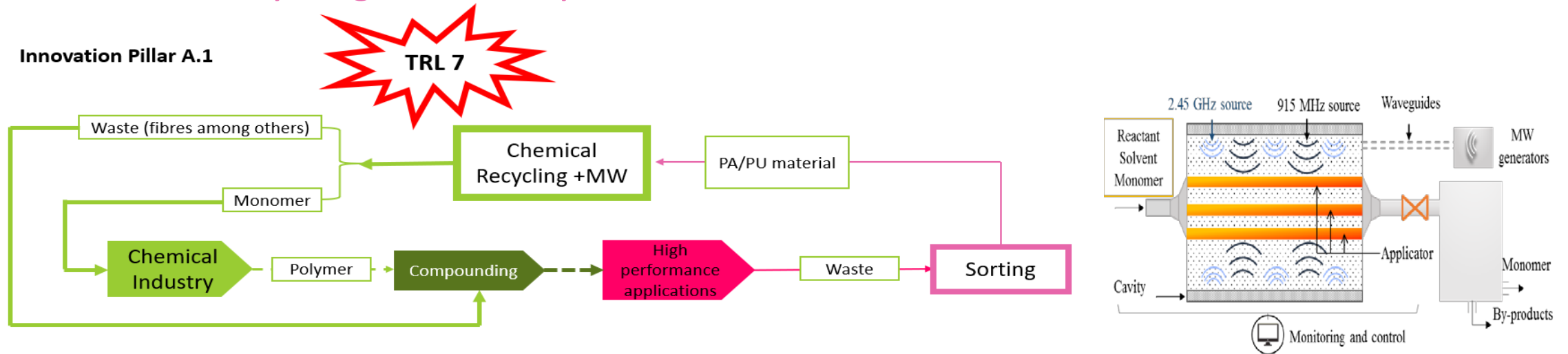
Chemical Recycling (Innovation A)



- the process leading in total depolymerisation of the plastic material to obtain their monomers (raw materials for polymer production)

Two approaches will be analyzed:

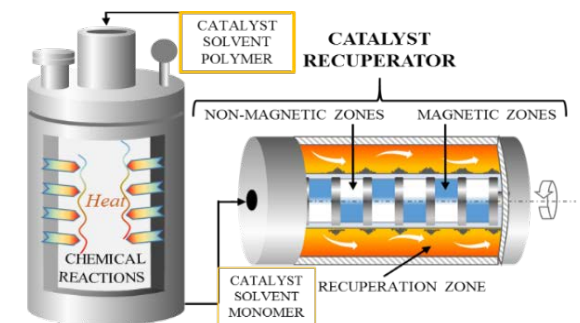
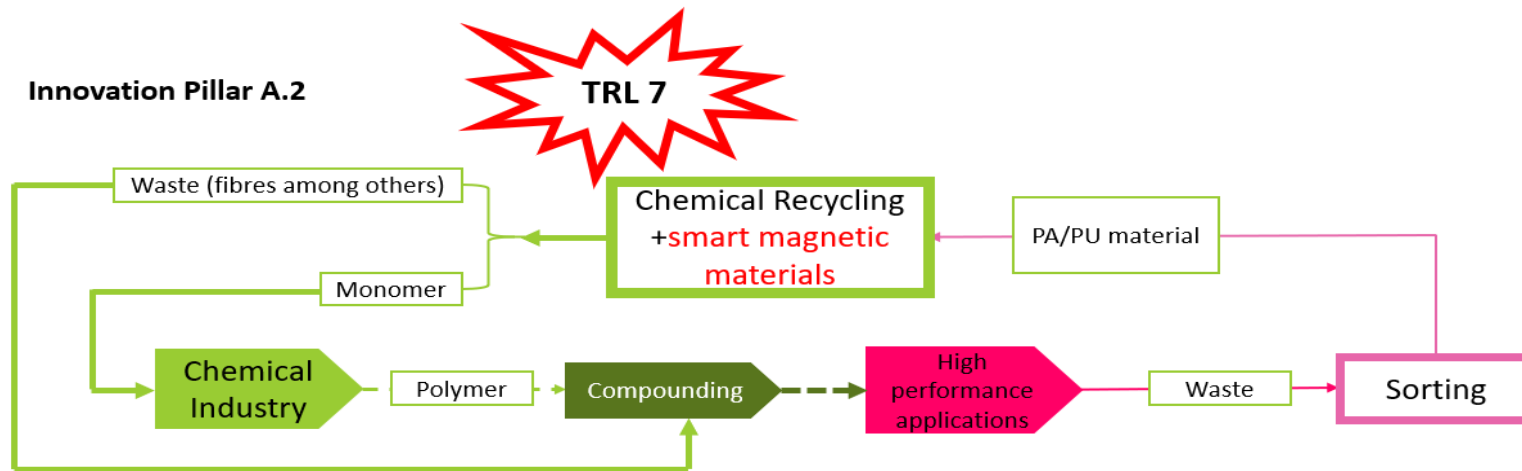
1. Chemical recycling assisted by microwaves



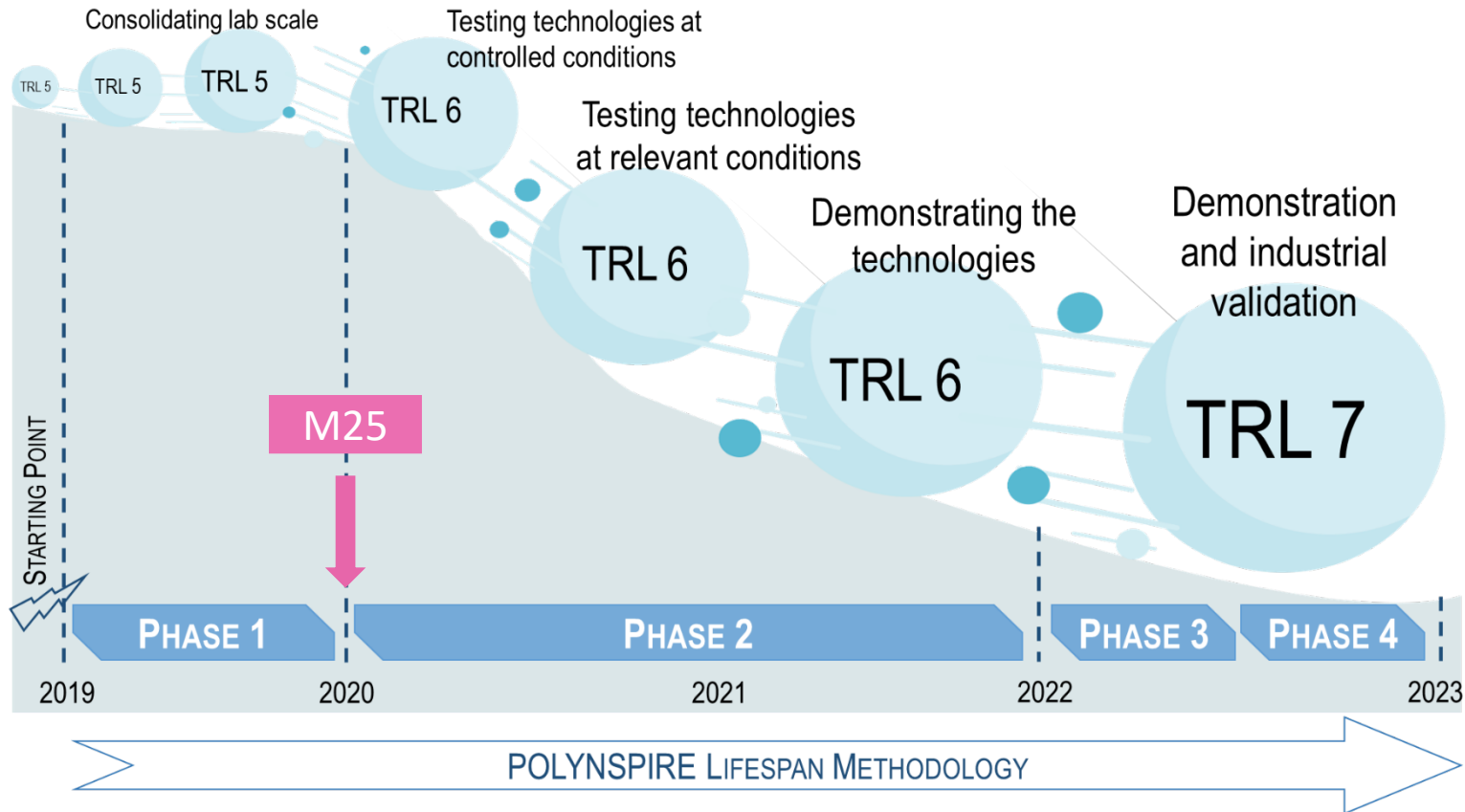
Chemical Recycling (Innovation A) cont.



2. Chemical Recycling assisted by Smart Magnetic Materials



Status quo of the project



Open questions:

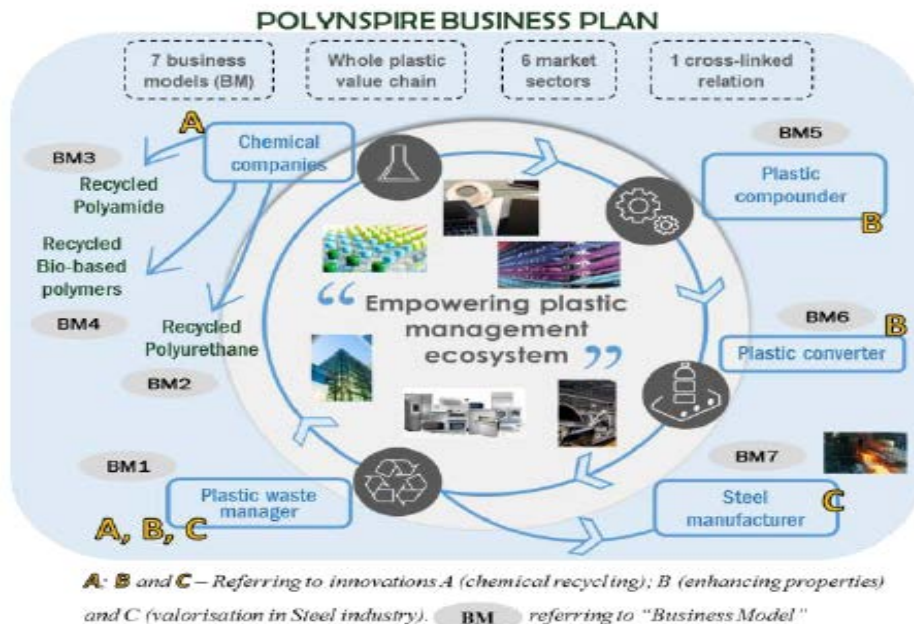
- Requirements
- Health and Safety issues
- Connection between chemistry and physics
- Scalability and optimisation
- Cost vs scale



Business Plan



- polynSPIRE will create a database by mapping the distribution of plastic wastes across Europe, with a focus on Polyamide (PA), Polyurethane (PU) wastes and their mixture with other plastics such as Polyolefins (e.g. PE or PP).
- polynSPIRE will also develop a guideline for the overcoming of potential legislative barriers



Six market sectors will benefit:

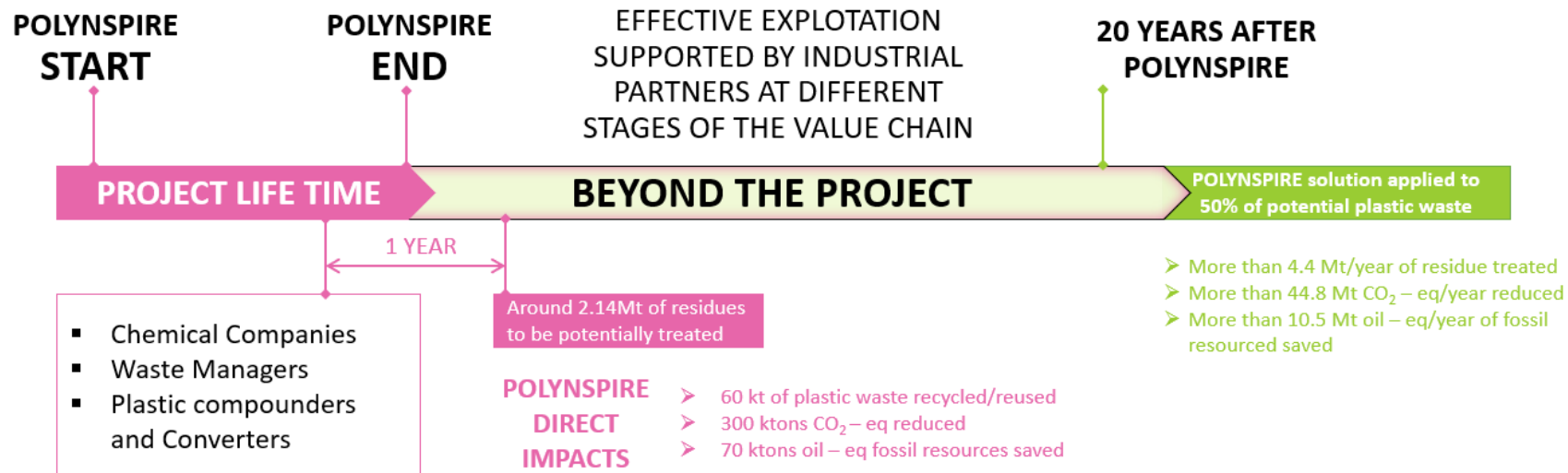
- Automotive
- Appliance
- Electronics
- Constructions
- Packaging
- Textile



Expected Impact



The project will address 100% waste containing streams ensuring the recycling of **at least a 50% of total plastics containing PA and PU leading to a reduction of CO₂ equivalent emissions between 30% and 40%.**



Thank you for your attention

www.polynspire.eu

info@polynspire.eu // nrgarcia@fcirce.es // fcirce@fcirce.es