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Pilot action on Industrial Symbiosis in the Municipality of Chihuahua



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Executive summary

The "Pilot action on industrial symbiosis in the municipality of Chihuahua" started in July 2021 and ended in February 2022. During 7 months the project has served as a pilot action on how to start applying the EU experience in "industrial symbiosis" to the municipality of Chihuahua by identifying those business opportunities between companies through wasted resources (waste from certain companies as resources for others).



The project developed through 3 main work packages:

WP1. Discovering the potential of industrial symbiosis in Chihuahua's ecosystem: What waste is generated with recycling opportunities? Which companies are linked? What technologies are needed?

WP2. Calculate the impacts that the implementation of the identified opportunities would have on the companies and on the territory: How much waste is recovered? How much money is saved/generated? How much CO2 emissions are avoided?

WP3. Design the action plan of the identified synergies and opportunities: methodology and steps to follow for the industrial symbiosis pilot in Chihuahua.

The final **objective** is to help Chihuahuan industries move towards a more efficient and resilient production and consumption model capable of generating value thanks to continuous and regenerative cycles taking into consideration, when needed, the greater territory with the participation of industries of Delicias, Cuauhtémoc, Querétaro and other cities of the State of Chihuahua.

The project was developed in cooperation with the business association COPARMEX, who provided technical staff dedicated to the project as well as communication and dissemination resources (Facilitators team) and who created and led the Steering Committee where most of the relevant stakeholder in the territory collaborate in the project through bimonthly meetings.

Chihuahua Green City is the name the Steering Committee gives to the industrial symbiosis project. Chihuahua Green city was publicly presented in a press conference in October the 10th 2021 with the presence of the EU Ambassador in Mexico, Mr. Gautier Mignot, the Mayor of Chihuahua, Mr. Marco Bonilla and the Secretary of Innovation and economic development of the State of Chihuahua, Mrs. Angelica Granados, among others. It has a specific website and active social media participation which has raised the interest of many companies and related institutions which facilitates a lot the work with company engagement when working in the implementation of the identified synergies.





Main results and conclusions

WP1. Discovering the potential

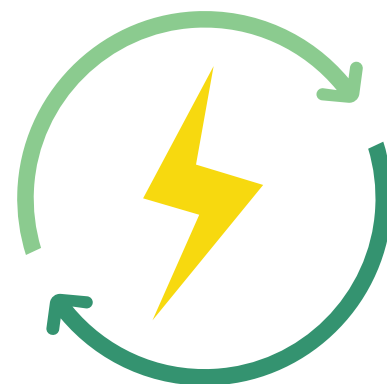


First step to discover the potential of the industrial symbiosis is to map companies and resources. According to the DENUE (National Statistic Directory for Economic Units) there are 38,000 companies based in the municipality of Chihuahua but 90% of them have less than 10 employees. Not all the activities have a role in an industrial symbiosis project; only companies related to agriculture, mining, energy & water supply, construction, manufacturing, wholesales trade, transport & storage, waste management, restaurants & hotels are considered part of the industrial ecosystem. Considering only these activities the industrial ecosystem is composed only by 10,496 companies, 8,704 of them micro (<10 employees), 1,369 small (11-50 employees), 277 medium (50 -250 employees) and 146 big (>251 employees). According to activities related to industrial symbiosis, size of the companies and available data, **the industrial ecosystem of the Chihuahua pilot project includes 230 companies** listed in Annex 1.

Publicly available data was not enough to map de resources flow and information was gathered through interviews with companies and questionnaires. **More than 70 companies were interviewed and now 46 actively participate in the identified synergies.**

Among these interviews and questionnaires answers, **80 opportunities were identified, grouped in 8 strategies, 5 of them pointed as priority** by the Steering Committee according to potential economic impact, potential environmental benefits, potential social benefits, strategical importance for Chihuahua and difficulty to be implemented:

1. Plastic valorization.
2. Reclaimed water reuse.
3. Biowaste valorization (bioenergy).
4. Renewable energy & energy symbiosis.
5. Tires recycling.





WP2. Calculating impacts



2.1 Plastics valorization

The Problem

The powerful maquiladora industry in Chihuahua is a great consumer of plastics for packaging and, therefore, a great generator of this type of waste: bags, film, strapping, etc. Distribution and commercial malls are also great generators of this type of waste. The dispersion in their generation (many points with few amounts each), the heterogeneity of materials (mixtures of plastics) and the low density (expensive transport) mean that these materials are not recovered; Chihuahua companies pay to dispose of materials that:

- a) can be recovered and
- b) have to be bought again.

The Opportunity

Valorization of plastic packaging waste into pellets (recycled) to be reintroduced into the market, ideally again in the form of bags or packaging materials. There is no bags/strip manufacturer in Chihuahua and its industry is a big consumer, which could justify attracting the investment of a new plant producing recycled plastic pellets and/or recycled plastic packaging materials.

The Quantification

All the companies generate plastic waste, but among them 89 companies are presumed to be outstanding and generating 1,000 T/year of packaging plastic waste → there are 1,000 T/year of waste avoided to landfilling saving 667.5 T CO₂/year of GHG emissions, and \$16,528,000/year (719,234€/year) of waste management cost.

A new plant for industrial plastic recycling could provide up to \$1,034,000,000 investment attraction and 200 employees. If recyclable municipal waste plastic is added there is an addition flow of 5,000 T/year → **total waste plastic available for recycling = 6,000 T/year.**

Post Industrial	Post Consume (RSU)	Total
1,000 T/year	700 T/day = 255,500 T/year 9,82% plastics → 25,000 T/year 20% recyclable → 5,000 T/year	6,000 T/year



WP2. Calculating impacts

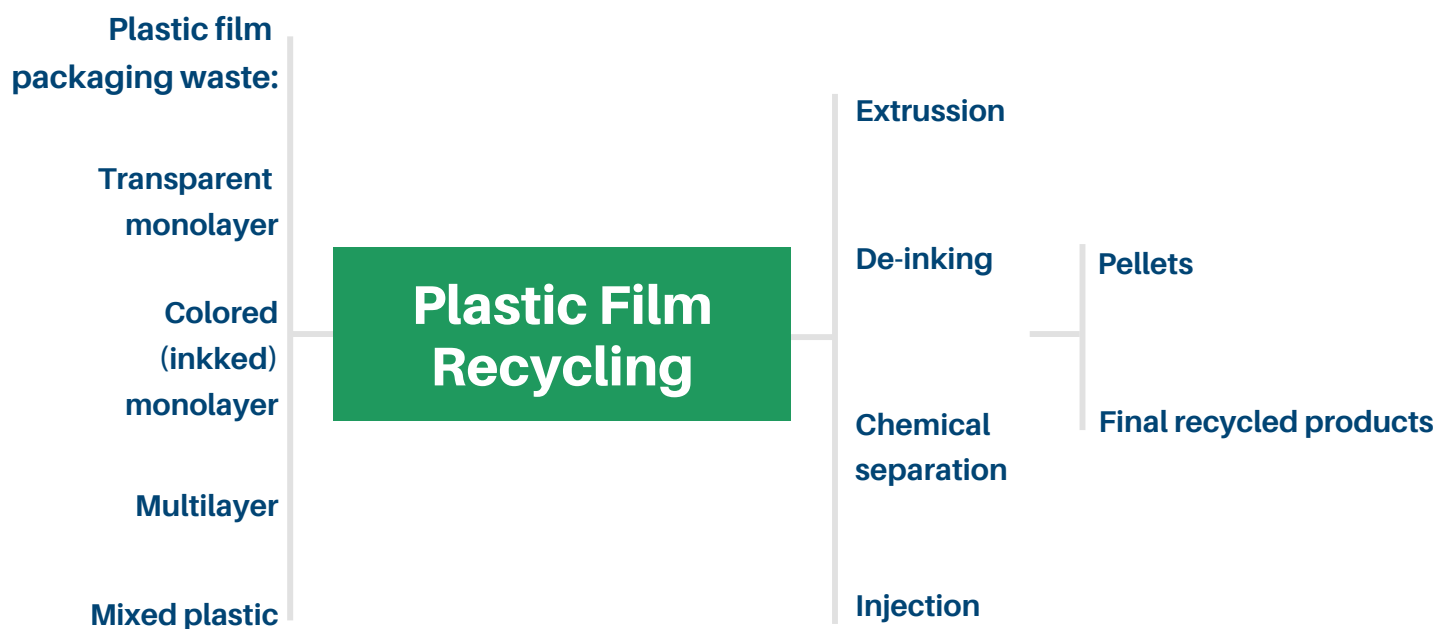
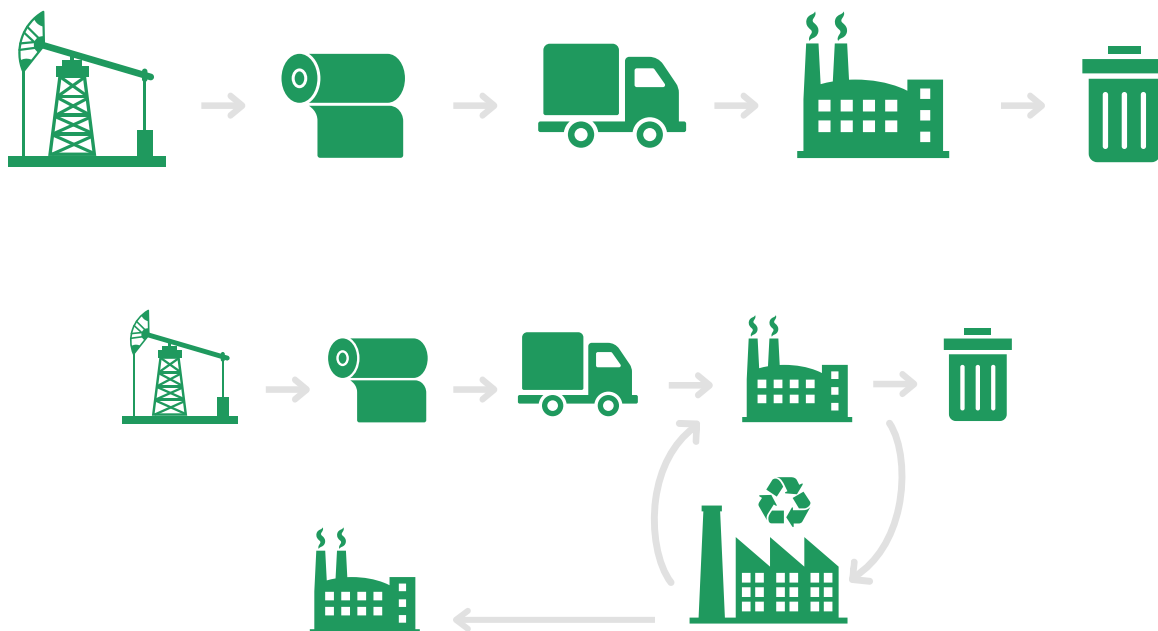


Figure 13 Current situation of plastic packaging material vs Opportunity





WP2. Calculating impacts



2.2. Reuse of reclaimed water

The Problem

In a territory with a shortage of drinking water, efficiency in the use of the water is a necessity. Chihuahua's industry includes processes that are large consumers of water; and not all of them require potable drinking water.

The Opportunity

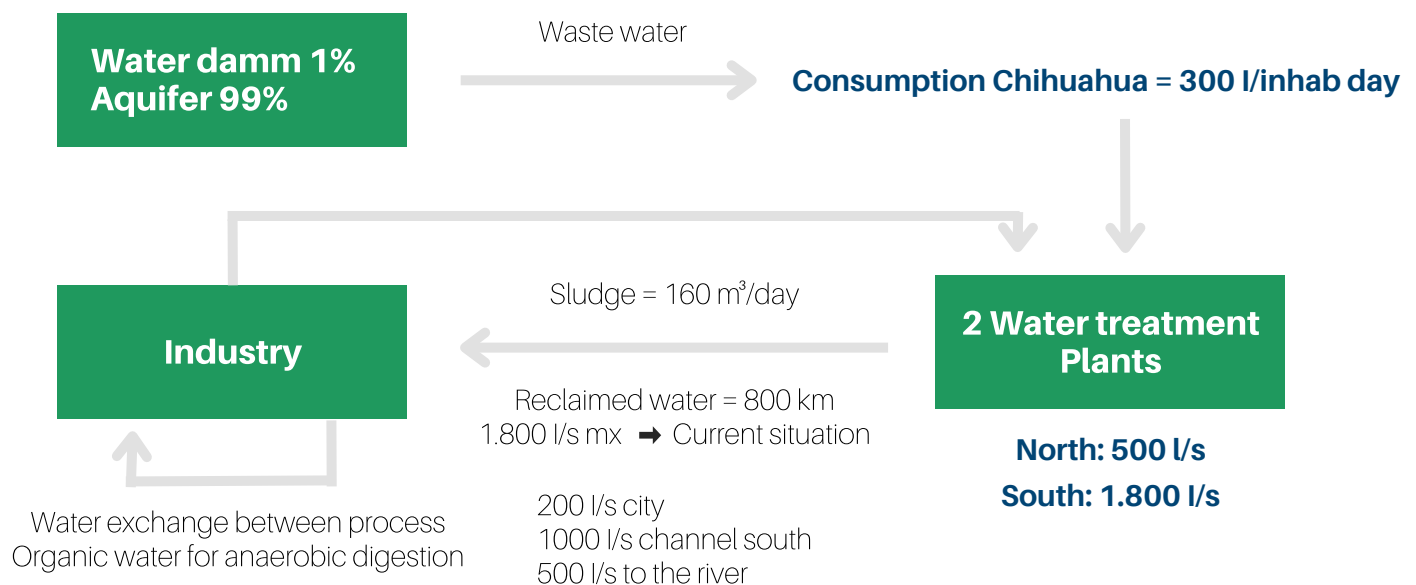
Identifying processes where reclaimed water from sewage treatment plants could potentially be used in industrial processes, would reduce the pressure on the consumption of drinking water in the territory (strengthen the purple line network).

The need for specific treatments to adapt qualities, the intelligent monitoring and management of distribution networks, are also business opportunities.

The Quantification

In the Chihuahua's industrial ecosystem there are 40 companies high consuming water and generating 400,000 m³ /year waste water potentially reusable in applications such as water for construction, for road basis and sub-basis, anti-dust irrigation, street cleaning, car-truck wash tunnel, toilets flushing, anaerobic digestion process. The waste water of 6 of the interviewed companies can provide 6% of the reclaimed municipal water currently used! The use of only this industrial unused water could decrease 1,6% the lack of water in the territory. Taking the municipal reclaimed water rates, there is \$9,3/m³ savings.

Figure 15 Conceptual diagram of the water usage and its potential.



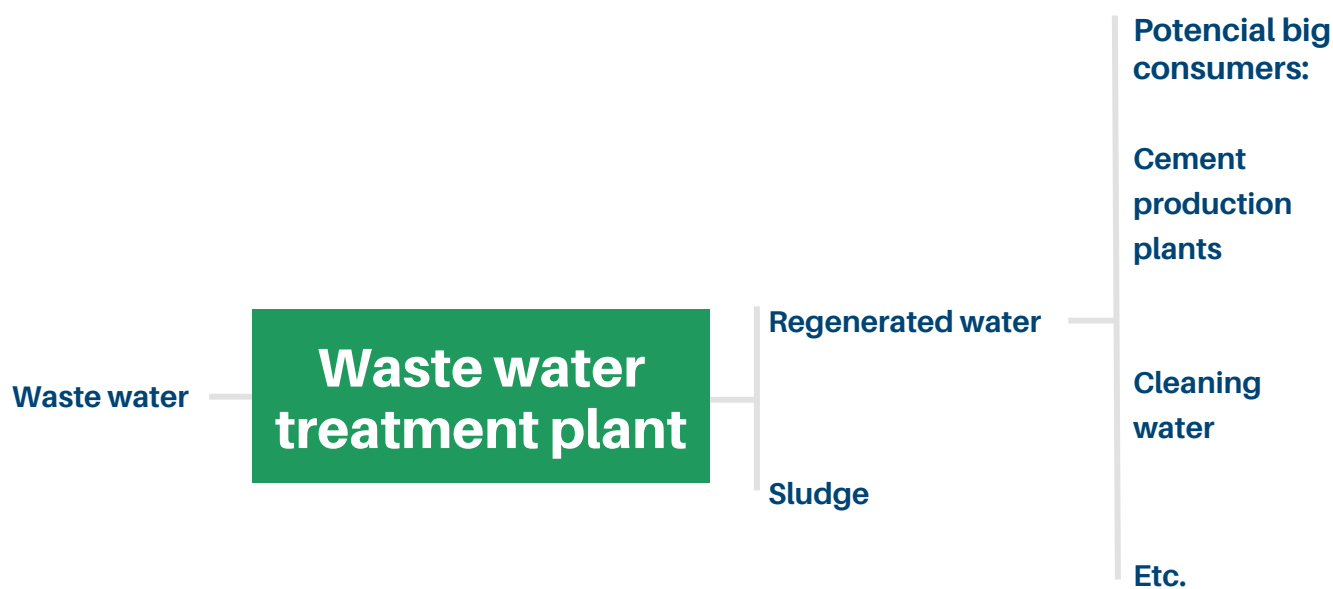


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WP2. Calculating impacts



2.2. Reuse of reclaimed water





WP2. Calculating impacts



2.3. Biowaste valorization (BIOENERGY)

The Problem

Biowaste is one of the biggest fractions of waste, of the most troublesome because of its easy degradability, and one of the easiest to valorize. Biowaste is produced in households but also in food industry, pharmaceutical industry, in canteens of big factories, in waste managers... It is usually mixed up with other fractions of waste (potentially valorized such as plastics or paper) and dumped into landfilling or composted in the best scenarios.

There are more valued ways to take profit of all the value of the organic waste: extracting materials or excipients and making energy.

Energy can be generated from biowaste through combustion of biomass or through anaerobic digestion (AD) of biodegradable materials.

The Opportunity

Transforming biodegradable waste (now dumped into landfilling) into biogas to reduce the high dependency of natural gas in the municipality and contribute towards decarbonizing the industry, while producing bio products.

Transforming organic waste management into "biorefineries" (A biorefinery is a facility (or network of facilities) that integrates biomass conversion processes and equipment to produce transportation biofuels, power, and chemicals from biomass. This concept is analogous to today's petroleum refinery, which produces multiple fuels and products from petroleum.

The Quantification

Chihuahua's industries and municipality is generating 253,600 T/year of biodegradable waste that generate 50,720,000 m³ biogas/year through anaerobic digestion that could provide 6% of all the natural gas consumed by industrial processes, saving 59% of CO₂ emissions compared to landfilling. Managing organic waste to produce biogas could save 50% costs compared to business as usual and provide 365 million \$/year (15,8 M€/year) of additional revenues by selling energy and 50 direct employees.



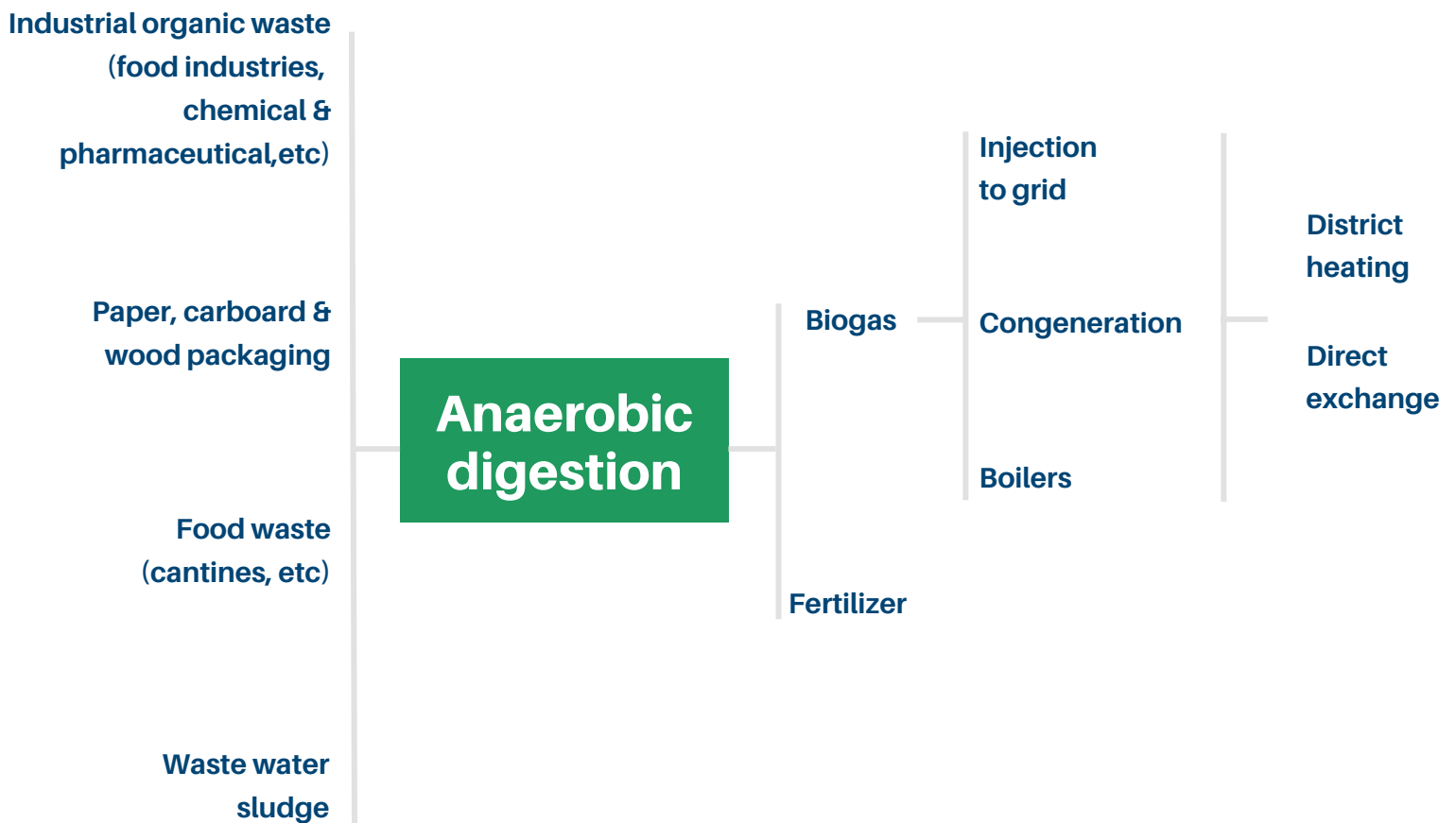


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WP2. Calculating impacts



2.3. Biowaste valorization (BIOENERGY)





WP2. Calculating impacts



2.4. Renewable energy & energy symbiosis

The Problem

Chihuahuan companies are very dependent on fossil energy and there is a need in helping them to keep them competitive while reducing levels of carbon emissions through renewable energy generation, energy efficiency improvement and energy symbiosis (district heating and cooling DHC).

The Opportunity

Analyzing sustainable and local energy resources for industry, there are three main opportunities for decarbonize energy in Chihuahua:

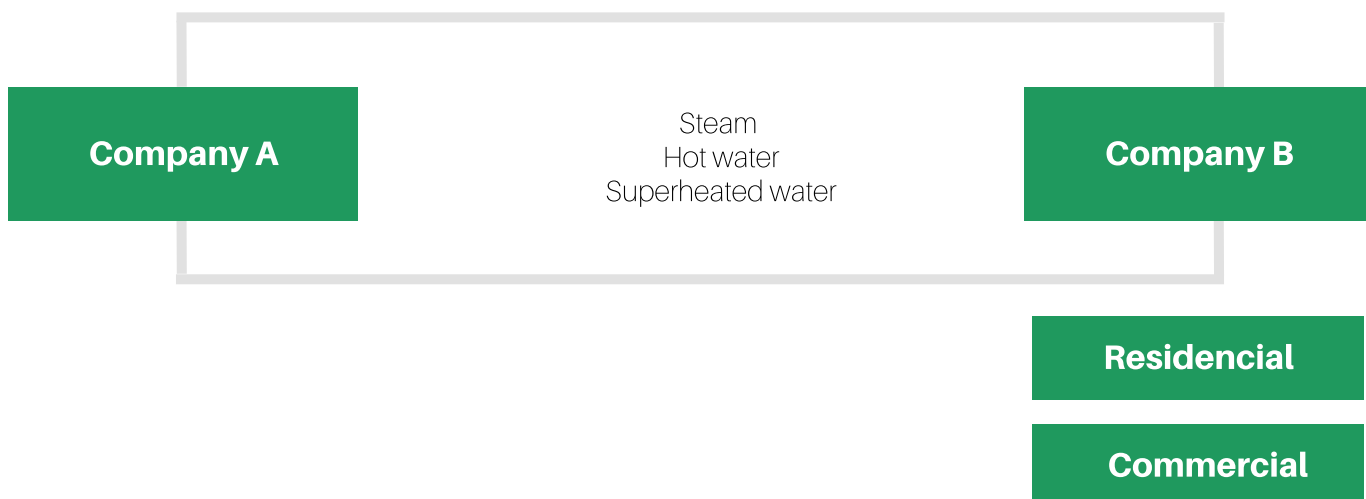
1. **Generating solar photovoltaic energy (PV).**
2. **Surplus heat exchange between companies.**
3. **Using waste as energy provider.**

The Quantification

The estimated 3,300,000 m² of industrial plants roofs available for photovoltaic generation could generate 1,333 GWh energy which could cover 18% of industrial consumption contributing to a 4,5% reduction of the total GHG emissions in current electricity generation.

An investment of 1,130 M€ (25930 M\$) could save \$1,343,664,000/year (58 M €/year) industry's energy bills.

The thermal wasted energy identified in industrial processes are concentrated in 4 companies, three of them in the "Complejo Industrial Chihuahua" park with high potential for a District Heating and Cooling network.





WP2. Calculating impacts



2.5. Tires recycling

The Problem

The use of road transport (goods and passengers) in Chihuahua is very high.

Waste derived from vehicle maintenance is therefore also presumed high (tires, motor oils, etc.). The territory's powerful mining industry also generates large amounts of tires (and large ones) along with other similar waste (conveyor belts).

Its management in landfills has serious environmental impacts as well as destabilizes their structure, occupying an enormous space.

The Opportunity

Transform waste tires into materials and energy. Materials such as rubber pellets are used to manufacture tiles for sports areas and children's playgrounds and anti-vibration elements, among others.

Technologies such as pyrolysis could provide power to cement factories using a local fuel (energy independence).

The Quantification

Industrial and passenger vehicles in Chihuahua generate 25,000 T/year of very dispersed waste tires, 5,000 T/year of which could be recycled and 20,000 T/year pirolized to provide energy to a local cement company.

Valorization of 25,000 T/year of waste tires avoids 109 MT CO₂/year emissions, 2,925 M liters water used and 35 M liters fuel, saving \$150,000,000 /year in waste management.

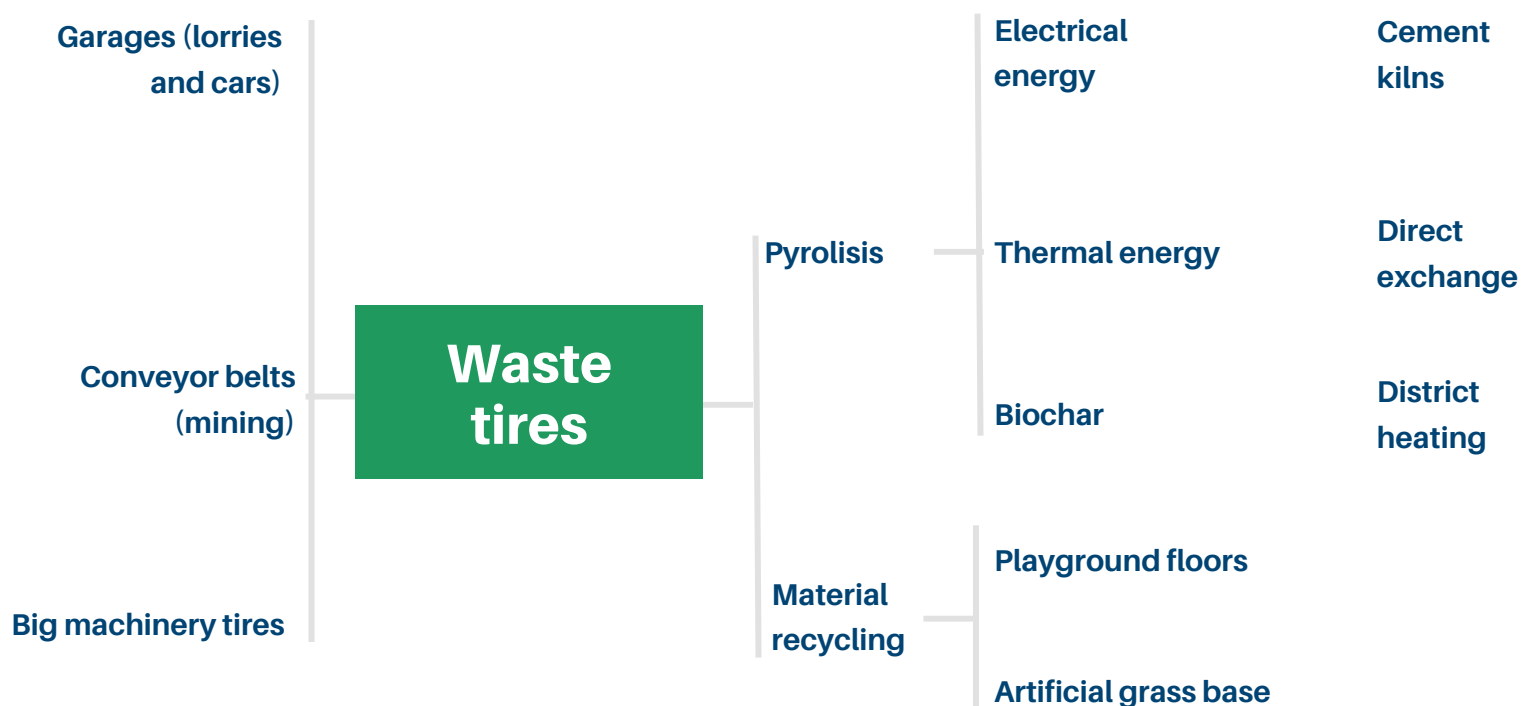




WP2. Calculating impacts



2.5. Tires recycling





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WP3. ACTION PLAN



During the pilot project interesting opportunities have been identified, opportunities that have arisen much interest from industries and other stakeholders. It is necessary for the continuity of the project, to make some of those opportunities happen; it is necessary to demonstrate with results that the industrial symbiosis project has come to stay since it is a provider of positive impacts in the region development.

The action plan includes actions to be developed in all the identified opportunities with special dedication to two synergies that have more potential due to the express interest of involved companies and benefits for the territory:

- 1. The use of heat between the companies of the Complejo Industrial Norte.**
- 2. Management of end-of-life tires for use as alternative fuel in the cement kilns of a cement manufacturer.**

Governance is key in the implementation of synergies and is also designed in the action plan.





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