Challenge 1. Increasing the share of bio-based polymers as alternatives of synthetic plastics in production of eco-packaging materials with focus on biodegradable polystyrene.

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PACKALL

Metodology

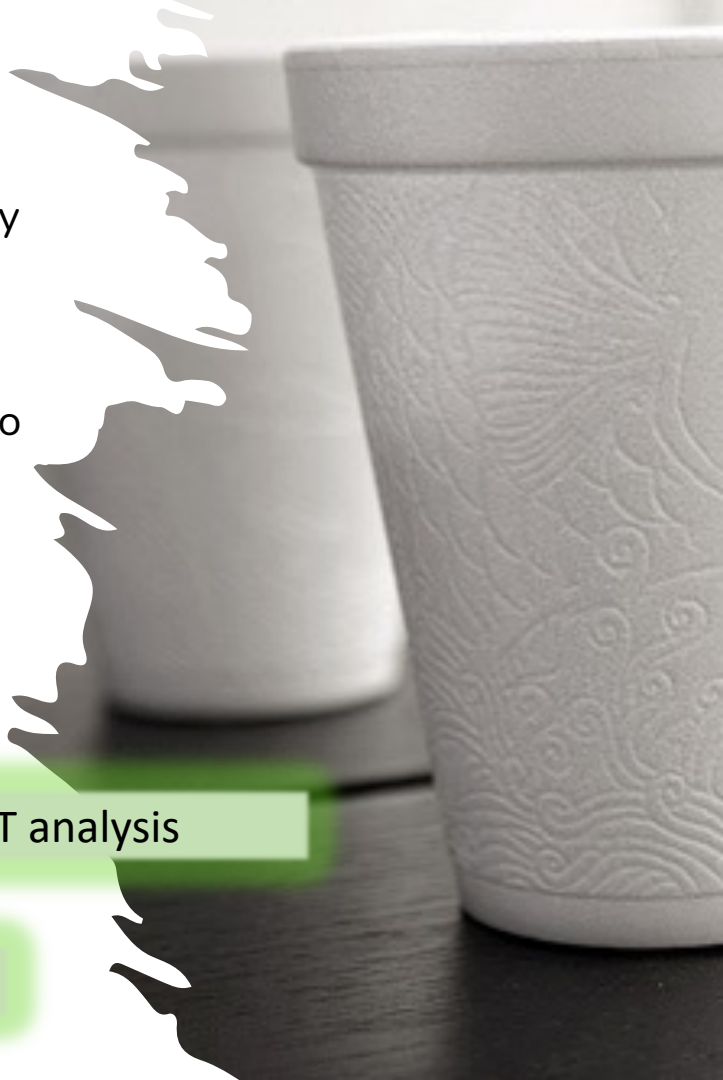
- The increase in demand for bio-based products is driven by a number of factors, including, of course, the 'green trend'. Consumers, however, are reluctant to give up their old habits.
- Disposable cups were selected as the research topic due to their **enormous** use around the world. Drinking containers are manufactured from a wide variety of raw materials, including **polystyrene**.
- Currently - no biodegradable polystyrene in the market
- => we focused on selecting the best alternative among the existing biopolymers.

Brainstorm

SWOT analysis

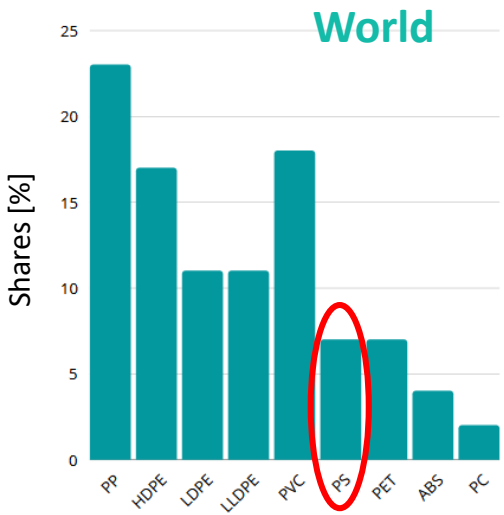
Literature review

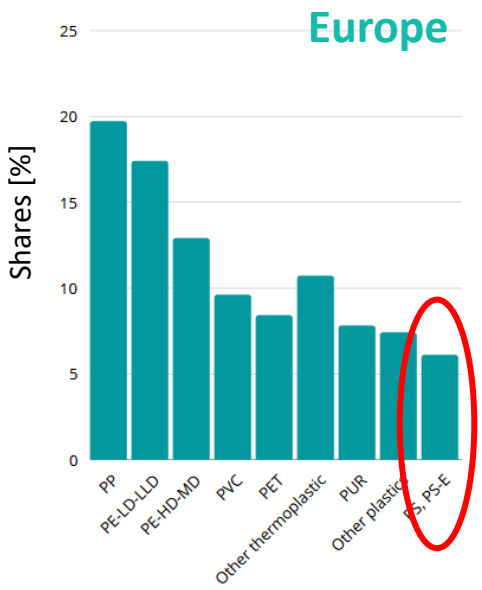
Product mapping

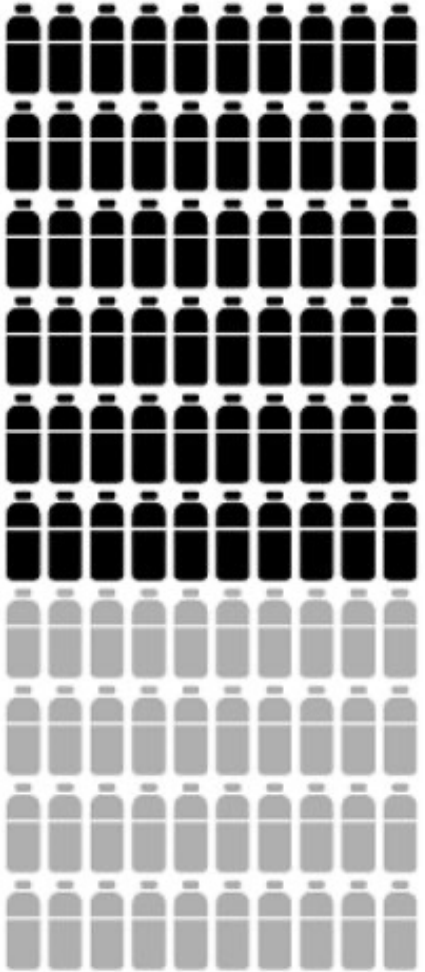


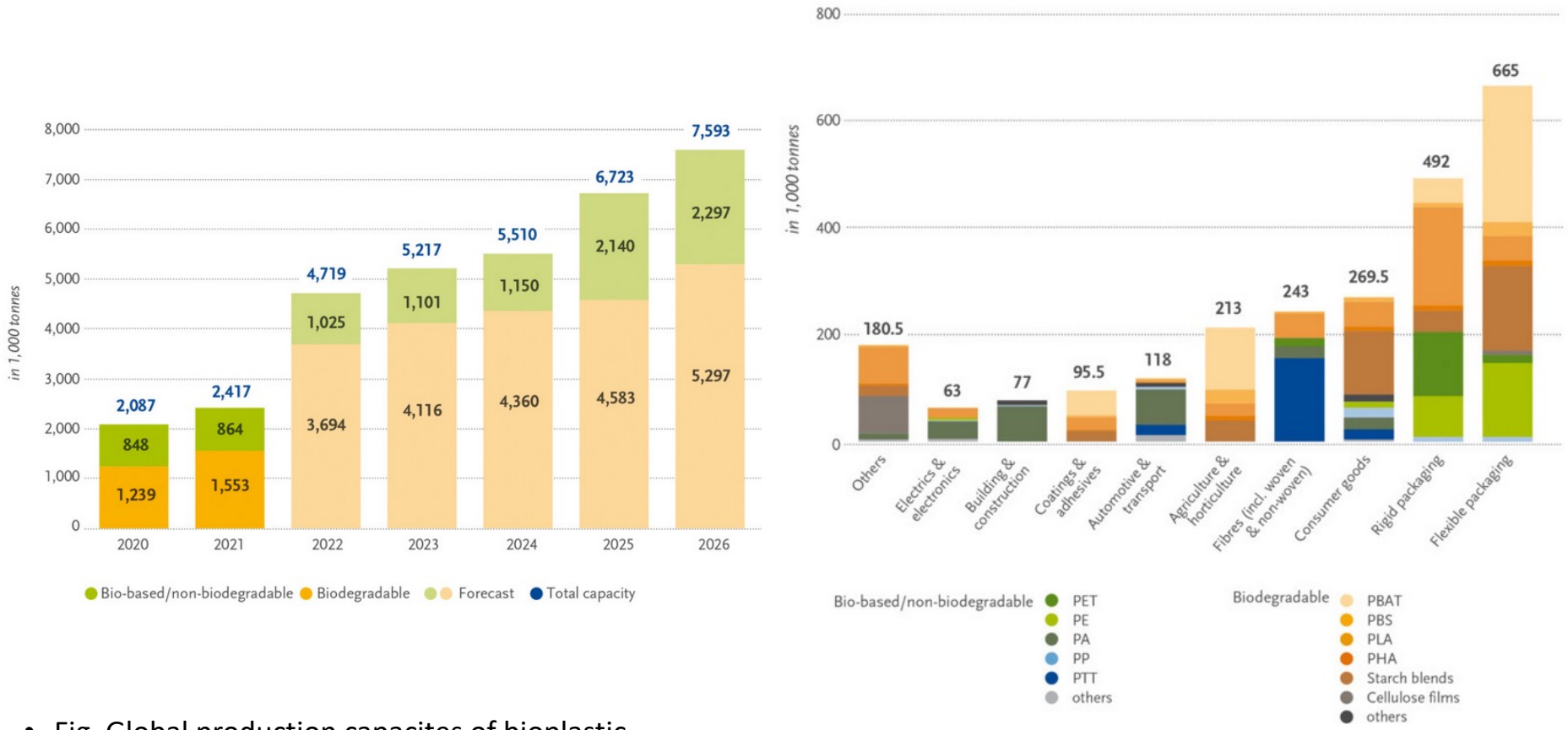
In Europe, plastic packaging constitutes 60% of the total generated plastic waste

The key polymers most commonly applied in plastic packaging:









- Fig. Global production capacites of bioplastic (based on https://www.european-bioplastics.org/market/)

Synthos. Green strategy for plastics

- GREEN RAW MATERIALSs
- GREEN PRODUCTION
- Recycled raw materials
- Sustainable design

- In the presented study, a cup for cold / hot drinks was used as a PS-based product for which we were looking for a biodegradable bioalternative polymers.
- Analysed features were polystyrene and biopolymer processing parameters

Alternative bio-plastics

Feature name	Polystyrene	MaterBi	PLA	PCL	PHB
Transparency	*Transparent /White*	*transparent*	*transparent*	*translucent*	*opaque*
Tensile strength [Mpa]	40	16 – 22	48 –60	40.4 – 42.4	35 – 40
Young's modulus [GPa]	3	0.24 – 1.5	3.35 –3.83	0.388 –0.441	3.5 – 4
Yield strength [MPa]	40	16 – 22	48 – 60	21.1 – 38.5	35 – 40
Hardness - Vickers [HV]	20	4.8 – 6.6	14 – 18*	6.32 – 11.5	11 – 13
Impact strength, notched 23 °C [kJ/m^2]	10	5.9 – 13.9	1.29 –2.59	48.6 – 55.2	0.73 – 1.87
Maximum service temperature [°C]	85	60 – 80	48 – 50*	40 – 50	60 – 80
Minimum service temperature [°C]	-20	-60 – -50	-12	-60 – - 50	-70 – -60
Thermal conductivity	0.16-0.18	0.13 – 0.23	0.12 – 0.13 *	0.17 – 0.18	0.13 – 0.23
Vicat softening point [°C]	88	~71.5	56 – 58	~40	~73
Bio-based	x	✓	✓	x	✓
Biodegradable	x	✓	✓	✓	✓

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Hot drink

Considered properties :

- Transparency
- Tensile strenght
- Maximum service temperature
- Thermal conductivity
- Biodegradability
- Recyclability

Considered polymers, in order from the best replacement:

- PHB
- MaterBi (improvement of the mechanical properties)

Polymers not meeting the required properties

- PLA
- PCL

Cold drink

Considered properties :

- Transparency
- Tensile strenght
- Biodegradability
- Recyclability

Considered polymers, in order from the best replacement:

- PLA
- MaterBi (necessary improvement of the mechanical properties)

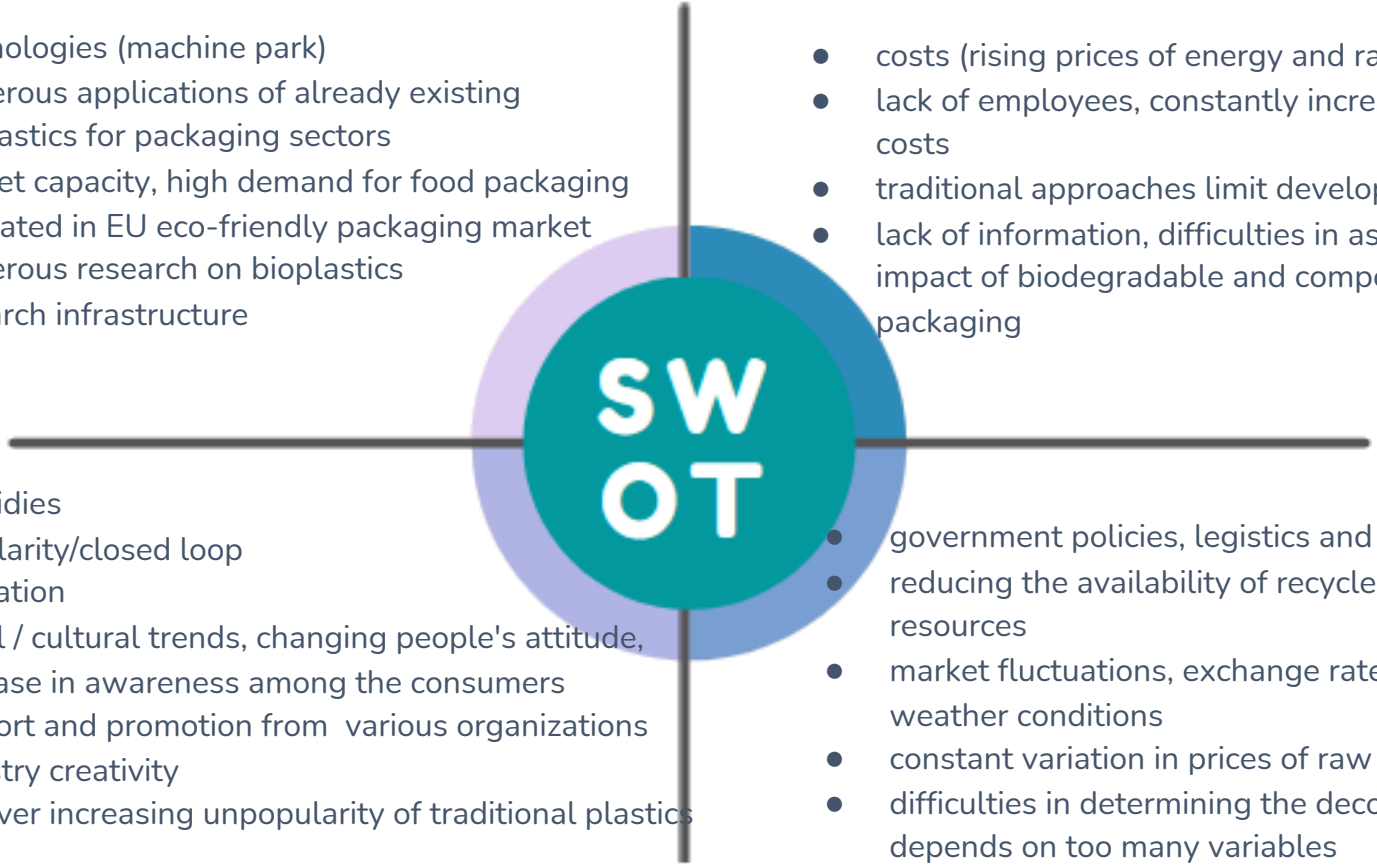
Polymers not meeting the required properties

- PHB
- PCL

47% of Polish may change their lifestyle to a more ecological one, even if it would involve sacrifices and less convenience.

- Over 50% declared that they want to introduce ecological habits regarding waste segregation,
- 45% intend to start saving water
- **35.2 % said that they want to reduce the consumption of plastic and disposable packaging**

Consumers are willing to pay an additional 10% above the market price for food if it is packed in biobased packaging.



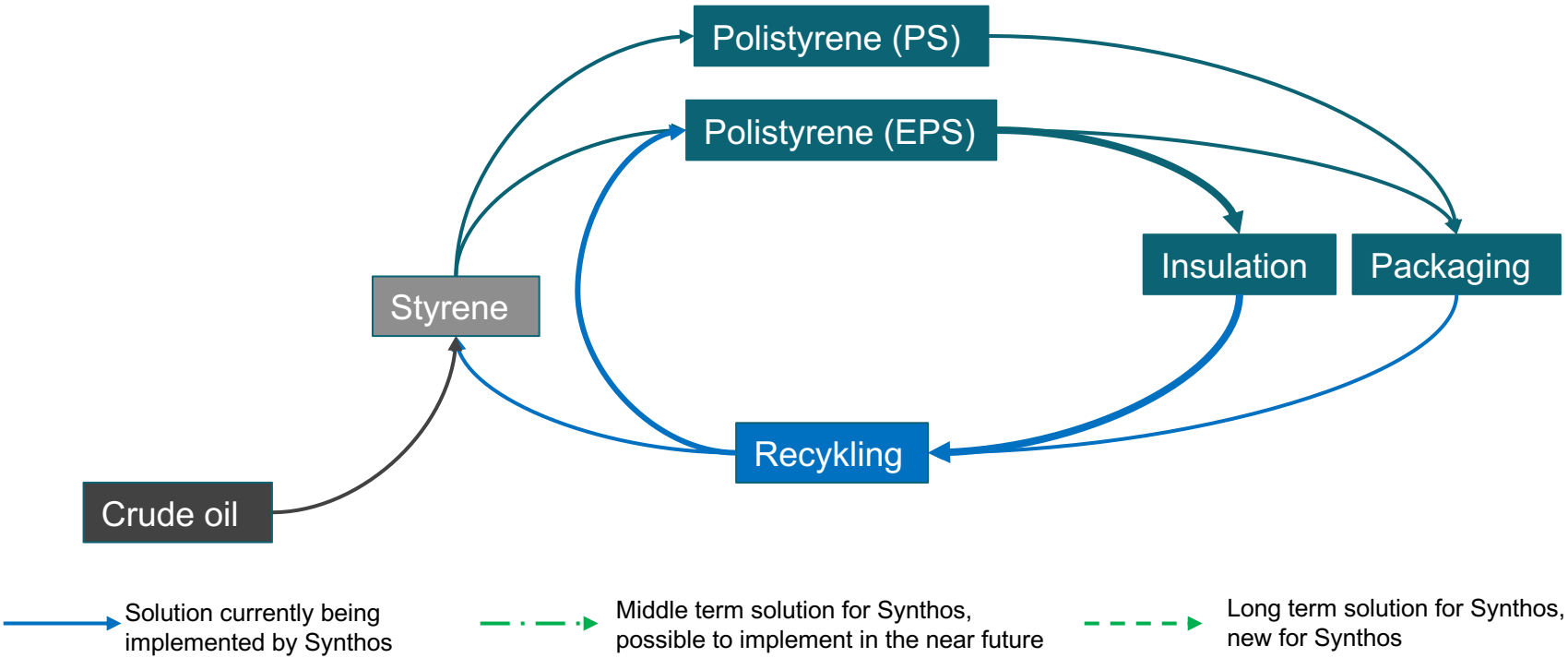
- technologies (machine park)
- numerous applications of already existing bioplastics for packaging sectors
- market capacity, high demand for food packaging
- regulated in EU eco-friendly packaging market
- numerous research on bioplastics
- research infrastructure

- costs (rising prices of energy and raw materials)
- lack of employees, constantly increasing labor costs
- traditional approaches limit development
- lack of information, difficulties in assessing the impact of biodegradable and compostable plastic packaging

- Subsidies
- Circularity/closed loop
- Education
- social / cultural trends, changing people's attitude, increase in awareness among the consumers
- support and promotion from various organizations
- industry creativity
- the ever increasing unpopularity of traditional plastics

- government policies, legistics and dispositions
- reducing the availability of recycled and renewable resources
- market fluctuations, exchange rates, currency control, weather conditions
- constant variation in prices of raw materials
- difficulties in determining the decomposition time, -> it depends on too many variables

Circular solutions for Synthos



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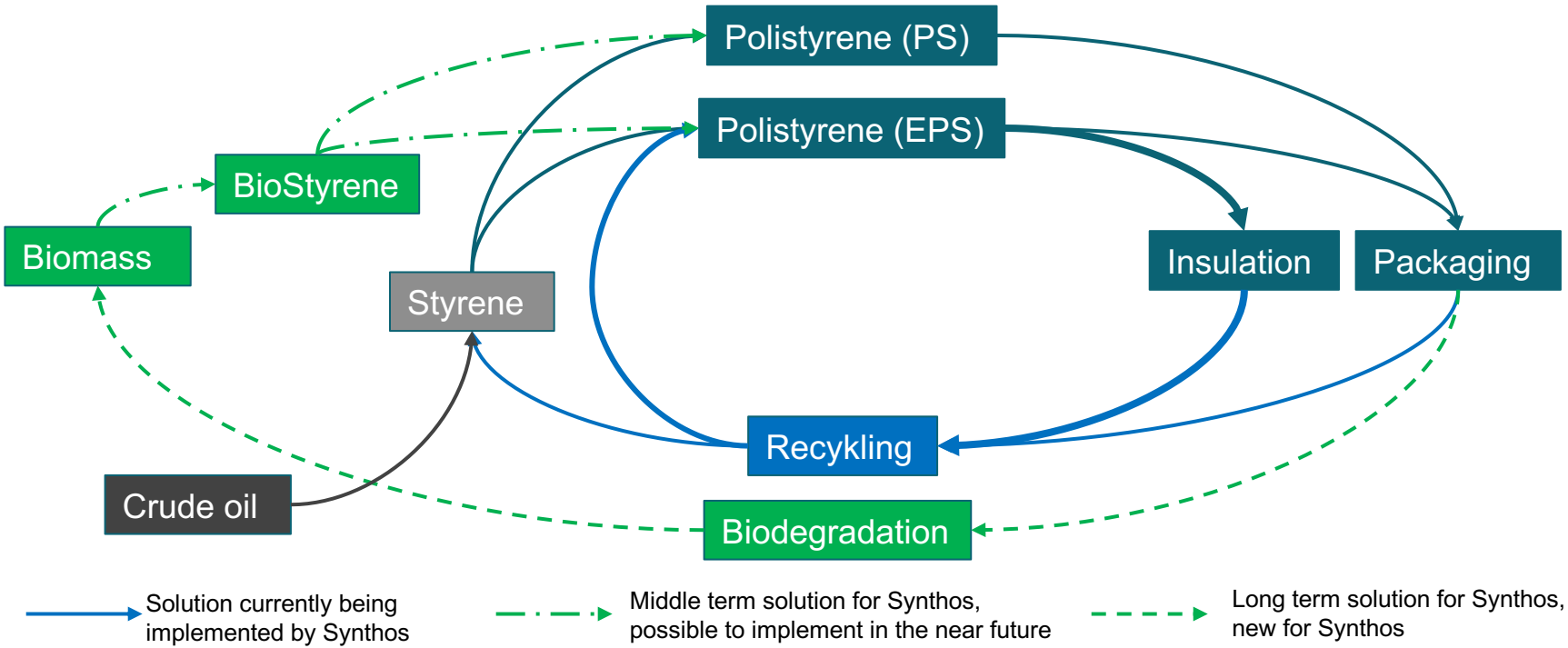

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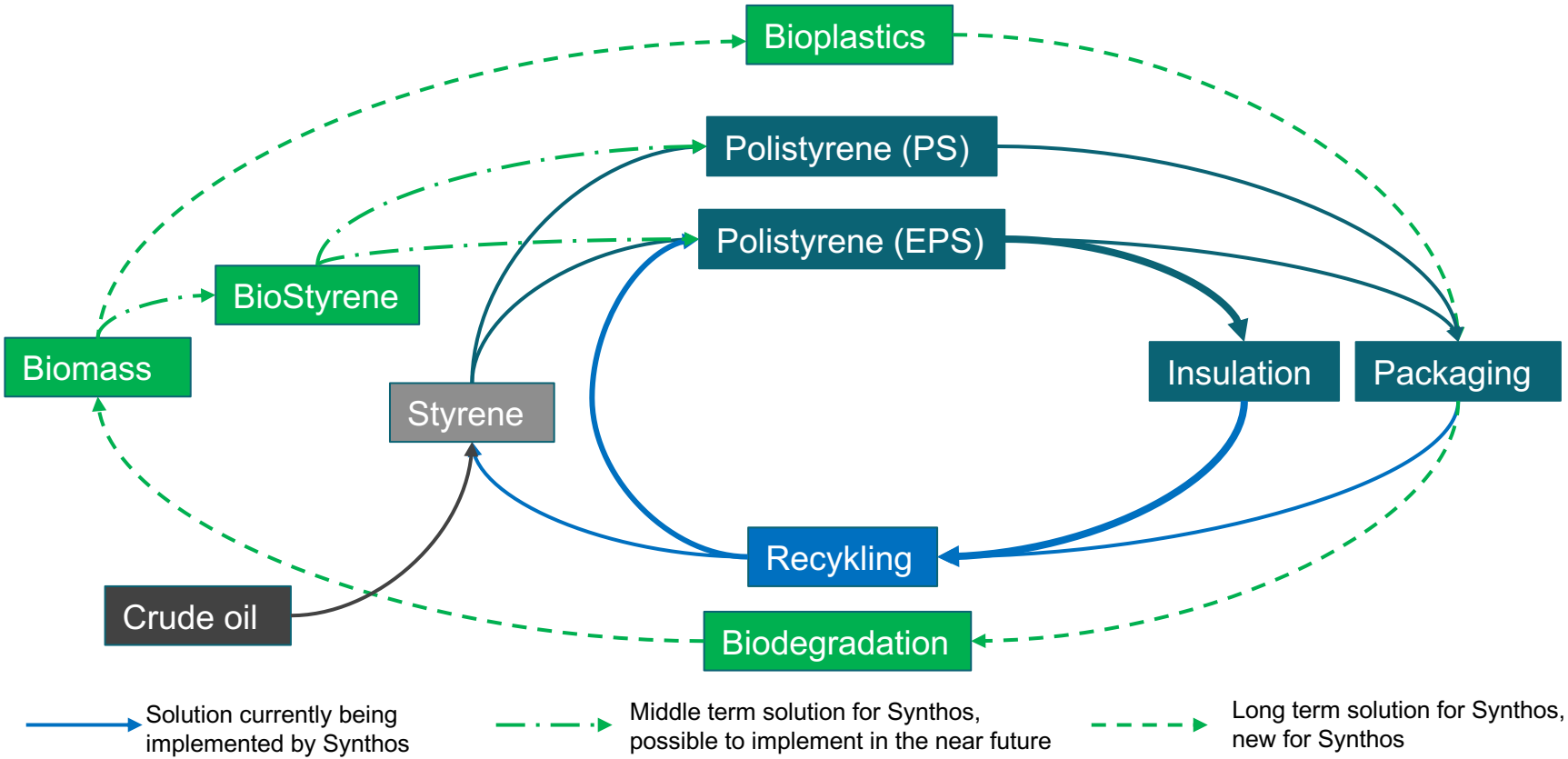

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Our team