Life cycle sustainability assessment of shopping bags available at supermarket retailers in South Africa

Prof. William Stafford,
Green Economy Solutions,
Council for Scientific and Industrial Research,
South Africa.

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The problem with plastic in South Africa

- Global plastic production increasing **4% pa, (322 million tonnes in 2015)** and accounting for 4 to 8% of global fossil fuel use
- Plastic biodegradation **slow**, physical breakdown to **microplastics**….
  ……**polluting terrestrial, aquatic and marine biota and ecosystems**
- South Africa ranked **11th in the world for mismanaged plastic waste** (est. 56% plastic waste estimated to be mismanaged and leaking into environment)
- DEA considering **ban on plastic** shopping bags and other ‘single-use’ plastics

But…

- *Is the problem with plastic, or peoples behaviour and waste management?*
- *What are the alternatives to plastic? and how do they compare ?*

Need and assessment that includes environmental, social & economic impacts of plastic bags & alternatives in order to inform decision-making

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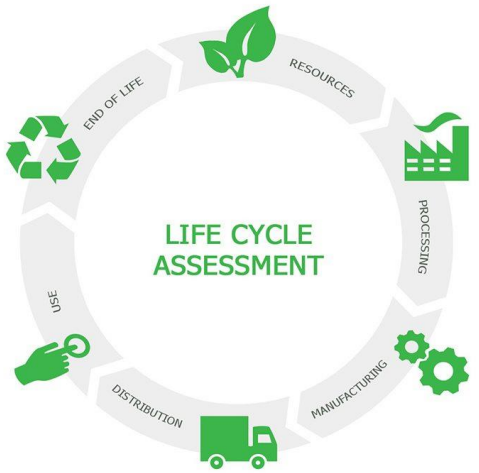
Life cycle Sustainability assessment (LCSA)

- LCA used to assess impacts of products through their life cycle: “from raw material acquisition through production, use, end-of-life treatment, recycling and final disposal ” (ISO 14040 and 14044))
- LCA is commonly used to assess environmental impacts only (eLCA)
- Product design & consumer choice should be informed by comprehensive assessment of economic, social & environmental impacts of product throughout life cycle
- **LCSA aims to combine/ integrate environment, economy, society**



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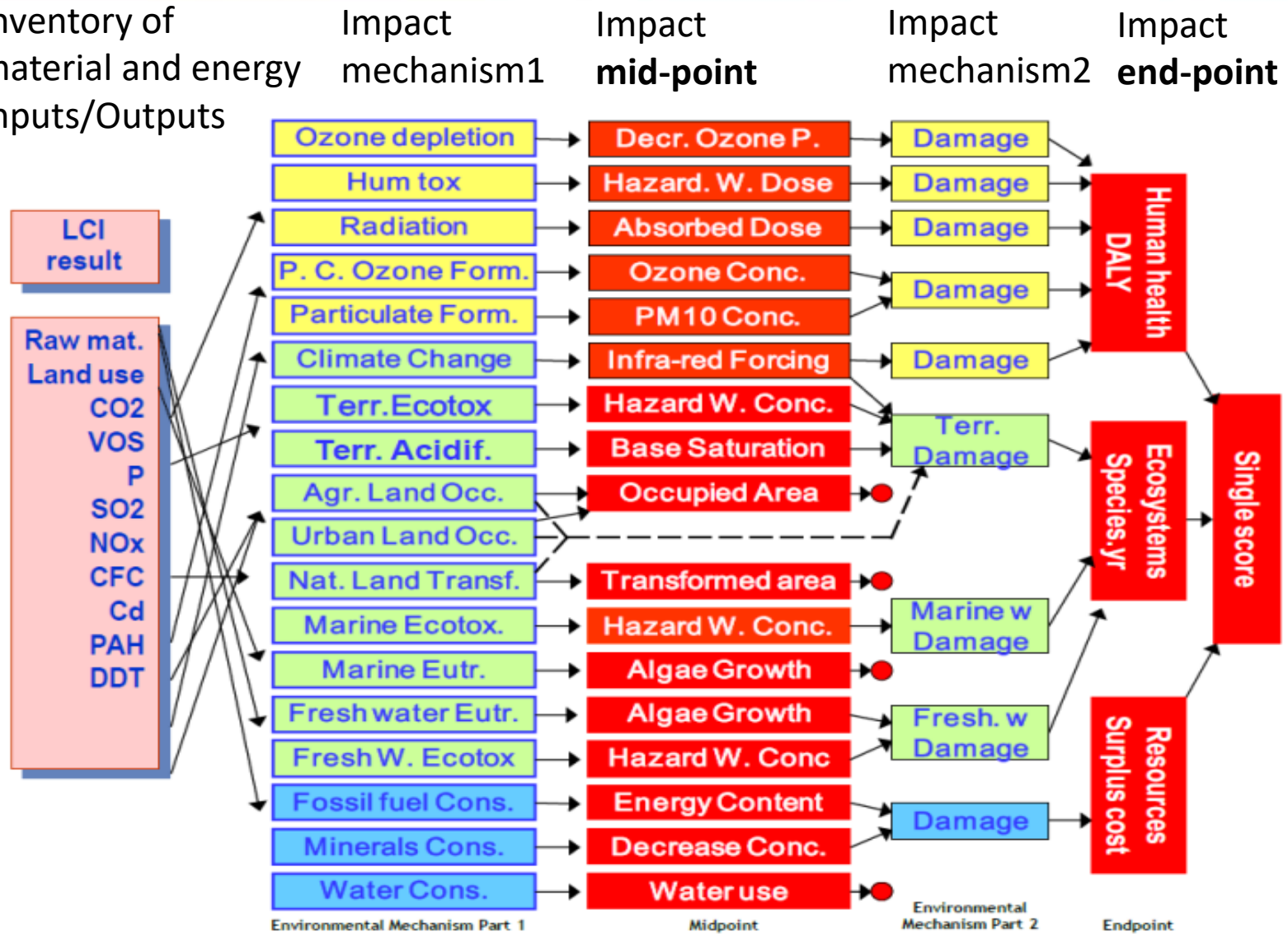
Aims and goal of this project

- Contribute to development of **LCA (and particularly LCSA) capabilities** in SA
- Contribute to international literature on **development of Life Cycle Sustainability Assessment methodology**, e.g. by developing a more integrative process
- Apply this methodology in **a case study** comparing the full life cycle impacts (economic, social and environmental) of **carrier bag options in SA; so as to inform which option is best from a sustainability perspective**, make recommendations for reducing impacts, and inform discussions around the potential banning of plastic bags
- Develop an **integrative framework / model / tool / process for applying LCSA to other sectors** in SA, in order to inform sustainable product design and consumer behaviour

Goal of the project is to **"compare the performance of different types of carrier bags currently offered by South African retailers, in terms of sustainability across the product life cycle"**

Environmental Life cycle assessment: *eLCA*



- Software (SimaPro, OpenLCA, Gabbi, Umberto) and db used to assess impacts
- Various methods to assess environmental impacts across a range of impact categories
- Scores in impact categories can be normalised (and weighted) to derive end-point score single score
- eLCA will need to be combined and integrated with social and economic assessments……

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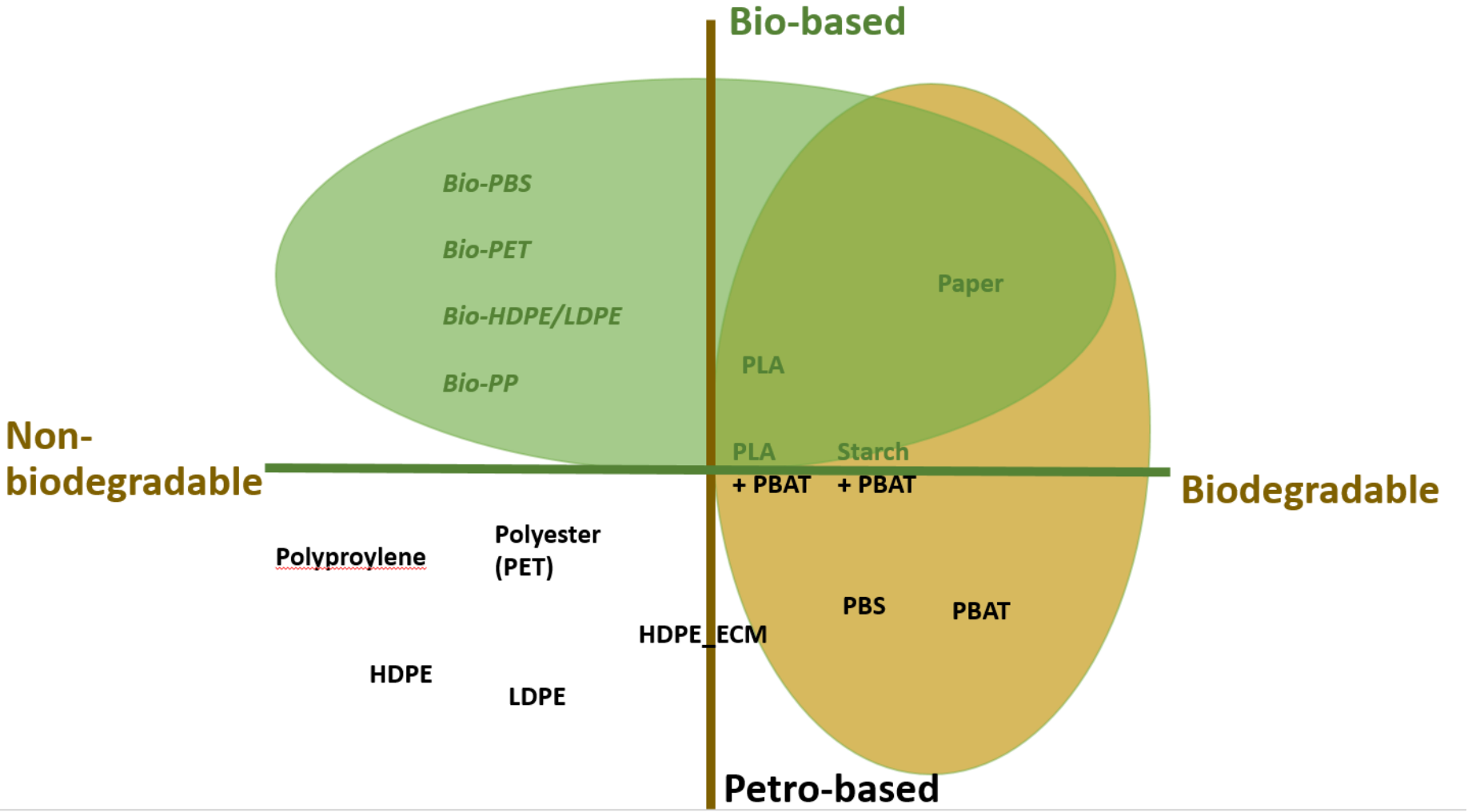
Alternatives to plastic?
Bio-based… and/or…biodegradable



* Not all biodegradable bags are bio-based.

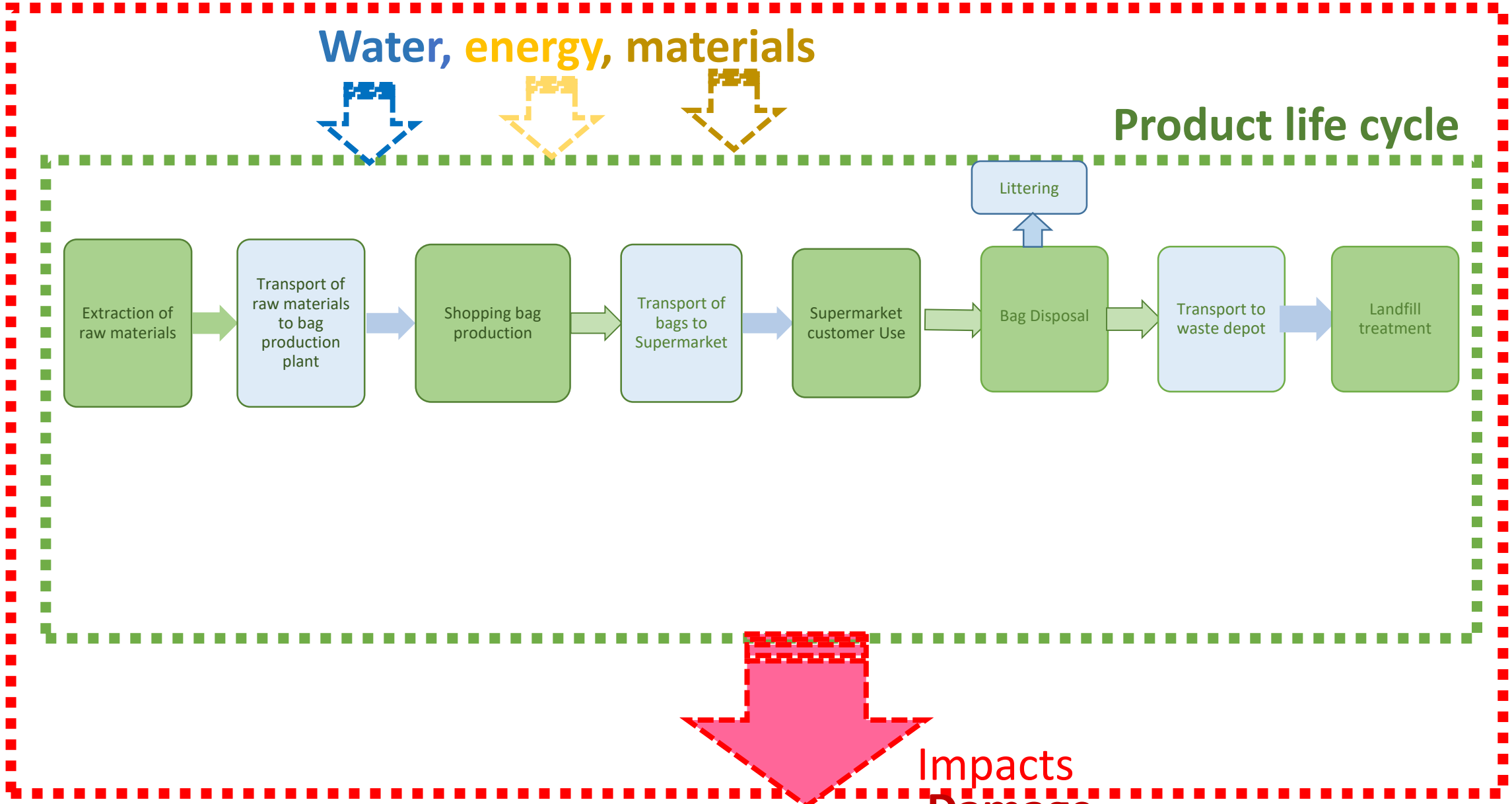
* Not all bio-based bags biodegrade readily (industrial vs home composting, landfill, ocean)

Carrier bags compared: functional unit & reference flows

- **Not all bags are equivalent in terms of carrying capacity (based on weight and volume).**
- **The functional unit** used for comparison is a conventional, 'single-use' HDPE bag that can "carry groceries with an average volume of 24 litres and with an average weight of 12 kilograms from the retailer to the home"
- Bag types are then assigned a numerical **reference flow** based on the number of bags required to fulfil the functional unit and the corresponding mass of material used to manufacture the bag

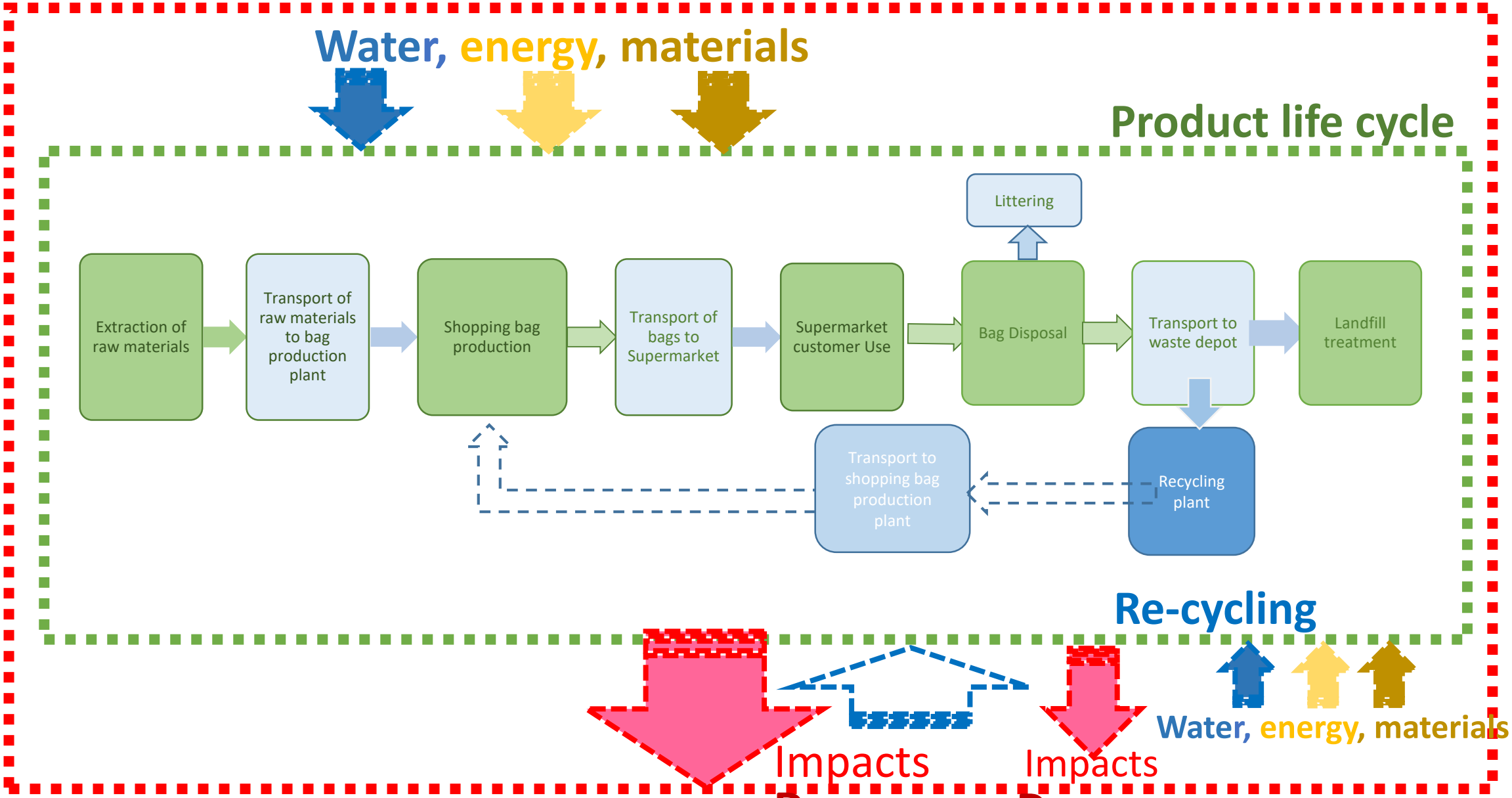
Bag type	Bag thickness (µm)	Mass of bag when empty (g)	Capacity (litres)	Maximum weight bearing (kg)	Ref flow (no. of bags needed to fulfil reference bag functionality) in terms of volume	Ref flow (no. of bags needed to fulfil reference bag functionality) in terms of weight	Ref flow - average
1 HDPE standard 24 micron, 100% recycled content (REFERENCE BAG) - Checkers	24	11.00	16.74	22.50	1.00	1.00	1.00
2. HDPE thicker 70 micron - Checkers	101	48.41	23.23	29.60	0.72	0.76	0.74
3. Polypropylene (woven) - WW	170	66.47	18.98	73.00	0.88	0.31	0.60
4. Polyester - WW	173	66.66	26.75	44.40	0.63	0.51	0.57
5. CSIR R&D Compostable bags	50	23.00	14.73	9.90	1.14	2.27	1.70
6. Paper - Spar	125	38.42	19.97	21.00	0.84	1.07	0.95
7. LDPE - Makro	35	15.32	24.00	27.00	0.70	0.83	0.77
8. Lension SA BaoBag (Oxo-degradable)	34	6.35	13.00	23.00	1.29	0.98	1.13

Product life cycle: environmental LCA



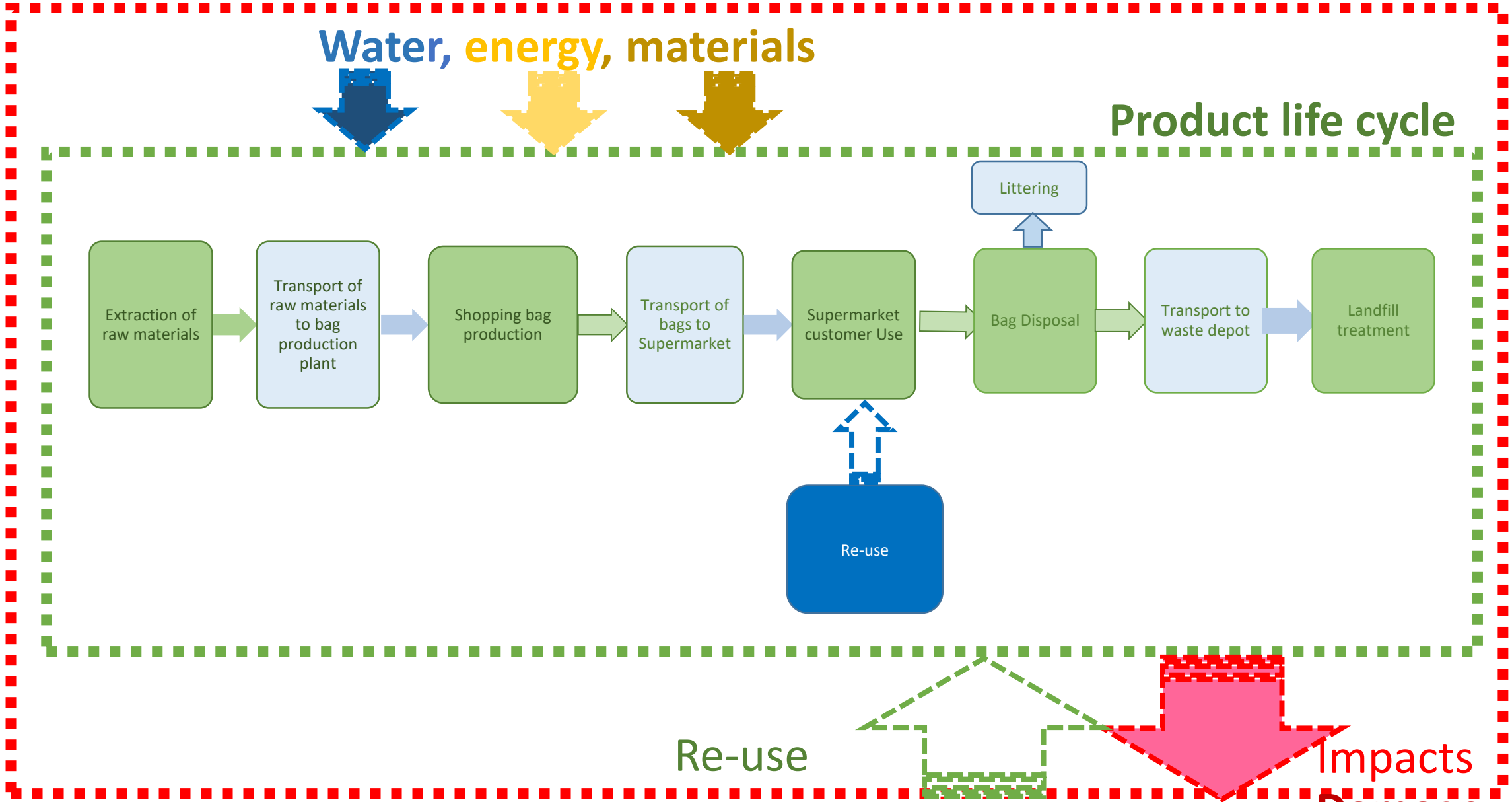
Re-cycling:

<u>Re-cycling</u> substitutes for raw materials and partially avoids impacts…
but may require additional inputs and generate new impacts!



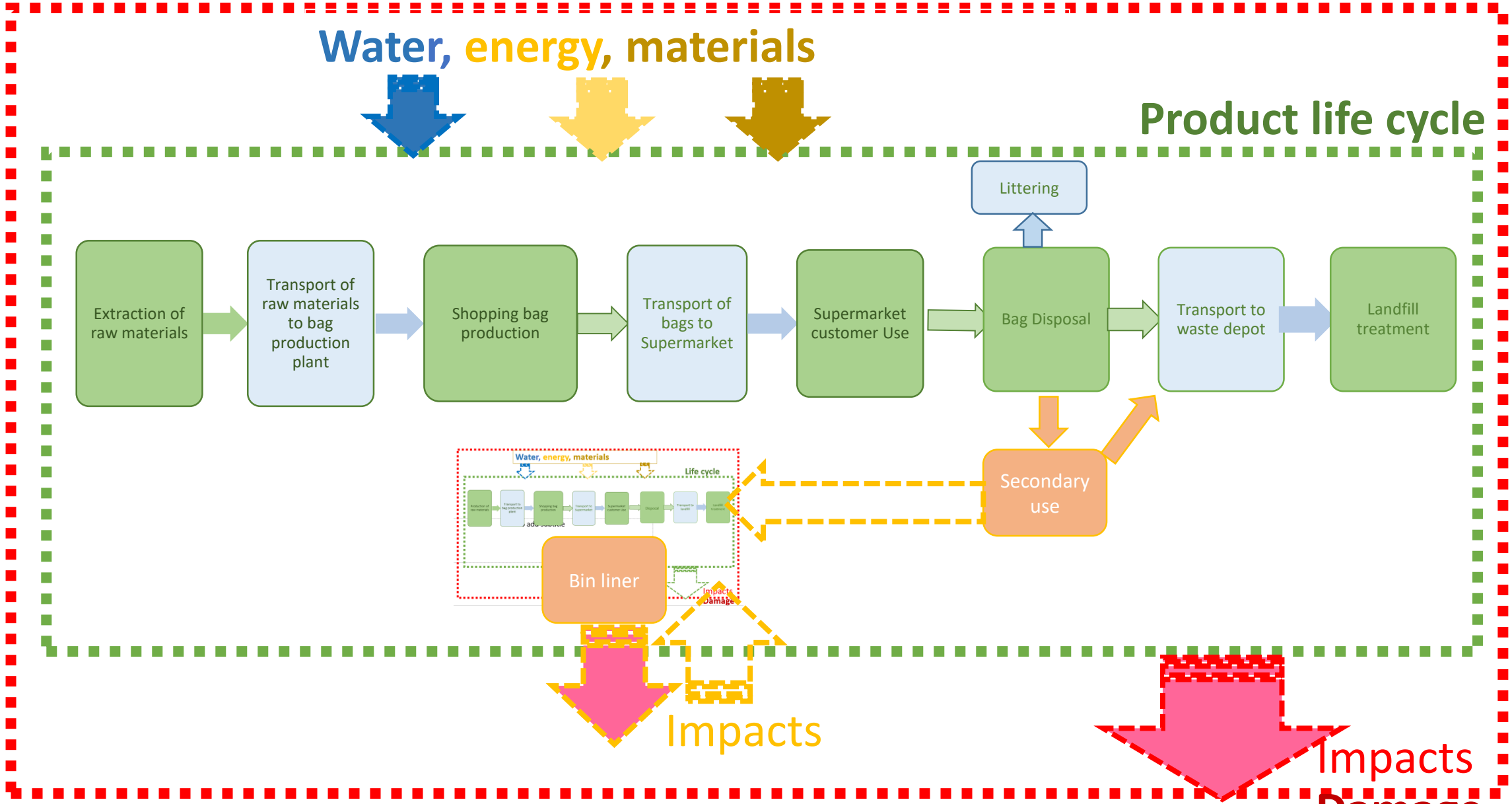
Re-use:

Re-use completely avoids impacts by substituting the need for another bag



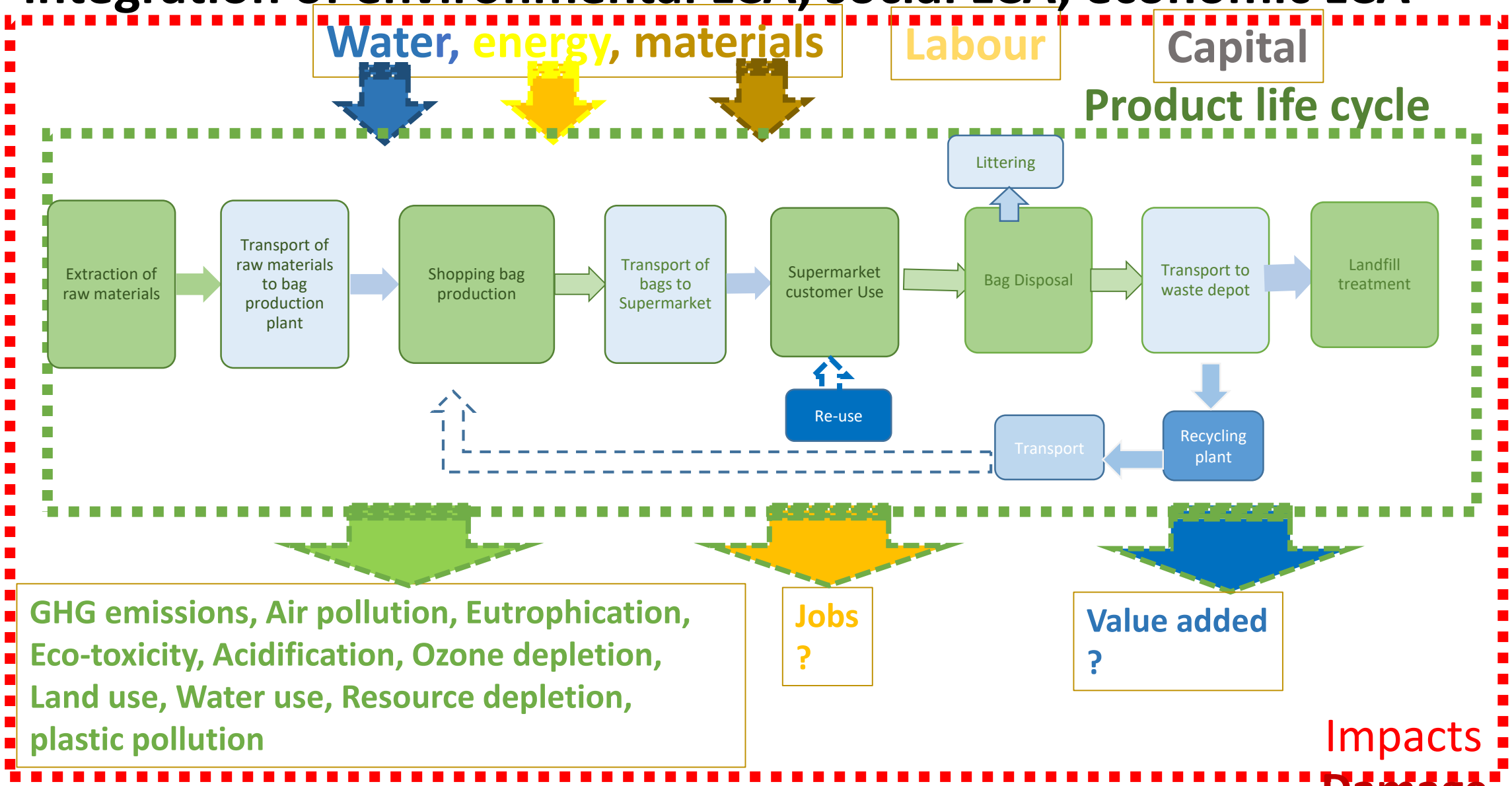
Secondary re-use (bin liner):

Secondary use forgoes the option of Re-use as shopping bag, but displaces a bin liner

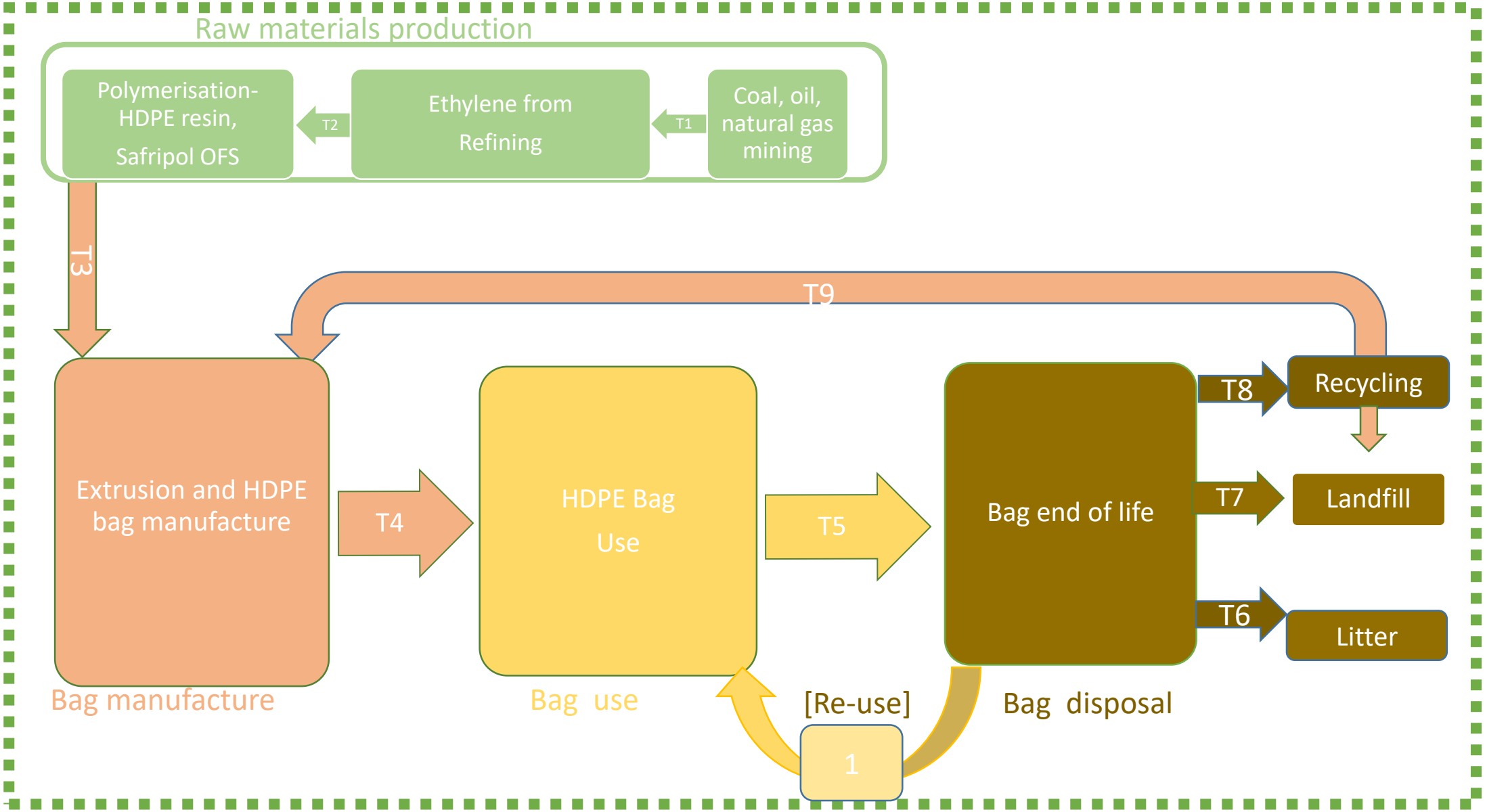


SLCA:

integration of environmental LCA, social LCA, economic LCA

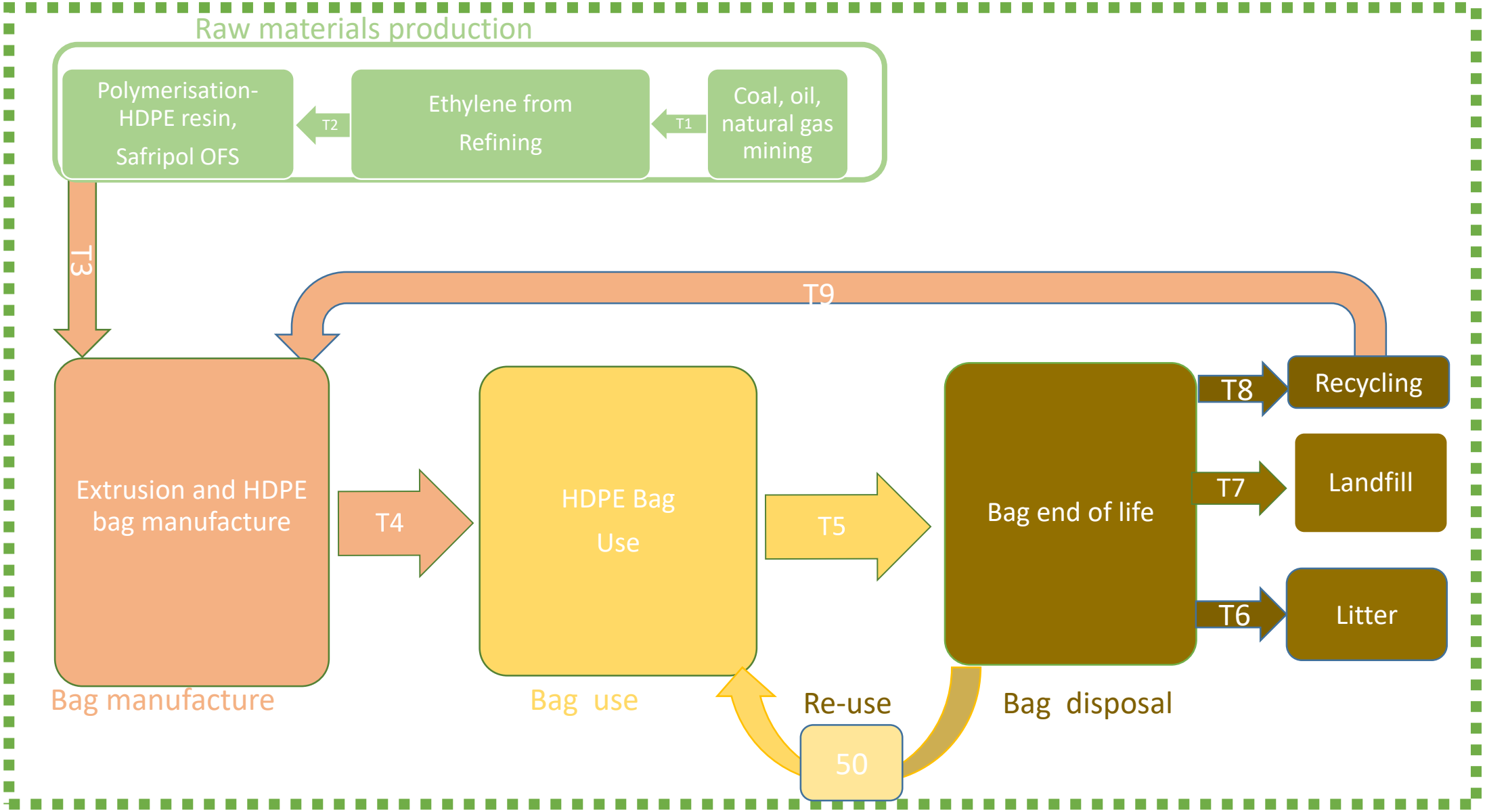


Business as usual bag: HDPE 24um

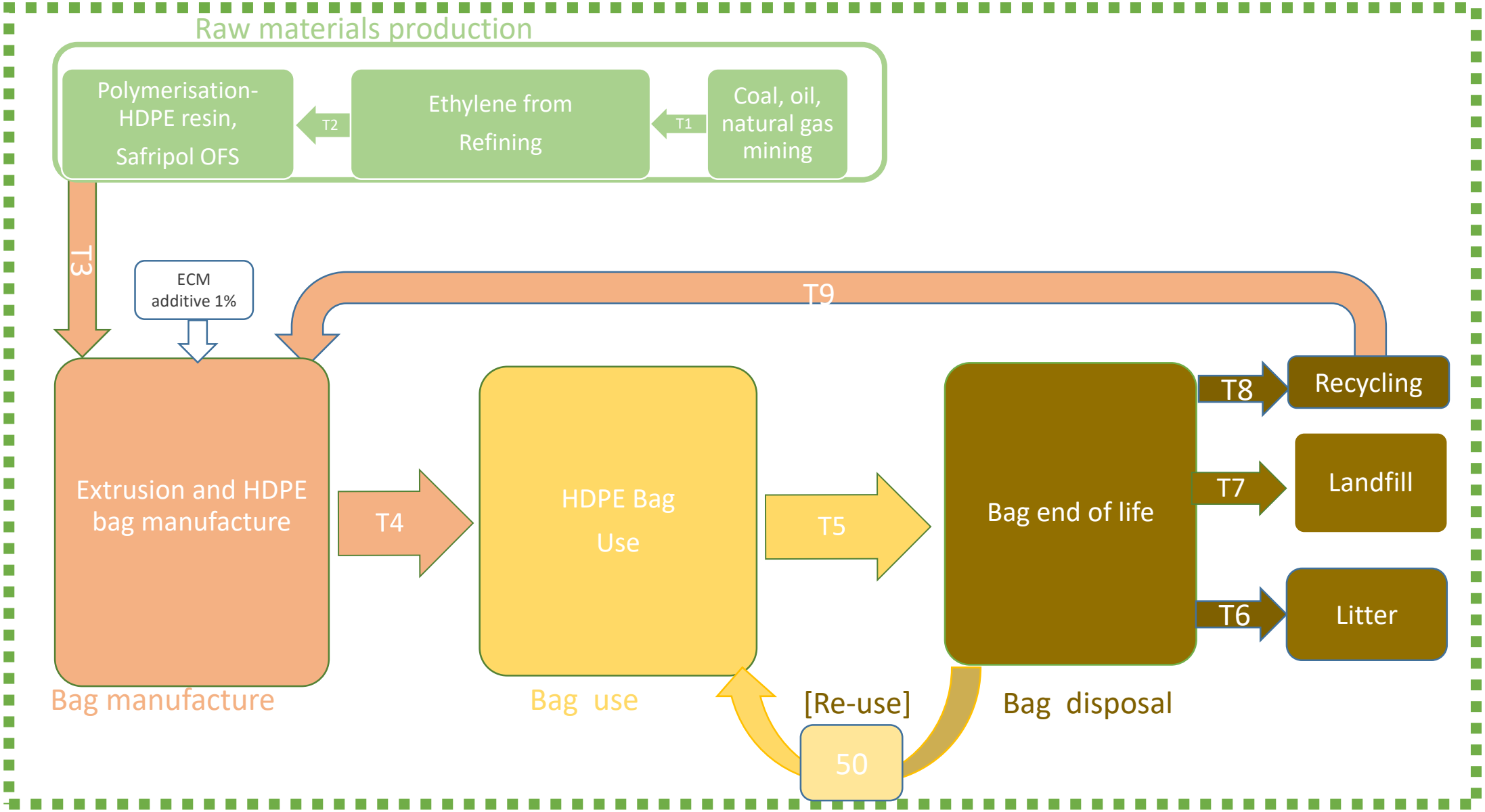


Ca. 2.9 billion bags per annum from plastic bag levy, 11g each
= 32 kt per annum (ca. 2% of total plastic)

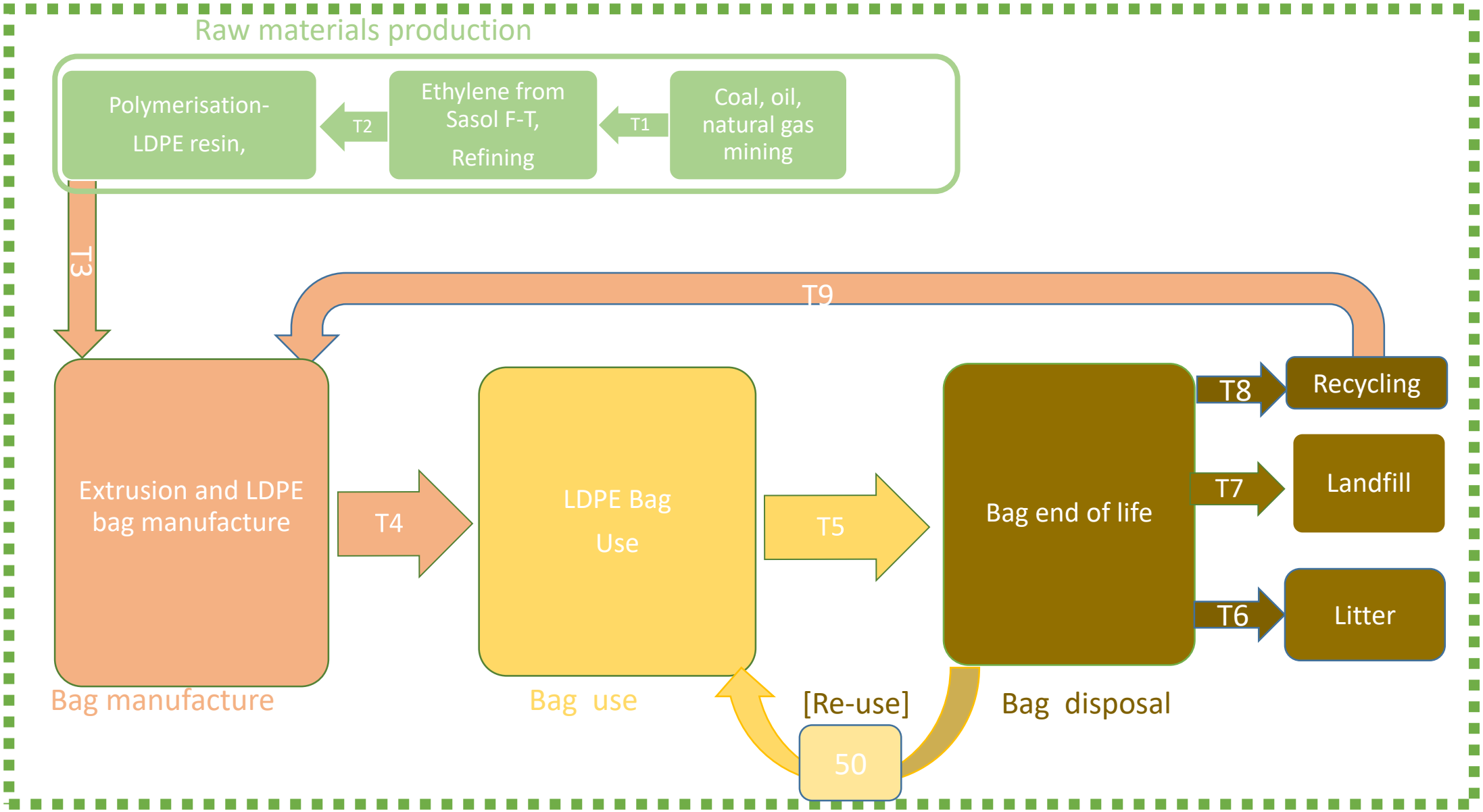
HDPE 70um


Raw materials production
Polymerisation- HDPE resin, Safripol OFS
T2
Ethylene from Refining
T1
Coal, oil, natural gas mining
T3
T9
Extrusion and HDPE bag manufacture
T4
HDPE Bag Use
T5
Bag end of life
T8
Recycling
T7
Landfill
T6
Litter
Bag manufacture
Bag use
Re-use
50
Bag disposal

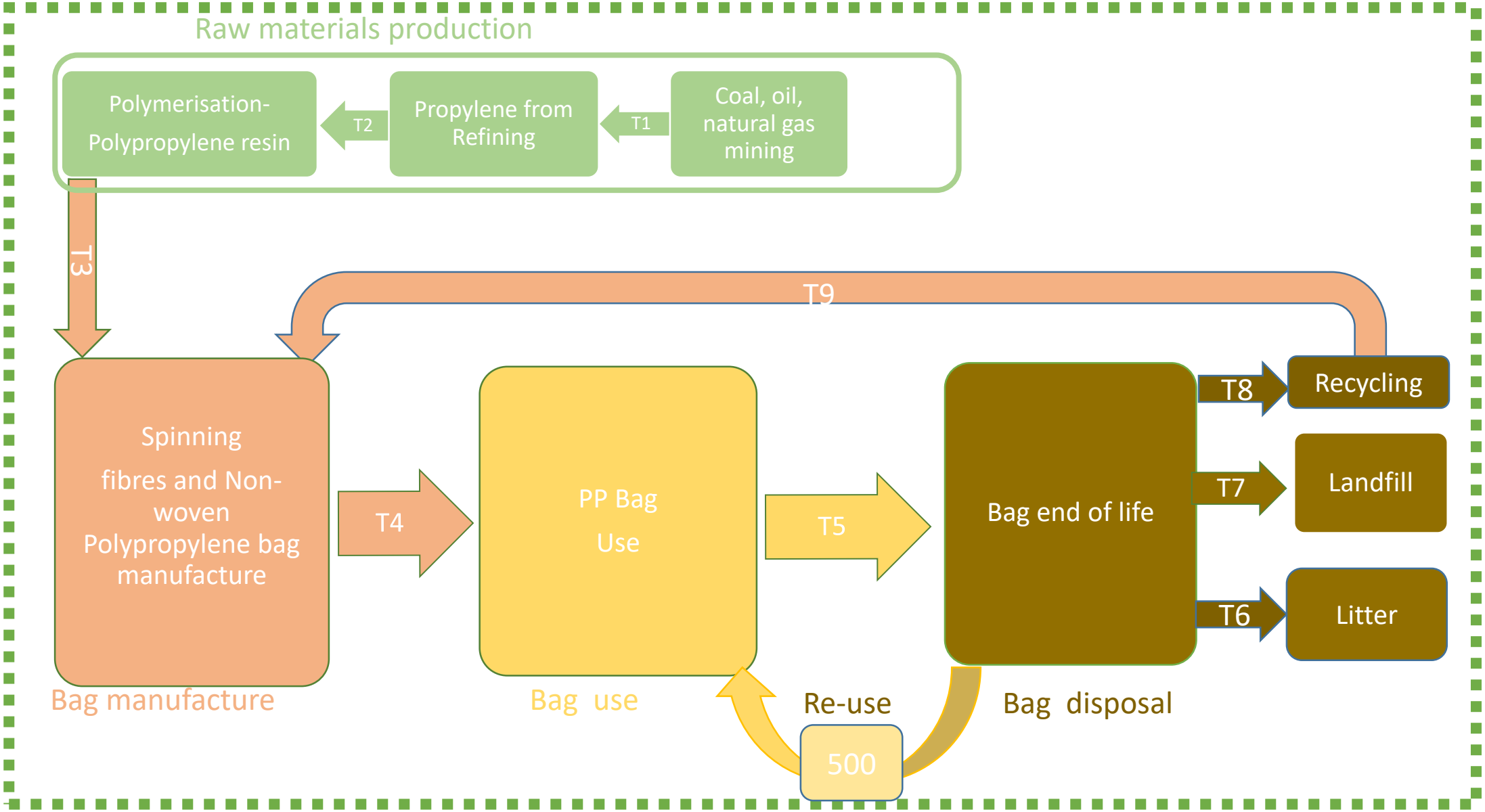
HDPE with ECM additive



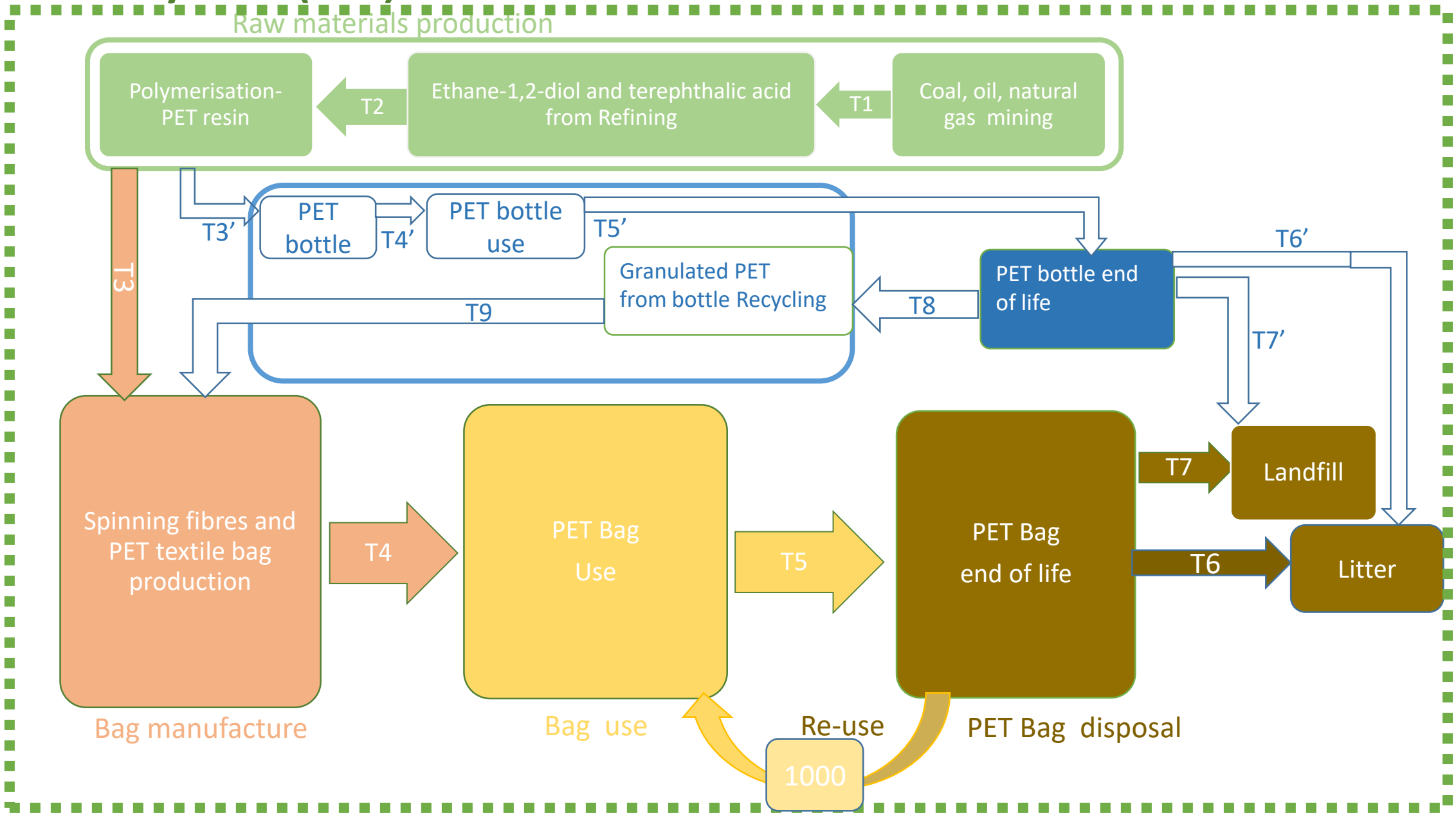
LDPE


Raw materials production
Polymerisation-
LDPE resin,
T2
Ethylene from
Sasol F-T,
Refining
T1
Coal, oil,
natural gas
mining
T3
T9
Extrusion and LDPE
bag manufacture
T4
LDPE Bag
Use
T5
Bag end of life
T8
Recycling
T7
Landfill
T6
Litter
Bag manufacture
Bag use
[Re-use]
50
Bag disposal

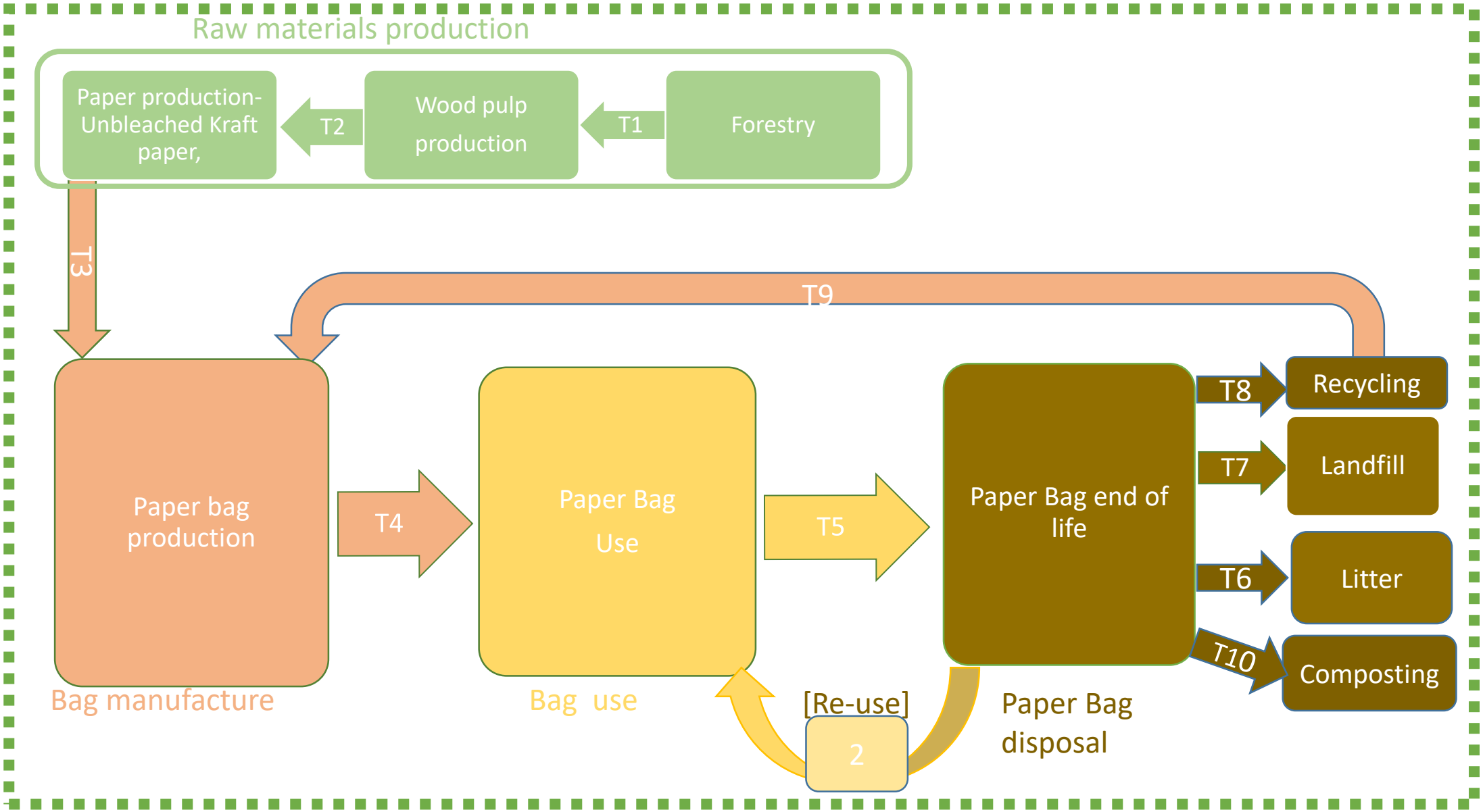
Polypropylene



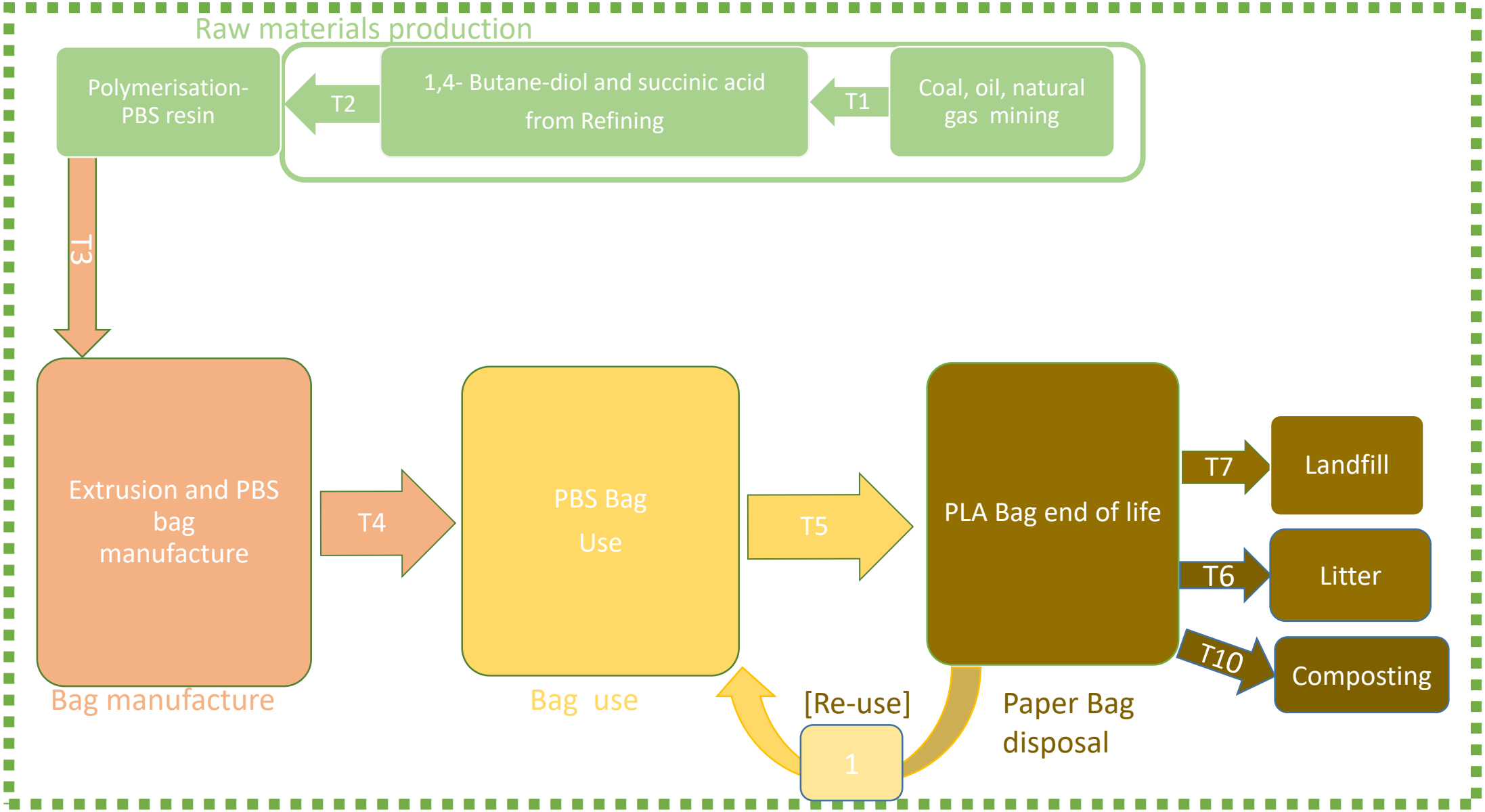
Polyester (PET)



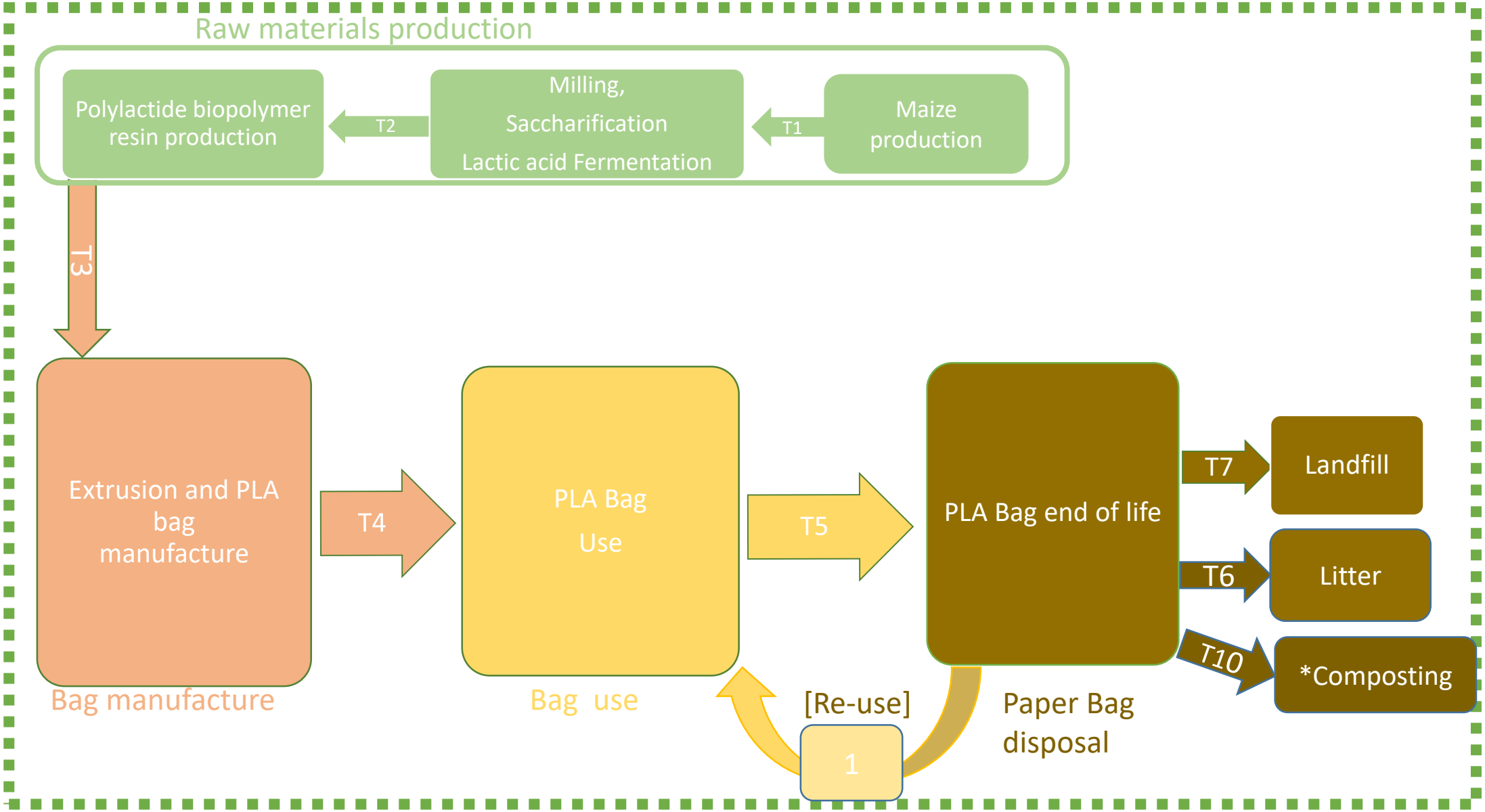
Kraft Paper


Raw materials production
Paper production- Unbleached Kraft paper,
T2
Wood pulp production
T1
Forestry
T3
T9
Paper bag production
T4
Paper Bag Use
T5
Paper Bag end of life
T8
Recycling
T7
Landfill
T6
Litter
T10
Composting
Bag manufacture
Bag use
[Re-use]
2
Paper Bag disposal

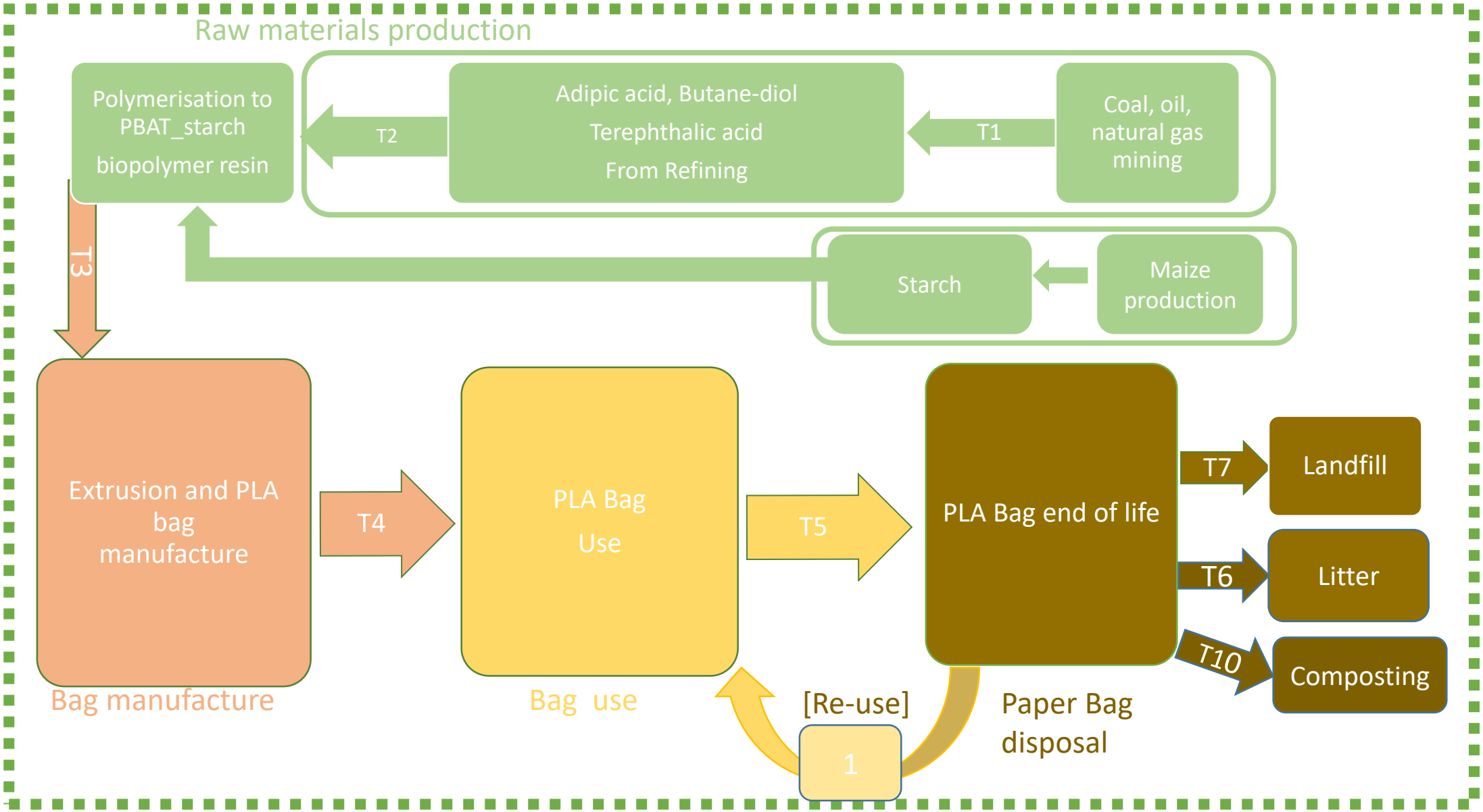
PBS


Raw materials production
Polymerisation-
PBS resin
T2
1,4- Butane-diol and succinic acid
from Refining
T1
Coal, oil, natural
gas mining
T3
Extrusion and PBS
bag
manufacture
Bag manufacture
T4
PBS Bag
Use
Bag use
T5
PLA Bag end of life
T7
Landfill
T6
Litter
T10
Composting
[Re-use]
1
Paper Bag
disposal

PLA- first generation from maize



PBAT_starch

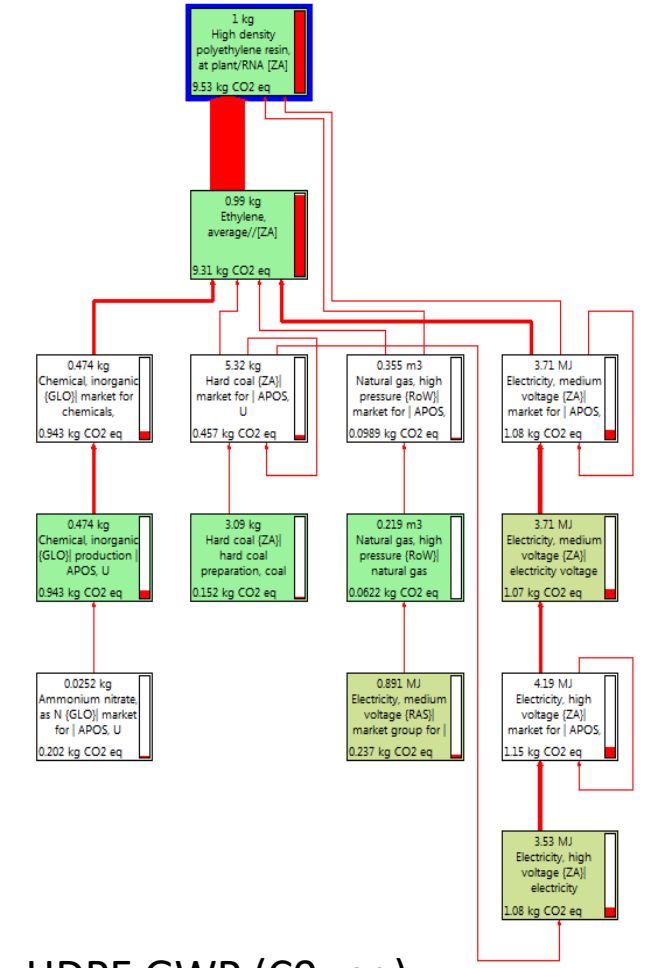

Raw materials production
Polymerisation to PBAT_starch biopolymer resin
T2
Adipic acid, Butane-diol
Terephthalic acid
From Refining
T1
Coal, oil, natural gas mining
T3
Starch
Maize production
Extrusion and PLA bag manufacture
T4
PLA Bag Use
T5
PLA Bag end of life
T7
Landfill
T6
Litter
T10
Composting
Bag manufacture
Bag use
[Re-use]
1
Paper Bag disposal

Scoping the impacts

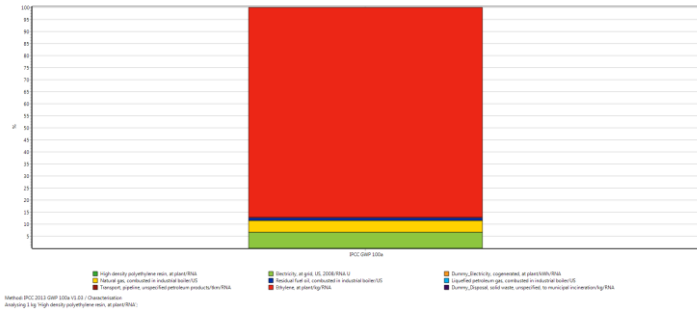
Impacts depend substantially on **raw materials** and **energy inputs** (ca.80%) of environmental impacts

- **Petro-based** inputs in SA are plastic monomers from Sasol FT coal-to-liquids and coal based electricity from Eskom which increases impacts relative to oil and natural gas based plastics in RoW. Land and water footprint of coal mining

- **Bio-based** inputs include land, fertiliser, water consumption for biomass and potential food vs bio-plastic competition



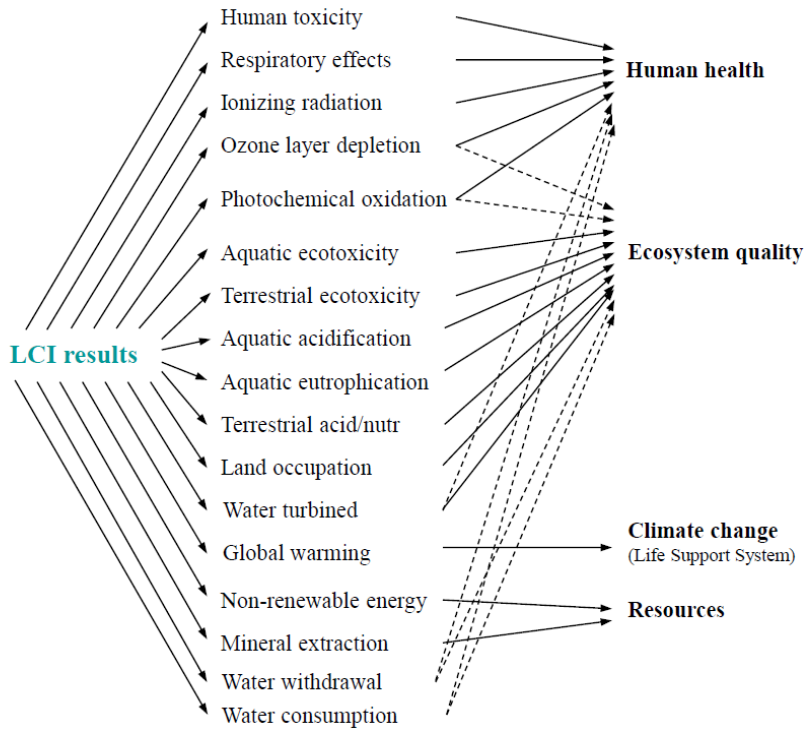
HDPE GWP (CO_2 eq)



Scoping the impacts - current research gaps?

Impacts strongly influenced by bag **end of life**: *re-use, re-cycling and disposal.*

- In South Africa, there is limited recycling (ca. 16% plastic recycling?)
- Also poor waste management- plastics end up as litter and non-complaint landfills (compliant landfill ca.30% of total, only a few capped to harvest methane



- **'Plastic pollution'** a notable research gap

  No established impact method in LCA to assess biodiversity, and socio-economic impacts of plastic materials

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Thank you!

Anton Nahman, William Stafford, Willem De Lange,
Lorren Haywood, Benita De Wet
Anton Nahman (anahman@csir.co.za / 021 888 2403)
William Stafford (wstafford@csir.co.za / 021 888 2467)

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