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The role of gasification for production of polymers in a circular economy

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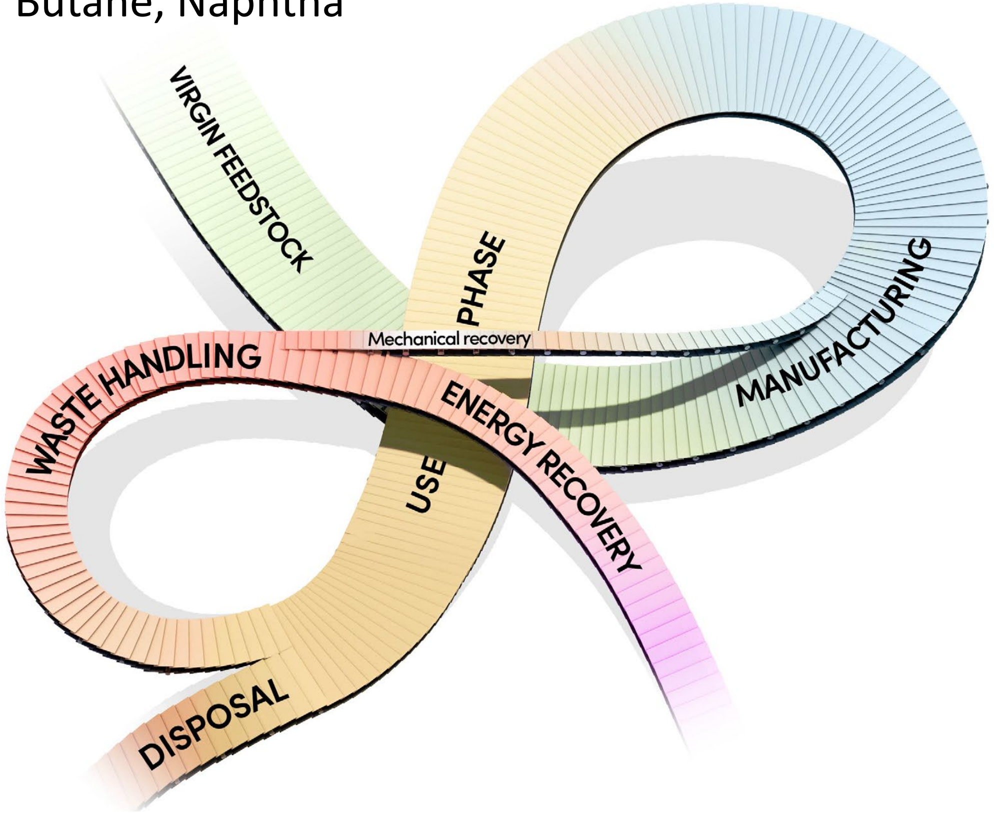
Today’s plastic system

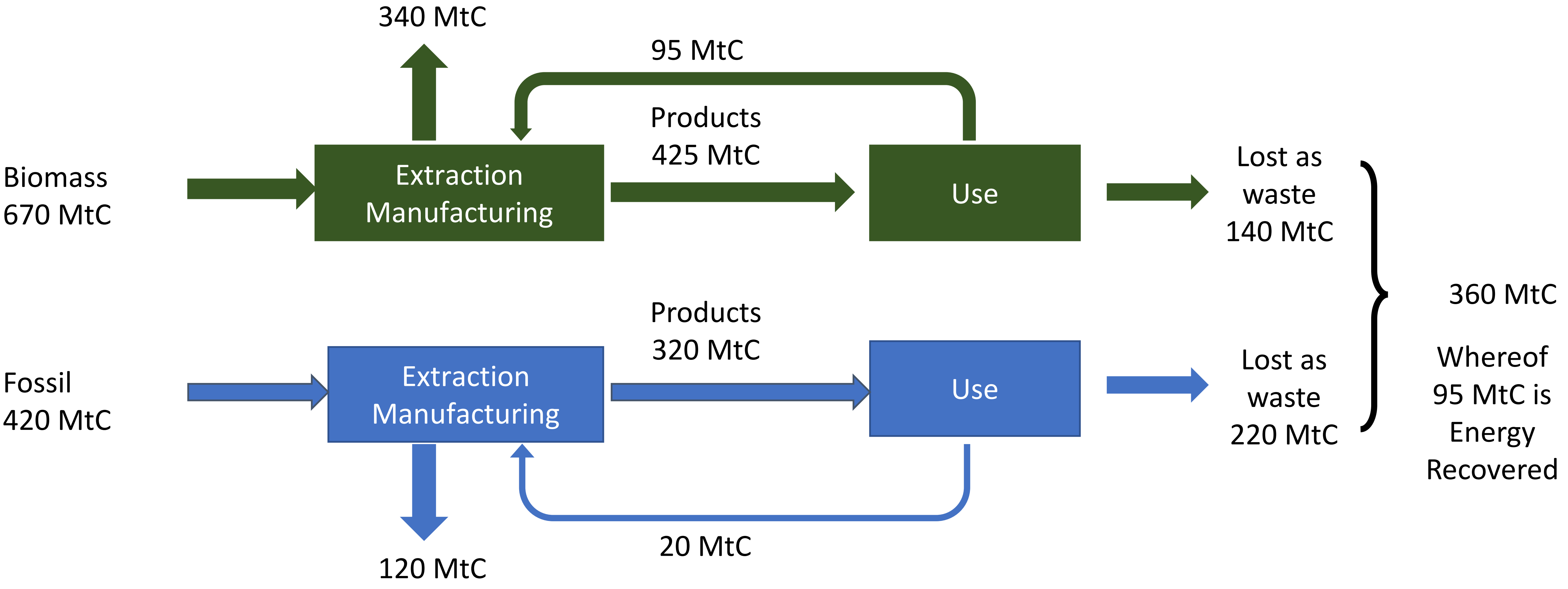
Ethane, Propane,
Butane, Naphtha



Local environmental issue
Carbon stored as plastics in landfills
or are accumulated in nature

Global environmental issue
CO2 to the atmosphere

Global Carbon Material System 2018



Input af carbon to the system	1090 MtC
Carbon lost in manufacturing	460 MtC
Carbon lost as waste management	360 MtC
Carbon stored in Ecosphere	270 MtC

Data collected from official statistics by Isabel Cañete Vela

Recycling methods

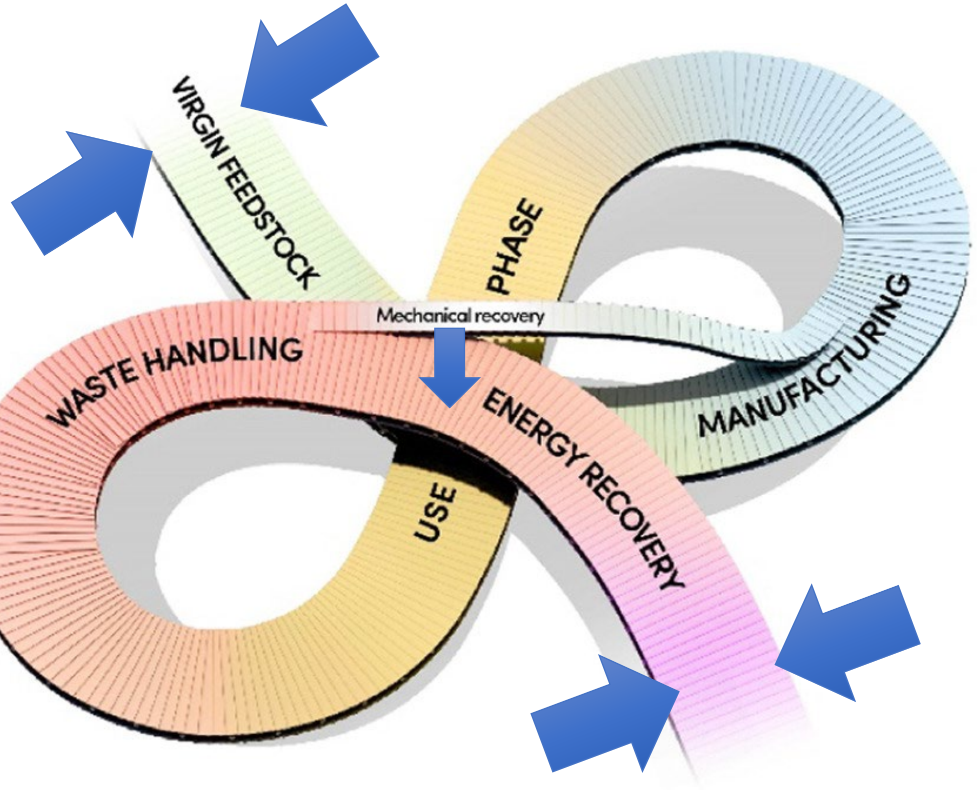
Selective methods << 100% carbon recycling

- Mechanical
- Solvent
- Pyrolysis to Naphtha

100 % in fraction going to recycling

Recycled	Residue	Energy

Recycled <100% C



"Recycling" is not necessarily synonymous with replacing virgin feedstock

EU pallets
If made from **100% recycled plastics**
70-90% of recycled material replaces fillers
10-30% replaces virgin feedstock

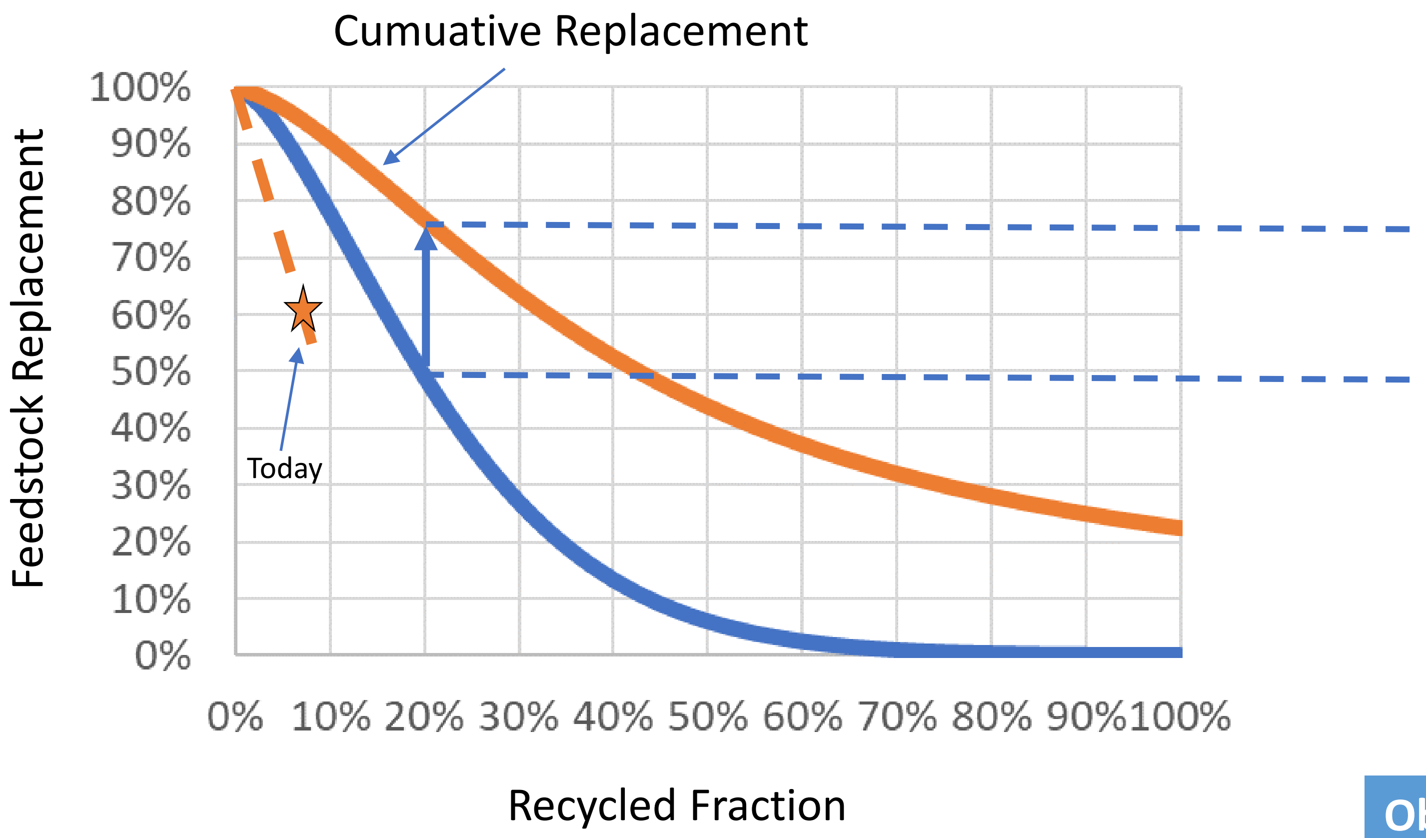
Alternative: **wood pallet**

10-30% increased use of fossil feedstock if plastic pallets made from recycled plastics are used instead of wood pallets

Plastic bags
Plastic Recycling 100%

To achieve same mechanical strength
Recycled material > Virgin material
Fossil replacement <100%

Fossil feedstock replacement for mechanical recycling

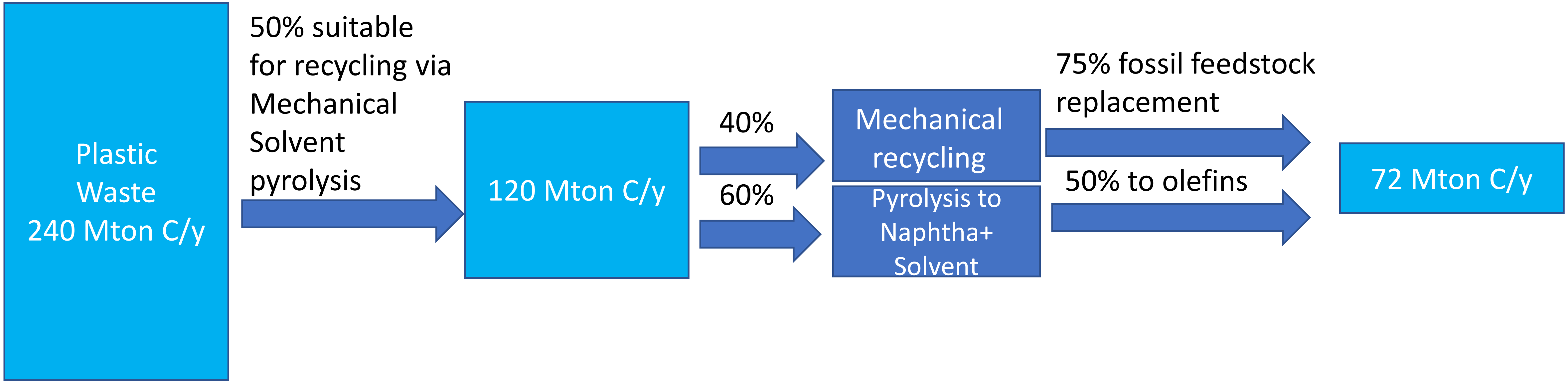


The cumulative fossil replacement @ 20% recycling is estimated to 75%

@ 20% recycling the fossil replacement is estimated to 50%

Observe this curves are arbitrary given, as reliable data for this is not available, today the estimated fossil replacement of the 6-8% that is recycled is in the order of 60%

Global potential of virgin feedstock replacement by using mechanical and solvent recycling as well as naphtha from pyrolysis



Need of fossil feedstock 320 Mton C/y for global production of plastics

Fossil feedstock replacement 72 Mton C/y, 23%
However, the plastic recycling would be 31%

Perfect recycling of separated polyolefinic plastics, where virgin feedstock is replaced 1:1, would replace 39% feedstock, but would correspond to a 50% plastic recycling.

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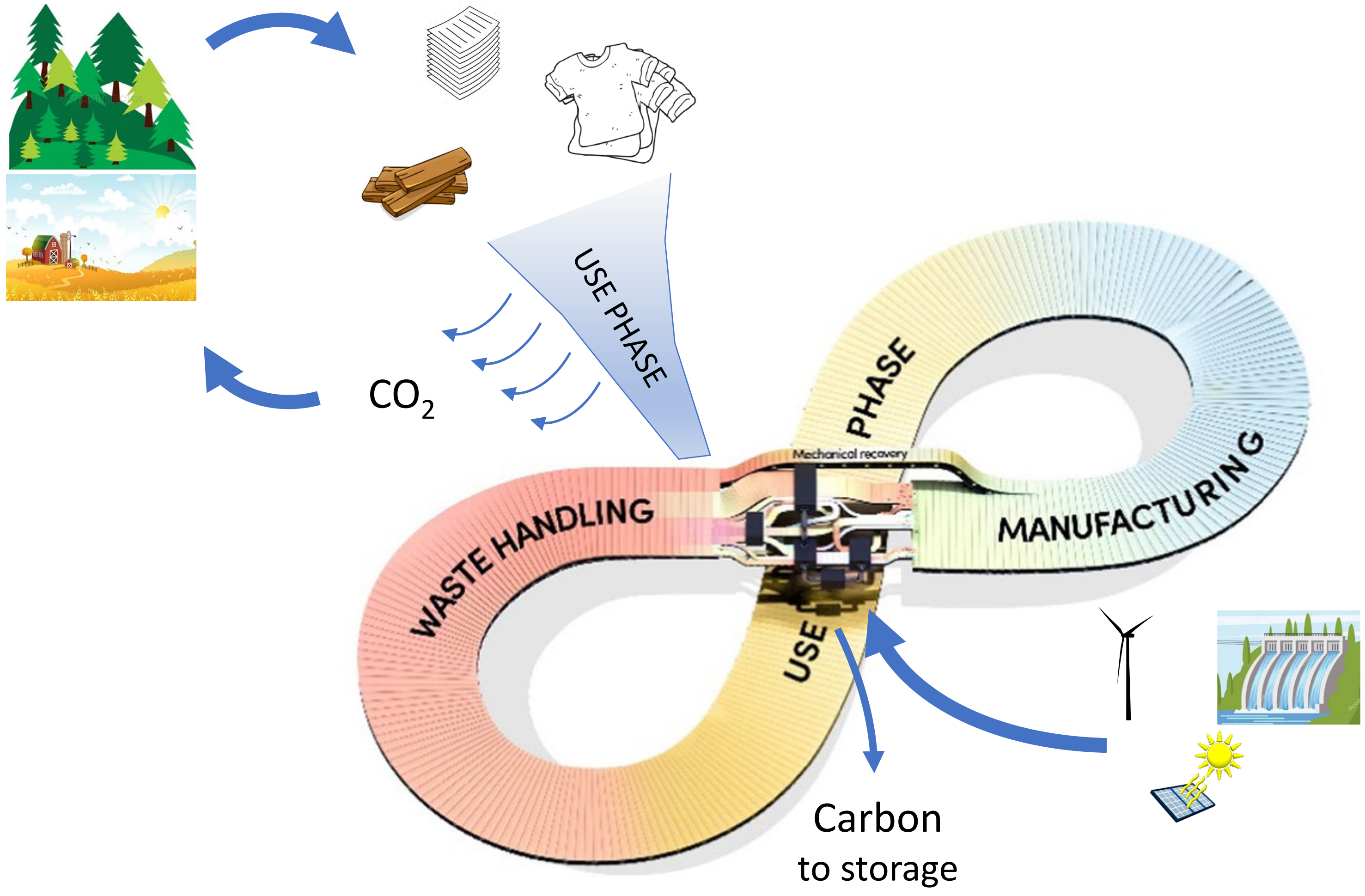
The way to go to a circular use of plastics



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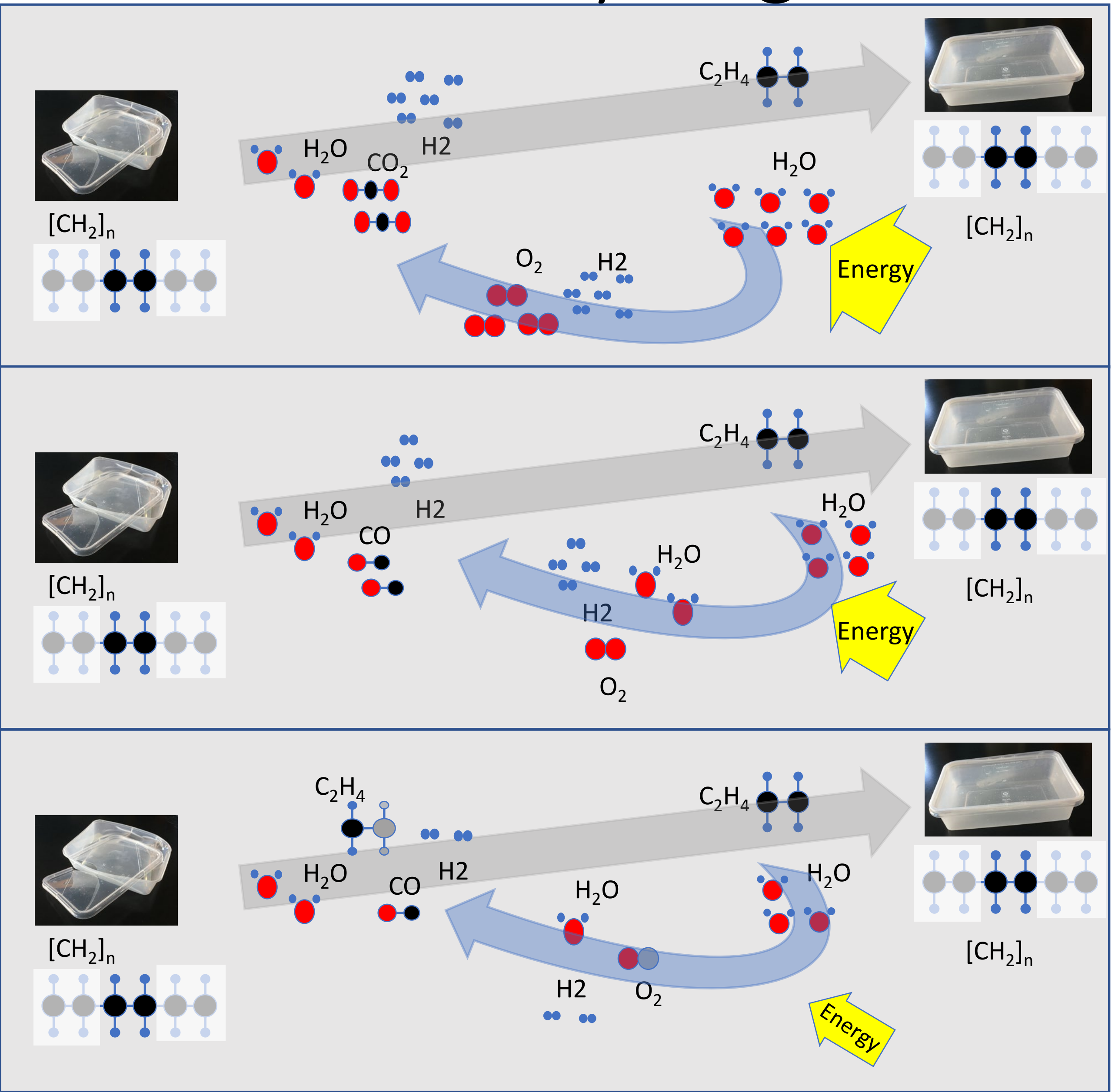
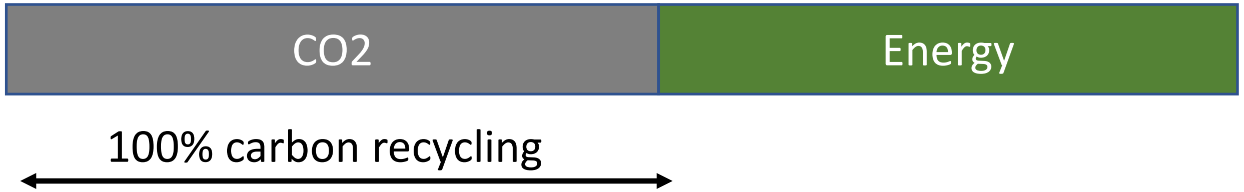
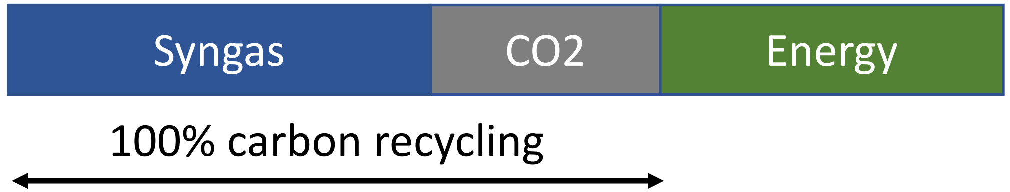
Thermal recycling methods for 100% carbon recycling



- Recycling via CO2 & H2 (CCU)

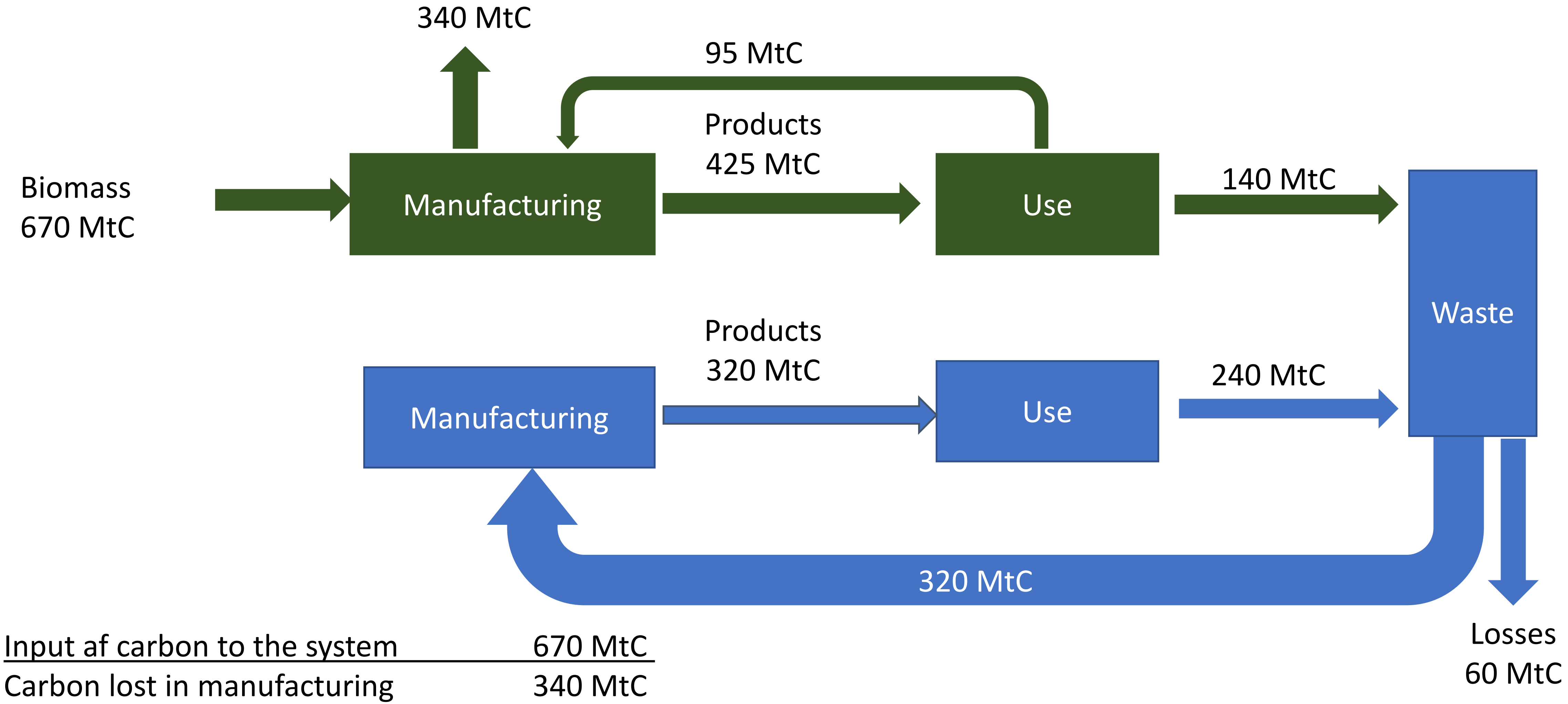


- Recycling via Gasification & H2



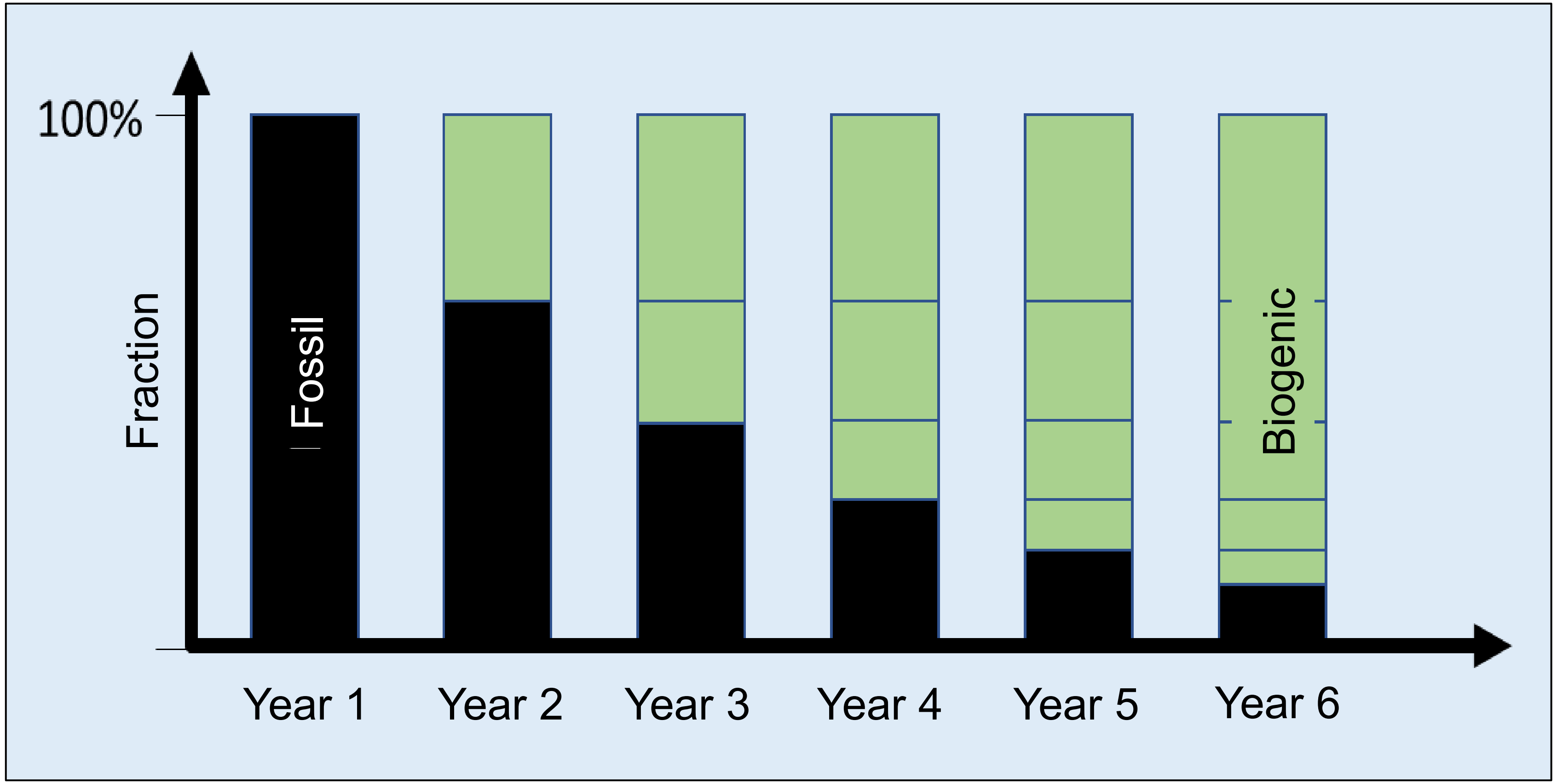
- Recycling via. Pyrolysis & H2

Circular material system based on 2018 data

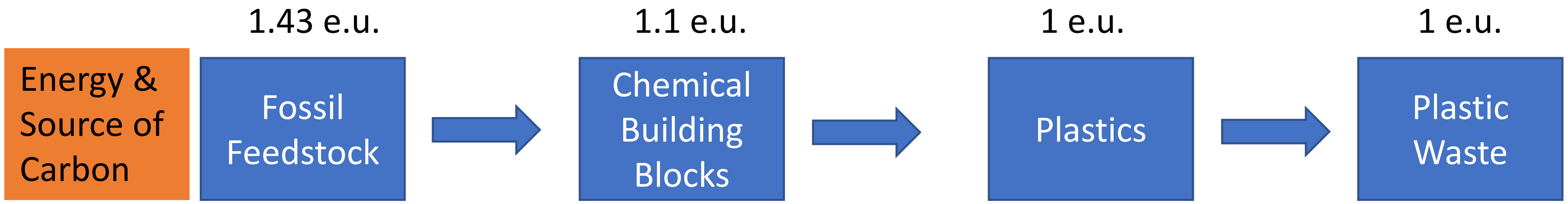


Input af carbon to the system	670 MtC
Carbon lost in manufacturing	340 MtC
Carbon lost as waste management	60 MtC
Carbon stored in Ecosphere	270 MtC

Plastics will go from fossil to biogenic



Efficiency related to a circular system



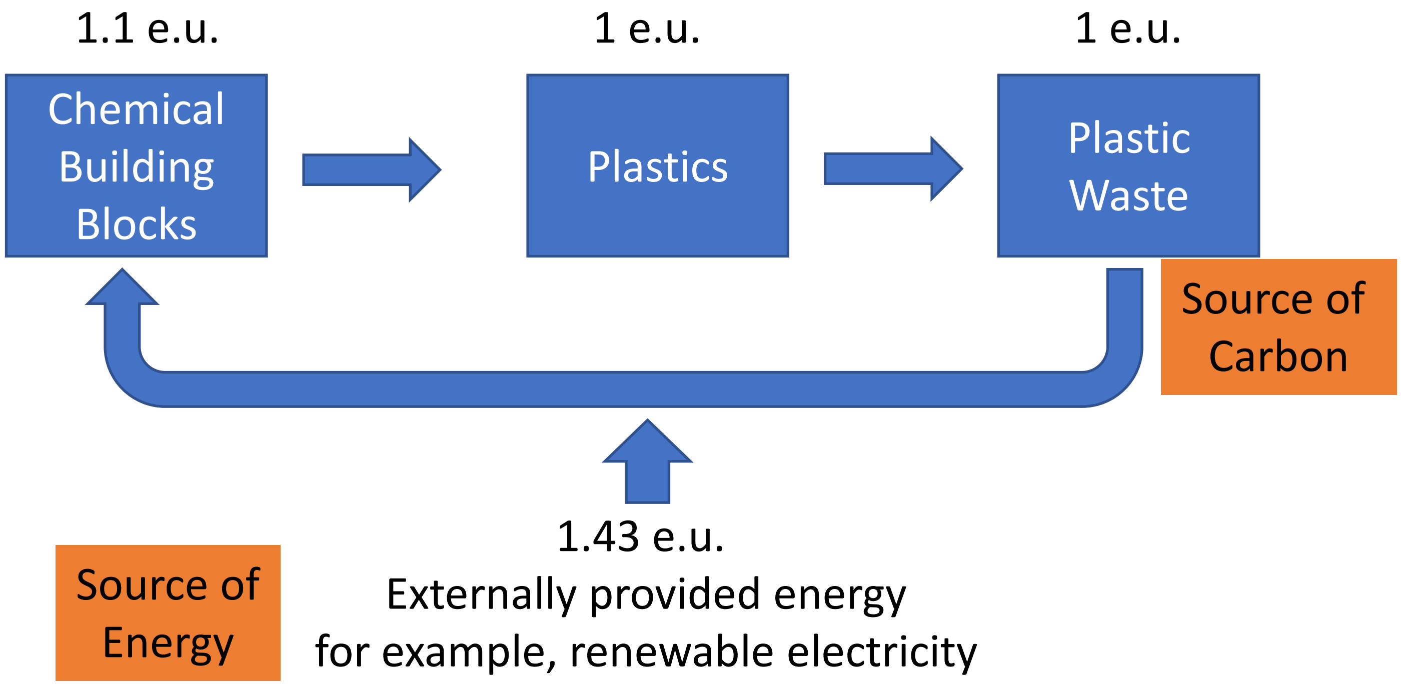
1.4 e.u. is the total energy to system that is needed to keep a constant amount of plastics in the system of 1 e.u.. Where 0.4 e.u. is used in the production of the plastics and 1 e.u. is released at the end-of-life for the plastics.

So the energy efficiency for the continues system becomes:

$$\eta = \frac{\text{Plastics in the system}}{\text{Plastics in the system + The energy provided to maintain the plastics in the system}} = \frac{1\text{ e.u.}}{1\text{ e.u.} + 1.4\text{ e.u.}} = 41.2\%$$

e.u Energy units

Efficiency related to a circular system



1.43 e.u. is the total energy to system that is needed to keep a constant amount of plastics in the system of 1 e.u..
So the energy efficiency for the continues system becomes:

$$\eta = \frac{\text{Plastics in the system}}{\text{Plastics in the system + The energy provided to maintain the plastics in the system}} = \frac{1\text{ e.u.}}{1\text{ e.u.} + 1.4\text{ e.u.}} = 41.2\%$$

e.u Energy units

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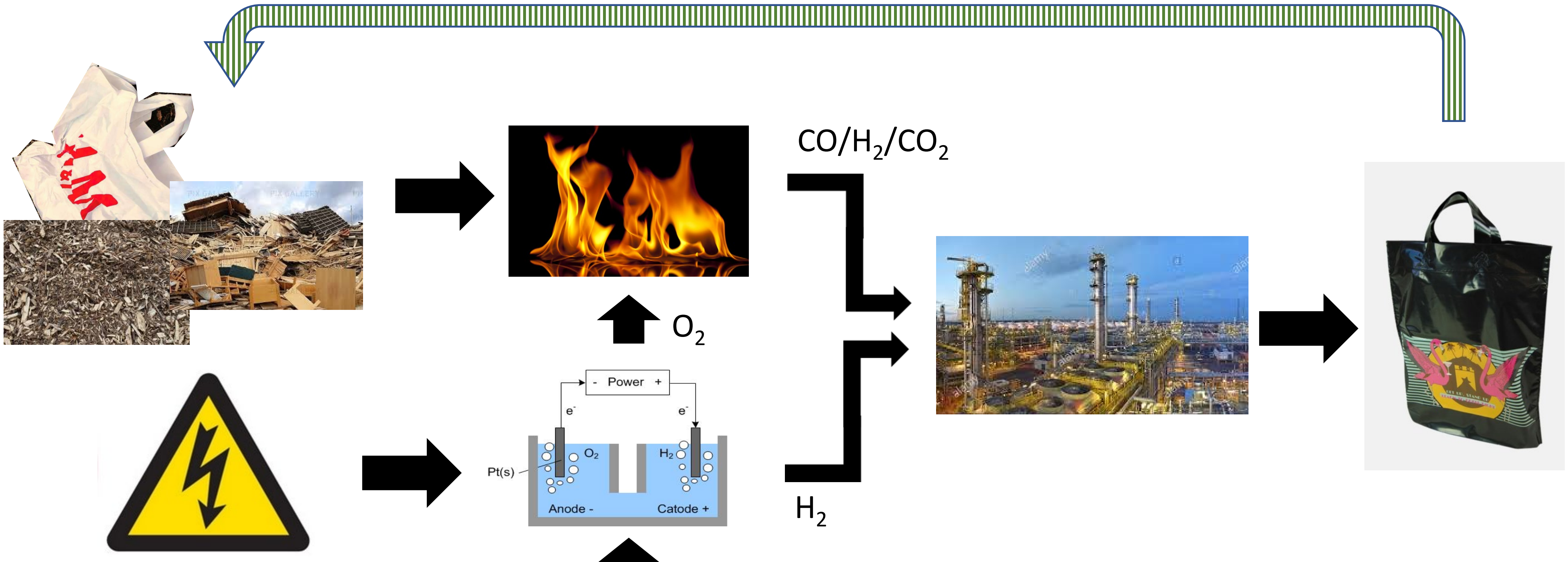
Production of hydrocarbons via Gasification & H_2

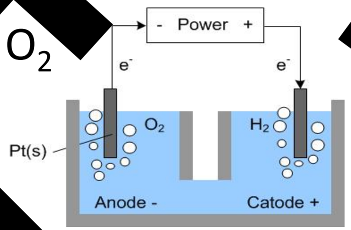


Energy efficiency 45-55%
Possible district heating ~75 % of losses
=> 0.6-0.9 times heating value in feedstock

Production of hydrocarbons via Pyrolysis (steam cracking) & H_2

$C_xH_yO_z$
CO, CO_2,
H2…

O_2



H_2

Energy efficiency 50-65%
Possible district heating ~75 % of losses
=> 0.4-0.75 times heating value in feedstock

Conclusions

- Gasification technologies are the key to go from energy recovery of plastic waste to true recycling
- The carbon collected in the waste system is enogh to provide the carbon for our need of carbon based materias
- To provide enough feedstock to the petrochemical production the technologies that is develeoped to be part of a circular economy need to handle the biogenic part of the waste