Bio energy and biomass

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Valorisation of rural and urban biowaste: feedstocks, technologies and production chains

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Contents

- Urban waste (MSW)
- Valorisation of MSW
  - Waste streams
  - Treatment
  - New production routes
- Conclusion

Large amounts of residues

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Availability of biomass residues (million ton / year)

Biomass type	Europe current	2020	Global current	2020
MSW biodegradable	591	460	2,694	3,253
C&I	460	359	1,941	2,390
Animal manure	969	853	10,320	12,016
Straw	405	870	4,963	5,240
POME			60	127
EFB			81	172
Bagasse			1,205	1,748
Husks			583	645
Bark, branches, leaves	554	1,377	532	1,376
Black and brown liquor	459	1,392	498	1,714

Source: E4Tech (2014)

Residue and waste streams

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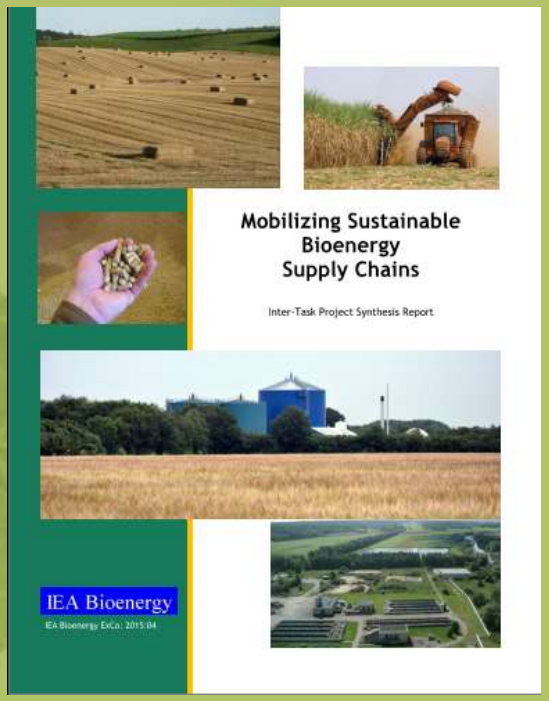
Availability

- 6 billion tonnes of urban waste, 1 billion biodegradable
- Globally, 14 billion tonnes of manure, 2.4 billion tonnes of crop residues
- Total availability 49-62 of Exajoules
- In 2050, 90 Exajoules will be available



Source: Smith et al. (2015) IEA Bioenergy

Urban Waste

- Urbanisation
  - >50% of the population living in cities
  - Amount of waste increases
  - Share of (non-)degradables
- Policy targets
  - Waste
  - Recycling
- Urban waste as feedstock

Addressing the waste issue

- Hierarchy in waste management
  - Prevent, Recycle, Recover (energy), Dispose
  - Upcycle
- Direct and indirect recycling
- Collection system design
  - Separate at source – or not
  - Public vs private collection
  - Drop-off points
  - Park and garden waste

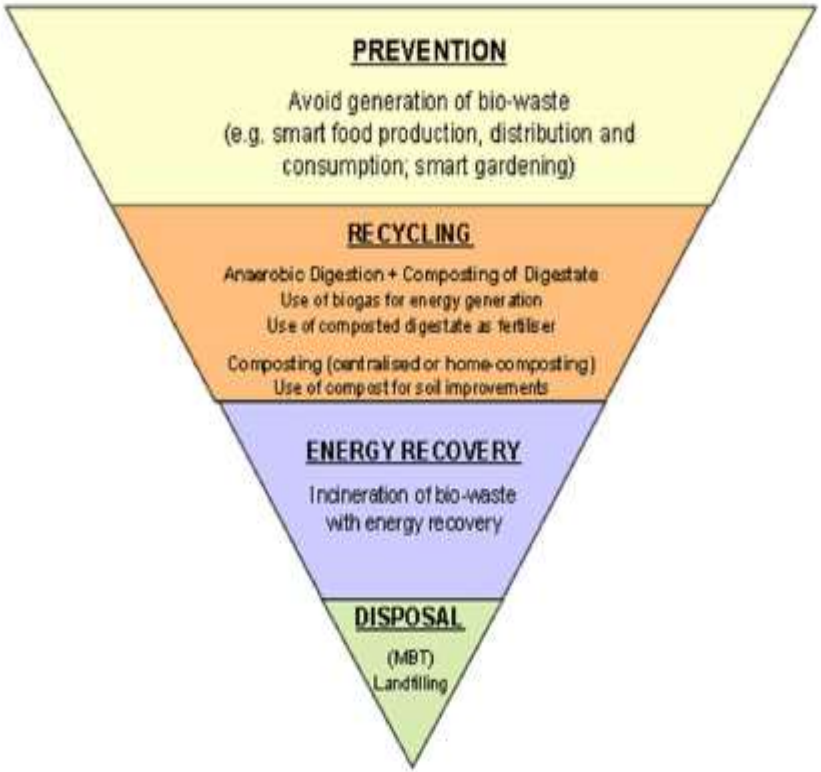
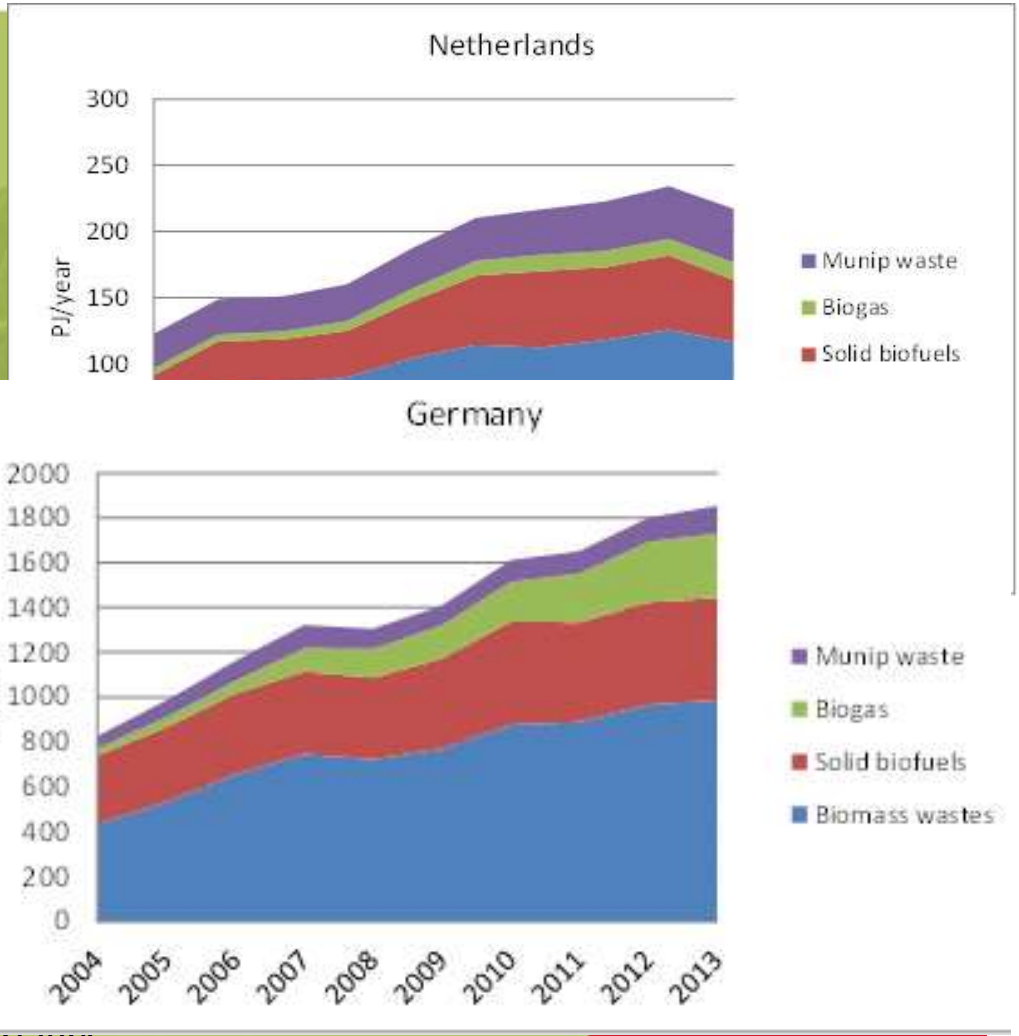


Figure 5. Hiearchy in waste management policy

Source: Joint Research Centre (2011)

Waste and bioenergy

- Primairy residues
  - Agriculturre, forestry
  - Manure, straw, tree cuttings
- Secundairy and tertia residues
  - Food industry
  - Paper- & pulp, fibr
  - Households, cities GFT, MSW



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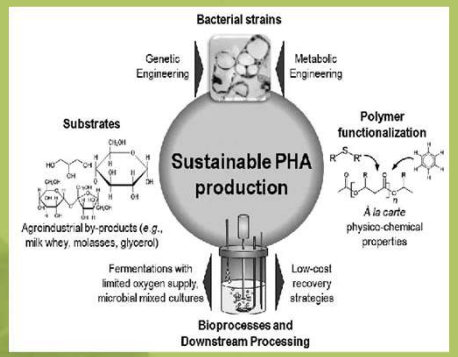
Valorisation of MSW

- Mixed waste: OFMSW, non-organic fraction
- Dedicated biodegradable waste
- Processing and treatment
  - Compost and Anaerobic Digestion (AD)
  - Sewage sludge
  - Bioplastics, biomaterials and dedicated products
- Interactive process
  - Development of business models
  - Stakeholder mobilisation



Anaerobic Digestion (AD)

- Mixed waste: OFMSW => CH4 +

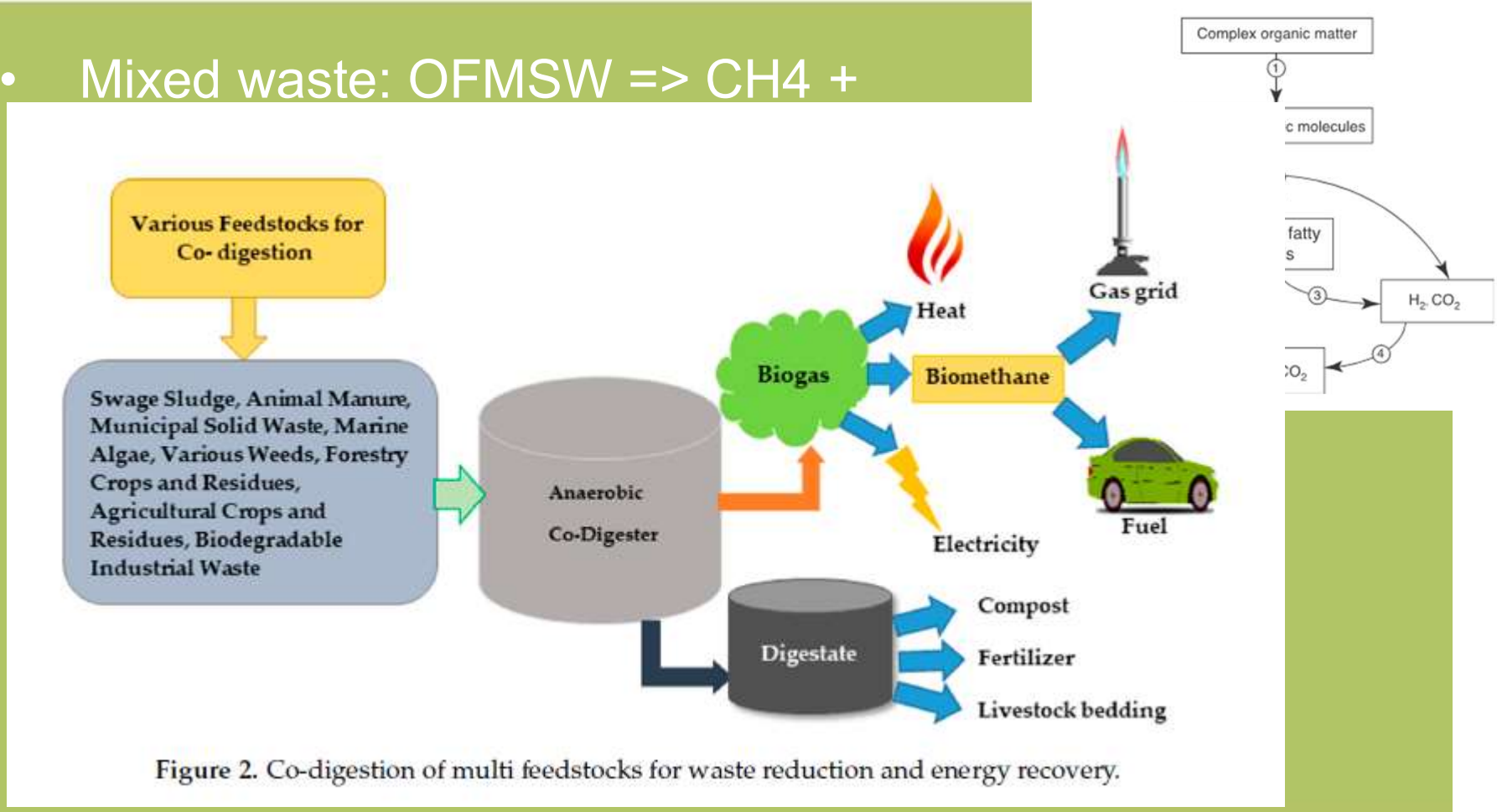


Figure 2. Co-digestion of multi feedstocks for waste reduction and energy recovery.

Anaerobic Digestion (AD)

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Table 1. Potential feedstocks for co-digestion to balance nutrient with regard to C/N ratio [26,50–52].

Feedstocks with Max C/N Ratio <20	C/N Ratio	Feedstocks with Max C/N Ratio ≤40	C/N Ratio	Feedstocks with C/N Ratio Around or >50	C/N Ratio
TWAS [1]	6–9	OFMSW [3]	24	Potatoes	35–60
CSW [2]	11	Cow dung	16–25	Oat straw	48–50
Poultry manure	5–15	Horse manure	20–25	Corn stalks/straw	50–56
Pig manure	6–14	Kitchen Waste	25–29	Fallen leaves	50–53
Goat manure	10–17	Peanut shoots/hulls	20–31	Rice straw	51–67
Grass/Grass trimmings	12–16	Slaughterhouse waste	22–37	Seaweed	70–79
Alfalfa	12–17	Mixed food waste	15–32	Algae	75–100
Food Waste	3–17	Waste cereal	16–40	Sugar cane/bagasse	140–150
-	-	Sugar beet/Sugar foliage	35–40	Sawdust	200–500
-	-	Waste cereals	16–40	-	-

Note: [1] Thickened Waste Activated Sludge, [2] Caned Seafood Waste, [3] Organic Fraction of Municipal Solid Wastes.

Anaerobic Digestion (AD)

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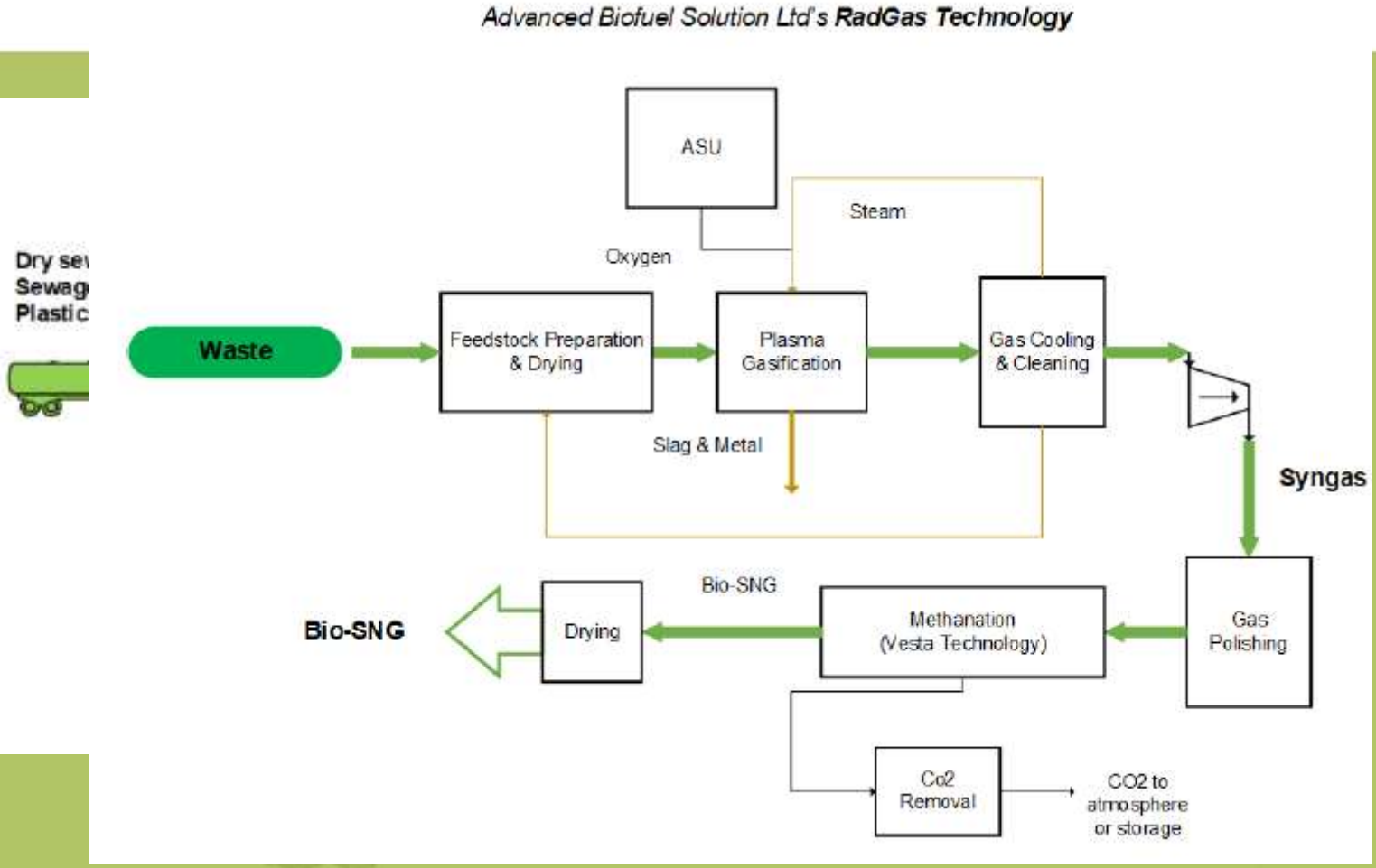
Product	Unit	Value
Total Solids	% of Fresh Matter	1.5–45.7
Volatile Solids	% of Total Solids	38.6–75.4
pH		7.3–9.0
N Total	% of Dry Matter	3.1 - 14
idem	% of Fresh Matter	0.12–1.5
Nitrogen NH_4	% of total N	35 - 81
Total phosphorus	% of Dry Matter	0.2–0.35
idem	% of Fresh Matter	0.04–0.26
Total potassium	% of Dry Matter	0.19–4.3
idem	% of Fresh Matter	0.12–1.15

Gasification



Jafri et al. (2020) Emerging Gasification Technologies for Waste & Biomass. IEA Bioenergy

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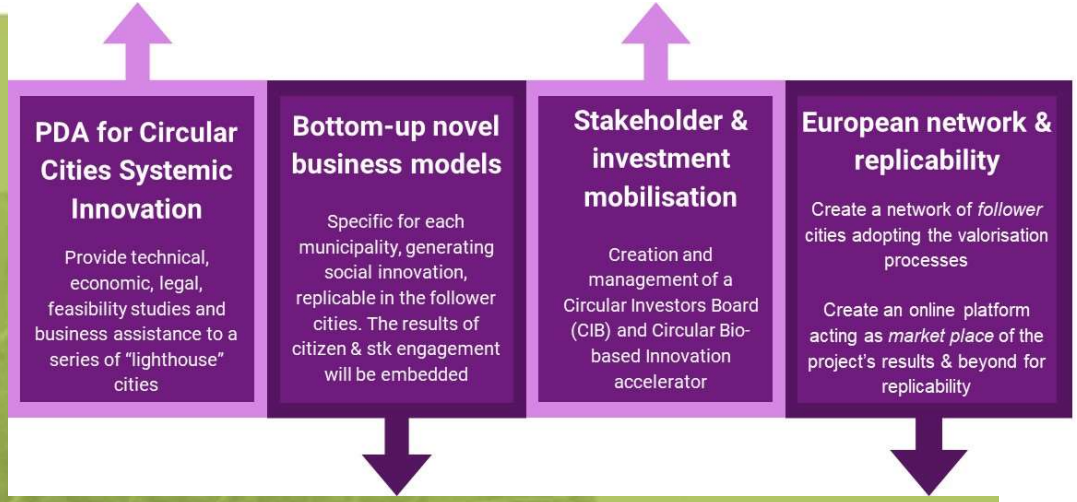
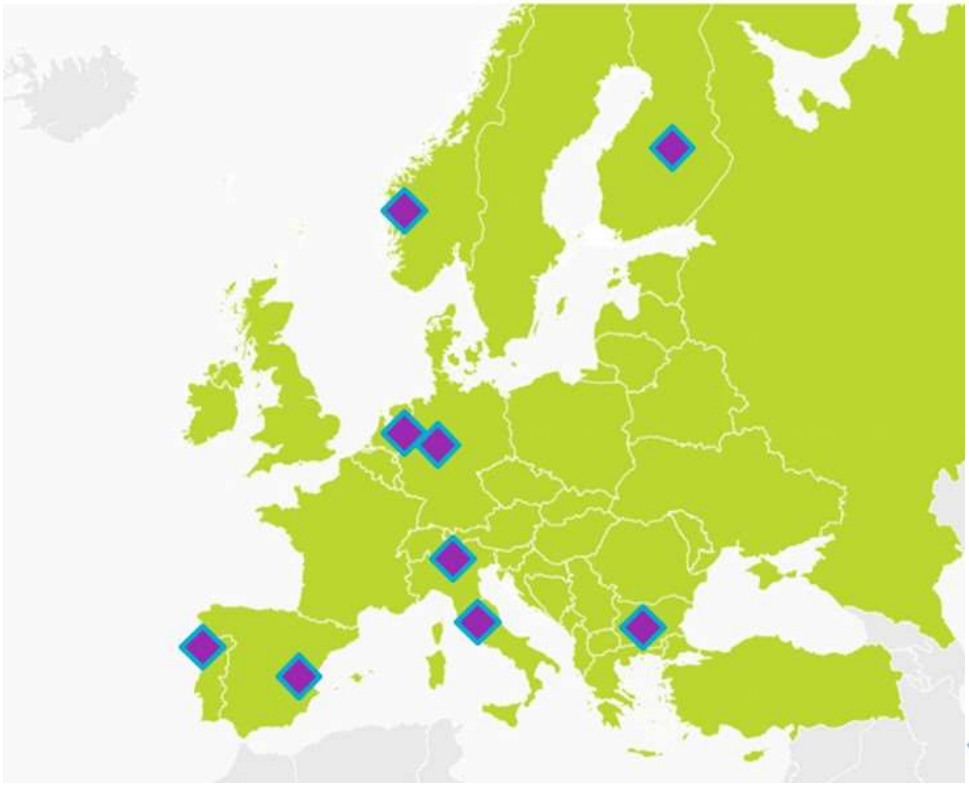
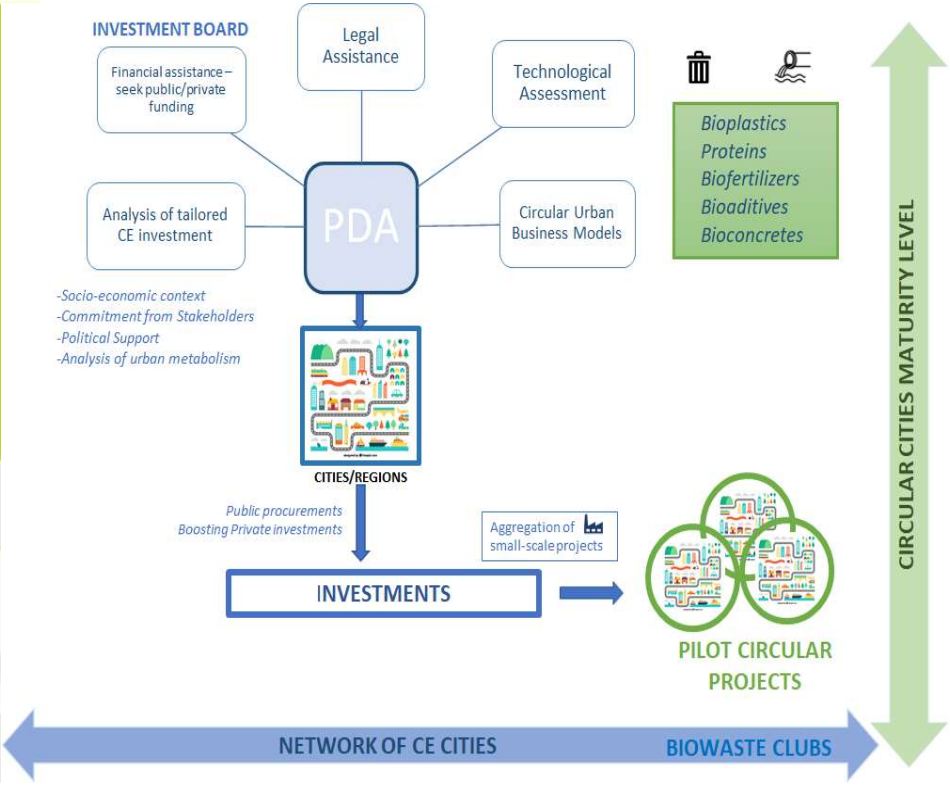
The HOOP Project

- Developing alternative production chains demonstrated by lighthouse cities
- Eight lighthouse cities / regions, 15 technical partners
- Developing circular Biobased Economy chains
    - Data on waste and treatment
    - Selection of biobased investment options



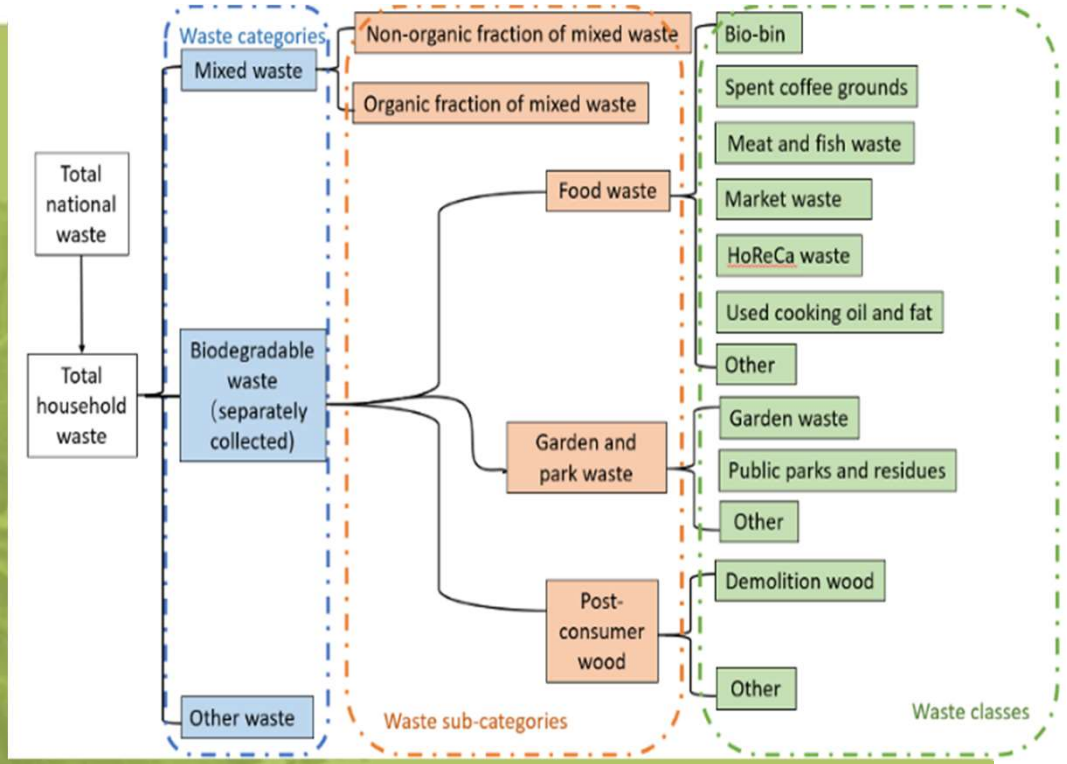
The HOOP Project





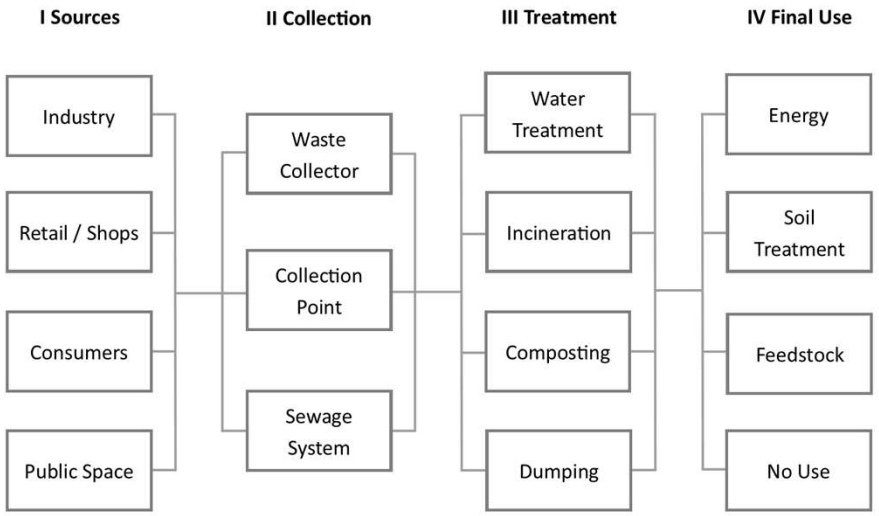
Waste streams

- Mixed waste
  - Organic Fraction (% of MSW)
  - Non-organic fraction
- Dedicated biodegradable waste streams
  - Food waste
  - Garden and park waste
  - Post-consumer wood
- Other municipal waste
- Sewage sludge from wastewater treatment

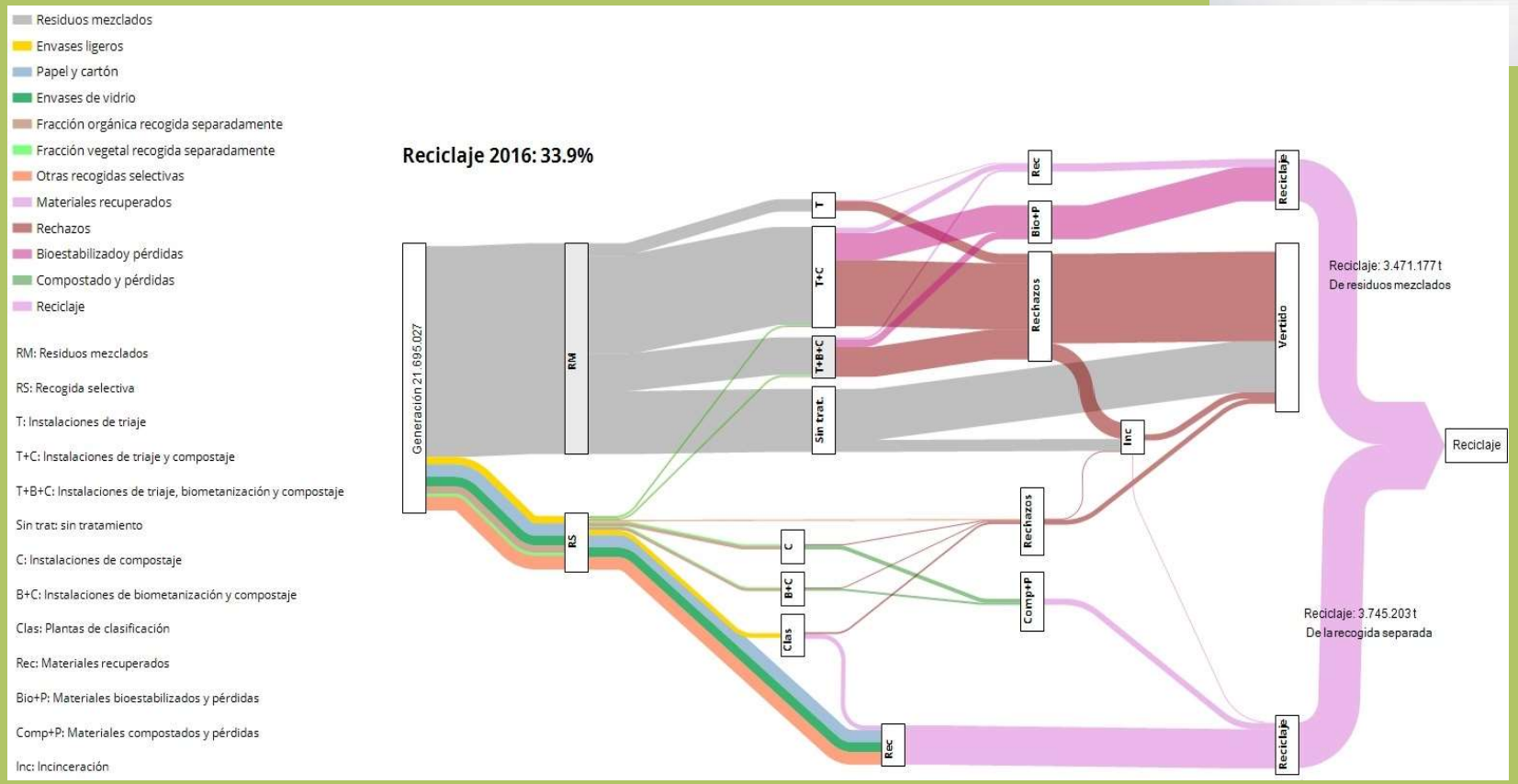


Urban Waste

- Urban Metabolism
  - Analytical concept
  - Implementation and use
- Streams
  - Food
  - Garden and parks
  - Wood
  - Water
  - (Energy)
- Performance and target reporting



Urban metabolism



Source: Sergio Sastre (2019) ‘Cuando Las Cuentas No Cuentan’

Valorisation

- Existing conversion routes
- Options for recycling
- Alternatives
- Biobased options
  - Waste streams
  - Treatment
  - New production c

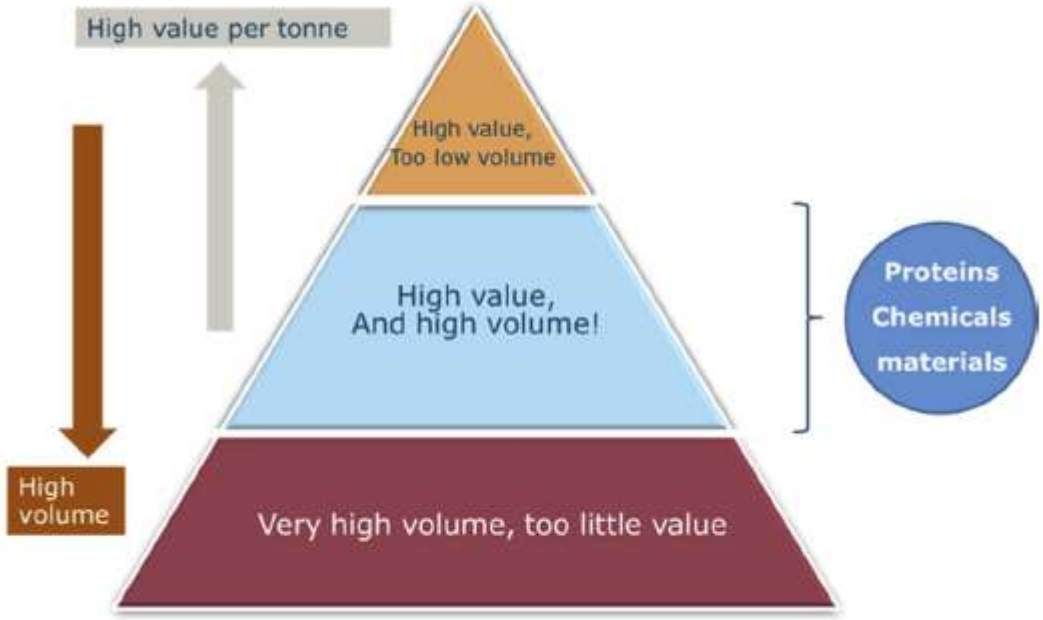
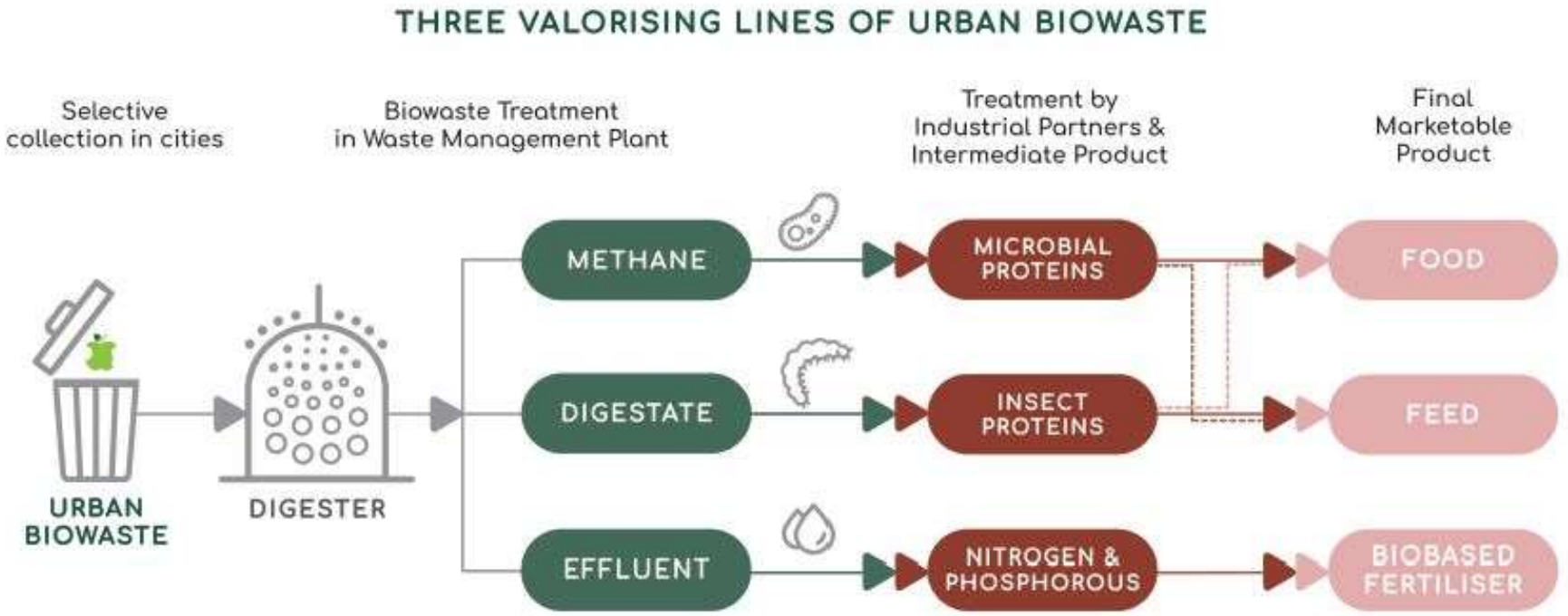


FIGURE 2.1 Ecopyramid.

Source: Sanders and Langeveld (2020)

New production chains

- Using existing waste streams
- Identify and compare processing options
- Develop value chains



Conclusion

- High policy targets have been set on GHG emissions, waste reduction and recycling
- Large amounts of MSW can serve as feedstocks for the production of energy and biobased materials
- Various routes for energy generation are available
- Anaerobic Digestion (AD) has few barriers
- Advanded technologies are under development

Questions

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