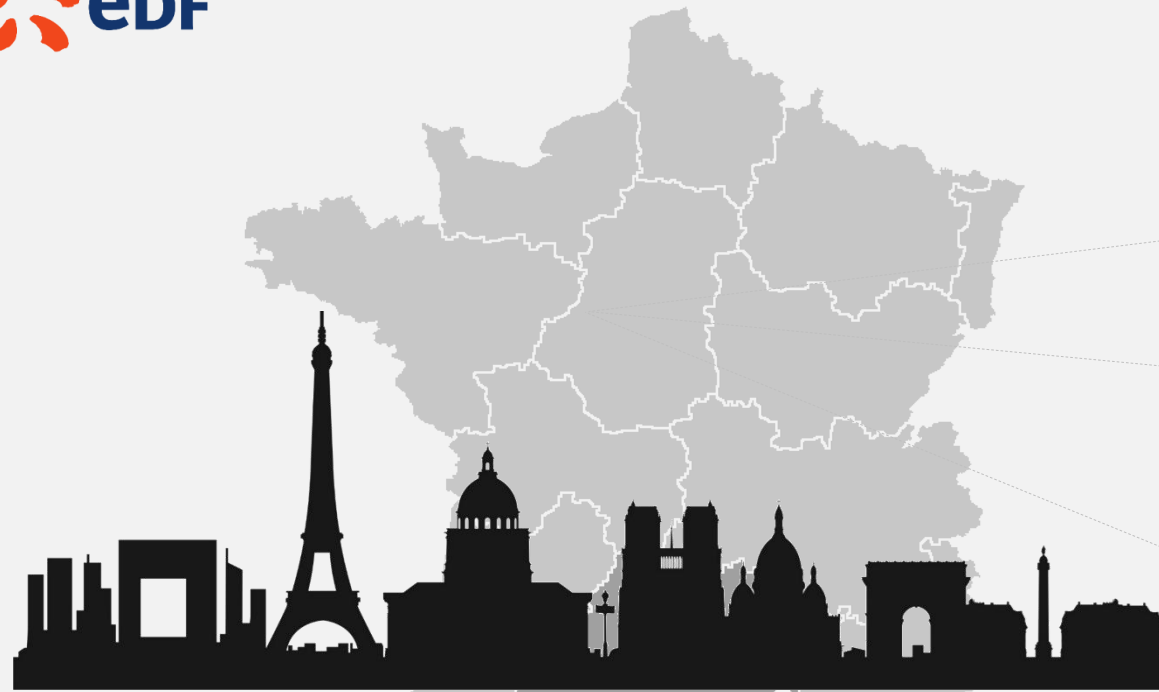




MULTI-CRITERIA BENCHMARKING OF WASTE VALORIZATION



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End of Study Internship
Palaiseau, 05.09.2018

OUTLINE

- I. Context and objectives
- II. Waste characterization
- III. Valorization routes
- IV. Case studies
 - a) Residual wastes in the metropolitan
- V. Conclusion and Perspectives

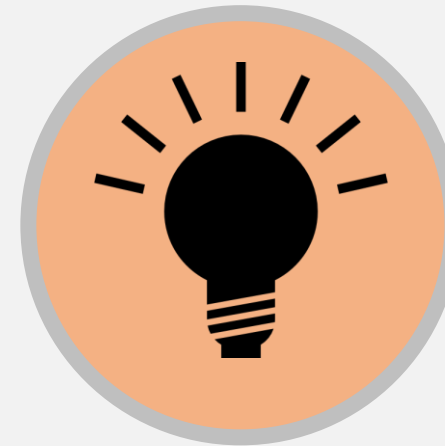


Any room for **alternatives** in France?

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Context and Objectives

The background of conducting this study



I. CONTEXT AND OBJECTIVES

“More Demanding Needs due to Energy Transition”



□ Governmental level regulation

- “National energy transition” directives (LTECV, 2015)



□ Collective movement towards energy transition, particularly in the waste valorization

- **Emergence** of various new technologies

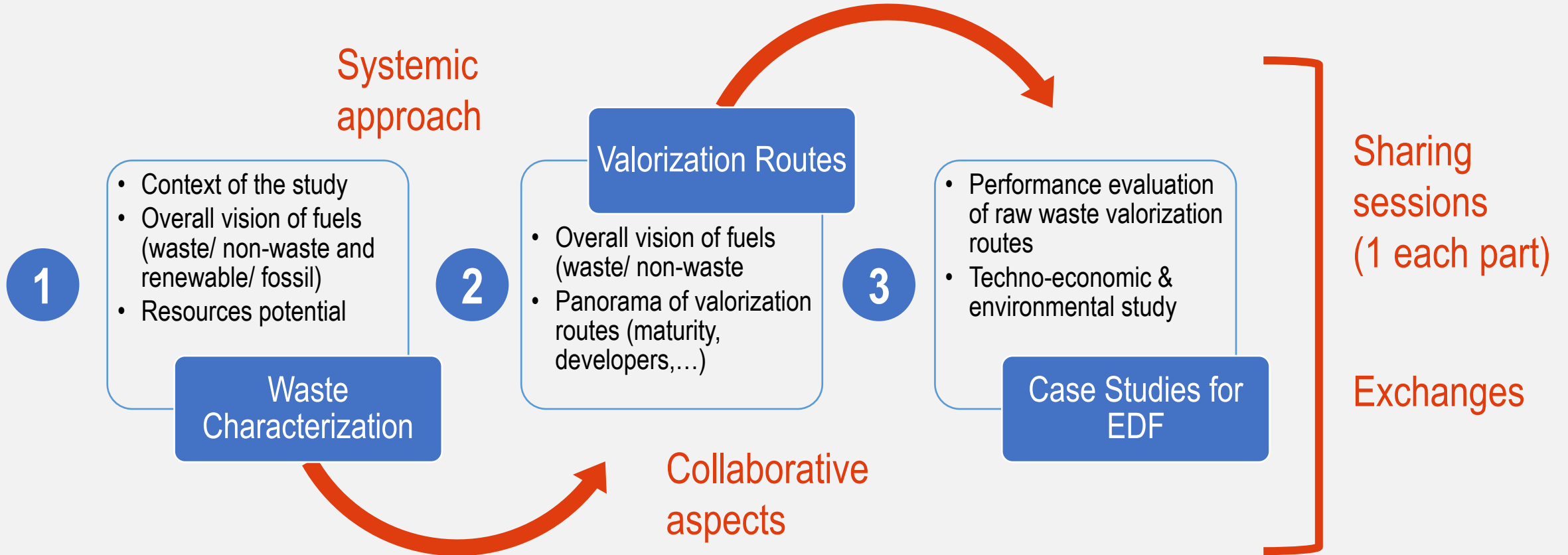


□ EDF as energy & waste actor should meet specific targets

- **Time constraint** and highly **deployable technologies** For examples:
 - DPIT – Transition towards **greener business model**
 - SEI – Seizing the opportunity of energy production from **waste on site**
 - Tiru – Finding **alternative solution to conventional combustion**

GENERAL METHODOLOGY

Systemic
approach



- Key literatures from: RECORD, ADEME, AMORCE, ANCRE
- Contributing departments: Colleagues from MFEE, EIFER, TREE
- Other entities: Interlocutors from SEI (client), TIRU

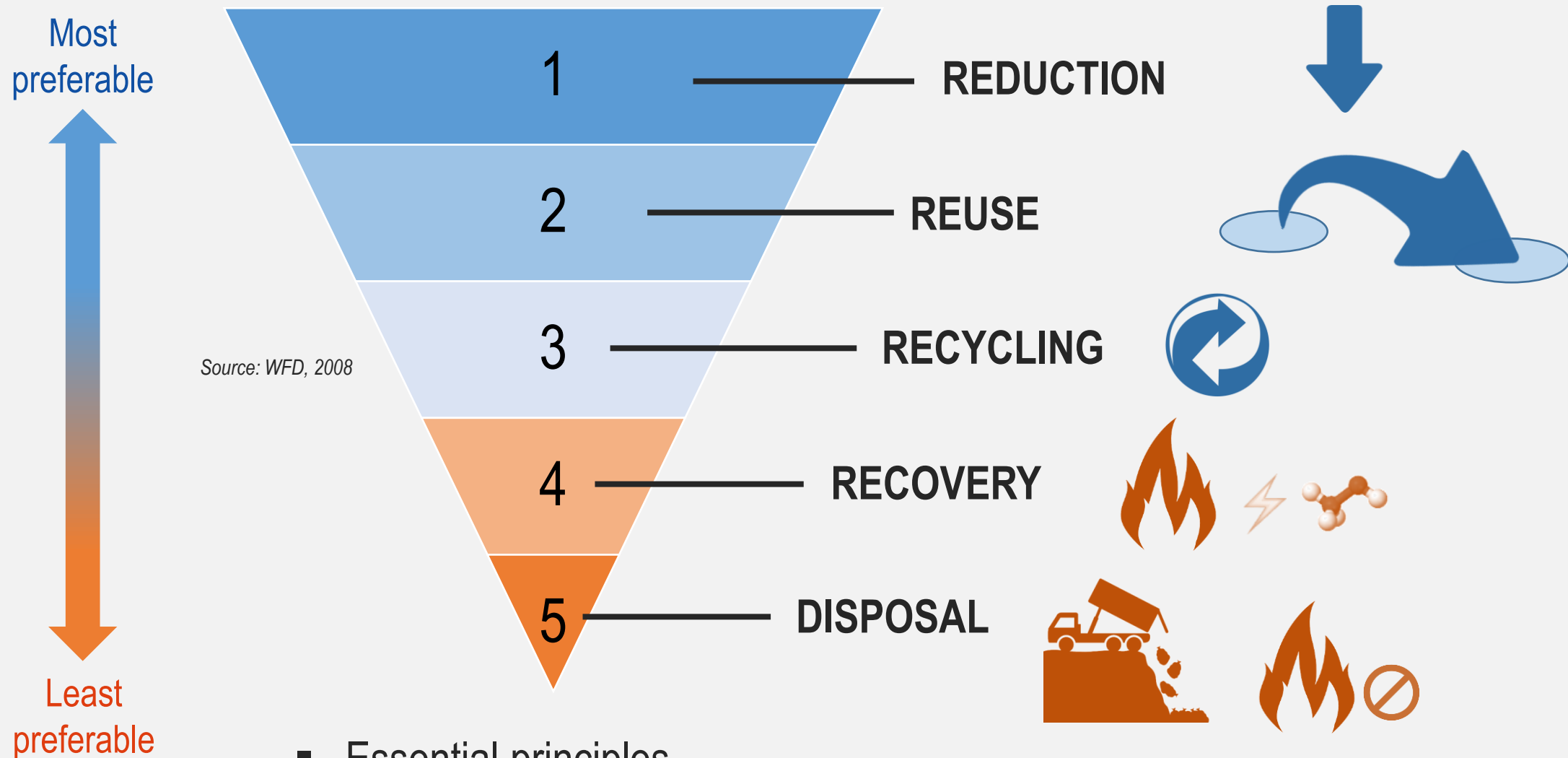
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Waste Characterization

Revealing the waste management practice and classification of wastes



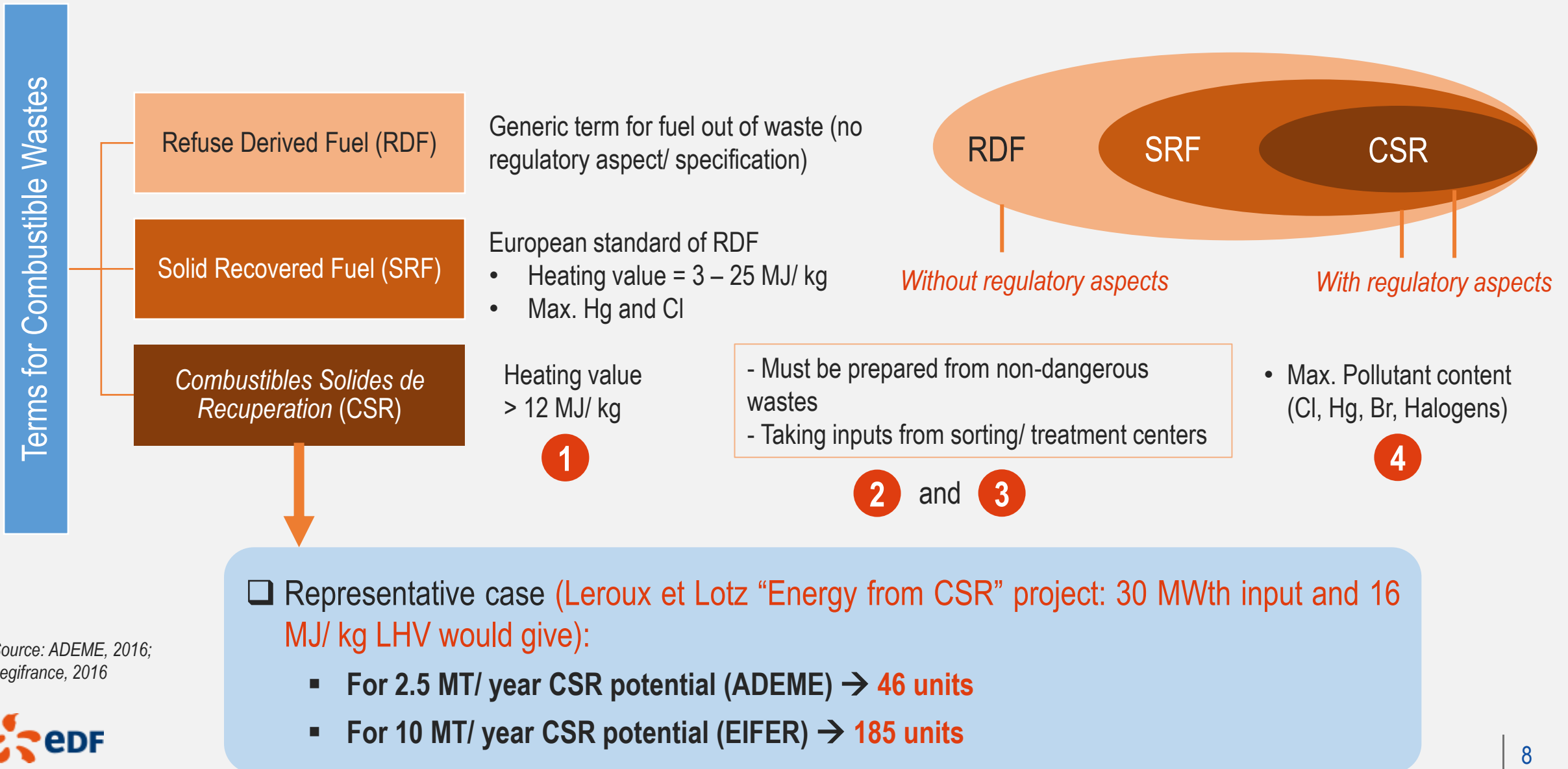
WASTE MANAGEMENT HIERARCHY



- Essential principles

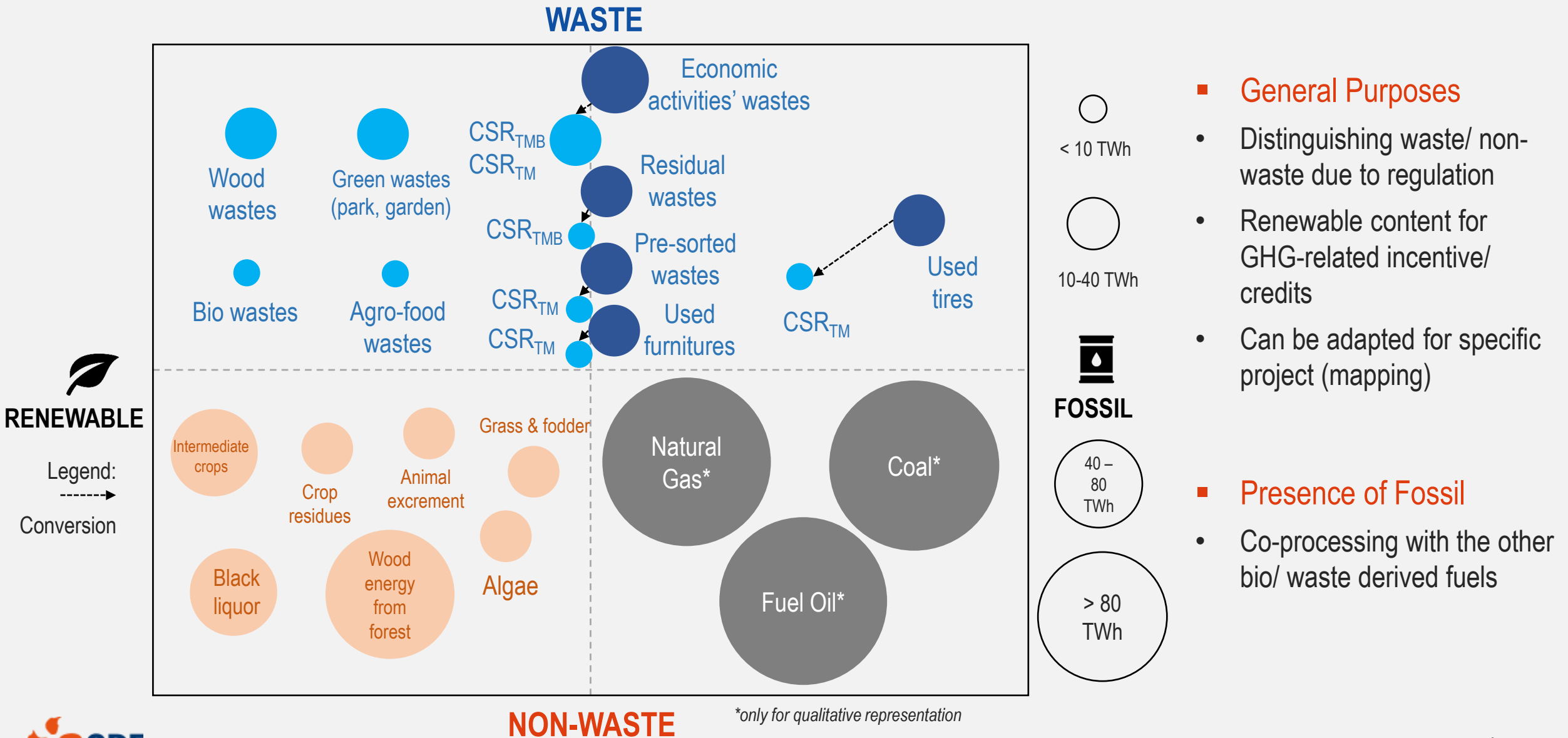
Some options should come after the others, if there is no demand (moving to the lower level)

FUELS FROM WASTE - CLASSIFICATION



Source: ADEME, 2016;
Legifrance, 2016

WASTE MATRIX – RESOURCE POTENTIAL



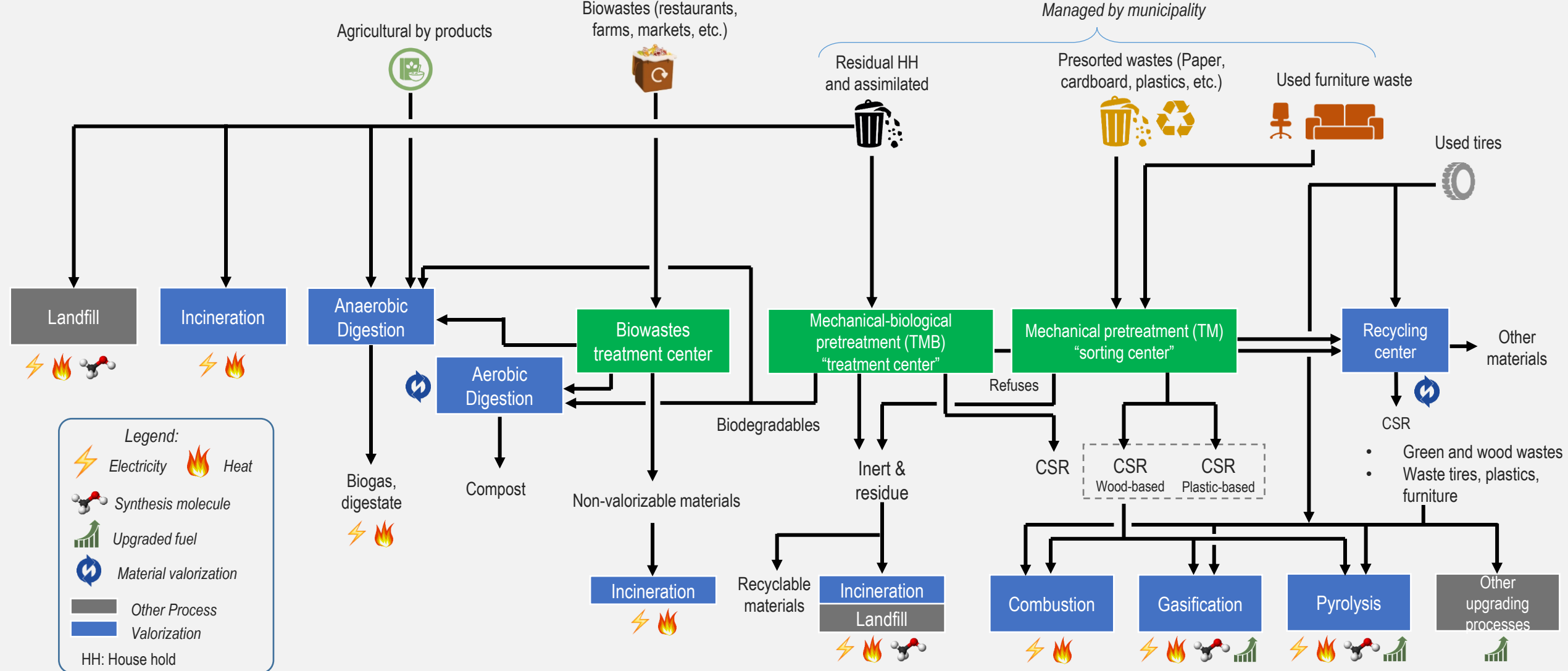
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Energy Valorization

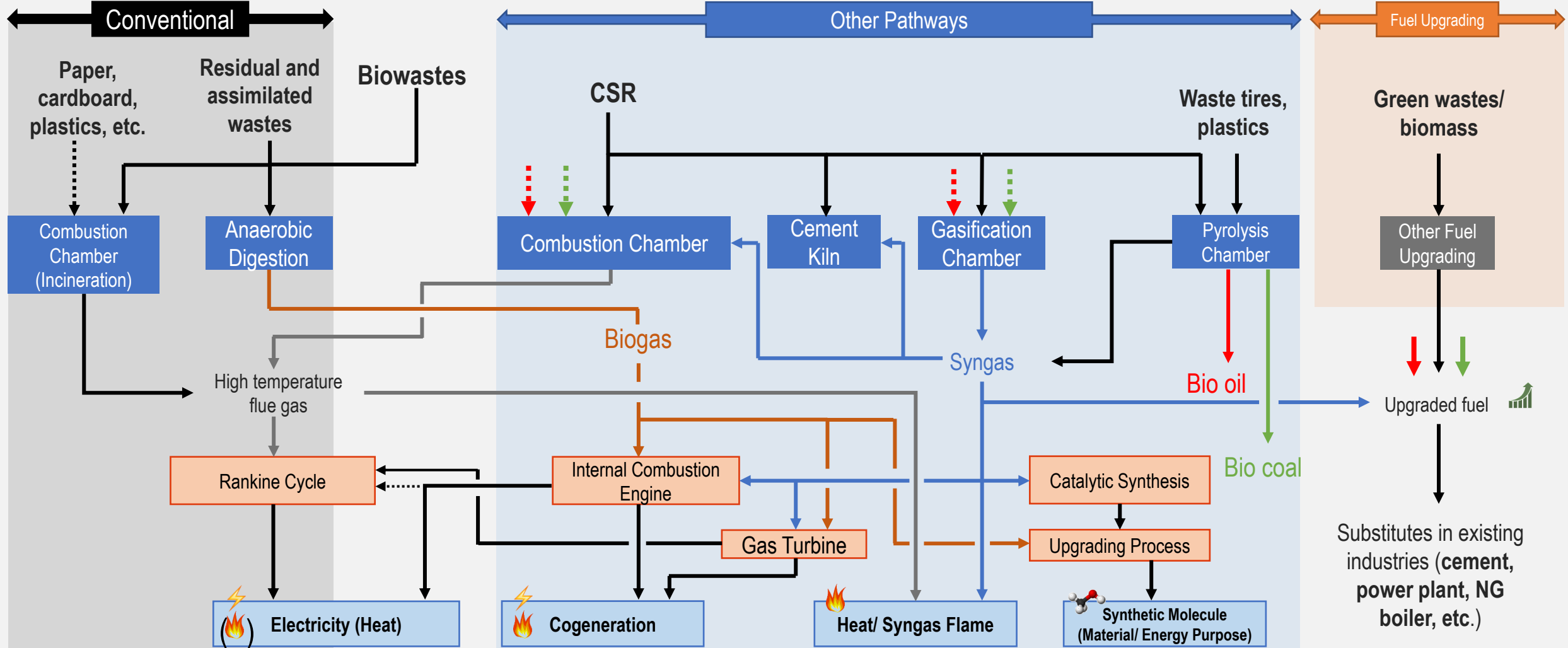
Describing various conversion technologies applied for waste processing



MUNICIPAL WASTE MANAGEMENT PATHWAYS

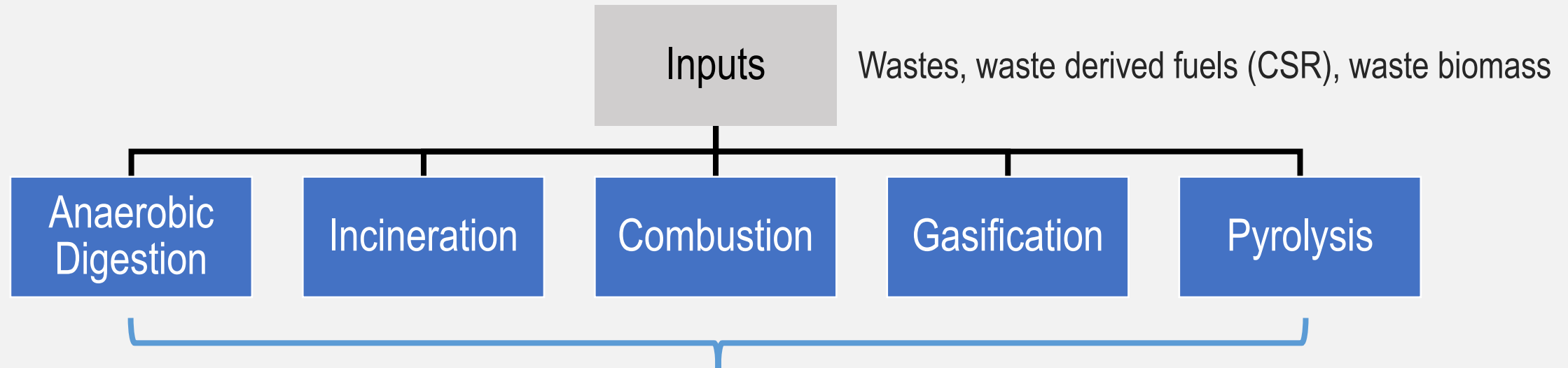


ENERGY VALORIZATION OPTIONS



- Complexity to draw holistic views and comparisons
- CSR valorization in France is mainly through cement kilns (although facing some burdens)

TECHNOLOGY COLLECTION METHOD



>80 Detected suppliers

Key sources:

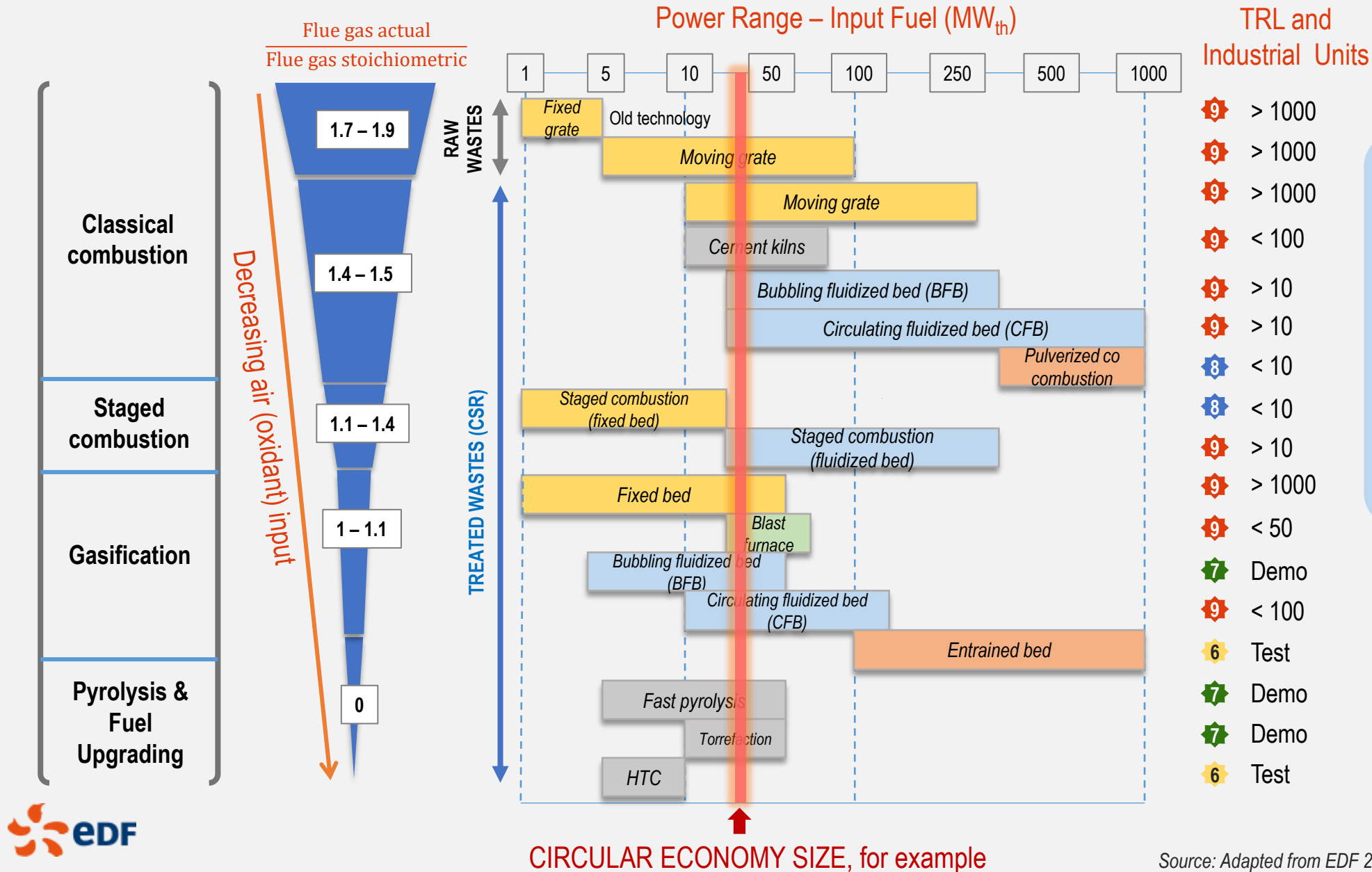
- Suppliers' data
- Study from the past projects (EDF, EIFER, ADEME)

Technologies

Technology collection

- Name of supplier
- Number of industrial units
- Maturity (Readiness level)
- Treatment capacity - MW_{th}
- Products: ⚡ 🔥 🧪 📈

TECHNOLOGIES – SIZE RANGE AND AIR INPUT



Essences:

- Thermochemical conversion data compilation
- Technology **pre-selection tool** based on size

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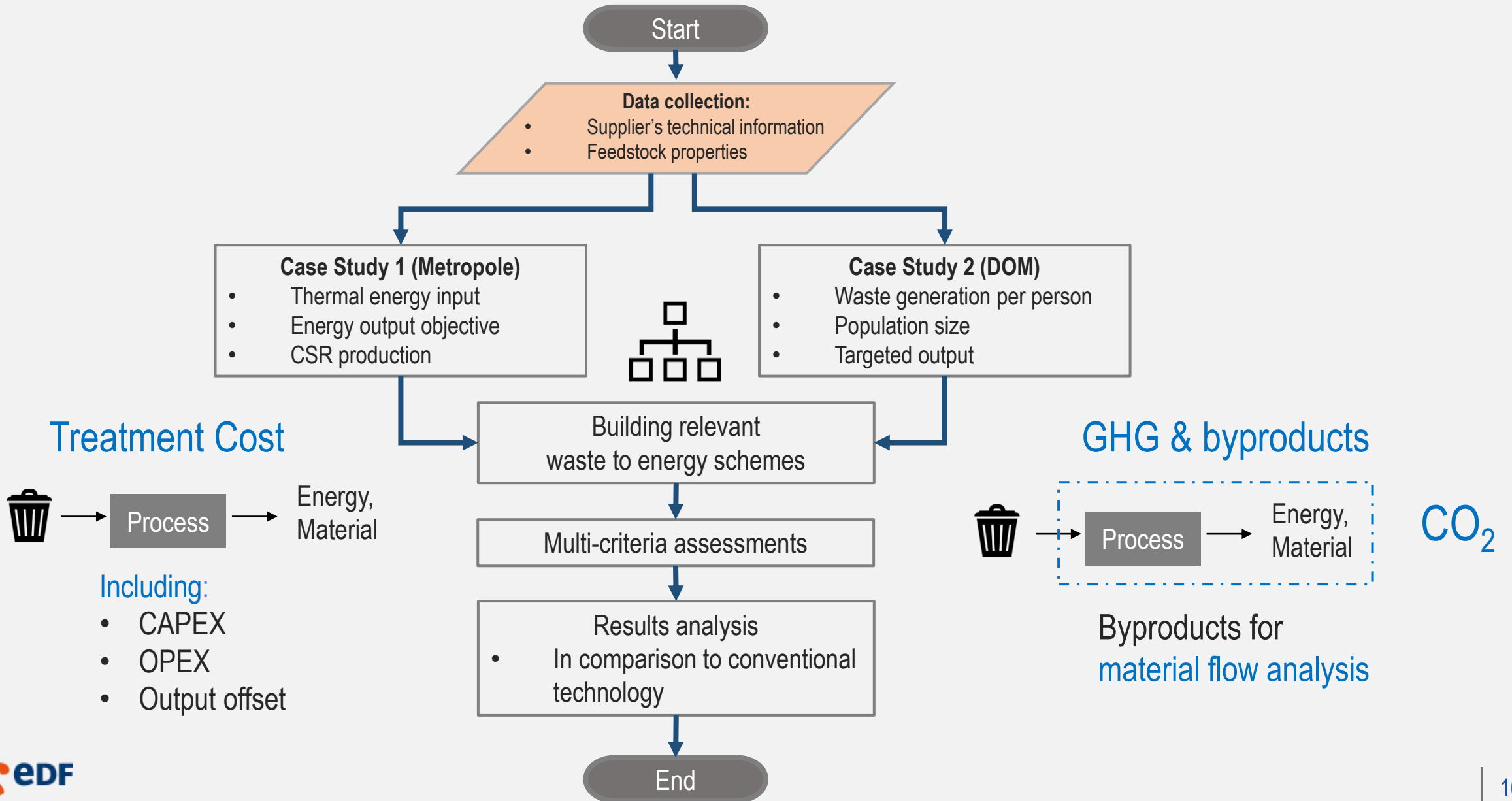
Case Studies

Evaluation of case study for energy valorization from wastes:

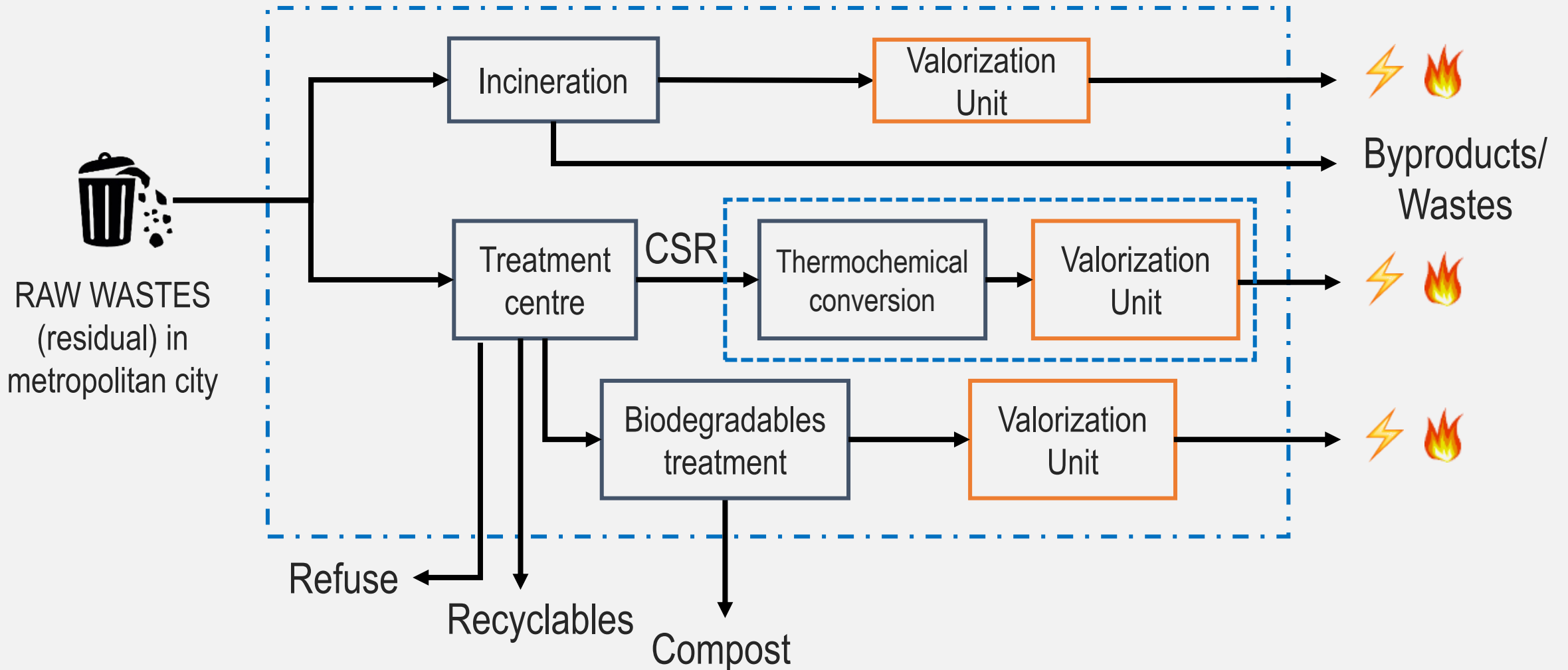
Residual wastes in the metropolitan



ASSESSMENT METHODOLOGY



CASE STUDY 1) RESIDUAL WASTES VALORIZATION



SCHEMES DEFINITION FOR METROPOLITAN CASE

Scheme, Power Block	MW _{th} Input		
	Heat	Cogeneration	Electricity
1: Large scale combustion, Rankine cycle	✓	100	
2: Medium scale combustion, Rankine cycle	✓	50	
3: TMB + combustion, Rankine cycle	✓	50	
4: TMB + gasification, Rankine cycle	✓	50	
5: TMB + gasification, Gas engine	✓	50	



Direct

Combustion

RAW WASTES



TMB

CSR

Combustion
Gasification

RAW WASTES

Valorization

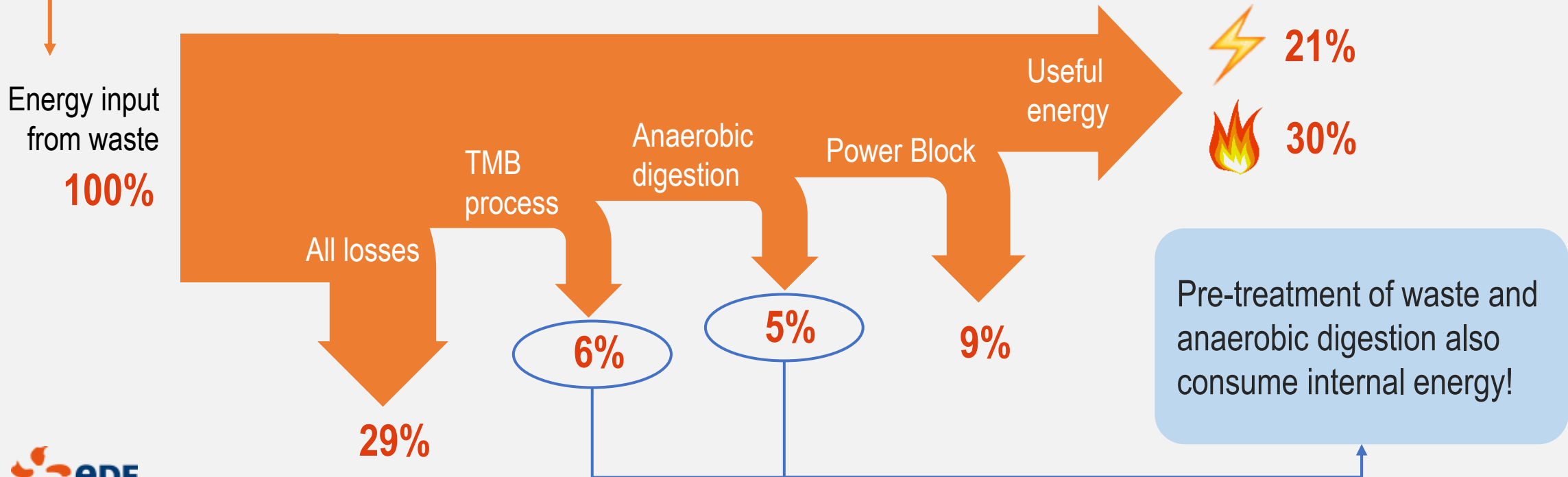
+ 4 other schemes

Recommendable size for territorial unit
(ADEME)

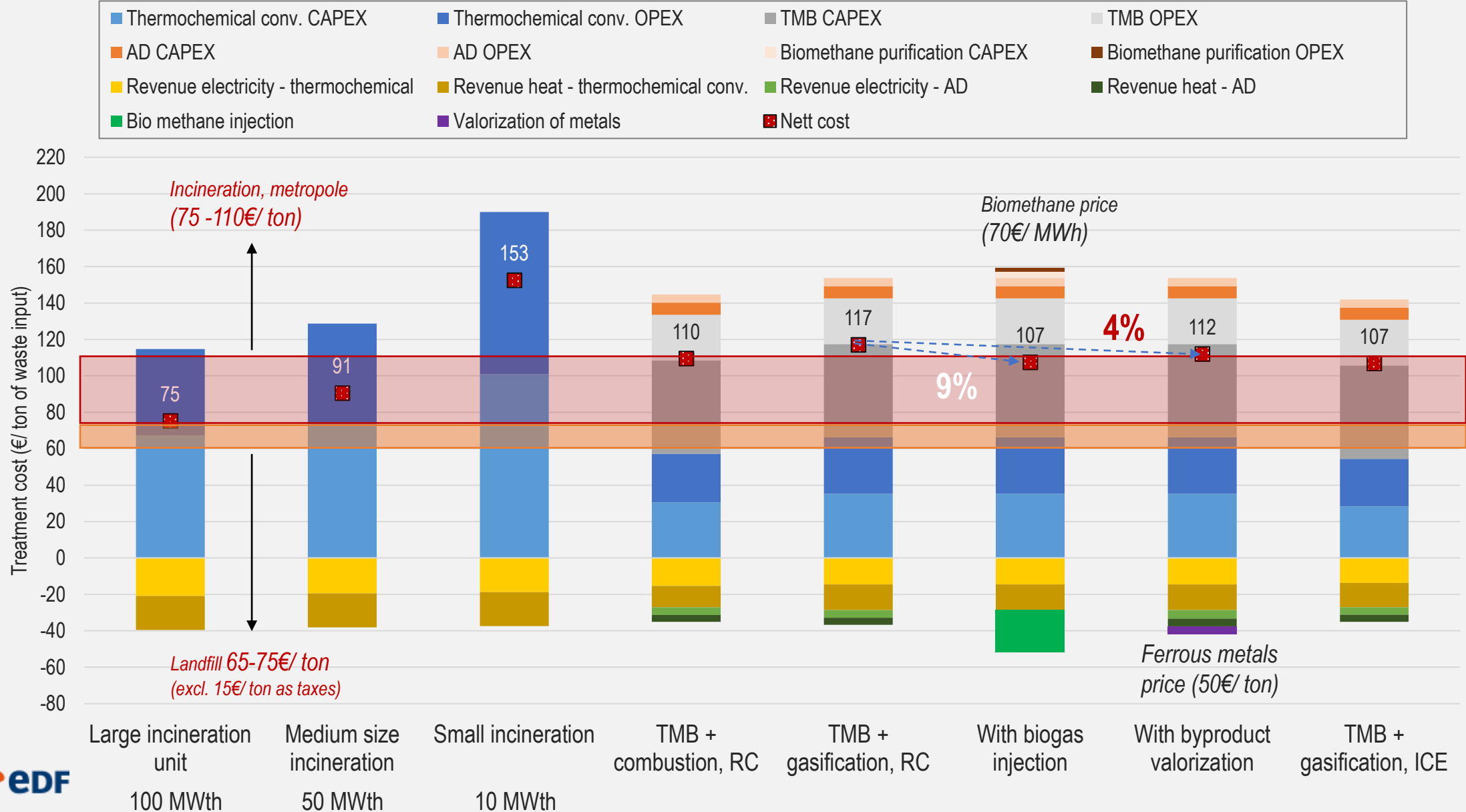
No single production is allowed for unit > 20 MW_{th}
(Article 4, Arrêté du 23 mai 2016)

TECHNO-ECONOMIC RESULTS

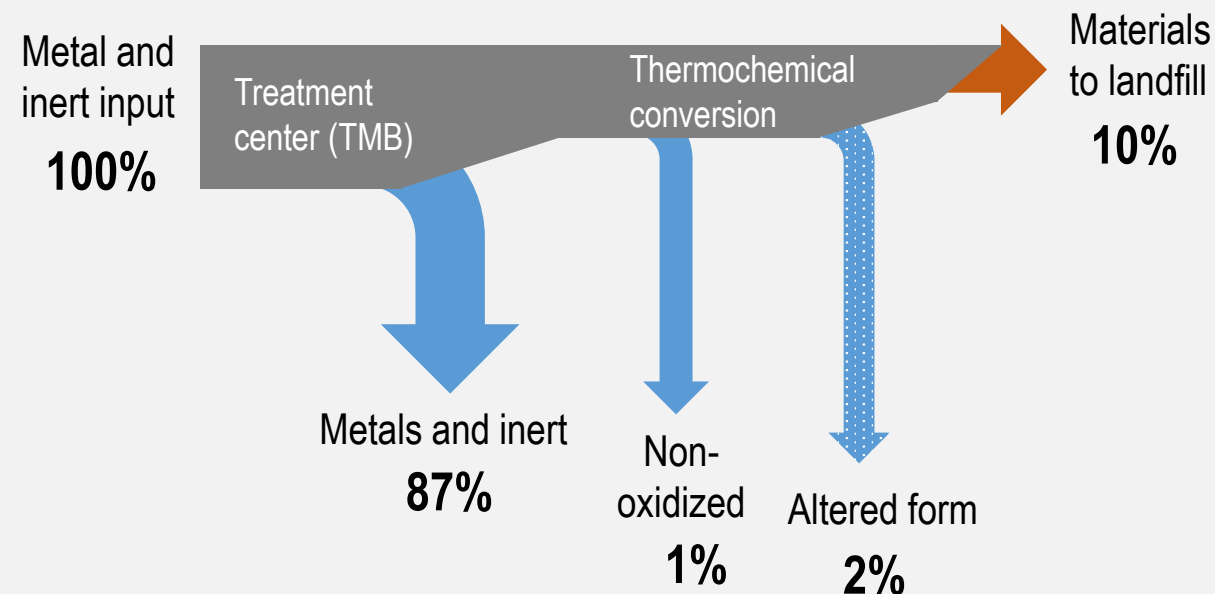
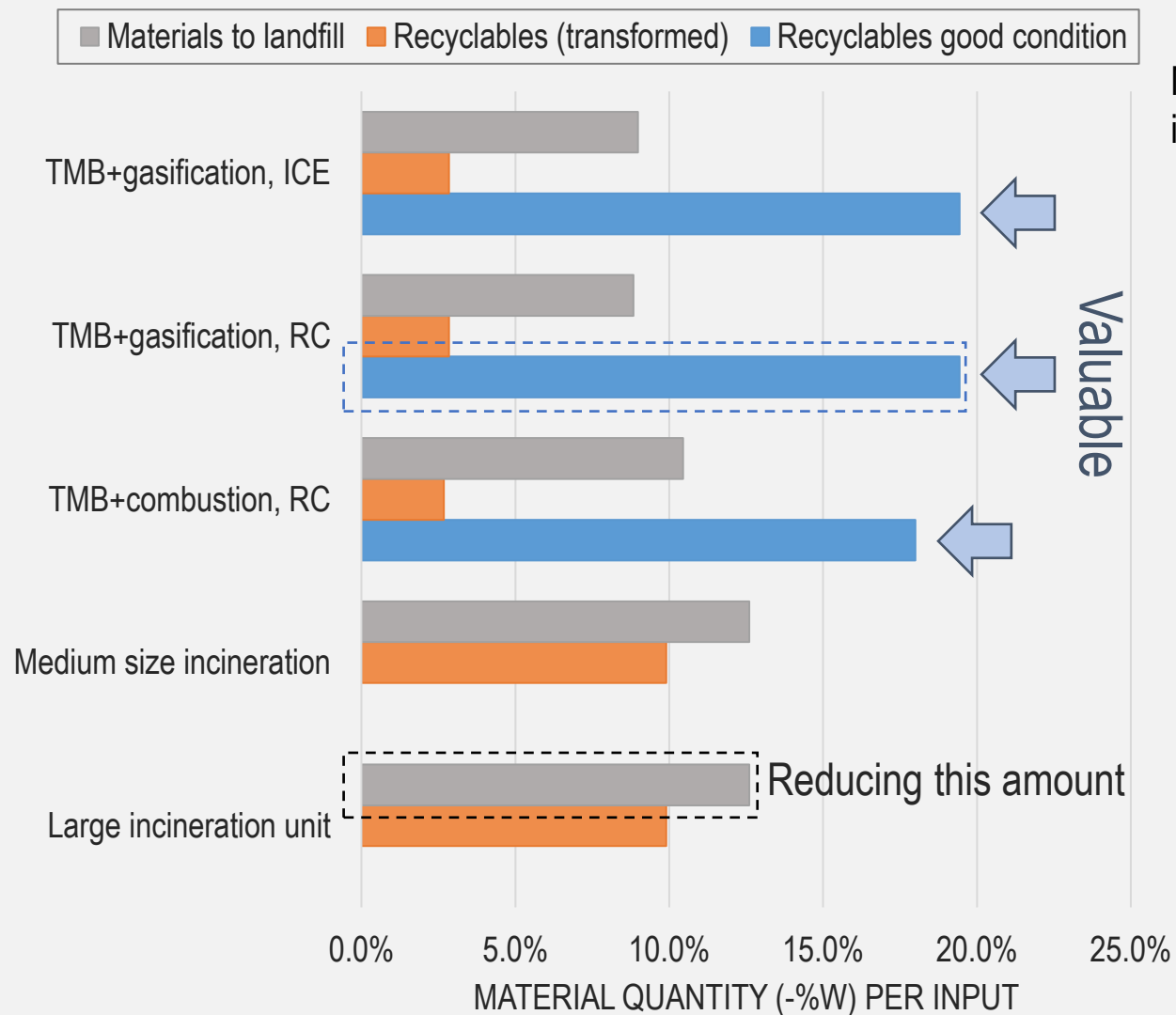
Scheme	Annual Energy Valorization		Parasitic load and losses (GWh)	Overall efficiency%	CAPEX (Million €)	OPEX (Million €/ year)
	Electricity (GWh)	Heat (GWh)				
1	205	257	338	0,57	190	12,3
2	96	128	176	0,56	104	7,8
3	87	103	210	0,48	125	8,1
4	83	119	198	0,51	131	8,7
5	79	114	207	0,49	121	8



TREATMENT COST (CASE STUDY METROPOLE)



MATERIAL VALORIZATION (RECOVERABILITY)



- **Recyclables good condition (inert and metals)**
 - Mainly separated at TMB
 - Certain portion from bottom ash
- **Transformed materials (slag/ oxidized metals)**
 - It can be recycled via post-treatment

MULTICRITERIA SUMMARY (SYNTHESIS)

Criteria	RESIDUAL WASTES VALORIZATION (CASE STUDY) - SCHEMES				
	1	2	3	4	5
	Large Direct C, RC	Medium Direct C, RC	TMB + C, RC	TMB + G, RC	TMB + G, ICE
Energy production	↑	↑	↓	=	↓
Treatment cost	↑	=	=	↓	=
Byproduct management	↓	↓	↗	↑	↑

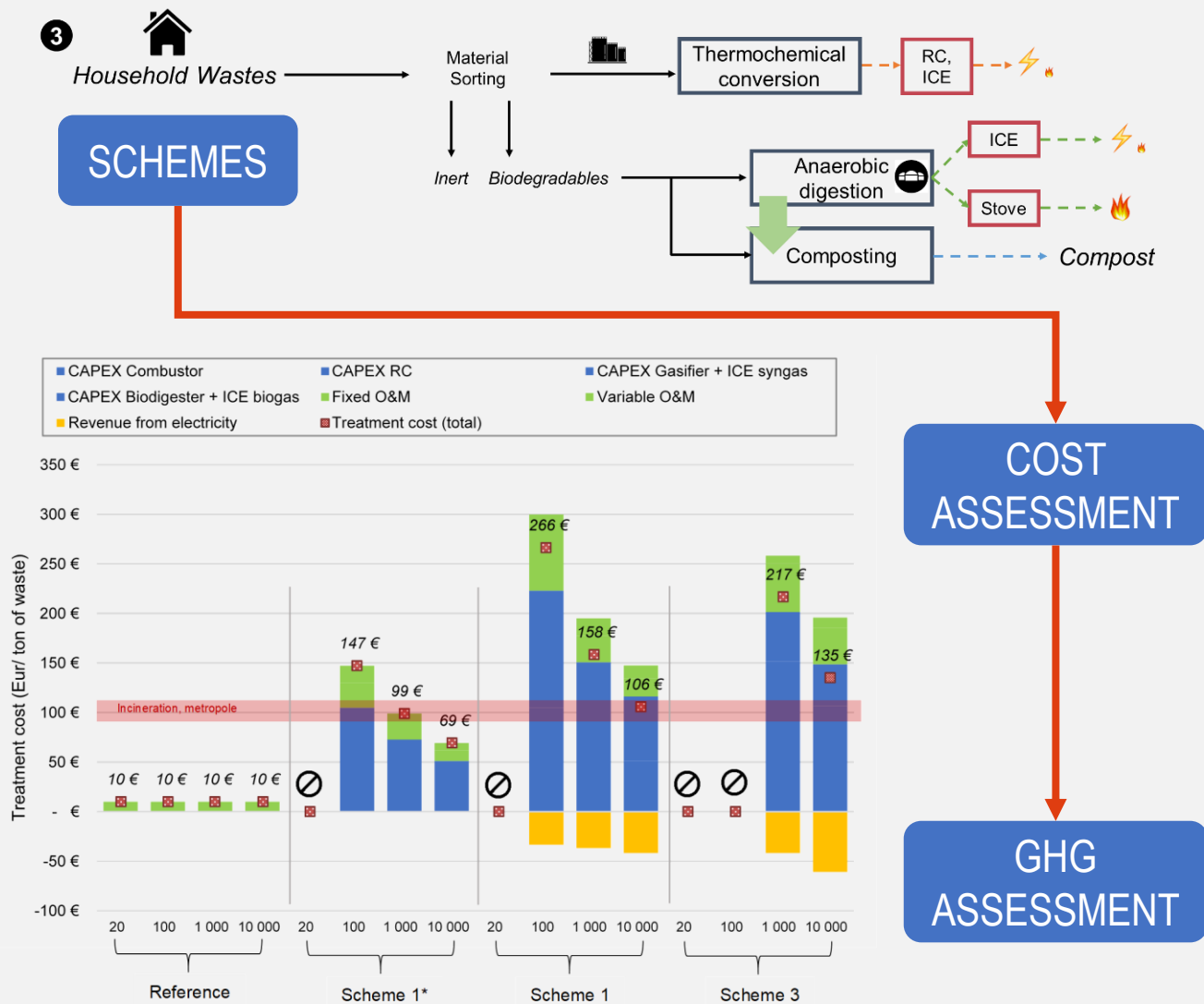
TMB: Mechanical-biological treatment
C: Combustion
G: Gasification

RC: Rankine cycle
ICE: Internal combustion engine

↑ : Good = : Neutral ↓ : Poor

- Various aspects are involved (complex)
- Always optimize resources following waste hierarchy

CASE STUDY 2) HOUSEHOLD WASTES IN 'DOM'



Case	WITHOUT VALORIZATION	WITH ENERGY VALORIZATION			
	Present	Before 2030 (Replacing Fossil fuel)		After 2030 (Replacing Renewable energy)	
	Combustion	Combustion	Gasification and Anaerobic digestion	Combustion	Gasification and Anaerobic digestion
	Scheme 1*	Scheme 1	Scheme 3	Scheme 1	Scheme 3
20	-	-	-	-	-
100	-824	854	-	-1539	-
10 00	-411	500	317	-685	-2598
10 000	-222	302	175	-359	-929

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Conclusion and Perspectives

Takeaways from this project and how to advance



V. CONCLUSIONS AND PERSPECTIVES



- Management techniques should always follow the waste hierarchy

Analysis of circular economy roadmap for France (French government has issued in May 2018)



- Various combinations are possible for 'waste to energy' units, depending on the needs

In-depth investigation about byproducts valorization through different technologies and purposes



- TMB unit to produce CSR increases the treatment cost, but with a better material valorization

Assessment of pre-sorted industrial/ economic activities' wastes for CSR production

Merci

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Palaiseau, 05.09.2018