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11 reasons why Carbon Capture should be prioritized in the Waste to Energy sector

ir. Benoit Englebert 26 October 2022

Introduction: key take-away of 6th IPCC report conclusions (April 2022)

- Besides the common mitigation options*, other measures are recognized to be **critical** to meet net zero:
  - Carbon capture and storage
  - Carbon capture and utilisation
  - Carbon dioxide removal
  - Reduce methane emissions from solid waste

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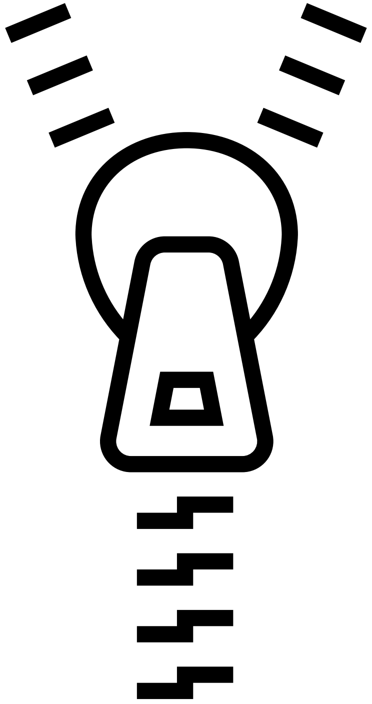
** i.e. renewable energy, electrification of transport, energy efficiency in building or material efficiency in industry, nature based solutions…*

Introduction: key take-away of 6th IPCC report conclusions (April 2022)

Waste to Energy

Carbon Capture Storage/Utilisation



- Carbon capture and storage
- Carbon capture and utilisation
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11 reasons why Carbon Capture should first be deployed in the Waste to Energy sector

WtE plant in Bao An, China

1. The low hanging fruit: methane

- Today, humankind produces 2 bio tonnes of municipal solid waste per year.
- 70% of it is still landfilled: 1,4 bio tonnes per year, or 45 000 kg per second
- Landfilling produces methane*
- Methane is 84X more harmful to the climate than CO_2 in its first 20 years in the atmosphere
- 18% of anthropogenic CH_4 emissions are from the waste sector, of which 90% from landfill and waste water.

** Besides other dramatic consequences like air pollution, water contamination, soil degradation, plastic dissemination, disease/virus propagation, and definitive loss of the materials that are landfilled*

1. The low hanging fruit: methane

Comparing emission factors, we need to urgently divert waste from landfills

600 kg CO_{2eq}/ton waste treated in Europe (100 yr) (CEWEP 2022)

Up to 5000 kg CO_{2eq} /ton waste treated (passive venting landfills - 20 yr) (Wang et al. 2020)

WtE plant in Fangshan, China

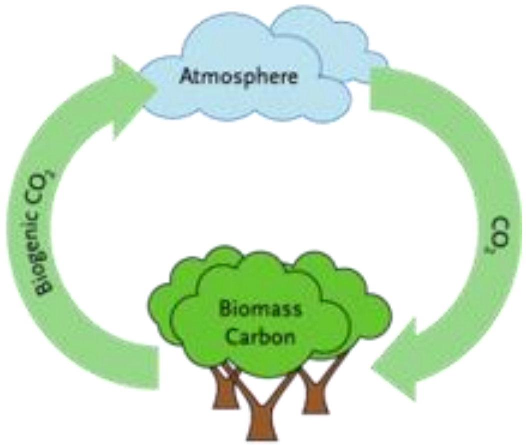
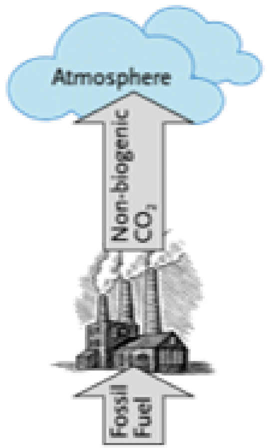
-20 kg CO_{2eq}/ton waste treated in Europe
Including energy substitution and IBA recovery (100yr) (CEWEP 2022)

2. WtE + CCS = CDR * = negative CO_2 emissions

- 50-60% of municipal solid waste is from biogenic source (wood, paper and food waste)

- WTE integrated with CCS is uniquely positioned as one of the few negative CO_2 emissions technologies

- As a negative emissions technology, WTE integrated with CCS will be able to off-set the emissions of other more challenging CO_2 emitters

	Biogenic	Non-biogenic
Source		
WTE	Net zero emission	Net positive emission
WTE + CCS	Net negative emission	Net zero emission

* *WtE = waste to energy*
CC = carbon capture
CDR = carbon dioxide removal

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3. Proven technical viability

Project	Operation start	Technology	Scale	Status
Klemetsrud WTE in Oslo, Norway 	2026	Amine	400 000 tCO_2 per year	Starting construction
Duiven WTE, Netherlands 	Q3 2019	Amine	100 000 tCO_2 per year	Operational
Twence WTE, Netherlands  	2014	Amine	2-3 000 tCO_2 per year	Operational
	Q4 2023	Amine	100 000 tCO_2 per year	Construction to commence in 2022

4. Stable & Reliable operation

- WTE plants run continuously
- Availability > 8000 hours/year
- Planned yearly shutdown

➔ Continuous delivery of:

- steam
- electricity
- CO_2

WtE plant in Singapore

5. Long term assests

- WtE plants are backed up by long term contracts for waste supply and energy offtake

- WtE plants are local: close to the waste source and to the energy offtake

- No risk of delocalisation

- Some examples:

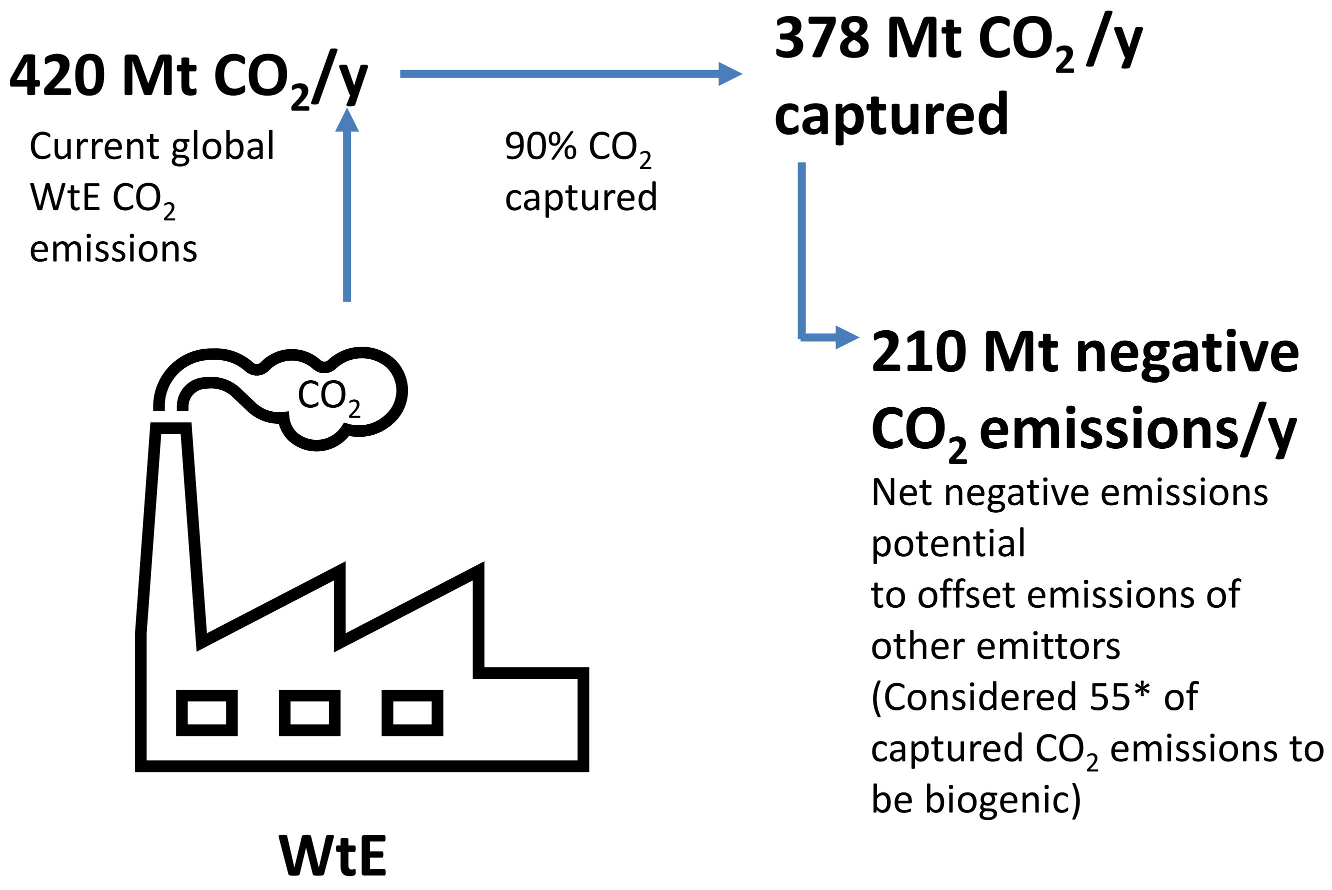
  - *ISVAG in Belgium: built in 1989 and still operating smoothly*
  - *French WtE fleet: 127 plants with an average age of 27 years.*

WtE plant in Antwerp, Belgium (ISVAG)

6. Ready to be deployed

- BECCS (Bio-Energy Carbon Capture Storage) is of the four technologies ready to be deployed on large scale according the National Academies of Sciences, Engineering and Medicine.

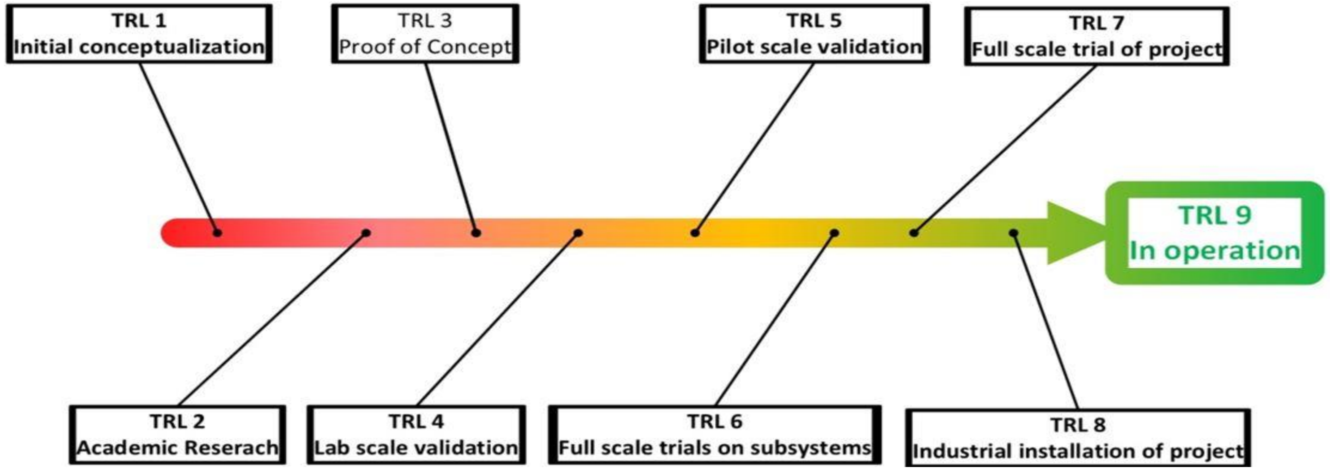
- 2500 WtE plants currently in operation. Total treatment capacity of 420 million tpy (Ecoprog 2022)



7. Scale range

Bialystok (Poland)
15,5 ton MSW/h or 372 ton MSW /day

Bao An (China)
367 ton MSW/h or 8800 ton MSW /day



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8. Integration and Synergies between WtE and CC

WtE produces:
- Heat
- Power
- Cooling
- Other utilities

CC consumes:
- Heat
- Power
- Cooling
- Other utilities

Synergies save:
- CAPEX
- OPEX
- Space

Other potential synergies:
- Flue gas cleaning
- Carbonated residues for bricks
- Sodium bicarbonate for flue gas cleaning


Bricks based on carbonated bottom ash


Bicar Production site in Twence WTE using captured CO2 of the WTE

9. Cost competitiveness

Sector	Estimated £/t CO_2
Waste to Energy	66 -110 £/t CO_2
Iron production & other metal processing	80 £/t CO_2
Cement & lime	80-140 £/t CO_2
Other Non-metallic Minerals	140 £/t CO_2
Glass	140 £/t CO_2
Refining & chemicals	140 - 200 £/t CO_2

Comparison of CCUS Costs by Industrial sector
Data Source: Eunomia report CCUS development pathway for the WtE sector

Factors influencing the total CC cost:

- Energy penalty ⇔ level of synergy with WtE
- Technology
- Solvent
- Distance from source to storage/utilisation site

10. Renewable Energy

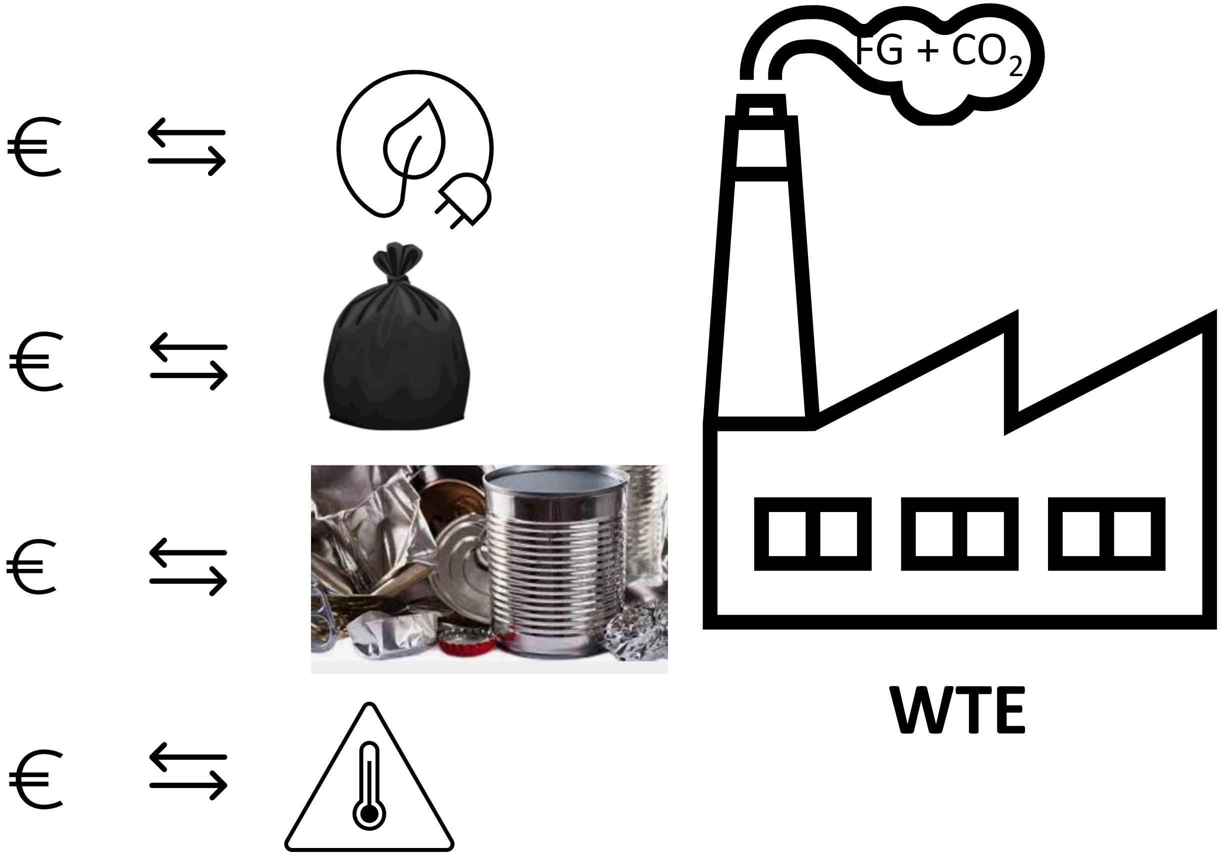
- Carbon capture is very energy intensive

- Energy utilized for capturing carbon should be renewable energy

- The majority of energy produced by a WtE is renewable energy

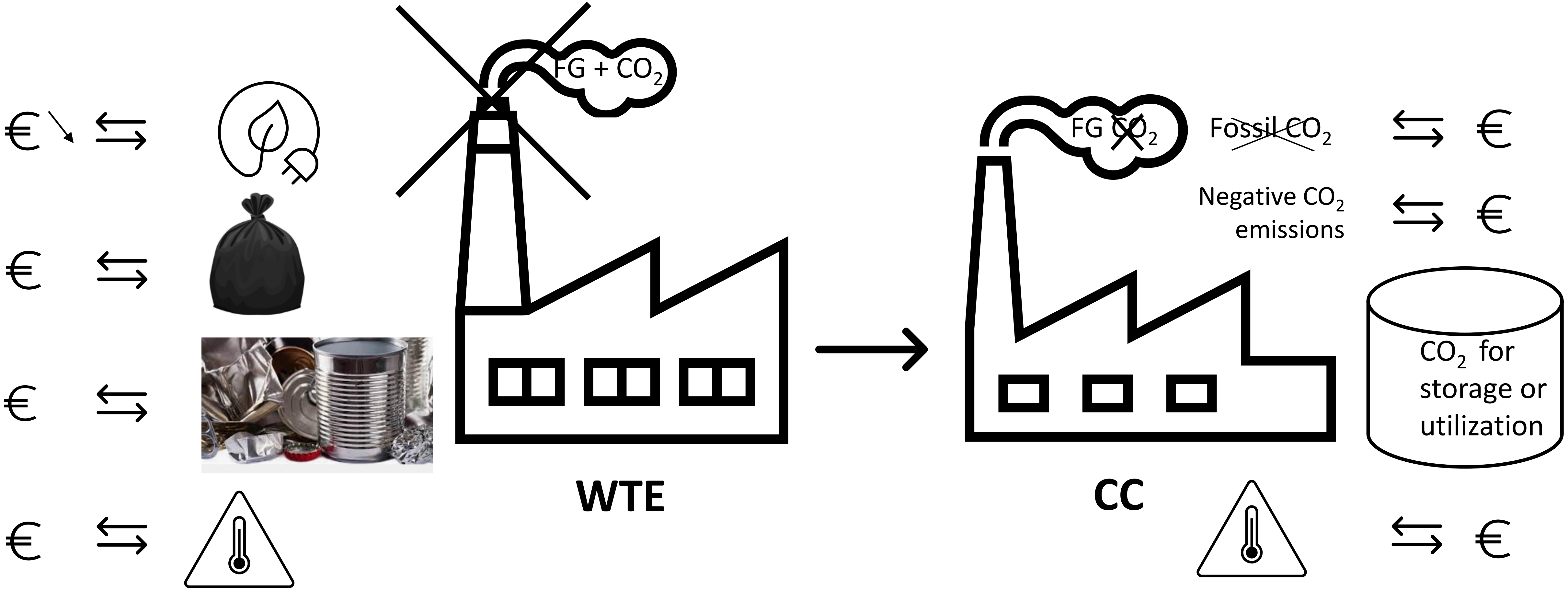
Direct air capture unit deployed in Iceland where there is a surplus of renewable energy available.

11. New financial incentive for project development



Actual economic model of a WtE plant

11. New financial incentive for project development



New economic model of a WtE plant combined with CC

Keppel Seghers and carbon capture

- Feasibility study of the integration of CC plant in the Runcorn ERF / 4 different technologies (1mio ton CO_2/y)
- Multiple CC feasibility studies in WTE in the pipe Asia
- Confidential dialogue with CC technology suppliers (amines, hot potassium, solid sorbents, etc...)
- Discussing pilot plant scale projects
- Chairing CCUS working group in Industry Association ESWET (European Suppliers of Waste to Energy Technologies)

WtE plant combined with CC in Runcorn, UK

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