

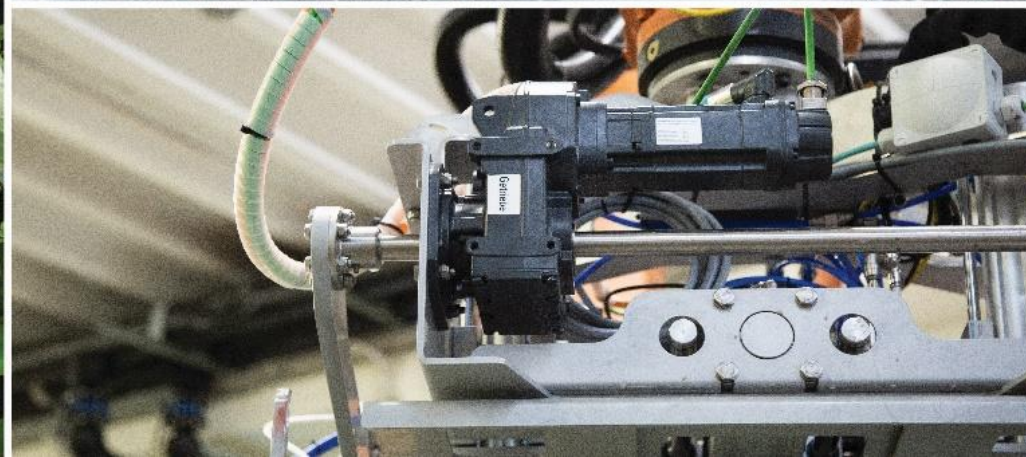
18.04.2024

# WtE in Iceland

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*Main Environmental Aspects*

**Helga Jóhanna Bjarnadóttir**  
Chemical and Environmental Engineer





A photograph of a large landfill site. A yellow excavator is visible on a pile of waste in the background. The foreground is dominated by a massive, colorful mound of trash, including plastic bags, cardboard, and other debris, under a cloudy sky.

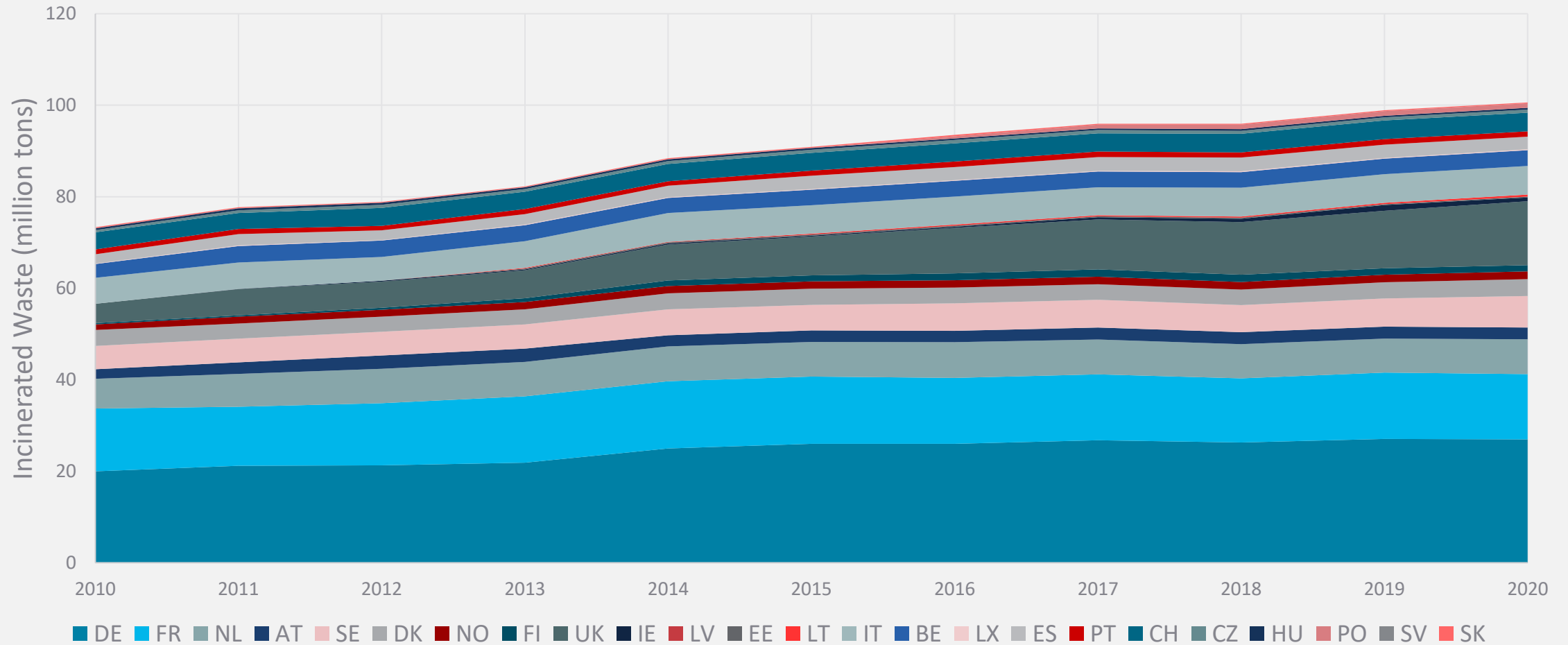
# Contents

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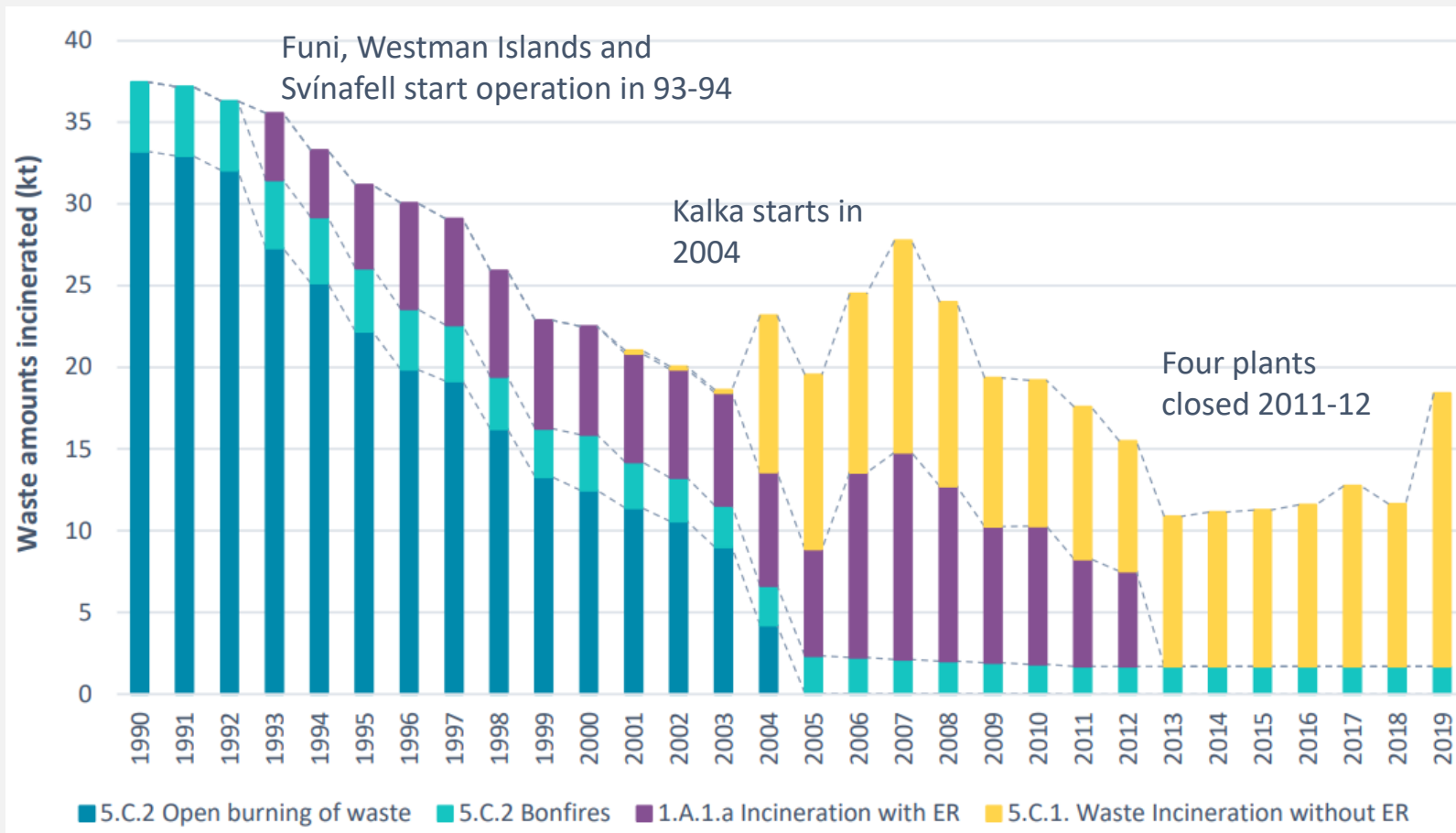
## *Main Environmental Aspects for WtE in Iceland*

- Summary part of pre-feasibility for implementation of future solution for treatment of combustible waste to replace landfilling
- Topics
  - WtE in Europe and Iceland
  - Legal framework of modern incinerators
  - Main environmental aspects in operation
  - Utilization of products
  - CO<sub>2</sub> emissions and carbon capture

# WtE in Europe



- 2010 - 2020; 73 -> 101 million tons  
452 -> 504 plants  
162.000 -> 200.000 tpa average plant size



## Incineration in Iceland

- Plants operating on exemptions from European directives (2000) to closing (2011-12)
- Issues including insufficient treatment and incomplete combustion
- One plant operational, Kalka (without Energy Recovery, ER)
  - Operating permit: 25kt/y (1,7 t/h)

# Legal framework

2010/75/EU

DIRECTIVE 2010/75/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 24 November 2010

on industrial emissions (integrated pollution prevention and control)

(Recast)

(Text with EEA relevance)

THE EUROPEAN PARLIAMENT AND THE COUNCIL OF THE EUROPEAN UNION, in view of the Treaty on the Functioning of the European Union, and in particular Article 192(1) thereof, of the proposal from the European Commission,

of the opinion of the European Economic and Social Committee (1),

of the opinion of the Committee of the Regions (2),

and having regard to the ordinary legislative procedure (3),

considering that substantial changes are to be made to Council Directive 78/176/EEC of 20 February 1978 on the implementation of industry (4), Council Directive 82/883/EEC of 3 December 1982 on procedures for environmental monitoring in environments concerned by waste from the titanium dioxide industry (5), Council Directive 92/24/EEC of 31 March 1992 on procedures for harmonising the programmes for the reduction and eventual elimination of emissions from the titanium dioxide industry (6), Council Directive 1999/13/EC of 11 March 1999 on the reduction of volatile organic compounds due to the use of organic solvents in certain activities and in installations, and in view of the European Parliament and of the Council of 4 December 2000 on the incineration of waste, and in view of the European Parliament and of the Council of 23 October 2001 on the limitation of emissions of air from large combustion plants (7) and Directive 2008/1/EC of the European Parliament and of the Council of 15 January 2008 concerning integrated pollution prevention and control (10). In the interests of clarity,

and in order to prevent, reduce and as far as possible eliminate pollution arising from industrial activities in accordance with the principle and the principle of pollution prevention, it is necessary to establish a general framework for industrial activities, giving priority to intervention at source, ensuring prudent management of resources, taking into account the precautionary principle and the principle of proportionality, and taking into account that industrial activity is

Directive 2010/75/EU on industrial emissions

BREF (2019)



JRC SCIENCE FOR POLICY REPORT

Best Available Techniques (BAT) Reference Document for Waste Incineration

Industrial Emissions Directive 2010/75/EU (Integrated Pollution Prevention and Control)

Frederik Neuvahl, Gianluca Cusano, Jorge Gómez Benavides, Simon Holbrook, Serge Roudier

2019



Descriptions of BAT, associated emission levels, monitoring and further environmental factors



Icelandic regulation 2018/550

Reglugerð um losun frá atvinnurekstri og mengunarnaefirtilit.

Birta efnisfritil. I. KAFLI Markmið, skilgreiningar og stjórn. 1. gr. Markmið þessarar reglugerðar er að búa landsmönnum heilinnæmu og ómenguðu umhverfi. Jafnframt er markmið út í andrúmsloft, vatn og jarðveg og að koma í veg fyrir myndun og útskipti loftslagsáhrifa. 2. gr. Markmið þessarar reglugerðar er að búa landsmönnum heilinnæmu og ómenguðu umhverfi. Jafnframt er markmið út í andrúmsloft, vatn og jarðveg og að koma í veg fyrir myndun og útskipti loftslagsáhrifa. Reglugerðin tekur til hvers konar starfsemi og framkvæmdarkostum sem ferðast undir íslenskum fána, sem hafa eð að svo miklu leyti sem önnur lög eða reglugerðir taka ekki tillit til. Reglugerðin gildir ekki um rannsóknarstarfsemi, þróunarstarf eða prófanir á nýjum vörum og vinnsluferlum sem falla undir I. viðauka.

Implementation into Icelandic legislative framework

Icelandic law 2021/111

2021.11.25 - 1101 Ferill máltíðar á Alþingi. Framvarp til laga. Tíðni gilda 1. september 2021; hefur til framkvæmda áhrif. Fyrirmælanir í 37. gr. EFS samningurinn XX. viðskili tilskipun 2000/42/EB. 2010/75/EB. 2010/75/EB. 2010/75/EB. 2010/75/EB. Ef lögum þessum er getið um ráðgjörð eða ráðgjörð á þessum á málafærni sé tilgreint séstaklega eða til orku- og loftslagsráðgjörð eða umhverfis-, orku- og loftslagsráðgjörð sem fer með lög þessi. Uppýsingarforstjanskerfi er að finna hér. I. KAFLI. Markmið, gildisvæði, skilgreiningar o.fl. 1. gr. Markmið. 2. gr. Markmið laga þessara er: a. sjálfbær þróun, heilinnæmt umhverfi og umhverfisvæðing sem vinna skal að með umhverfismátt framkvæmda að hafa umhverfisvæðing umhverfisáhrifa. b. skilvirki við umhverfismátt framkvæmda og áætlaða. c. að áhrifningar hafi aðhætti að umhverfismátt framkvæmda og áætlaða og samrinna aðila sem hafa áhrif vegna umhverfismátt framkvæmda og áætlaða. 3. gr. Gildisvæði. 4. gr. Lög þessi gilda um: a. skipulagsáætlanir og breytingar á þeim samkvæmt skipulagsáætlanum og lögum um skipulag haf- og strandmála. b. aðrar áætlanir og breytingar á þeim sem markað stefnu fyrir heyrifveitingar til framkvæmda sem tilgreindar eru í 1. viðauka við lög þessi og eru undirbúnar og eða afgreiddar af stjórnvöldum og umnar samkvæmt lögum eða ákvörðun ráðgjörð. c. framkvæmdir sem koma eða eru liðlegar til að hafa umhverfisvæðing umhverfisáhrifa. d. lög þessi gilda um framkvæmdir og áætlanir á landi, loftslagi og mengunarlögum Íslands. Lög þessi eiga við um umhverfismátt framkvæmda eða áætlaða í öðru eðli innan Evrópska efnahagsvæðisins sem koma að hafa áhrif hér á landi, sbr. 5. gr. 5. gr. Lög þessi gilda ekki um áætlanir sem hafa þann eina tilgang að þjóna öryggi eða vörnum ríkisins eða almannavarnarvæðingum. Þá gilda lög þessi ekki um fjárhags- og fjárfestingaráætlanir. 6. gr. Överlögur breytingar á áætlunum eru ekki hábar ákvæðum laga þessara. Við mat ábyrgðar á viðkomandi áætlunum á því hvort breytingar teljast verulegar skal taka með af áhrifum á framkvæmdir og aðra áætlanagerð og áhrifum á umhverfi.

Environmental Impact Assessment

Icelandic regulation 2013/90

90/2013 Skipulagsreglugerð. Breytingarreglugerðir: 903/2016 Reglugerð um (3.) breytingu á skipulagsreglugerð nr. 90/2013. 842/2016 Reglugerð um (2.) breytingu á skipulagsreglugerð nr. 90/2013. 578/2013 Reglugerð um breytingu á skipulagsreglugerð nr. 90/2013. Reglugerð á PDF formi. I. KAFLI Almenn ákvæði. 1.1. gr. Markmið. Markmið reglugerðar þessarar eru: a) að þróun byggðar og landnotkunar á landinu öllu verði í samræmi við skipulagsáætlanir þar sem efnahagslegar, félagslegar og menningarlegar þarfir landsmanna, heilbrigði þeirra og öryggi er haft að leiðarlíði, b) að stuðla að skynsamlegri og hagkvæmri nýtingu lands og landgæða, tryggja vernd landslags, náttúru og menningarverðmæta og koma í veg fyrir umhverfisspjölli og ofnýtingu, með sjálfbærri þróun að leiðarlíði.

Planning regulation



# WtE Legal Framework in Iceland

*Plants with capacity over 3 ton/hour*

Plants located in designated industrial and commercial areas, as per municipal plan and it requires specific local plan

Operation subject to legislation on EIA (111/2021)  
(Environmental Impact Assessment)

Operational license acc. to regulation (550/2018) on pollution from commercial activities and monitoring

Operator shall utilize BAT with regards to use of resources, energy efficiency, monitoring noise, Odour and emissions to air and water

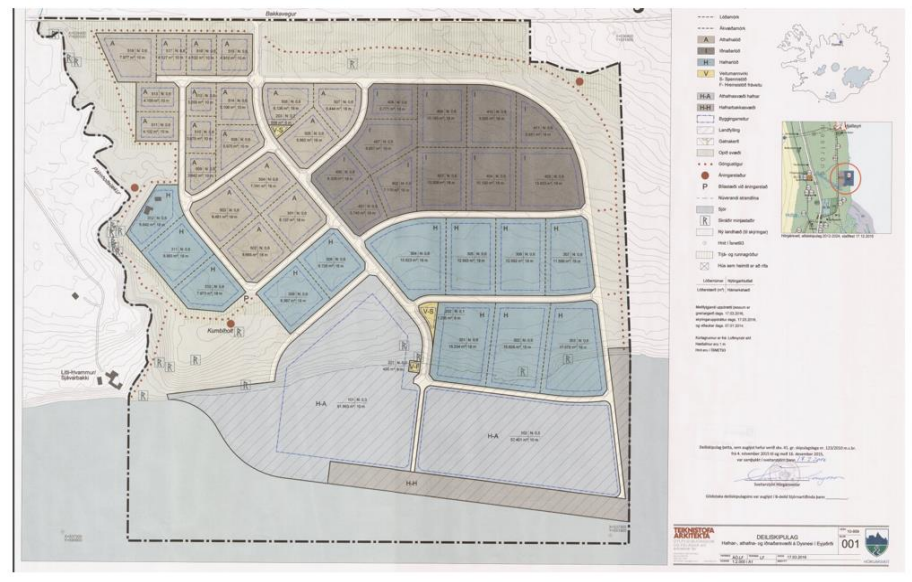
Operator shall implement certified EMS in accordance with ISO 14001

# Possible locations for WtE in Iceland

Both plans ascribe allowance to locate WtE plant

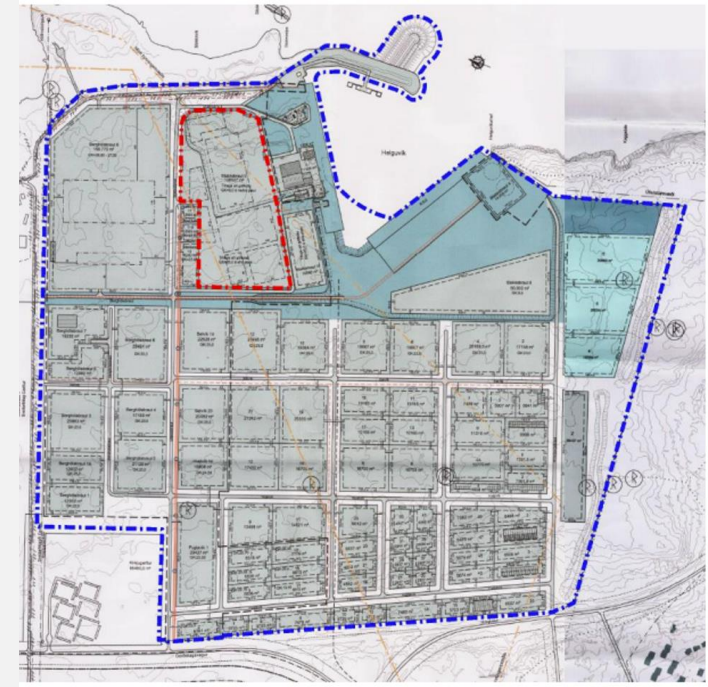


## *Dysnes 15 km north of Akureyri*



- No harbour but local plan for harbour-industrial and commercial areas agreed in 2015
- Nearest farm building 400 m away

## *Helguvík near Reykjanesbær*



- Helgurvík harbour; 2 quays, 100 m and 150m, with plans for expansion.
- Distance to residential area could be 1-2 km





# Environmental impacts

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## *Main Environmental Aspects*

- Emissions to air
- Emissions to water
- Transportation
- Noise
- Odour
- Visual impacts
- Impact on ecosystem
- Impact on society and public health

## *Circular Economy*

- Electricity
- Heat energy
- Bottom ash
- Fly ash
- Carbon dioxide



# Emissions to Air

*Main aspects impacting various emissions*

Chemicals	Waste Composition	Furnace type, quality and operation	Gas treatment type, quality and operation
Dioxins/Furans (PCDD/F)	X	X	X
CO og VOC	X	X	
Dust			X
HCl, HF, SO <sub>2</sub> , NO <sub>x</sub>	X		X
Metals	X		X

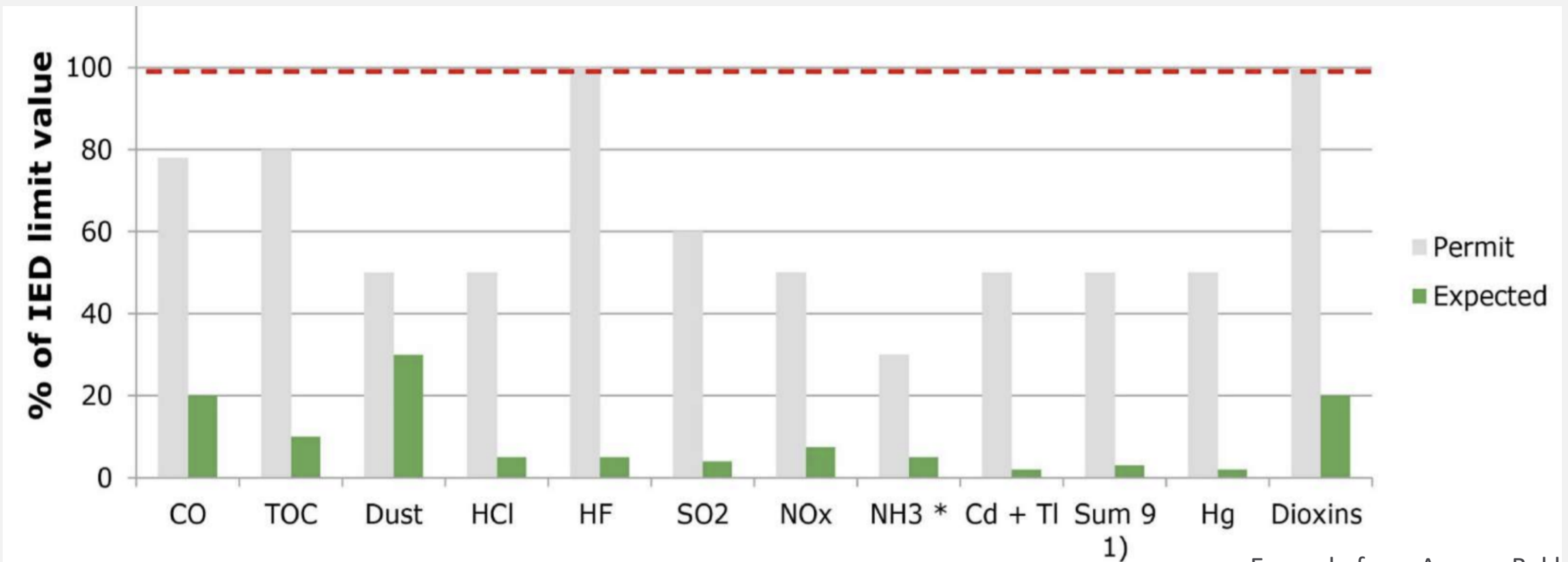
# Emissions to Air

Parameter	Low value	High value	High value*	Averaging Period	Monitoring	Treatment efficiency as suggested for an Icelandic plant
Dust (mg/Nm <sup>3</sup> )	2,00	5,00	5,00	Daily average	Continuous	<5 mg/m <sup>3</sup> with bag filter
Cd/Tl (mg/Nm <sup>3</sup> )	0,005	0,02	0,02	Average over sampling period	Periodic – six months	93%+ w active carbon
Sb/As/Pb/Cr/Co/Cu/Mn/Ni/V (mg/Nm <sup>3</sup> )	0,01	0,30	0,30	Average over sampling period	Periodic – six months	95%+ w active carbon
HCl (mg/Nm <sup>3</sup> )	2,00	6,00	8,00	Daily average	Continuous	2-8mg w semi-wet treatment
HF (mg/Nm <sup>3</sup> )		<1	1,00	Daily average or average over sampling period	Continuous <sup>1</sup>	<1mg w semi-wet treatment
SO <sub>2</sub> (mg/Nm <sup>3</sup> )	5,00	30,00	40,00	Daily average	Continuous	30-70mg w semi-wet treatment
NO <sub>x</sub> (mg/Nm <sup>3</sup> )	50,00	120,00	150,00	Daily average	Continuous	75% w SNCR
CO (mg/Nm <sup>3</sup> )	10,00	50,00	50,00	Daily average	Continuous	Nothing proposed
NH <sub>3</sub> (mg/Nm <sup>3</sup> )	2,00	10,00	10,00	Daily average	Continuous	
TVOC (mg/Nm <sup>3</sup> )	3,00	10,00	10,00	Daily average	Continuous	
PCDD/F (ng I-TEQ/Nm <sup>3</sup> )	0,01	0,04	0,06	Average over sampling period	Periodic– six months	0,5-2kg/t <0,06 ng/Nm <sup>3</sup>
PCDD/F (ng I-TEQ/Nm <sup>3</sup> )	0,01	0,06	0,08	Average over longer sampling period	Continuous, once per month <sup>2</sup>	
PCDD/F+PCB (ng WHO-TEQ/Nm <sup>3</sup> )	0,01	0,06	0,08	Average over sampling period	Periodic – six months	
PCDD/F+PCB (ng WHO-TEQ/Nm <sup>3</sup> )	0,01	0,08	0,10	Average over longer sampling period	Continuous, once per month <sup>3</sup>	
Hg (mg/Nm <sup>3</sup> )	0,005	0,020	0,020	Daily average or average over sampling period	Continuous <sup>4</sup>	95% - 30µg/Nm <sup>3</sup>
Hg (mg/Nm <sup>3</sup> )	0,001	0,010	0,01	Average over longer sampling period	Periodic – six months	
* Value for currently operating plants						
1 Measurements of HF may be periodic once every six months if the HCl emission levels are proven to be sufficiently stable						
2 Measurements of PCDD/F may be periodic once every six months if emission levels are proven to be sufficiently stable						
3 Measurements of PCB-DL may be periodic once every six months if concentration of PCB < 0,01 ng/m <sup>3</sup>						
4 For plants incinerating wastes with a proven low and stable Hg content, measurements may be periodic once every six months over a longer-term sampling period						



# Progress of Emissions Levels

*Various levels associated with WtE plant*



# Emissions to Water



EMISSIONS	LOW VALUE	HIGH VALUE	SOURCE*	MONITORING FREQUENCY
TSS (mg/L)	10	30	Flue gas treatment Bottom ash treatment	Daglega Monthly
Lífrænt kolefni - TOC (mg/L)	15	40	Flue gas treatment Bottom ash treatment	Monthly
As (mg/L)	0,01	0,05	Flue gas treatment	Monthly
Cd (mg/L)	0,005	0,03	Flue gas treatment	Monthly
Cr (mg/L)	0,01	0,1	Flue gas treatment	Monthly
Cu (mg/L)	0,03	0,15	Flue gas treatment	Monthly
Hg (mg/L)	0,001	0,01	Flue gas treatment	Monthly
Ni (mg/L)	0,03	0,15	Flue gas treatment	Monthly
Pb (mg/L)	0,02	0,06	Flue gas treatment Bottom ash treatment	Monthly
Sb (mg/L)	0,02	0,9	Flue gas treatment	Monthly
Tl (mg/L)	0,005	0,03	Flue gas treatment	Monthly
Zn (mg/L)	0,01	0,5	Flue gas treatment	Monthly
Ammonium-nitrogen - NH <sub>4</sub> -N (mg/L)	10	30	Bottom ash treatment	Monthly
Chloride (Cl <sup>-</sup> )			Bottom ash treatment	Monthly
Sulphate - SO <sub>4</sub> <sup>2-</sup> (mg/L)	400	1000	Bottom ash treatment	Monthly
PCDD/F (ng I-TEQ/L)	0,01	0,05	Flue gas treatment Bottom ash treatment	Monthly Every six months

\*Emissions originating from flue gas treatment, mainly relevant for wet treatment, release from dry or semi-wet treatment minimal



# Emissions to Water



EMISSIONS	LOW VALUE	HIGH VALUE	SOURCE*	MONITORING FREQUENCY
TSS (mg/L)	10	30	Flue gas treatment	Daglega
			Bottom ash treatment	Monthly
Lífrænt kolefni - TOC (mg/L)	15	40	Flue gas treatment	Monthly
			Bottom ash treatment	
As (mg/L)	0,01	0,05	Flue gas treatment	Monthly
Cd (mg/L)	0,005	0,03	Flue gas treatment	Monthly
Cr (mg/L)	0,01	0,1	Flue gas treatment	Monthly
Cu (mg/L)	0,03	0,15	Flue gas treatment	Monthly
Hg (mg/L)	0,001	0,01	Flue gas treatment	Monthly
Ni (mg/L)	0,03	0,15	Flue gas treatment	Monthly
Pb (mg/L)	0,02	0,06	Flue gas treatment	Monthly
			Bottom ash treatment	
Sb (mg/L)	0,02	0,9	Flue gas treatment	Monthly
Tl (mg/L)	0,005	0,03	Flue gas treatment	Monthly
Zn (mg/L)	0,01	0,5	Flue gas treatment	Monthly
Ammonium-nitrogen - NH <sub>4</sub> -N (mg/L)	10	30	Bottom ash treatment	Monthly
Chloride (Cl <sup>-</sup> )			Bottom ash treatment	Monthly
Sulphate - SO <sub>4</sub> <sup>2-</sup> (mg/L)			Bottom ash treatment	Monthly
PCDD/F (ng I-TEQ/L)			Flue gas treatment	Monthly
			Bottom ash treatment	Every six months

Emissions originating from flue gas treatment, mainly relevant for wet treatment, release from dry or semi-wet treatment minimal

\*



## Society, people and health

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- Active environmental management key to good operations
- Health
  - Studies looking specifically at well operated modern incinerators have not shown harmful effects on health in vicinity.
- Noise
  - Limits to 70dB inside industrial areas and 55dB by residential areas
  - Good operating procedures should ensure fulfillment
- Odour
  - No specific levels set in BAT
  - Prevention, response and monitoring are key factors

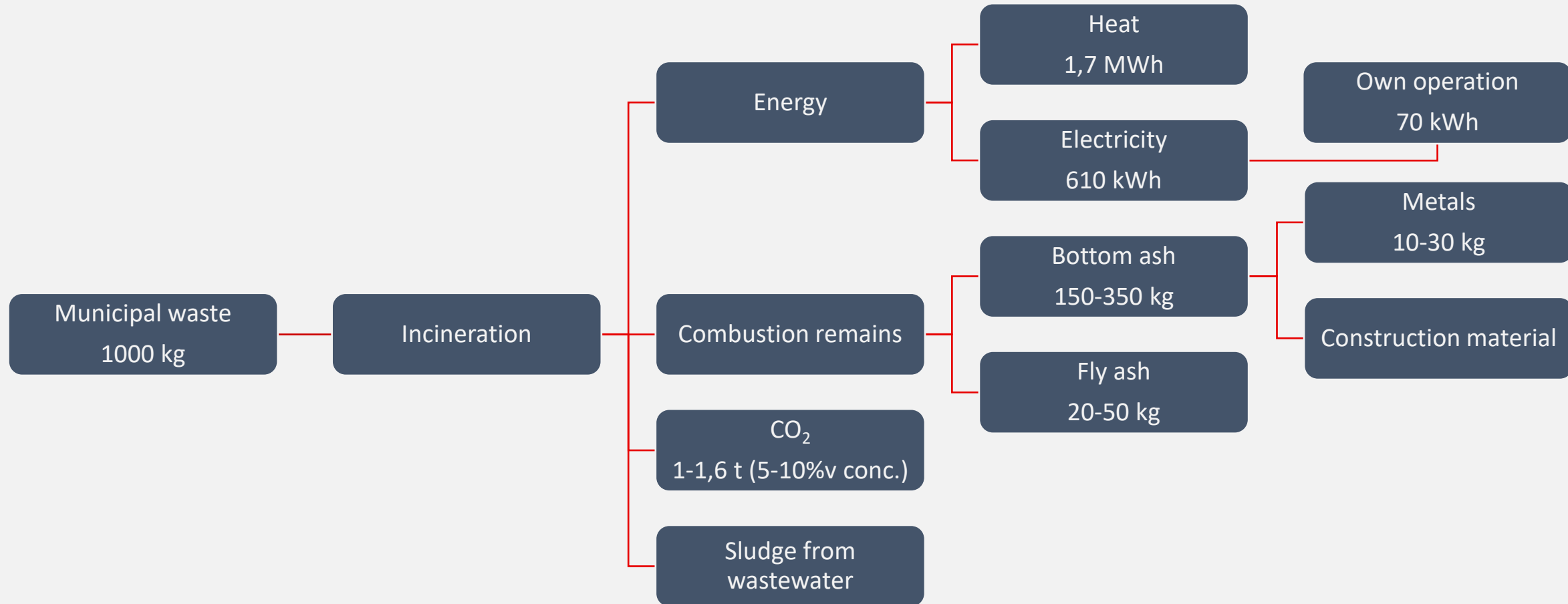




*Examples of WtE plants with capacity around 100.000 tons per year*

# Circular Economy

## Utilization Possibilities







## Use of Ash

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### *Bottom Ash*

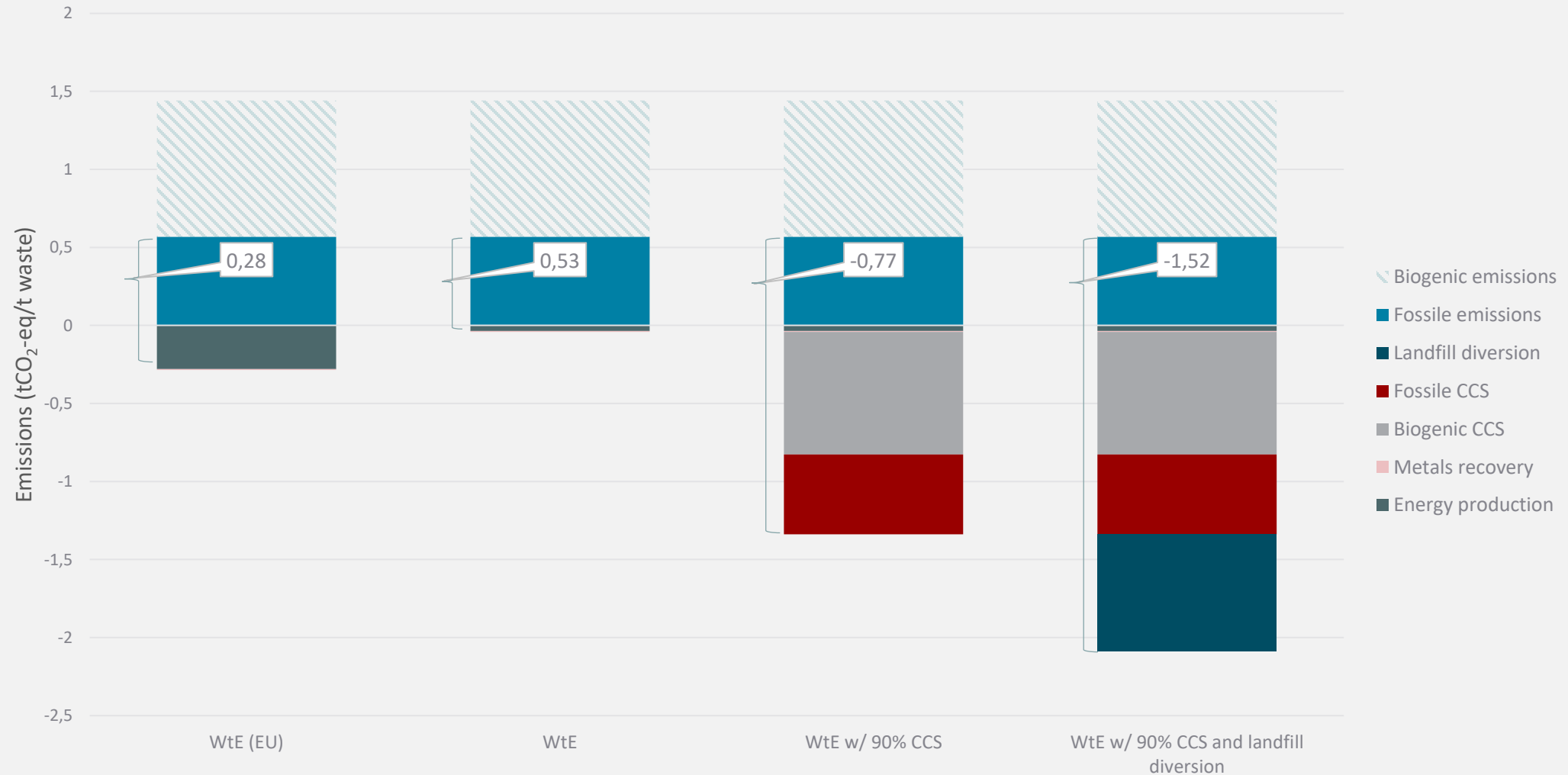
- Treatment includes
  - Metal recovery (12-15%)
  - Ageing (6-20 weeks)
- Construction use increasing within EU:
  - Asphalt
    - Belgium, Denmark, France, Netherlands, England, Spain, Portugal
  - Concrete aggregate
    - BSB, Noceto, Italy
    - 37.000 tons used for 2012 OL

### *Fly Ash*

- Requires cost intensive treatment not practiced in WtE today
  - Material from Norway and Iceland landfilled in Langøya
- 43% utilization from coal power plants
  - Increasing demand, deminishing sourcing

# Carbon Negativity

## Operational Possibilities with CCS



An aerial photograph of the AVR carbon capture facility in Duiven, NL. The image shows a complex industrial site with several large, cylindrical storage tanks in the foreground, a network of pipes and walkways, and various processing units. The facility is situated in an open area with some greenery and a road visible in the background.

# Carbon Capture

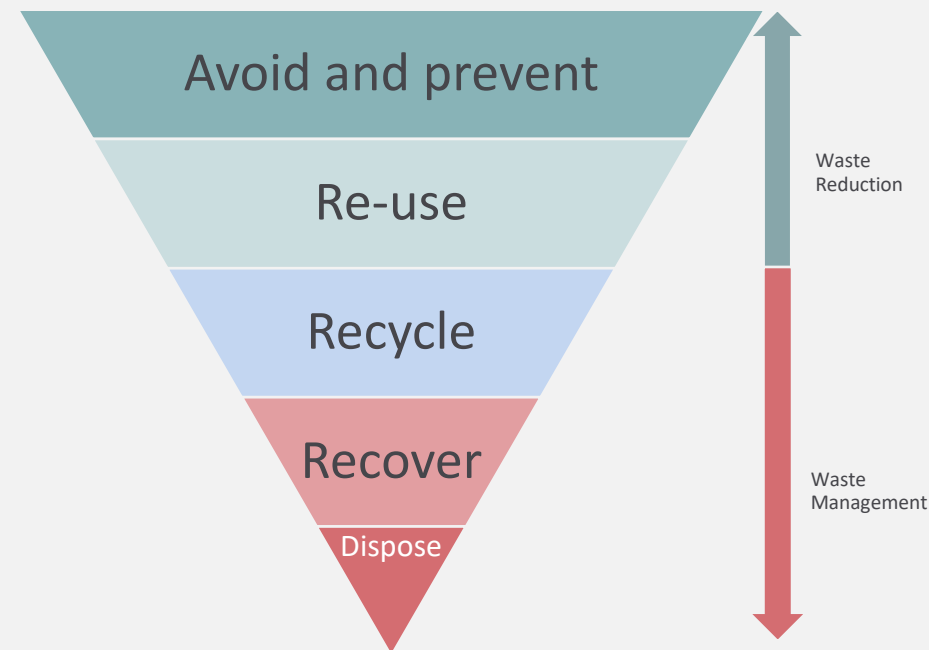
## *Status and Projects*

- EU CCUS Vision Working Group: “Going forward, the EU and national governments should **strive to equip existing plants with CCUS** technology, and **all new waste-to-energy plants should be built with CCUS.**”
  - Waste streams 50-85% biogenic -> potential for WtE to be carbon negative
  - Directive 2022/0304/COD establishing a Union certification framework for carbon removals. Financial incentives for negative emissions?
  - WtE included in EU ETS from 2028 -> incentives for carbon capture
- Today; 60+ active CCUS projects and one in commercial operation, AVR in Duiven, sells around 40.000 tpa for greenhouses.
- Still uncertainty on the cost for CCUS



# Waste and Resource Management Matters

## *Drivers for Decision-Making*



- Landfill Directive <10% of all MW by 2035
  - Driver for alternative solution
- Circular economy thinking fundamental to Green Deal
  - Various recycling and reduction targets are set
  - Will impact waste streams that are available for incineration
- ReFuelEU targets demand use of SAF
  - Demand for alternative products
- Carbon Neutral Iceland 2040
  - Carbon capture required

# Thank you!

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