Supplementary materials

A comparative analysis of EDGAR and UNFCCC GHG emissions inventories: insights on trends, methodology and data discrepancies

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Supplementary figures

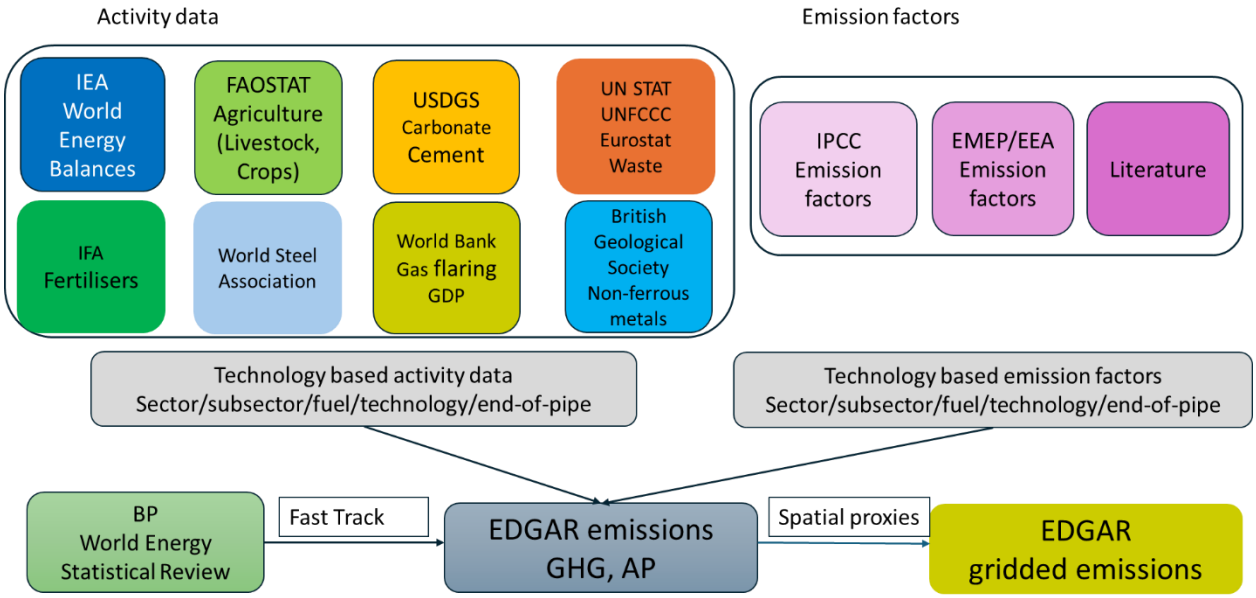


Figure S. 1. Data sources used to compile bottom-up EDGAR GHG and air pollutant emissions
Source: EDGAR 2024

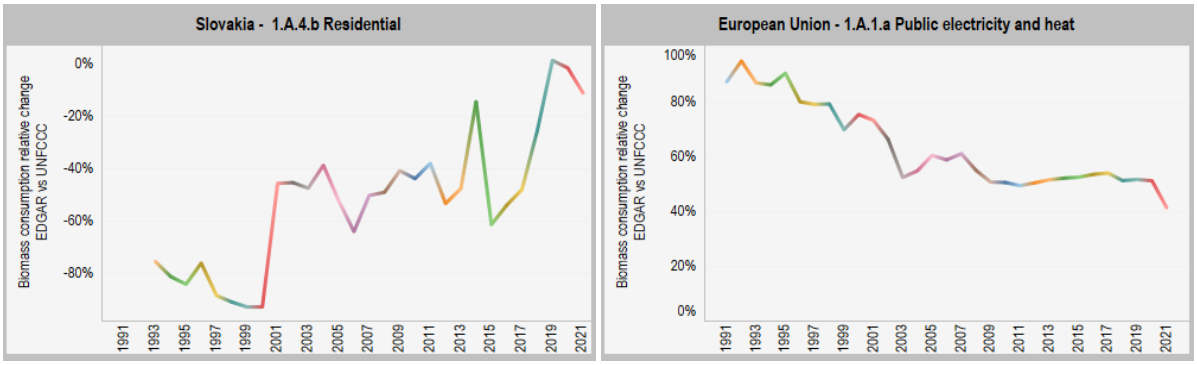


Figure S. 2. Relative change of biomass consumption in Slovakia's residential sector and EU27 public electricity and heat sector: EDGAR vs UNFCCC, 1990-2021, (%) – coloured by year

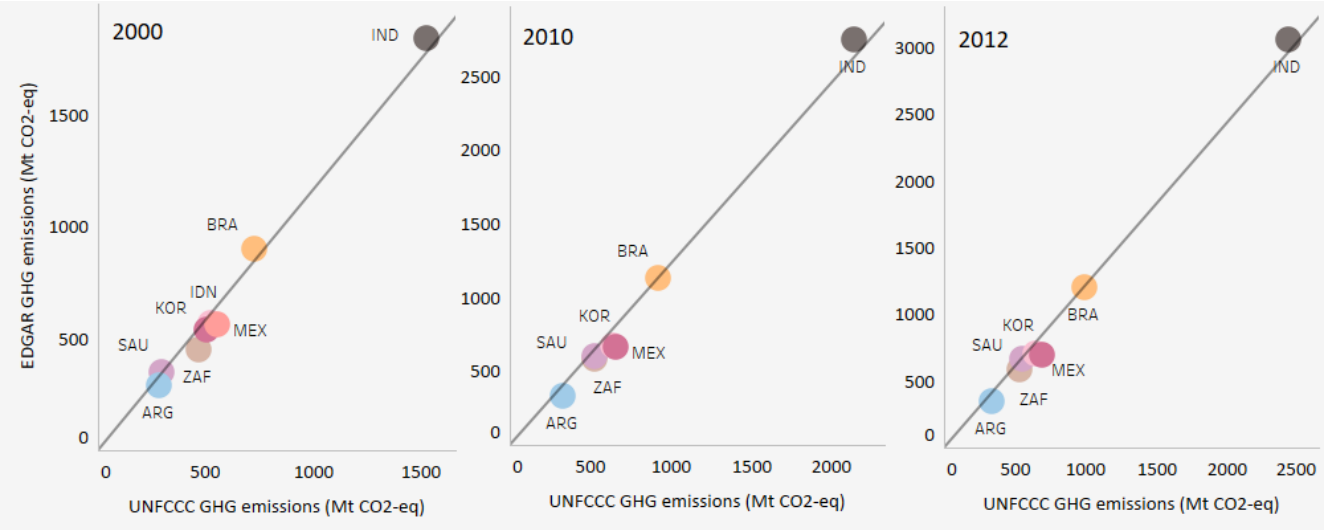
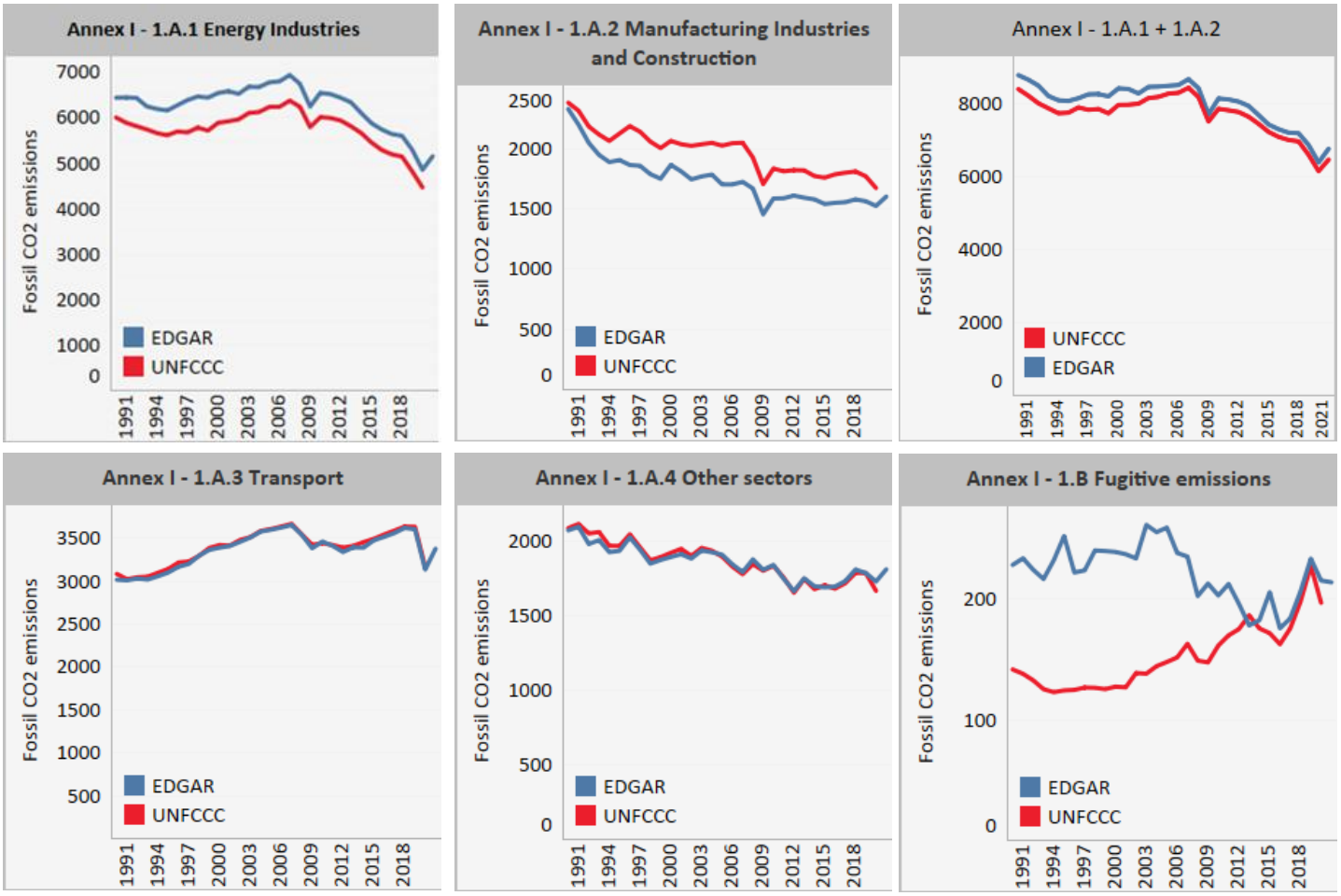


Figure S. 3. Correlation between EDGARv8.0 2023 and UNFCCC 2023 GHG emissions for G20 countries in years 2000, 2010 and 2012
Source: UNFCCC 2023, EDGARv8.0 2023



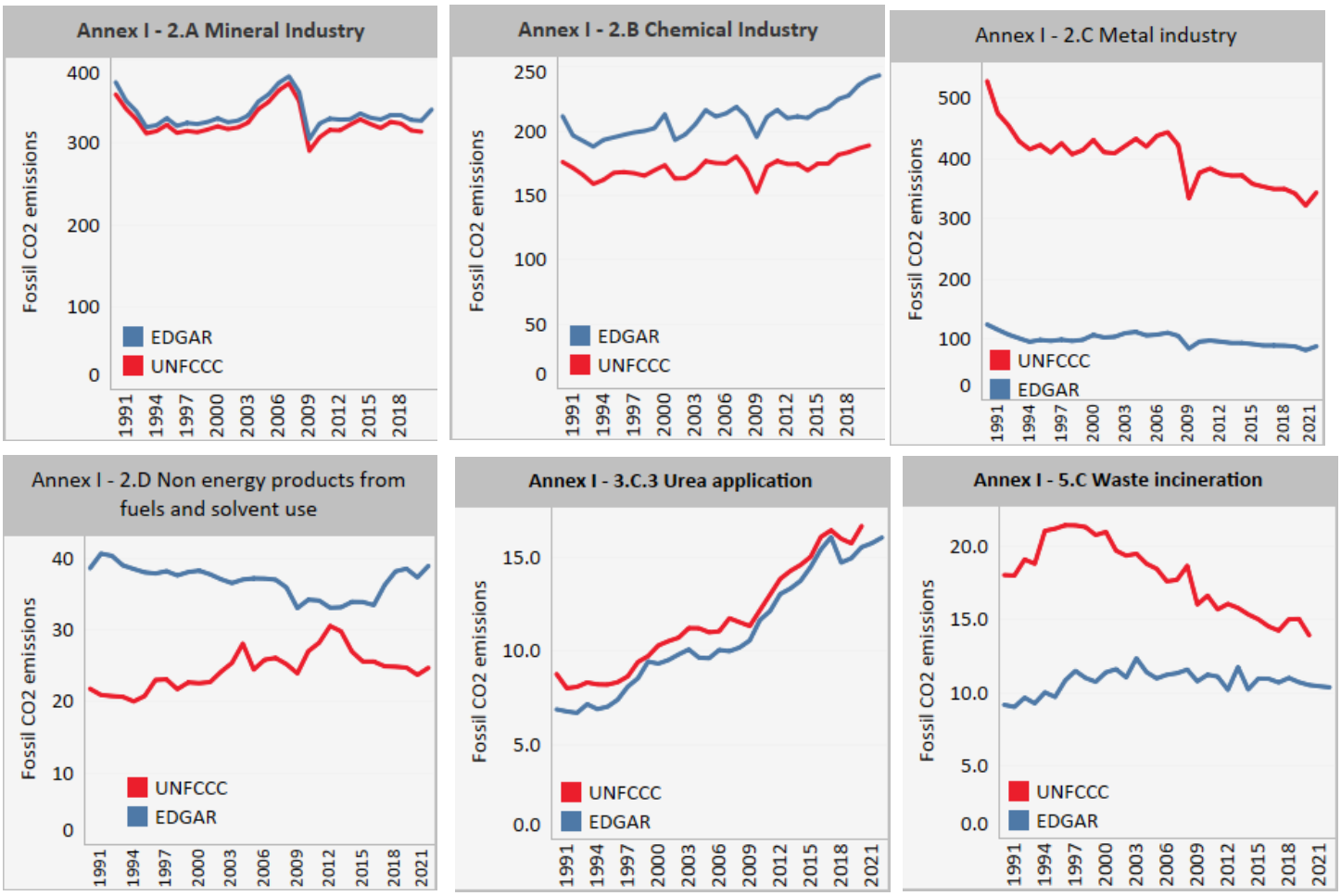


Figure S. 4. Temporal trends by sector of fossil CO_2 emissions in Annex I: EDGAR vs UNFCCC inventories, 1990-2021, Mt

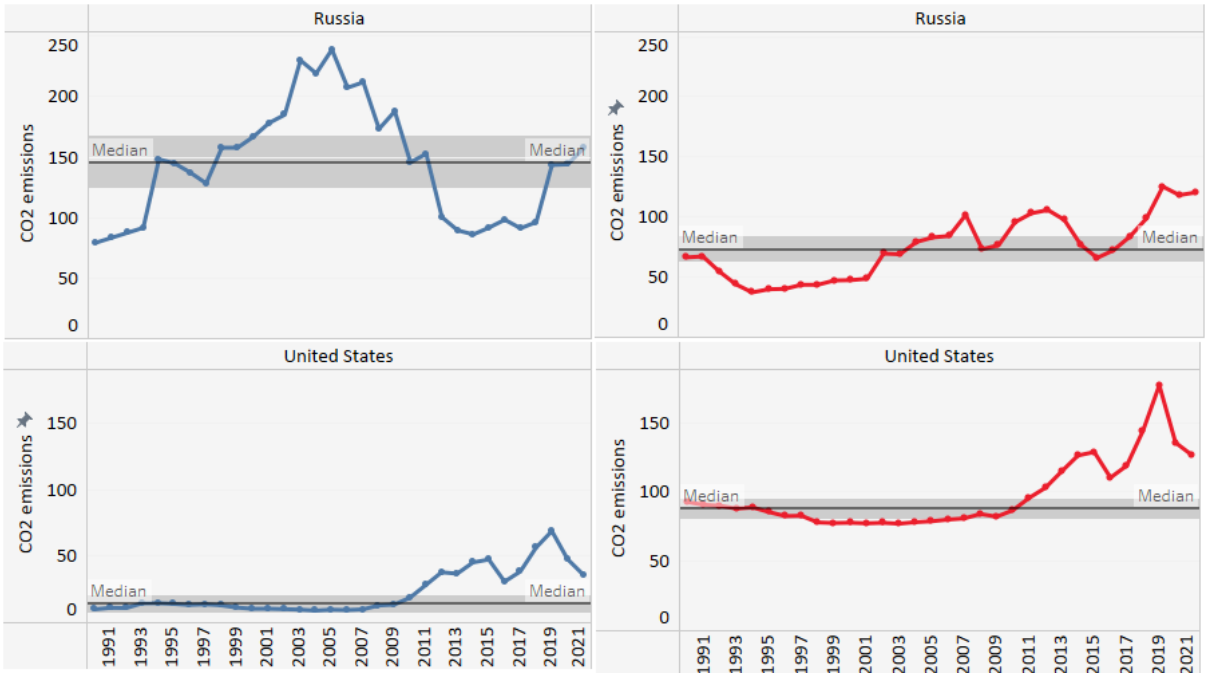


Figure S. 5. Fossil CO_2 fugitive emissions for Russia and USA: EDGAR (left) vs UNFCCC (right) – 1990-2021, kt
Source: UNFCCC GHG Locator 2023, EDGARv8.0
NB. Median with 95% confidence limit is shown in darker grey bands

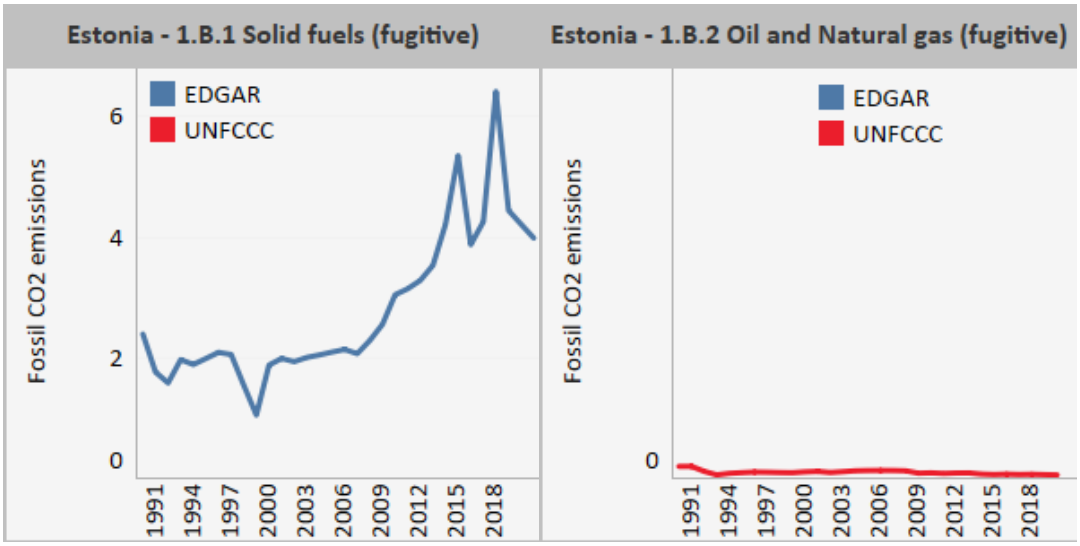


Figure S. 6 Fossil CO_2 emissions in Estonia – fugitive emissions from solid fuels (1.B.1): EDGAR vs UNFCCC

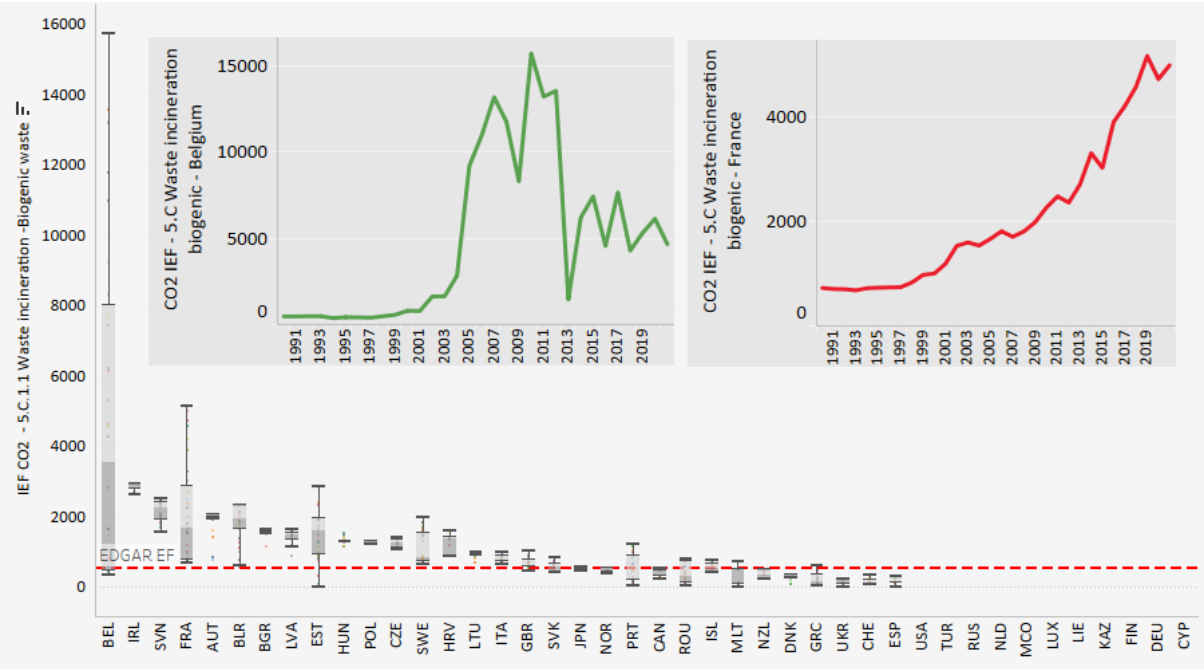


Figure S. 7. CO_2 biogenic waste implied emission factors in Annex I countries - temporal trend in Belgium and France, kg/t
Source: UNFCCC GHG Locator 2023, EDGARv8.0
NB. EDGAR CO_2 emission factor for biogenic waste is 550 kg CO_2/ton wet waste, based on assumption of 15% Degradable Organic Carbon (DOC) content of biogenic waste (IPCC 2006 default EF for food waste).

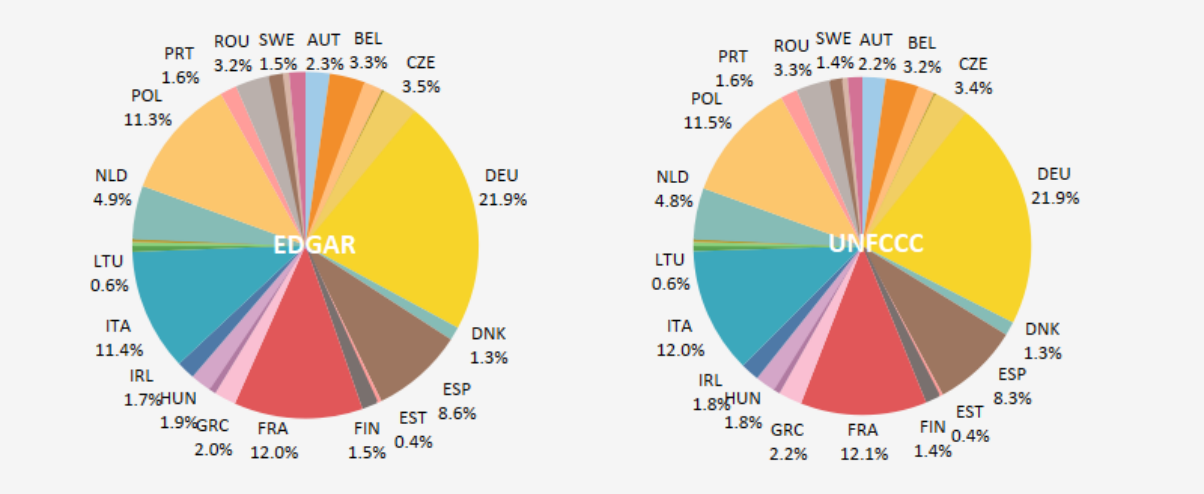


Figure S. 8. Relative contribution of EU27 MS in fossil CO_2 emissions, 2021, EDGAR vs UNFCCC

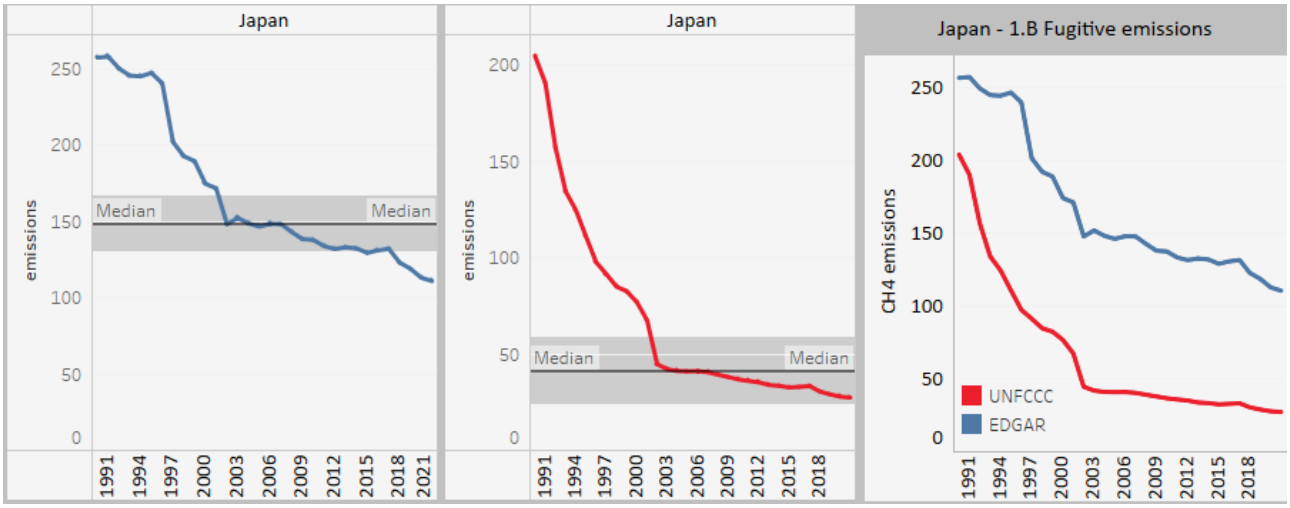


Figure S. 9, Japan CH_4 fugitive emissions: EDGAR (left) vs UNFCCC (middle), temporal trend (right), 1990-2021, kt

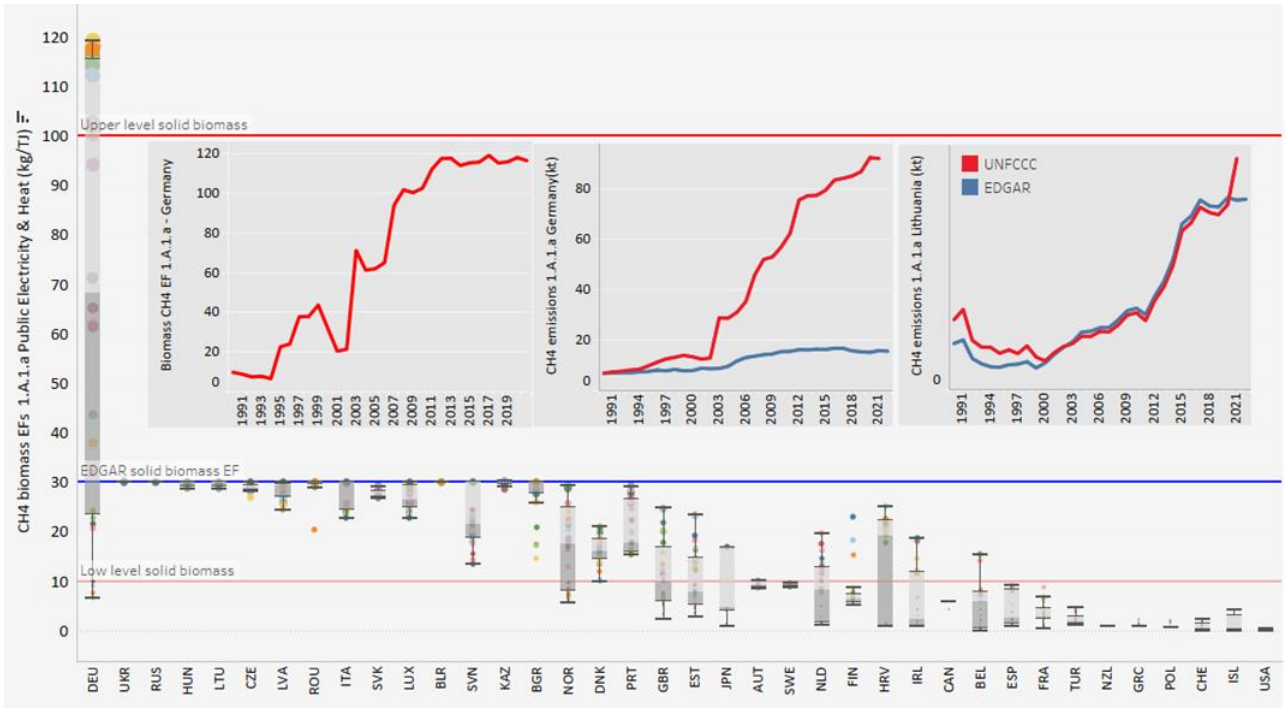


Figure S. 10. CH_4 biomass emission factors in Annex I countries, Germany temporal trend of CH_4 biomass EF and emissions, Lithuania CH_4 emissions in Public Electricity and Heat sector (1.A.1.a), 1990-2021, kg/TJ

Source: UNFCCC GHG Locator 2023, EDGARv8.0

NB. EDGAR line represents the default CH_4 emission factor for solid biomass as in the Chapter 2 of the IPCC 2006 Guidelines

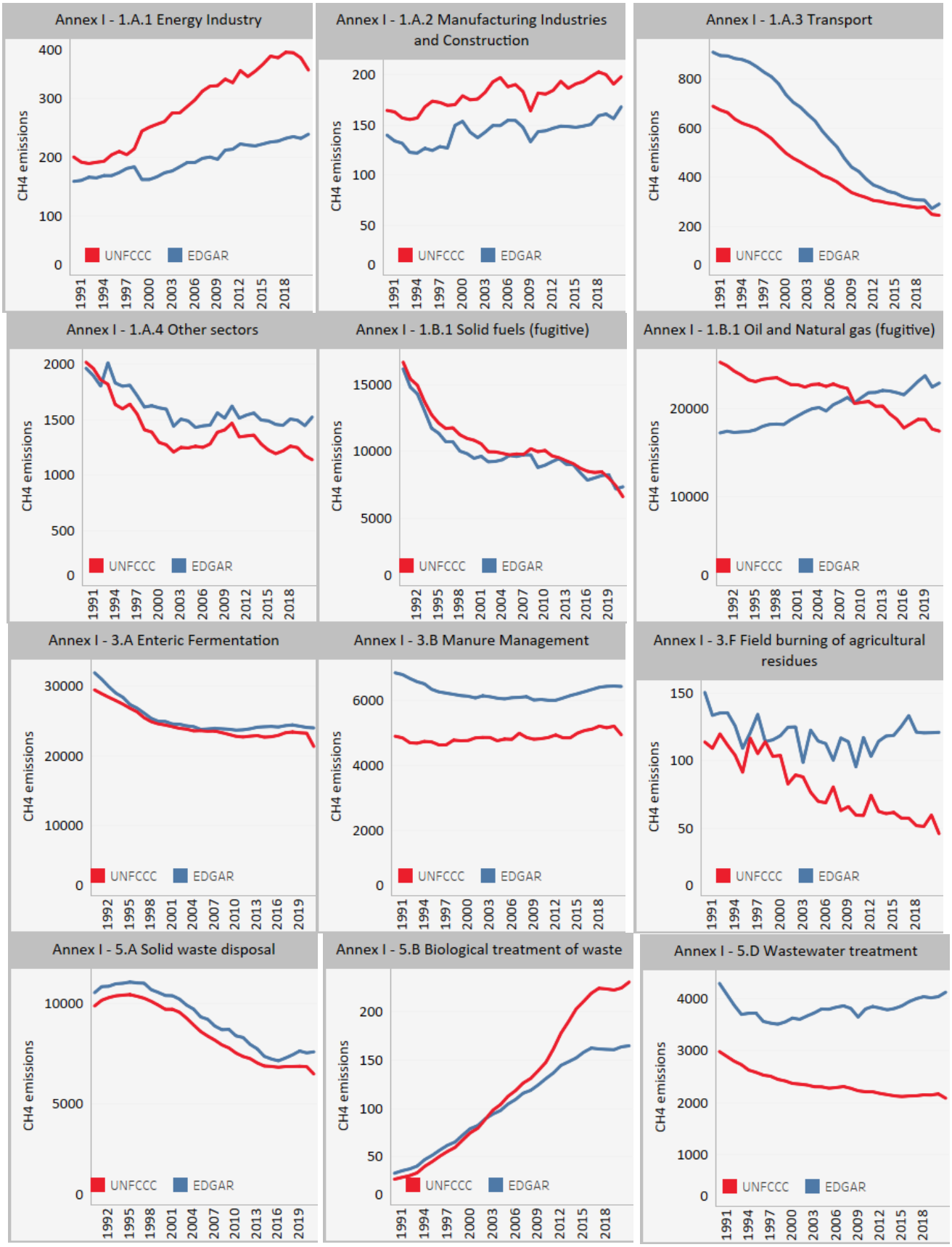
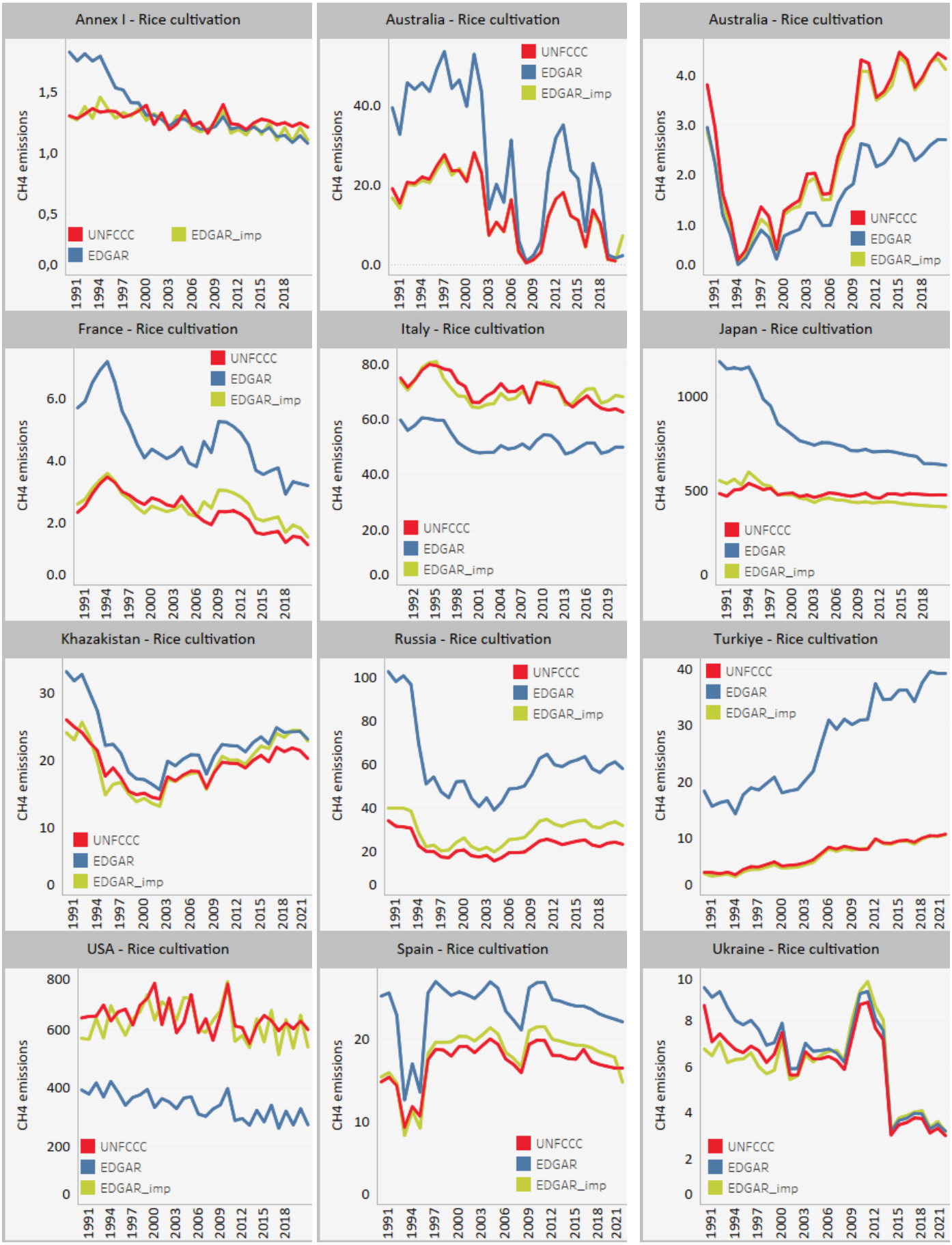


Figure S. 11. Temporal trend by sector of CH_4 emissions in Annex I, 1990-2021, kt CO2-eq


Annex I - Rice cultivation
Australia - Rice cultivation
Australia - Rice cultivation
France - Rice cultivation
Italy - Rice cultivation
Japan - Rice cultivation
Khazakistan - Rice cultivation
Russia - Rice cultivation
Turkiye - Rice cultivation
USA - Rice cultivation
Spain - Rice cultivation
Ukraine - Rice cultivation
CH4 emissions
UNFCCC
EDGAR
EDGAR_imp

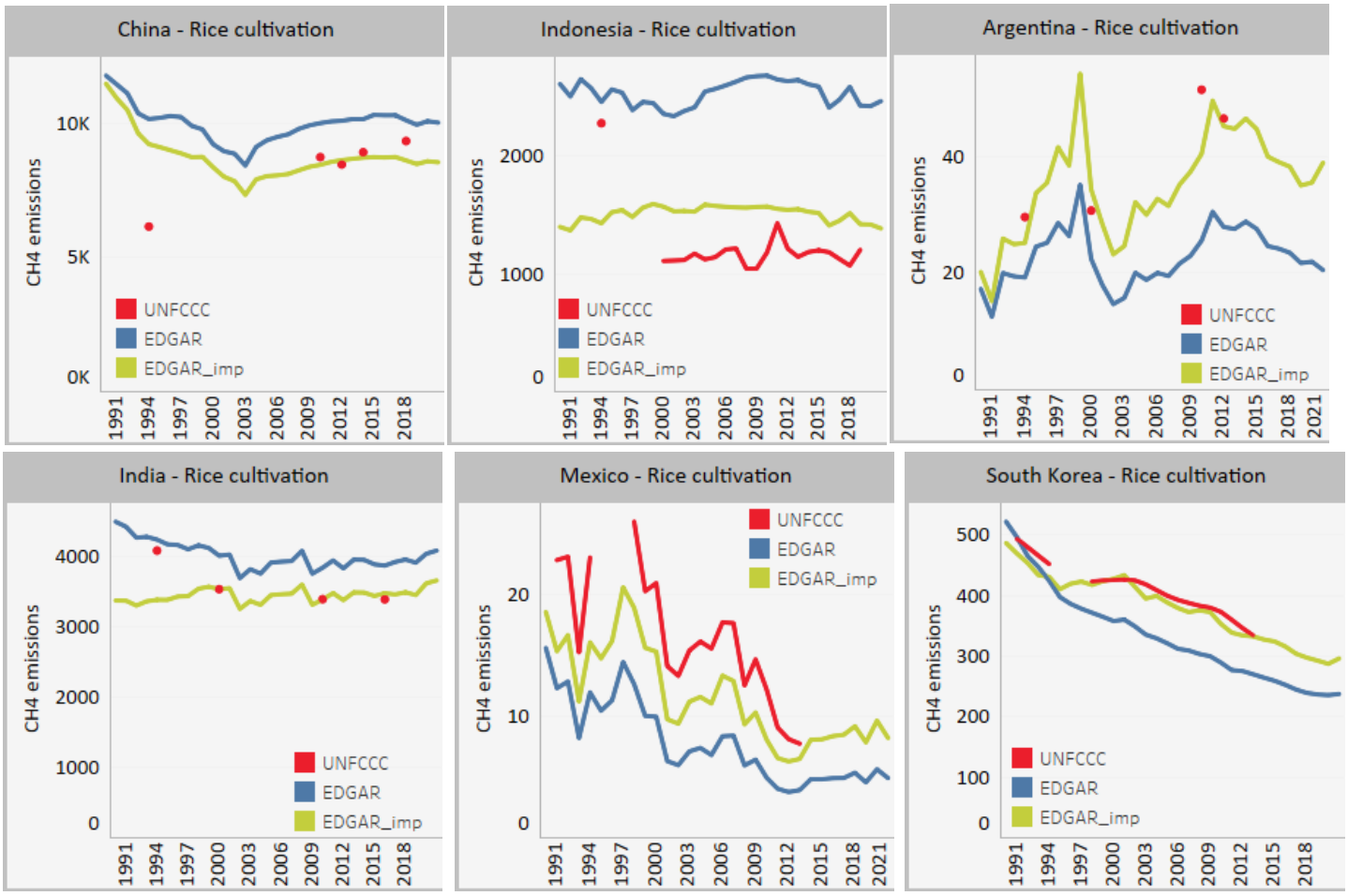


Figure S. 12. Temporal trend of CH4 emissions from rice cultivation in Annex I countries: EDGARv8.0, 2023, UNFCCC 2023, and EDGARv8.0 2023 improved (EDGAR_imp), 1990-2021, kt

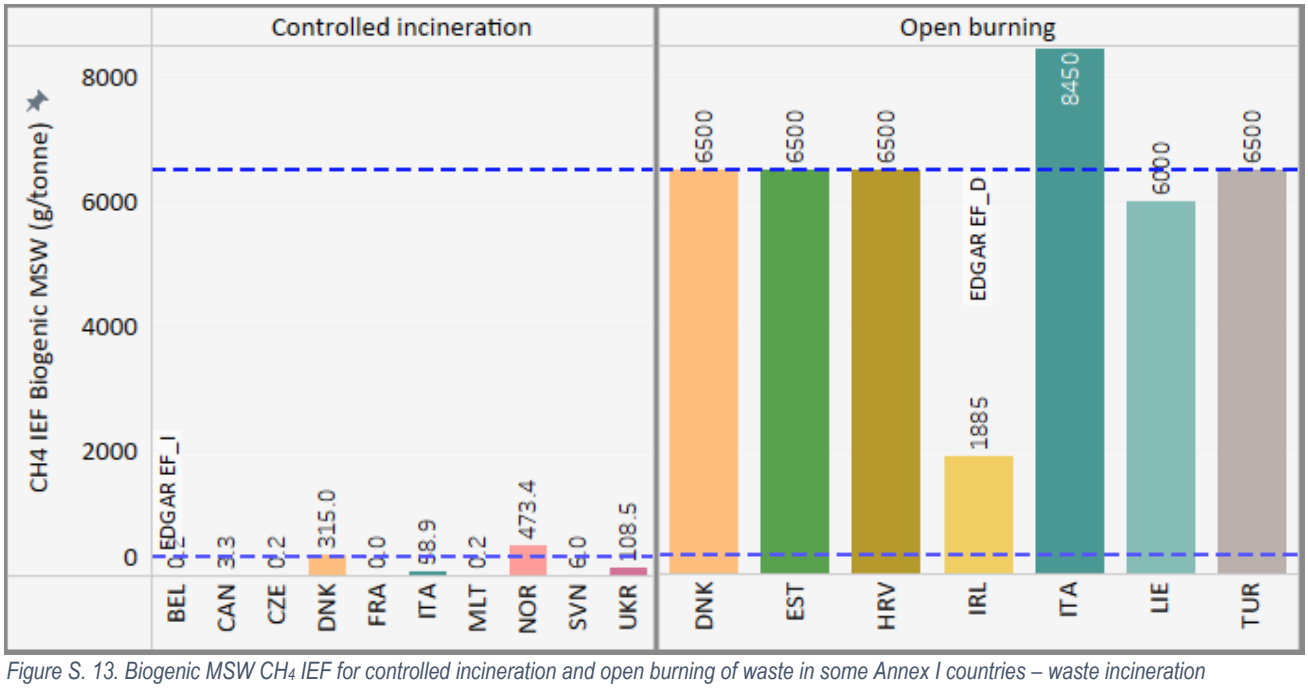


Figure S. 13. Biogenic MSW CH_4 IEF for controlled incineration and open burning of waste in some Annex I countries – waste incineration EDGAR CH_4 EFs for industrialised (RDGAR EF_I) and developing countries (EDGAR EF_D)

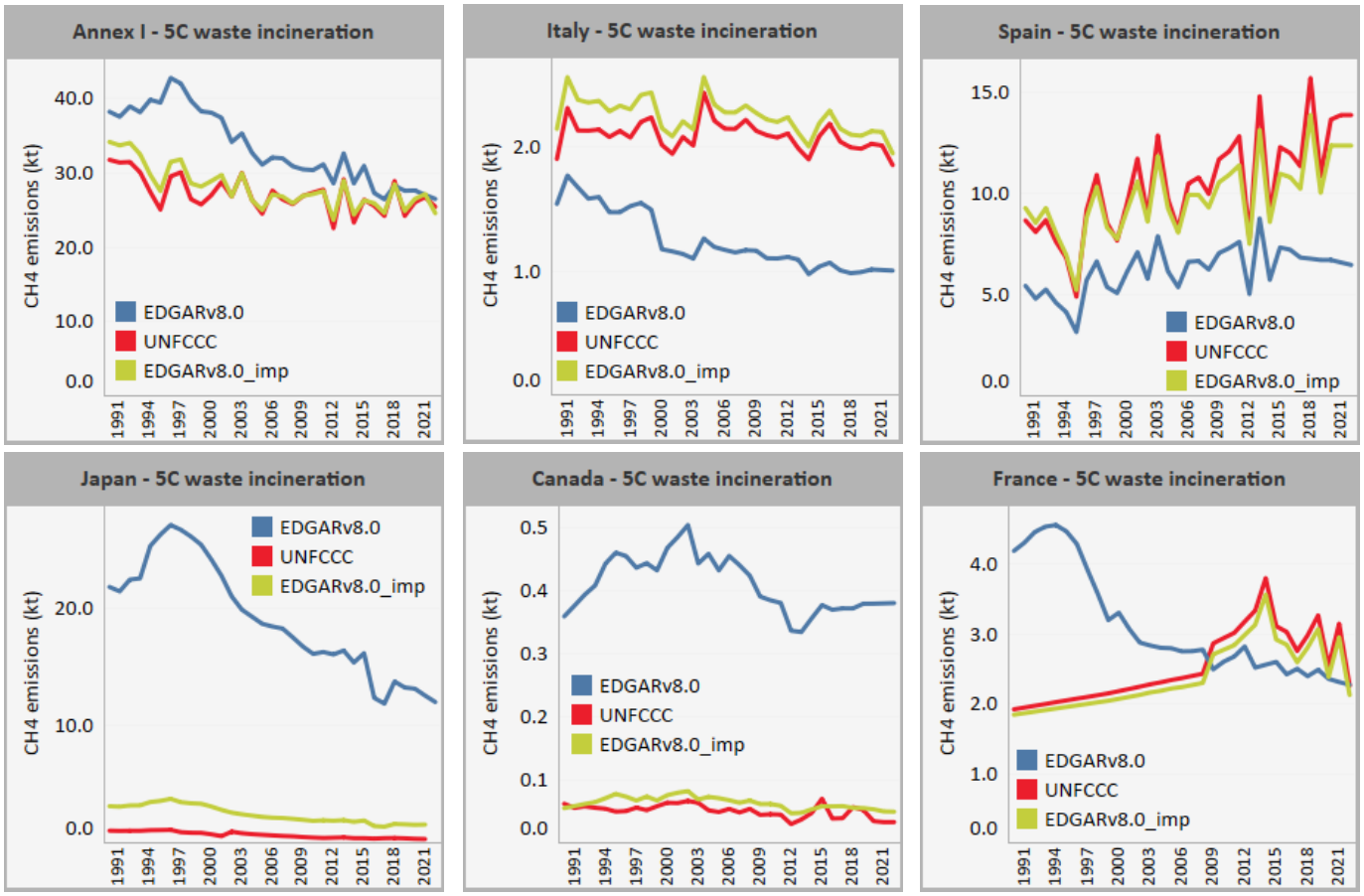
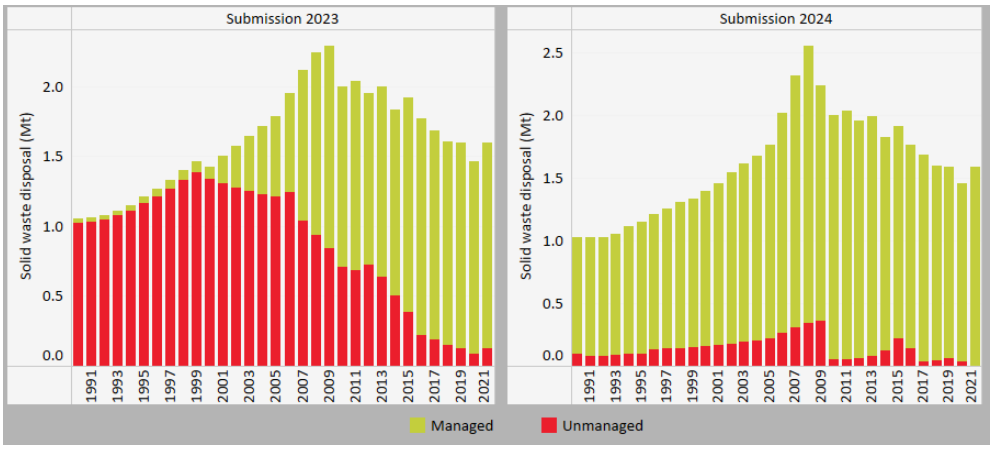
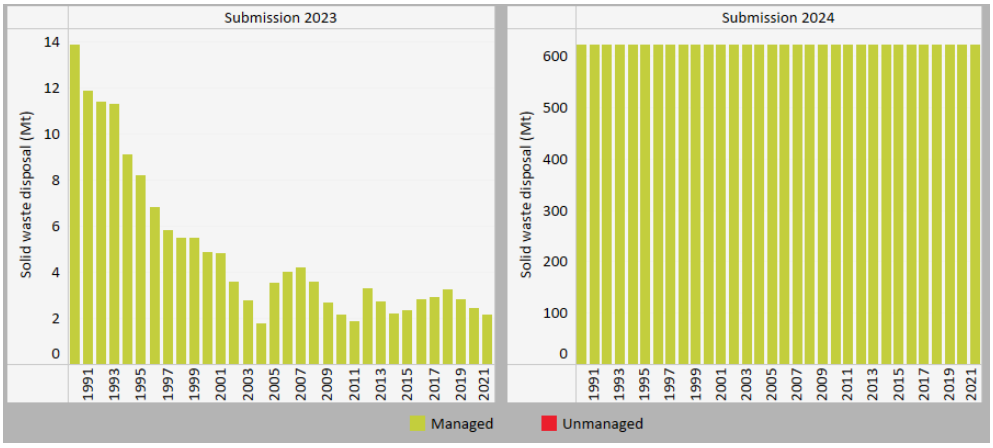


Figure S. 14 Temporal trend of CH_4 emissions from waste incineration in some Annex I countries: EDGARv8.0, 2023, UNFCCC 2023, and EDGARv8.0 2023 improved, 1990-2021

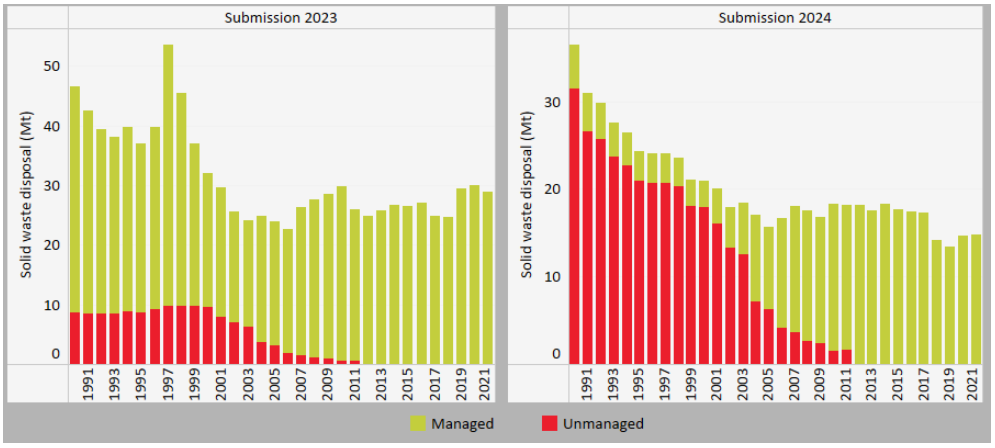
a)



b)



c)



d)

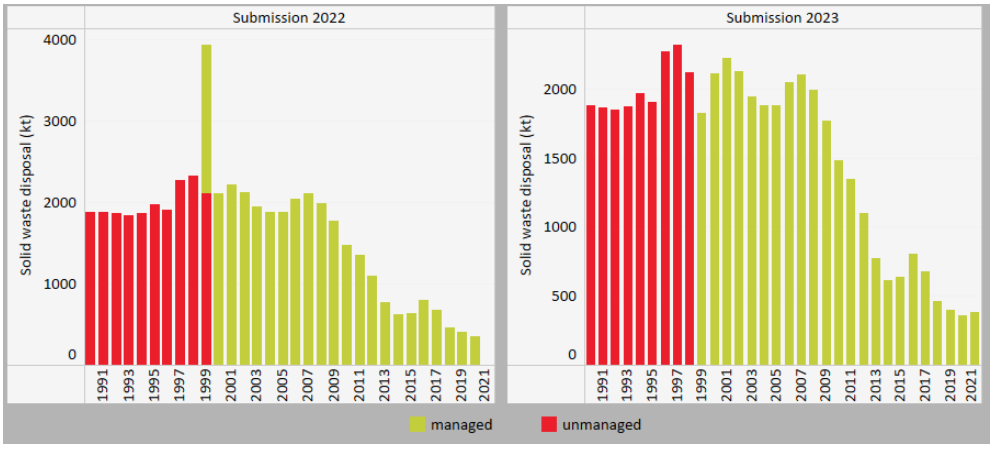


Figure S. 15 Solid waste disposal trend and typology in some EU27 MS as in their 2022, 2023 and 2024 UNFCCC submissions: a) Croatia, b) Netherlands, c) Poland, d) Ireland

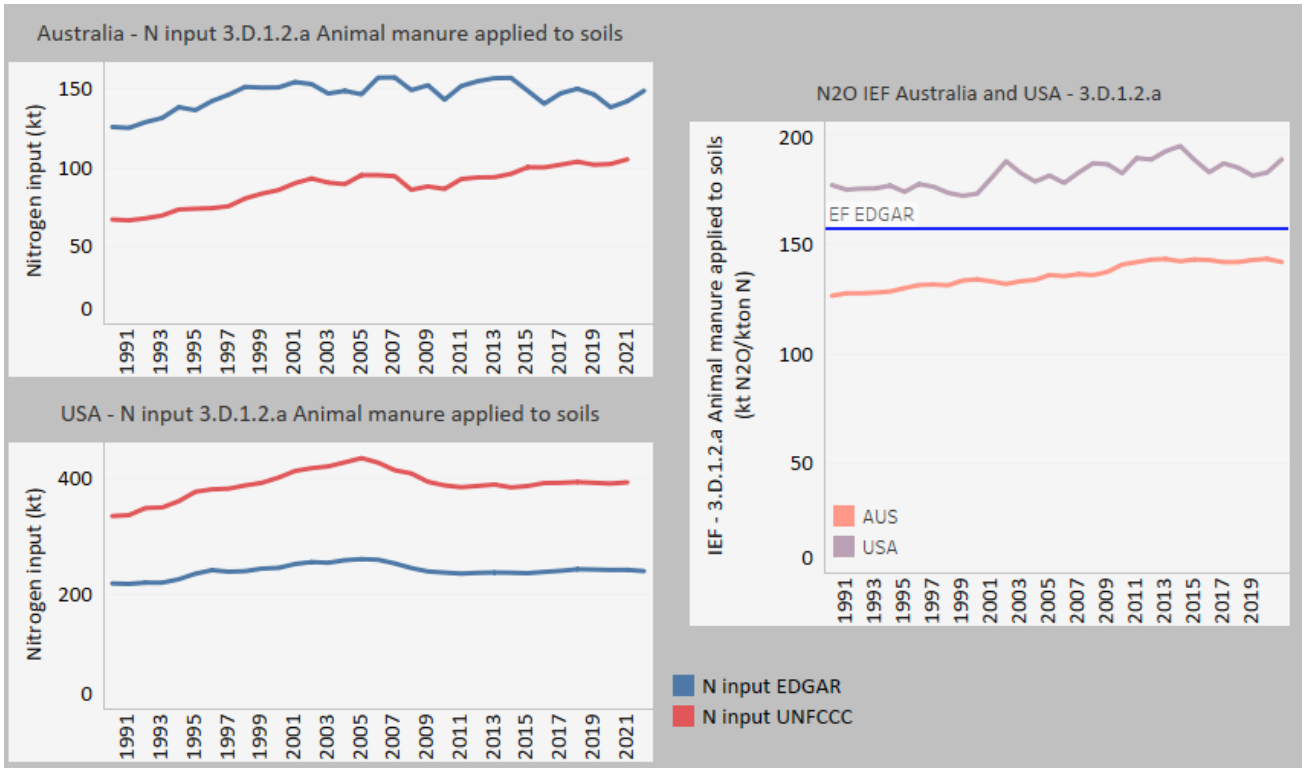


Figure S. 16 Nitrogen input for N_2O emissions from animal manure applied to soils and N_2O emission factors for Australia and USA, 1990-2021, EDGARv8.0 vs UNFCCC 2023

Supplementary tables

Table S. 1. G20, Annex I and EU27 country names and ISO 3 codes

Country name	iso 3 code	Group	Country name EU27	iso 3 code
Argentina	ARG	G20 / non-Annex I	Austria	AUT
Australia	AUS	G20 / Annex I	Belgium	BEL
Brazil	BRA	G20 / non-Annex I	Bulgaria	BGR
Canada	CAN	G20 / Annex I	Croatia	HRV
China	CHN	G20 / non-Annex I	Cyprus	CYP
European Union	EU27	G20 / Annex I	Czechia	CZE
Germany	DEU	G20 / EU27 /Annex I	Denmark	DNK
France	FRA	G20 / EU27 /Annex I	Estonia	EST
United Kingdom	GBR	G20 / Annex I	Finland	FIN
Indonesia	IDN	G20 / non-Annex I	Greece	GRC
India	IND	G20 / non-Annex I	Hungary	HUN
Italia	ITA	G20 / EU27 /Annex I	Ireland	IRL
Japan	JPN	G20 / Annex I	Latvia	LVA
South Korea	KOR	G20 / non-Annex I	Lithuania	LTU
Mexico	MEX	G20 / non-Annex I	Luxembourg	LUX
Russia	RUS	G20 / Annex I	Malta	MLT
Saudi Arabia	SAU	G20 / non-Annex I	Netherlands	MLD
Turkiye	TUR	G20 / Annex I	Poland	POL
United States	USA	G20 / Annex I	Portugal	PRT
South Africa	ZAF	G20 / non-Annex I	Romania	ROU
Iceland	ISL	Annex I	Slovakia	SVK
New Zealand	NZL	Annex I	Slovenia	SVN
Norway	NOR	Annex I	Spain	ESP
Switzerland	CHE	Annex I	Sweden	SWE
Ukraine	UKR	Annex I		
Belarus	BLR	Annex I		
Kazakhstan	KAZ	Annex I		

Table S. 2 Methodologies applied in some Annex I countries for CO_2 and CH_4 emission estimation upon sectors (UNFCCC CRT tables codes)

sector	substance	CAN	DEU	FRA	ITA	JPN	RUS	TUR	USA
1.A.1	CH4	T2	T2	T2	T3	T3	T1	T2,T3	T2
	CO2	CS	CS	CS,PS	CS	CS	CS,D	CS,D,PS	CS
1.A.2	CH4	M,T2,T3	CS	T1,T2,T3	T2	CS,T1,T3	T1	T1	T1
	CO2	M,T2	CS,T1	T2,T3	T2	CS,T2	T1,T2,T3	T1,T2	T2
1.A.3.b	CH4	M,T3	CS,M,T2,T3	T3	T3	T3	T1,T2,T3	T1	M,T3
	CO2	M,T2	CS,M,T1,T2,T3	T3	T2	T2	T1,T2	T1,T2	CS,M,T2
1.A.4	CH4	M,T1,T2,T3	CS,T2,T3	T1,T2	T2	CS,T1,T3	T1	T1	T1
	CO2	M,T2	CS,T1,T2,T3	T1,T2	T2	CS,T2	T1,T2	T1,T2	T2
1.A.5.a	CO2		CS				T1,T2		CS,T2
1.A.5.b	CH4	M,T1,T3	CS,D,M		T2				T1
	CO2	M,T2	CS,D,M		T2				CS,T2
1.B.1	CH4	CS	CS,T2,T3	T2,T3	T1,T2	T1,T2,T3	T1,T2	T1	T2,T3
	CO2		CS,T3			CS,T2			T1
1.B.2	CH4	CS	T1,T2,T3	T1,T2,T3	T1,T2	CS,T1,T2	T1b,T2	T1	CS
	CO2	CS	T1,T2,T3	T1,T2,T3	T1,T2	CS,T1,T3	T1b,T2	T1	CS
2.A	CO2	T1,T2,T3	T1,T2	T1,T2,T3	T2	CS,T2	T1,T2	T1,T2	T1,T2,T3
2.B	CH4	T1,T2,T3	T1,T2	T2,T3	D,T1	CS,T1	T1,T2		T1
	CO2	T1,T2,T3	T1,T2,T3	T1,T2,T3	D,T2,T3	CS,T1,T2,T3	T1,T1a,T2,T3	T1,T2	CS,T1
2.C	CH4	T1	T2	T2,T3	D	CS	T1	T1	T1
	CO2	T2,T3	T1,T2,T3	T1,T2,T3	T2	T1,T2	T1,T2,T3	T1,T2,T3	T1,T2,T3
3.A	CH4	T1,T2	T1,T2,T3	T2,T3	T1,T2	CS,T1	CS,T1,T2	T1,T2	M,T1,T2
3.B	CH4	T1,T2	T2	T2	T1,T2	CS,T1	CS,T1,T2	T1	M,T1,T2
3.C	CH4			T1	T2	T3	T1	T1	OTH
5.A	CH4	CS	T2	T2	T2	T3	T3	T2	CS
5.B	CH4	T3	T2	T2	D	T2	T1	T1	D,T1
5.C	CH4	T2,T3		T1,T2	D,T1	CS,T2		T1	
5.D	CH4	CS,T3	CS,D,T2	T1	D,T1	CS,D	T1,T2,T3	T2	CS,D,T2

Source: UNFCCC GHG Locator, 2023
NB: D (IPCC default), CS (Country specific), T1 (IPCC Tier1), T2 (IPCC (Tier 2), T3 (IPCC Tier 3), M (Model), OTH (Other)

Table S. 3 UNFCCC and EDGAR classification systems (Diego check)

EDGAR booklet sectors	EDGAR codes/process group name	UNFCCC non Annex I (IPCC 1996)	UNFCCC Annex I (IPCC 2006)
Power Industry	1.A.1.a Main Activity Electricity and Heat Production	1.A.1.a Public Electricity and Heat Production	1.A.1.a Main activity Electricity and Heat production (1.A.1.a.i, ii, iii)
Fuel explotation	1.A.1.b Oil refineries	1.A.1.b Petroleum Refining	1.A.1.b Petroleum Refining
Fuel explotation	1.A.1.c Transformation Industry	1.A.1.c Manufacture of Solid Fuels and Other Energy Industries	1.A.1.c Manufacture of Solid Fuels and Other Energy Industries (1.A.1.c.i, ii)
Industrial combustion	1.A.2 Manufacturing Industry	1.A.2 Manufacturing Industries and Construction	1.A.2 Manufacturing Industries and Construction (subdivided 1.A.2.f - 1.A.2.m)
Transport	1.A.3.a Non-road transport	1.A.3.a Civil Aviation	1.A.3.a Civil Aviation
Transport	1.A.3.a.ii Non-road transport	1.A.3.a.ii Domestic	1.A.3.a.ii Domestic Aviation
Transport	1.A.3.b_noRES Road transport	1.A.3.b Road Transportation	1.A.3.b Road Transportation
Transport	1.A.3.c Non-road transport	1.A.3.c Railways	1.A.3.c Railways
Transport	1.A.3.d Non-road transport	1.A.3.d Navigation	1.A.3.d Water-borne Navigation
Transport	1.A.3.d.ii Non-road transport	1.A.3.d.ii National Navigation	1.A.3.d.ii Domestic Navigation
Transport	1.A.3.e Non-road transport	1.A.3.e Other Transportation	1.A.3.e Other Transportation
Buildings	1.A.4 Residential	1.A.4 Other Sectors	1.A.4 Other Sectors (subdivided 1.A.4.c.i, ii, iii)
Buildings	1.A.5 Residential	1.A.5 Other	1.A.5 Other (Not specified elsewhere) (subdivided 1.A.5.b.i, ii, iii)
Fuel explotation	1.A.5.b.iii Transformation Industry		
Fuel explotation	1.B.1.a Fuel production/transmision	1.B.1.a Solid Fuels (coal mining and handling)	1.B.1.a Coal mining and handling
Fuel explotation	1.B.1.b Transformation Industry	1.B.1.b Solid fuel transformation	1.B.1.b Fuel transformation
Fuel explotation	1.B.1.c Transformation Industry	1.B.1.a Coal mining	1.B.1.c Others (please specify)
Fuel explotation	1.B.2 Transformation Industry	1.B.2 Oil and Natural Gas	1.B.2 Oil and Natural Gas and Other Emissions from Energy Production
Fuel explotation	1.B.2.a.ii / iii Fuel production (Venting & Flaring)/Transmision (Oil)		1.B.2.a.ii / iii Production and upgrading/Transport (Oil)
Fuel explotation	1.B.2.b.ii / iii Fuel production (Venting)/Transmision (Gas)		1.B.2.b.ii / iii Production and gathering/Processing (Natural gas)
		1.B.2.c Venting and flaring	1.B.2.c Venting and flaring (Oil, gas, combined)
Processes	2.A.1 Production of non-metallic minerals (Cement)	2.A.1 Cement Production	2.A.1 Cement Production
Processes	2.A.2 Production of non-metallic minerals (Lime)	2.A.2 Lime Production	2.A.2 Lime Production
Processes	2.A.3 Production of non-metallic minerals (Glass)	2.A.7 Other (Glass production)	2.A.3 Glass production
Processes	2.A.4 Production of non-metallic minerals (Carbonates)	2.A.3 Limestone and Dolomite use	2.A.4 Other Process Uses of Carbonates
Processes	2.B Production of chemicals	2.B Chemical Industry	2.B Chemical Industry
Processes	2.C Production of iron & steel/non-ferrous metals	2.C Metal Production	2.C Metal Industry
Processes	2.D Production and use of other products	3. Solvent and Other Product Use	2.D Non-energy Products from Fuels and Solvent Use
Processes	2.E Production and use of other products	2.E Production of Halocarbons and SF_6	2.E Electronics Industry
Processes	2.F Production and use of other products	2.F Consumption of Halocarbons and SF_6	2.F Product Uses as Substitutes for ODS
Processes	2.G Production and use of other products	2.G Other	2.G Other Product Manufacture and Use
Agriculture	3.A.1 Enteric Fermentation	4.A Enteric Fermentation	3.A Enteric Fermentation
Agriculture	3.A.2 Manure management	4.B Manure Management	3.B Manure Management
Agriculture	3.C.7 Rice cultivation	4.C Rice Cultivation	3.C Rice Cultivation
Agriculture	3.C.4 Agricultural soils (Direct N2O from managed soils)	4.D.1 Direct soil emissions	3.D.1 Direct N_2O Emissions From Managed Soils
Agriculture	3.C.5 Indirect N2O emissions	4.D.3 Indirect emissions	3.D.2 Indirect N_2O Emissions From Managed Soils
Agriculture	3.C.1 Agriculture waste burning	4.F Field Burning of Agricultural Residues	3.F Field Burning of Agricultural Residues
Agriculture	3.C.2 Agricultural soils (lime application)	4.D.4.b CO2 from agricultural lime application	3.G Liming
Agriculture	3.C.3 Agricultural soils (urea application)		3.H Urea Application
Agriculture	3.C.6 Indirect N2O emissions	4.G Other	3.J Other
Waste	4.A Solid Waste Disposal (Landfill)	6.A Solid Waste Disposal on Land	5.A Solid Waste Disposal
Waste	4.B Solid Waste Disposal (Composting)	6.D Other	5.B Biological Treatment of Solid Waste
Waste	4.C Solid Waste Disposal (Incineration)	6.C Waste Incineration	5.C Incineration and Open Burning of Waste
Waste	4.D Waste water	6.B Wastewater Handling	5.D Wastewater Treatment and Discharge
Agriculture	5.A Indirect N2O emissions from the atmospheric deposition of nitro	7. Other	6. Other
Fuel explotation	5.B Fossil fuel fires		

Source: UNFCCC inventory system, EDGAR 2024
the IPCC, classification the Land Use, Land-Use Change, and Forestry (LULUCF) is Sector 5. Under UNFCCC, inventory system (CRF/CRT) for Annex I the LULUCF is Sector 4.

Table S. 4 Sub-sectors included in EDGAR emissions estimation from waste incineration – Biogenic waste

BIOGENIC		
5.C.1.1.a	SWD.INC.BIO	Biogenic - 5.C.1.1.a Municipal Solid Waste
5.C.1.1.b_Clinical Waste	SWD.INC.BIO	Biogenic - 5.C.1.1.b Others (please specify)
5.C.1.1.b_Hazardous Waste	SWD.INC.BIO	Biogenic - 5.C.1.1.b Others (please specify)
5.C.1.1.b_Industrial Solid Wastes	SWD.INC.BIO	Biogenic - 5.C.1.1.b Others (please specify)
5.C.1.1.b_Sewage Sludge	SWD.INC.BIO	Biogenic - 5.C.1.1.b Others (please specify)
5.C.2.1.a	SWD.INC.BIO	Open burning of waste: Biogenic - 5.C.2.1.a Municipal Solid Waste
5.C.1.1.b_Cremation	SWD.INC.CRM	Biogenic - 5.C.1.1.b Others (please specify)