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JRC SCIENTIFIC INFORMATION SYSTEMS AND DATABASES REPORT

Development of EDGAR-POLES JRC platform on historic and projected greenhouse gases and air pollutant emissions

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Contents

Abstract

To support the development and integration of tools and models in line with the European Green Deal priorities using JRC resources, a technical work has been performed towards setting the basis for the development of EDGAR-POLES JRC platform on historic and projected greenhouse gas and air pollutant emissions. To achieve this goal, the work has started from the mapping between Emissions Database for Global Atmospheric Research (EDGAR) database and Prospective Outlook on Long-term Energy Systems (POLES JRC) model having the main aim to provide insights on the level to which the substances, categories, sectors, subsectors, fuels and technologies of both in-house data sources can be equivalent to one-another.

This report is work on progress and will be updated and complemented with the upcoming work under the JRC Work Programme 2023-2024 having in focus the further development of EDGAR-POLES JRC platform in order to provide consistent emissions scenarios use to analyse the impact of climate policies.

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1 Introduction

Combining results of different databases and models requires a more consistent use of these data sources through a series on assumptions and mapping. Ensuring coherence among in-house data sources requires collaboration work of different teams.

The DETECT project (Detecting unexpected and emerging signals from emissions and technologies) is an example of this collaboration work that involves JRC Units C5, C6 and D1. The project supports the European Green Deal priorities and a stronger Europe in the world strategy. The project is part of JRC Climate and Energy Diplomacy Portfolio, which main objectives are as following:

- Application/development of analytical models and tools
- Policy relevant outputs for international climate negotiations
- Outreach and Capacity building, engage in international research networks

DETECT project main objectives are listed below:

- Support the 'climate ambition strategy' exploring pathways to achieve climate neutrality,
- Support the 'stronger EU in the world' strategy,
- Develop the EDGAR-LULUCF database

Under the framework of the first objective the harmonisation of the JRC Emissions Database for Global Atmospheric Research (EDGAR) and energy-economy model Prospective Outlook on Long-term Energy System (POLES JRC) to develop regional and global scenarios is aimed.

Within the DETECT project this objective is pursued by Task 4 and is coined as "*Development of the EDGAR-POLES platform*".

The main aim of this work is to provide emission time series of greenhouse gases (GHGs) and air pollutants of both EDGAR databases and POLES-JRC model in a consistent way. To this end, the following steps have been accomplished:

- Mapping variables between EDGAR and POLES-JRC in a consistent way,
- Aggregating emission time series corresponding to the mapping series from EDGAR and POLES JRC,
- Making GHG and air pollutant emission time series available in a visualisation tool (e.g. Qlik).

This deliverable aims to document and present the match between EDGAR and POLES JRC allowing to point out and discuss issues arising from the mapping.

The first approach will be to Identify for each GHG and air pollutant the lowest[1] available level of granualarity of variables matching POLES JRC with EDGAR. In case of GHGs it is needed to specify the Intergovernmental Panel on Climate Change (IPCC) category corresponding to this matching as well as the aggregation of EDGAR sectors, fuels and technologies.

This informative report is organised as follows: in Chapter 2 a description of EDGAR database and POLES JRC is provided, followed by Chapter 3 that describes the basis of mapping methodology between these two in-house data sources. Chapter 4 provides a description on mapping performed in each sector followed by Chapter 5 in which the concept of an EDGAR-POLES JRC platform is provided. Some results of this mapping are showed in Chapter 6 while discussions and conclusions remarks are provided in Chapter 7. This report provides a number of Annexes that includes very detailed description on mapping procedure between EDGAR and POLES JRC for energy, manufacturing industry and transport sector.

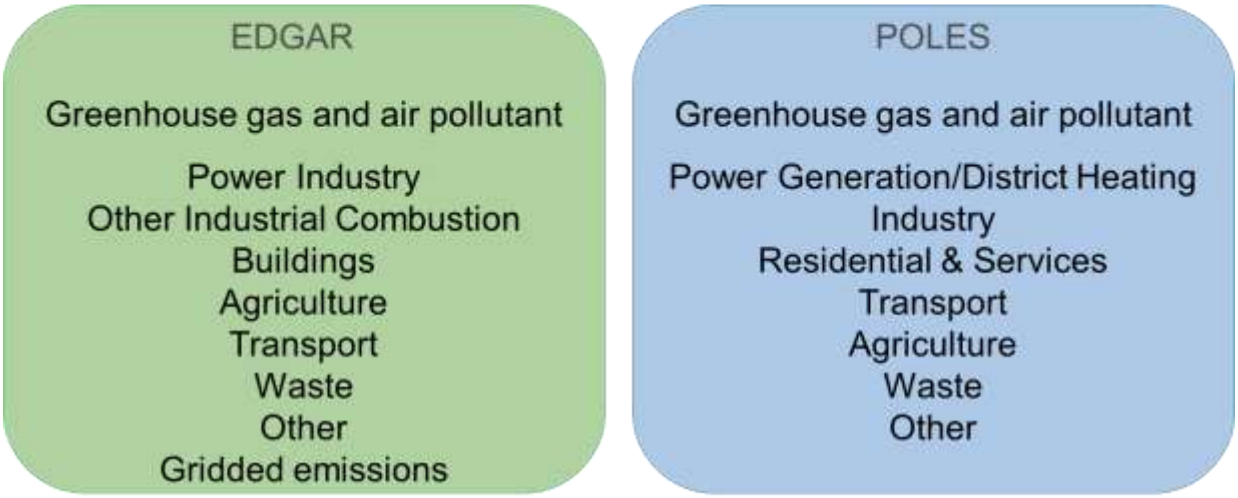
The actual mapping is contained in an Excel document ("Mapping EDGAR-POLES.xlsx") that provides in very detailed way the mapping between these two data sources..

([1]) The "lowest level" we can map EDGAR and POLES JRC is used based on the EDGAR levels (see more in EDGAR database desctiption).

2 Description of EDGAR and POLES JRC

The EDGAR database provides historic emission time series at "t-1" level (the most recent time series covers the period 1970 - 2021), while the POLES-JRC model provides historic and projected emission time series (covering the period 1990 - 2100) for both GHG and air pollutants for the sectors as shown in Figure 1. EDGAR provides also global gridded emissions of both GHG and air pollutants[2].

Figure 1. Main sectors included in GHG and air pollutant emissions estimation in EDGAR and POLES-JRC



The major difference between EDGAR and POLES-JRC is that the granularity of EDGAR is much finer than in POLES-JRC (see Table 1 and Table 2).

Table 1. EDGAR and POLES JRC mapping granularity levels corresponding to EDGAR structure (levels 1-5)

	Type	Main Sector (level 1)	Sub Sector (level 2)	Fuel (level 3)	Technology (level 4)	Controlled Emission Factor (level 5)
EDGAR	Granularity	energy, industry, residential, agriculture, transport, waste, other -IPCC coarse	95	75	>90	several by fuel / technology
	CO_2, CH_4, N_2O, pollutants				X	
POLES	Type	Sector (level 1/2)		Fuel (level 3)	Technology (level 4)	Emission Factor
	Granularity	power, industry, transport, residential, coal mining, oil & gas		coal, lignite, gas, oil, biomass, etc.	many	no emission factor (EF by fuel only) & EFs for air pollutants (IIASA)
	CO_2				X	
	N_2O, CH_4	X				
	Air pollutants	X		X		
	Activity Variable				X	

Table 2. EDGAR and POLES JRC differences in countries domain and methodology

Item	EDGAR	POLES-JRC
Geography	208 countries	54 countries, 12 multi-country regions
Methodology	IPCC (Tier1 & Tier 2)	Energy model
Abatement	End of Pipe (EoP) for air pollutant, non-CO_2	Marginal abatement cost curve (MACC), Carbon capture and storage (CCS)

(2) https://edgar.jrc.ec.europa.eu/emissions_data_and_maps

2.1 EDGAR database

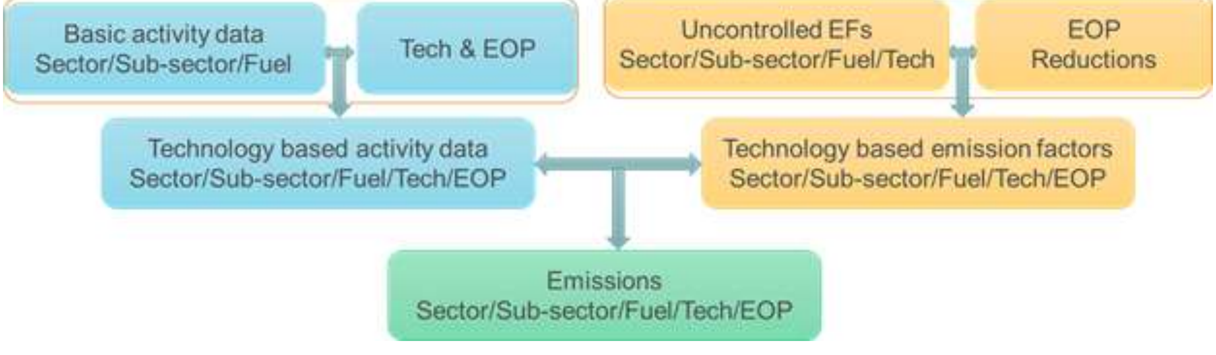
EDGAR is a global database that provides estimates of country and sector-specific emissions of greenhouse gases (GHGs), including CO_2, and air pollutants implementing a transparent state-of-the-art methodology. EDGAR provides emissions consistently estimated for more than 220 world countries (see Figure 2) based on international statistics and a detailed bottom-up methodology [2], [8], [11], [12] following the IPCC guidelines.

Figure 2. EDGAR database geographical coverage

To achieve this estimation, EDGAR uses four different dimensions shown in the schematic structure in Figure 3.

- sector;
- fuel;
- a general-purpose technology;
- a range of so-called end-of-pipe (EOP) measures

Figure 3. Schematic structure of EDGAR database



The EDGAR methodology used is transparent and in line with the most recent scientific literature and Intergovernmental Panel on Climate Change (IPCC) recommendations. In EDGAR emissions are based on activity variables at the level of sector, fuel, and general-purpose technology. Emissions are calculated by multiplying activity variables by emission factors (EF) of the EOP measures. The latter calculations are repeated over all kind of GHGs and pollutants.

Regarding fossil CO_2 emissions, all anthropogenic activities leading to climate relevant emissions are included, except biomass/biofuel combustion (short-cycle carbon) in the power, industry, buildings, transport and agricultural sectors, large-scale biomass burning and land use, land-use change and forestry (LULUCF).

Table 3. Main activities included in EDGAR greenhouse gas emission estimation following IPCC categories

<table>
<tr><th>Fossil CO_2</th><th>CH_4, N_2O</th><th>F-gases</th><th>CO_2 LULUCF</th></tr>
<tr><td colspan="2">Power Industry: power and heat generation plants (public and auto-producers)</td><td rowspan="5">Non-Ferrous Metal and Electronics Industry

Product uses as substitute for ozone depleting substances</td><td rowspan="5">Forest remaining forest
Land converted to forest
Deforestation
Organic soil
Fires
Other: cropland, grassland and settlements</td></tr>
<tr><td colspan="2">Other industrial combustion: combustion for industrial manufacturing and fuel production</td></tr>
<tr><td colspan="2">Buildings: small scale non-industrial stationary combustion</td></tr>
<tr><td colspan="2">Transport: road, non-road, domestic and international aviation, inland waterways and international shipping</td></tr>
<tr><td>Other sectors: industrial processes, agriculture soils (urea application and lime) and waste</td><td>Other sectors: agriculture livestock (enteric fermentation, manure management), agriculture soils (fertilisers, lime application, rice cultivation, bread and paper production), field burning of agricultural residues and waste</td></tr>
</table>

Source: GHG emissions in all world countries [1]

Table 3 shows the main activities included in EDGAR emissions estimation. EDGAR makes use of the IPCC sectorial classification, and a consistent bottom-up emission calculation methodology is applied to all countries, so that emissions of different countries can be compared, considering their respective levels of detail, uncertainties or data limitations [13]. In particular, for developing countries with less robust and systematic statistical data infrastructures and limited experience in reporting their fossil fuel emissions inventories, EDGAR can provide information and support them in complying with their inventory preparation.

Figure 4 and Figure 5 illustrate substances and the schematic view of sectors allocation according to the main processes included in EDGAR. In the following sub-sections, a short description of EDGAR main sectors is provided. In Annex 2 sectors/subsectors codes and names are provided.

Figure 4. Substances included in EDGAR

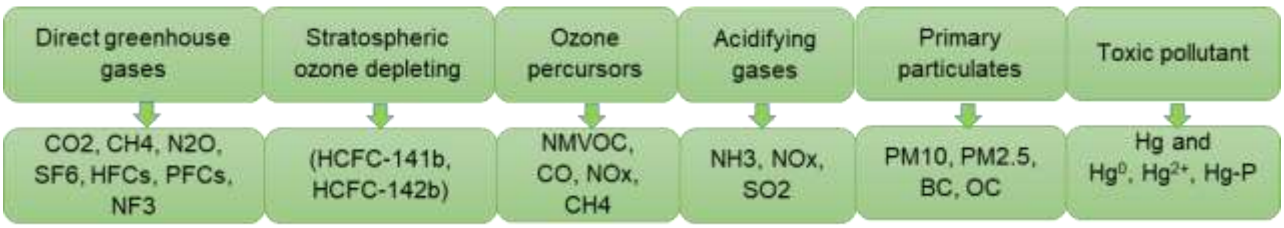
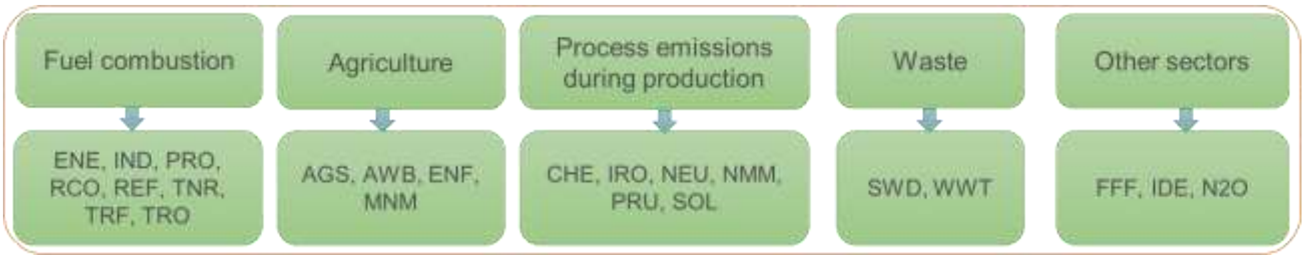


Figure 5. Allocation of sectors in EDGAR main processes[3]



(3) Refer to Annex 2 for the names of sectors/subsectors that corresponds to the abbreviations in Figure 5.

2.1.1 EDGAR methodology for energy sector

Emissions from the energy sector are included in EDGAR named as "ENE". Activity data are sourced from the International Energy Agency (IEA) fuel balances. UDI Platts installed capacity is used for the fuel distribution to the different combustion technologies at country level.. Emission factors applied in "ENE" take into consideration the C. N and S content of fuels, the type of combustor device in which the fuel is burned and the internal/downstream installed air pollutant removal processes.

Seven types of sub-sectors are defined within the "ENE" sector for which the IEA fuel balances [4] definitions are applied. The IEA definitions are also applied for the fuel allocation in the "ENE" sector. Below the description and the codes used in EDGAR system for the "ENE" sub-sectors is provided. Combustion technologies included in EDGAR ENE sector are shown in Table 4. Annex 1 provides codes and description of fuels included in "ENE".

- Auto-produced cogeneration (AHP),
- Public electricity production (PEL),
- Own use in energy industry sector (POW),
- Public district heating (DHE),
- Public cogeneration (CHP),
- Auto-produced electricity (AEL),
- Auto-produced heat plants (AHE).

Table 4. Combustion technologies included in EDGAR "ENE" sector

Main fuel	EDGAR code	Description
Solid Fuels	PD0	Pulverised dry bottom boiler
	GF0	Grate firing
	FB0	Fluidised bed boiler
Gas & Liquid Fuels	BO0	Boiler for gas/liquids (any size)
	GT0	Gas turbine
	IC0	Internal combustion engine

2.1.2 EDGAR methodology for transport sector

Emissions from transport sector are included in EDGAR named as "TRO" for road transport, "TNR" for non-road transport (rail, domestic and international aviation, inland waterways, international shipping and other transportation). Not considered in road transport a) driving cycles as urban, rural or highway and b) cold start conditions. Activity data on fuel consumption are sourced from the IEA energy balances [4]. Statistics on fuel consumption are based on data on fuel sale.

Fuels are distributed to different vehicle categories for which different emission standards may exist applying technology penetration rates based on literature review and commercially available data. Emissions are estimated for buses (BS0), heavy duty vehicles (HD0), light duty vehicles (LD0), passenger cars (PC0), motorcycles (MC0) and mopeds (MP0). Type of fossil fuels included in this sector are described in Table 5.

Table 5. Type of fossil fuels included in EDGAR TRO and TNR sector

Main fuel	EDGAR code	Description
Gas	NGS	Natural gas
	RGS	Refinery gas
Liquid	AVG	Aviation gasoline
	BIT	Bitumen
	DIE	Gas/Diesel oil
	HFO	Residual fuel oil
	JET	Kerosene type jet fuel
	LPG	Liquefied petroleum gases
	LUB	Lubricants
	MOG	Motor gasoline
	NAP	Naphtha
	NGL	Natural gas liquids
	OKE	Kerosene
	OPR	Non specified petroleum products
	WSP	White spirit & SBP

2.1.3 EDGAR methodology for manufacturing industry sector

Emissions from manufacturing industry sector are included in EDGAR named as "IND". In line with IEA the following industries are included: Chemical, Construction, Food and tobacco, Iron and steel, Machinery, Mining, Non-ferrous metals, Non-metallic minerals, Paper, pulp and print, Transport equipment, Textiles, Wood and wood products and Non-specified industry (see Table 6).

Table 6. EDGARv6.0 codes for industry sector and the respective IPCC 2006 code

Description	EDGARv6.0 code	IPCC 2006 code
Chemical (combustion)	CHE	1.A.2.c
Construction (combustion)	CON	1.A.2.k
Food and tobacco (combustion)	FOO	1.A.2.e
Iron and steel (combustion)	IRO	1.A.2.a
Machinery (combustion)	MAC	1.A.2.h
Mining (combustion)	MIN	1.A.2.i
Non-ferrous metals (combustion)	NFE	1.A.2.b
Non-metallic minerals (combustion)	NMM	1.A.2.f
Paper, pulp and print (combustion)	PAP	1.A.2.d
Transport equipment (combustion)	TEQ	1.A.2.g
Textiles (combustion)	TEX	1.A.2.l
Wood and wood products (combustion)	WOO	1.A.2.j
Non-specified industry	INO	1.A.2.m

2.1.4 EDGAR methodology for the agricultural sector

Emissions from agricultural sector are included in EDGAR named as "ENF", "MNM", "AGS" and 'AWB" respectively for enteric fermentation, manure management, agricultural soil and agricultural waste burning. EDGAR applies the IPCC methodology to estimate emissions from agriculture sector based on Chapter 10 [6] and Chapter 11 [7] of the IPCC 2006 Guideline.

Livestock is the main input for the emission estimation and are allocated in the Animal Waste Management System (AWMS) based on the shares provided in the IPCC 2006 Guideline Chapter 10 Tables 10A-4 up to 10A-9 (for cattle, swine and buffalo) and assumptions on allocation are applied for other livestock. Other activity data such as N excretion, Typical Animal Mass and Carcass weight are taken from the Guideline but also from Common Reporting Format (CRF) tables/ models/literature. In EDGAR the AWMS as Lagoons, Liquid/Slurry, Solid storage, Dry Lot, Dairy Spread, Pit Storage, Poultry Manure, Digesters and Others are included in the "MNM" whereas Pasture/Range/Paddock and Burned for fuel systems are included in the "AGS".

Unit C5 has developed a web tool - Agricultural Emission Estimation (AgrEE tool)[4] - to estimate air pollutant and GHG emissions from agricultural activities applying EMEP/EEA 2019 Guidebook and IPCC 2006 Guideline. Both Tier 1 and Tier 2 methods are available. The tool has been developed for the EU Member States inventory compilers.

2.1.5 EDGAR methodology for waste sector

Emissions from the waste sector are included in EDGAR named as "SWD" and 'WWT" respectively for solid waste disposal (on landfills, incinerated, composted and hazardous solid waste processing/storage) and waste water handling (industrial, domestic and commercial). CO_2 emissions are estimated only for incineration of solid waste process (SWD.INC) that covers waste incineration and open burning without energy recovery. The activities under this subsector are: municipal solid waste (MSW), biogenic waste (BIO), industrial solid waste (industrial waste, solvents, waste oil, hazardous waste) (ISW), industrial sludge (ISL), sewage sludge (SEW), hospital waste and cremation (HOS) and non-specified waste (OTH). Methane (CH_4) is mostly emitted by landfills, while nitrous oxide (N_2O) shows relevant contribution from waste water treatment.

([4]) https://edgar.jrc.ec.europa.eu/agree_tool

2.2 POLES JRC

POLES[5] is a partial equilibrium model of the energy system that covers the entire energy balance, from final energy demand, transformation and power production to primary supply and trade of energy commodities across countries and regions. Core of POLES JRC is the detailed modelling of the energy systems and GHG emissions. It allows assessing the contribution to future energy needs of the various energy types (fossil fuels, nuclear, renewables) and energy vectors. The model has been initially developed in 1990 at University of Grenoble (France) to be after transferred to a simulation software by the JRC. The JRC has co-developed the model for some time and has already issued the POLES JRC version. The POLES JRC model is implemented with the Vensim system dynamics software and its domain covers 66 regional entities (see Figure 6) including 12 non EU regions, EU27 and 26 non-EU countries (detailed OECD, G20 and emerging Asia).

Figure 6. POLES JRC model geographical coverage

Source: POLES JRC model documentation [3]

The POLES JRC model can be used for the following analytical support: (i) Assessment of policies releated to energy sector; (ii) GHG emissions abatement strategies; (iii) Technology dynamics; (iv) International fuel markets and price feedback. In addition, it calculates the evolution of GHG emissions: endogenously for the energy-industry sectors and through linkage with specialist models for GHG emissions from agriculture and LULUCF, and air pollution. POLES operates on a yearly time step, allowing integrating recent developments. POLES JRC models energy and emission scenarios allowing the selected scenarios to be developed and policies to be translated into quantitative modelling inputs, by sector and region, by 2050 in a standard configuration and up to 2100 for long-term mitigation strategies.

In the climate and energy policies dimension, POLES JRC takes into account the policies in (i) climate and environment e.g cap & pricing for all or selected GHG emissions; (ii) Technology support policies e.g technology availability and purchase, power specific policies, transport specific policies; and (iii) energy consumption policies e.g fiscal policy and subsidies on energy fuels, building specific policies, transport specific policies (fuel and emission standards).

The POLES JRC model uses annual historical data to initialise the projections, typically for the period 1980 to the latest data available. The data needed to run projections are those on (i) socioeconomic and activity variables (e.g population, GDP, sectoral value added etc.); (ii) energy balances (final demand, transformation, supply); (iii) energy prices and taxes; (iv) energy reserves and resources; (v) GHG emissions.

([5]) https://joint-research-centre.ec.europa.eu/poles_en

2.2.1 POLES JRC methodology for CO_2 and non-CO_2 emissions

Energy-related emissions refer to GHG emissions where the primary driver is energy production or consumption. They consist in CO_2 emissions from fossil fuel combustion and non-CO_2 emissions from energy-related activities.

Emission factors by fossil fuels (coal, oil, gas) are applied in POLES JRC for CO and non-CO_2 emissions from combustion. For CO_2 emissions from fossil fuel combustion, emission volumes are obtained directly from the use of individual fossil fuels with an emission factor. Carbon capture and storage (CCS) technology can be developed both in power generation and in industry sectors. Total emissions balances take into account carbon that is captured in CCS (in power plants, synthetic fuel production, hydrogen production and industry) and the uptake of carbon in steelmaking from coking coal. Full energy system in POLES IRC model is shown in Figure 7.

Figure 7. POLES JRC full energy system

For CO_2 and non-CO_2 process emissions, POLES JRC does not apply emission factors. Instead, emissions are based on historic emissions which are then extrapolated by using as driver the main activity data in combination with certain parameters (e.g. elasticities, trend parameters, etc.). Abatement measures (marginal abatement cost curves) might be applied in POLES JR on top of these extrapolation modelling in order to retrieve the actual emissions. Table 7 illustrates the main GHG emissions flows used in POLES JRC model.

Table 7. GHG emissions flows in POLES JRC model

Sector	Category	Substance	Emission activity	Modelling driver
Energy	Fuel combustion	CO_2	Burning fossil fuel	Fossil fuel combusstion
	Oil and gas	CH_4	Production, transmission & distribution	Oil & gas production Gas transport & use
	Coal production	CH_4	Underground & surface mining	Coal production (underground and surface)
	Power & heat transport, residential	N_2O CH_4	Combustion by-products	Sectoral final energy consumption
	Power system	SF6	Transmission & distribution	Electricity production
Industrial processes	Steel	CO_2	Iron ore reduction	Steel in thermal processes
	Non-metallic minerals	CO_2	Carbonate decomposition	Non-metallic mineral industry value added
	Chemicals	CO_2 N_2O	Steam reforming Nitric & adipic acid	Chemicals industry value added
	Aluminium	PFCs	Primary aluminium Semiconductor & PV	"Other" industry value added
	Magnesium, semiconductors	SF_6	Magnesium refining Semiconductor & PV	Industry value added
	Residential, services, transport	HFCs	Air conditioning, refrigeration, aerosols, foams, solvents	Industry value added
Waste	Waste	CH_4, N_2O	Solid waste & wastewater Burning waste	Urban population (urban waste) Industry value added (industrial waste)
Agriculture, forestry and other land use (AFOLU)	Agriculture	CH_4, N_2O	Enteric fermentation, manure management, soils & rice cultivation	Default emission profile from GLOBIOM (influenced by biomass price as proxy in land use
	Forestry and land use	CO_2	Deforestation, afforestation, other forestry and land use	Biomass price (derived by GLOBIOM cost curves) as proxy for forestry activity and other land use

Source: POLES JRC model documentation [3]

Industry is disaggregated into different manufacturing sectors, mining and construction. The industrial energy consumption does not include transport used by industry (which is reported under transport) excluding also the fuel input for auto-production but including the auto-produced electricity.

Additionally, the consumption of fuels for non-energy uses is captured for two types of products: chemical fertilisers, plastics and rubber.The projection of other GHG emissions from energy and industrial processes is based on: (i) a sector-specific economic driver (sectoral value added, energy production or energy consumption); (ii) a trend capturing technology changes; (iii) a marginal abatement cost curve (MACC) that describes the interaction with climate mitigation policies.

In building sector POLES JRC models energy consumption by end-use for residential and services sectors since they are mostly related to building activities and share several common features. Modelling is performed for space heating & cooling and water heating & cooking.

For GHG emissions from agriculture, forestry and land use (AFOLU), baseline emissions and mitigation potential are derived from the specialised International Institute for Applied Statistical Analysis (IIASA) Global Biosphere Management (GLOBIOM) model [5]. Non-energy related emissions (directly related to energy production, transport or consumption) are captured by an emission intensity (with a MACC) applied to the relevant activity.

In waste sector the main drivers used in the estimation are urban population and industrial value added, a technological trend and the abatement potential in case of GHG mitigation policy. The modelling includes the CH_4 emissions from solid waste disposal (municipal and industrial origin) and wastewater treatment and N_2O emissions from processing wastewater due to the de/nitrification processes of the nitrogen present.

2.2.2 POLES JRC methodology for air pollutant emissions

Air pollution modelling in POLES JRC is done by sector and fuel being performed using inputs from specialized sources as GAINS model that provides emission factors per pollutant and sector fuel that are then mapped to time series. The POLES-JRC energy balances are used as inputs to the GAINS model to derive the evolution of air pollutant emissions. Practically 48 flows/pollutant (with respective emission factors considered as direct inputs and recalculated based on historic data) are included in modelling e.g coal in residential and services or diesel & gas use in road transport.

Estimation of pollutants with EFs as direct inputs are included in Power generation (see Table 8), Industry, Buildings, Transport, Agriculture and Other Energy transformation. Estimation with EFs recalculated from historical data are included in Industrial production (see Table 8), Buldings (unattributed), Surface transportation, Agriculture (non-energy), Energy transformation (unattributed)

Table 8. Power generation with EFs as direct inputs and Industrial production with EFs recalculated from historical data

Sector	Source	Activity indicator
Power generation	Biomass	Biomass inputs in power generation (*)
	Coal	Coal inputs in power system for capacity historically installed (conventional coal)
		Coal inputs in newly installed power capacity (conventional coal)
		Coal inputs in newly installed power capacity (advanced coal) (*)
	Gas	Gas inputs in power generation (*)
	Oil	Oil inputs in power generation
Industrial production	Cement	Total energy in non-metallic minerals industry
	Chemicals	Total energy in chemicals industry
	Fertilisers	Total energy in chemical feedstocks industry
	Solvents	Value added of chemicals industry
	Other combustion	Oil in other industry
	Other processes	Total energy in other industry

Source: POLES JRC model documentation [3]
(*) An additional flow is considered when associated to CCS, where a multiplying emission coefficient is applied to the coefficient without CCS.

POLES JRC provides estimation of emissions for SO_2, NOx, CO, BC, PM_{10}, $PM_{2.5}$, NH_3 and (NM) VOC. Pollutants resulting from the interaction of the above species with other gases (precursors) such as ozone are not modelled. Results on air pollutants have been used for a cooperation with the model TM5-FASST [10].

The estimation of air pollutant emissions in medium terms takes into account the current legislation adopted by countries in POLES JRC domain. In the longer term, it is assumed that technologies and air pollution policies diffuse across world regions at different speeds depending on per capita income.

3 EDGAR - POLES JRC mapping methodology

Mapping methodology for EDGAR-POLES JRC consist of creating a common matrix for each sector aiming to match at the finest possible granularity taking into account limitations that exist on fuels and technologies. In Table 9 are illustrated issues and cooperation topics between EDGAR and POLES JRC from the point of view of categories, substances, sectors and categories.

Table 9. EDGAR-POLES JRC possible mapping categories

EDGAR			POLES	
Substance & Category		Issues & Cooperation	Categories	Issues & Cooperation
CO_2 combustion	IPCC	IEA as main data source	CO_2 emissions by sector & fuel	
CO_2 process emissions	IPCC	Possibility to map categories and aggregate emissions accordingly	• Some variables match IPCC categories • Other aggregate several IPCC categories	• Understand methodology of EDGAR • Harmonize POLES Modelling with EDGAR methodology
Non-CO_2 (CH_4, N_2O, F-gases)				
Agriculture	IPCC	Possibility to map categories and aggregate emissions accordingly	• Aggregates for CH_4 & N_2O • Higher aggregated than EDGAR	• Understand methodology of EDGAR • Harmonize POLES Modelling with EDGAR methodology
LULUCF	IPCC	In development, fires not yet included, limited time coverage and no country specific data. Updates foreseen by end 2022	Higher aggregation than EDGAR • Forest Management • Deforestation • Afforestation • Other	• Understand LULUCF methodology of EDGAR

EDGAR database categories for CO_2, CH_4, N_2O and F-gases correspond to the detailed IPCC categories within the sector included in the mapping exercise (see Table 10). In POLES JRC the categories for the estimation of CO_2 emission from combustion also correspond to the IPCC categories. In other sectors and for other substances due to the less detailed structure several categories match the IPCC categories whereas other are aggregated. In the case of CH_4, N_2O and pollutants the POLES emissions are not available at aggregated technology 4 level (see Table 1).

Table 10. Granulariy of mapping between EDGAR and POLES JRC

Species	Granularity	Variables Items
CO_2	highest possible granularity	CO_2
CH_4, N_2O	- high granularity for specific categories (oil & gas, mining) - for others merely sum for entire sector (agriculture, energy combustion, transport)	CH_4, N_2O
F-gases	- energy related: SF6 (switches - industry: aluminium, SF6 (foundries), HFCs, PFCs	SF6, PFCs, HFCs: total of species, average GWP
Air pollutants	sectoral level: totals and by fuel	BC, OC, VOC, NOx, SO_2, NH_3, CO. PM_{10}, PM25
CO_2 biomass combustion	highest possible granularity	CO_2BIO
Activity Variable	highest possible granularity (usually CO_2 level) - final energy consumption (usually) - PM tyres & road wear: t*km, km travelled - calculation of air pollutants, CH_4/N_2O/F-gases	Activity Variable (AV)
Additional variables		- captured CO_2 emissions: CCSCO_2, CCSCO_2BIO - activity variables corresponding to captured CO_2 emissions (e.g. energy consumption) - activity variable corresponding to CO_2BIO

In case where no match exists (e.g. in power sector the internal combustion and biofuels do not exist in POLES) these are omitted from the matching. Table 11 illustrates the case of technologies in the energy sector for both EDGAR and POLES JRC.

Table 11. Technologies included in EDGAR database and POLES JRC model in ENE sector

EDGAR technologies in ENE	POLES JRC technologies in ENE
Gas turbines	Gas turbines, Combined cycles
Fluidized bed, Pulverized coal dry, bottom boiler, Grate firing	Sub/super coal steam turbine, ultra-critical steam turbine, integrated gasification

In POLES JRC most of the technology development (efficiencies, learning curves, etc.) is usually contained in the activity variable (in most cases energy consumption) which is different to how emission factors/EOP are applied in EDGAR.

In POLES JRC biomass combustion emissions (CO_2BIO) are not accounted as CO_2 emissions in inventories (supposed to be CO_2 neutral). However, an emission factor for biomass combustion is included in order to account for carbon captured when biomass is used in carbon captured and storage (CCS). CCS emissions from biomass combustion are accounted as negative emissions.

In POLES JRC for CH_4 and N_2O high granularity exist for specific categories (e.g oil & gas, mining). For other categories a lump sump for whole sector (e.g agriculture, energy combustion, transport) is provided.

POLES JRC will provide activity variable with the highest possible granularity (usually CO_2 level) and usually for final energy consumption which will allow to calculate emissions of CO_2, air pollutants and CH_4/N_2O at high granularity level.

POLES JRC additional variables will be: (1) captured CO_2 emissions (for CO_2, CO_2BIO); (2) activity variables corresponding to captured CO_2 emissions; (3) activity variable corresponing to CO_2BIO.

For air pollutants mapping will be provided at sectoral level: totals and by fuel. Names of air pollutants in EDGAR and POLES JRC are slightly different in the selection sector/fuel and in the case of non methane volatile organic compounds (NMVOC)

These differences refer to the type of air pollutant emissions that will be provided to EDGAR from POLES JRC. For example if air pollutant emissions coming within a selected sector are fuel based their name will include the ending letter "p". In case of total emissions the names of air pollutants in EDGAR and POLES JRC will remain the same except for NMVOC (see Table 12)..

Table 12. Granularity of mapping between EDGAR and POLES JRC in case of air pollutants[6]

EDGAR	BC	OC	PM_{10}	PM25	NMVOC	NOX	CO	SO_2	NH_3
sector/subsector/fuel	X	X	X	X	X	X	X	X	X
POLES	BCp	OCp	PM_{10}	$PM_{2.5}$	VOCp	NOxp	COp	SO_2p	NH_3
sector/fuel	X	X	X	X	X	X	X	X	X
	BC	OC	PM_{10}	PM25	VOC	NOX	CO	SO_2	NH_3
sector total	X	X			X	X	X	X	

For POLES JRC and EDGAR the emissions of GHG and air pollutants are always provided in kt. POLES JRC energy consumption is always given in ktoe; whereas for EDGAR energy consumption is always given in TJ.

([6]) In POLES JRC the estimation of PM_{10} and $PM_{2.5}$ is based in the following equations:
(1) PM25 = BCp + OCp*x + PM25Op and (2) PM_{10} = PM25 + PM_{10}Op

4 EDGAR - POLES JRC matrixes

EDGAR-POLES JRC matrixes are grouped following the allocation of sectors in EDGAR main processes as shown in Figure 5. More detailed information about these matrixes and the issues related is provided in Annexes 3 to 7.

4.1 EDGAR-POLES JRC fuel combustion matrix

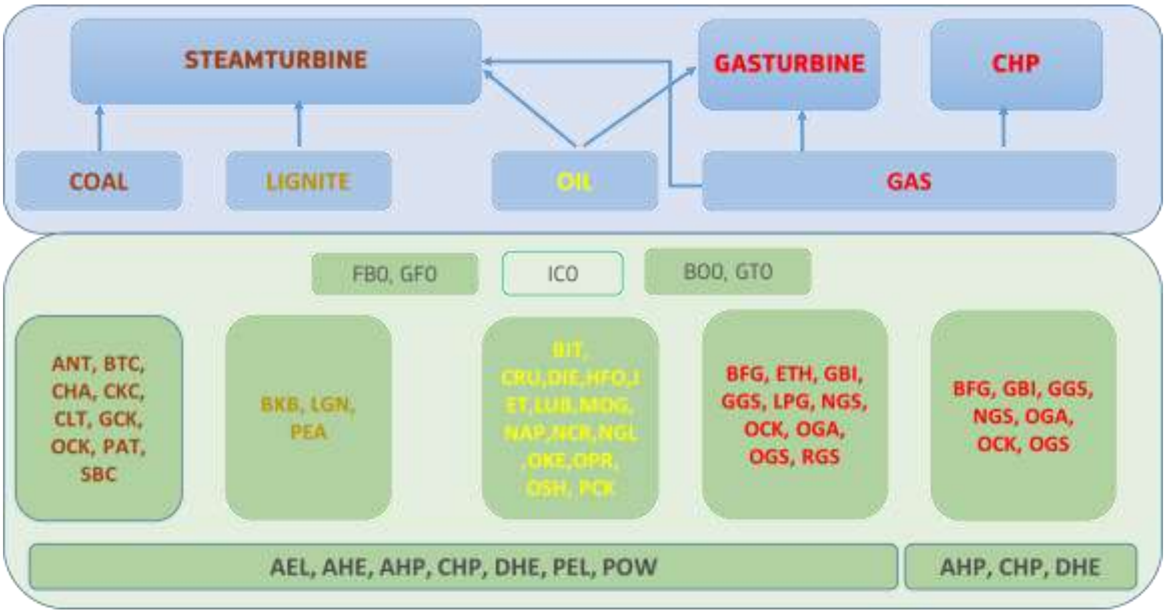
Fuel combustion matrix includes mapping of “ENE”, “IND”, “TRO”, “RCO”, “PRO”, “REF”, “TRF” and “TNR”.

4.1.1 EDGAR-**POLES JRC “ENE” matrix**

EDGAR-POLES JRC “ENE” matrix is build based on EDGAR level 4 combination of sector/subsector/fuel/technology. Both EDGAR and POLES JRC have the same rank of these levels. EDGAR fuels have been grouped in 4 types of fuels present in POLES JRC: Coal, Lignite, Oil and Gas. POLES JRC will provide total values for CH_4 and N_2O. These totals are the sum of power and industry sectors, which in EDGAR are estimated separately.

Figure 8 illustrates the mapping between EDGAR and POLES JRC for “ENE”, based on the fuel type. POLES JRC main fuels are used as basis for this match. It can be seen that several EDGAR fuels are allocated to each POLES JRC fuel, which is then allocated to one or more technologies.. In POLES JRC model the CHP is applied only to gas fuel

Figure 8. Matching structure for energy sector by technology and fuel type (EDGAR below- POLES JRC above)



More in detail the technologies that are currently included in the matching between EDGAR and POLES JRC in “ENE” matrix are shown in the following tables 13-16. The main issue in mapping is the allocation of internal combustion technology (ICO) which doesn’t exist in POLES JRC. From the literature we can consider gas turbines as a type of internal combustion engine. This can be taken into consideration when allocating the ICO to POLES JRC to gas turbine.

Table 13. EDGAR and POLES JRC technologies included in the “ENE” matrix in Steamturbine - coal category

	POLES		EDGAR	
	Fuels	Technologies	Fuels	Technologies
Steam turbine	Coal	• Conventional coal (sub-critical & super-critical) • Advanced coal (ultra-critical) • Integrated gasification combined cycle • CCS retrofitted: Conventional coal (sub-critical & super-critical) • CCS: Advanced coal (ultra-critical) • CCS: Integrated gasification combined cycle	• Coke Oven Coke • Sub-Bituminous Coal • Coal Tar • Gas Coke • Anthracite • Coking Coal • Other Bituminous Coal • Charcoal • Patent Fuel	• fluidized bed • pulverized coal dry bottom boiler • grate firing

Table 14. EDGAR and POLES JRC technologies in the "ENE" matrix in Steamturbine – Lignite & Bio category

	POLES		EDGAR	
	Fuels	Technologies	Fuels	Technologies
Steam turbine	Lignite	• Conventional lignite • CCS retrofitted: Conventional lignite	• Peat • Lignite/Brown Coal • BKB/Peat Briquettes	• fluidized bed • pulverized coal dry bottom boiler • grate firing
	Biomass & waste	• Biomass thermal conventional, • Biomass gasification (*not* biogas from anaerobic digestion!) • CCS biomass combustion (retrofitted) • CCS biomass gasification	• Primary Solid Biomass • Municipal Waste (Non-Renew) • Municipal Waste (Renew) • Industrial Waste	• fluidized bed • pulverized coal dry bottom boiler • grate firing

Table 15. EDGAR and POLES JRC technologies included in the "ENE" matrix in Steamturbine – Oil and Gas

	POLES		EDGAR	
	Fuels	Technologies	Fuels	Technologies
Steam turbine	Oil	Conventional steam turbine using oil (sub-critical & super-critical)	• Petroleum Coke • Non-specified Petroleum Products • Residual Fuel Oil • Other Hydrocarbons • Natural Gas Liquids • Crude Oil • Naphtha • Gas/Diesel Oil • Motor Gasoline • Kerosene Type Jet Fuel • Lubricants • Bitumen	Boiler for gas/liquid of any size
	Gas	Conventional steam turbine using gas (sub-critical & super-critical)	• Coke Oven Gas • Blast Furnace Gas • Natural Gas • Gas Works Gas • Refinery Gas • Liquefied Petroleum Gases (LPG) • Ethane	

Table 16. EDGAR and POLES JRC technologies included in the "ENE" matrix in Gasturbine – Oil and Gas

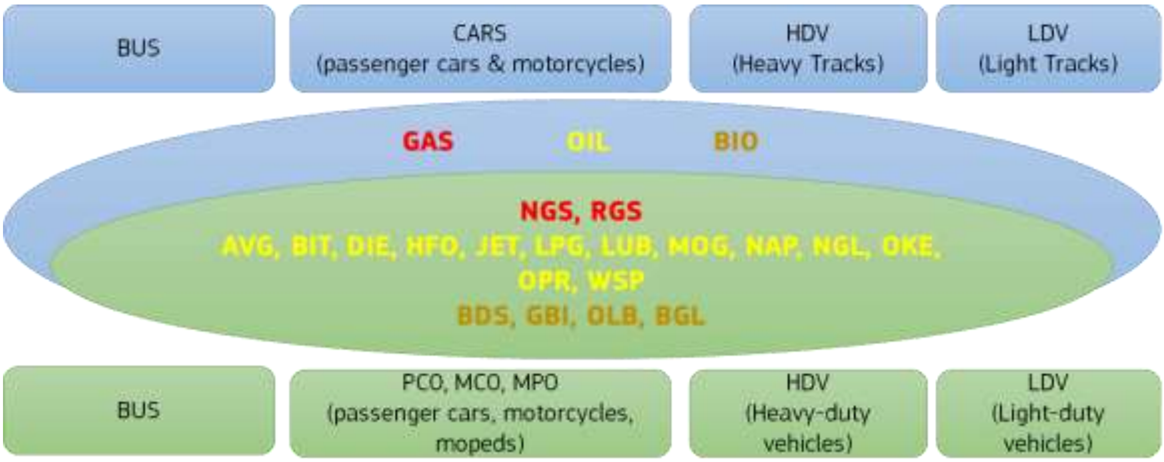
	POLES		EDGAR	
	Fuels	Technologies	Fuels	Technologies
Gas turbine	Oil	Gas turbine (open cycle)	• Petroleum Coke • Non-specified Petroleum Products • Residual Fuel Oil • Other Hydrocarbons • Natural Gas Liquids • Crude Oil • Naphtha • Gas/Diesel Oil • Motor Gasoline • Kerosene Type Jet Fuel • Lubricants • Bitumen	Gas turbine
	Gas	• Gas turbine (open cycle) • Combined cycle gas turbine • CCS- Combined cycle gas turbine	• Coke Oven Gas • Blast Furnace Gas • Natural Gas • Gas Works Gas • Refinery Gas • Liquefied Petroleum Gases (LPG) • Ethane	

4.1.2 EDGAR-**POLES JRC "TRO" and "TNR"**matrix

EDGAR-POLES JRC "TRO" matrix is build based on EDGAR level 4 combination of sector/subsector/fuel/technology. In POLES JRC the ranking of in this combination is sector/subsector/technology/fuel. So the mapping is based on the corresponding technologies and fuels. For CH_4 and N_2O mapping will be only at the sector level whereas for air pollutants mapping will reach the sector and fuel level (see Table 1).

Figure 9 illustrates the mapping structure for road transport sector. EDGAR vehicle types as passenger cars (PCO), motorcycle (MCO) and mopeds (MPO) are aggregated under the POLES JRC cars typology (includes passenger cars and motorcycle POLES JRC categories).

Figure 9. Mapping structure for road transport by vehicle and fuel type (EDGAR below- POLES JRC above)



The structure of EDGAR and POLES JRC in transport sector is similar. As shown in Table 17 the EDGAR applies also abatement measures following the development of regional legislations for the relevant air pollutants as SO_2, NOx, PM_{10} and $PM_{2.5}$. In POLES JRC six types of vehicle engines are included.

Table 17. EDGAR abatement standards and POLES JRC engine types in road transport sector

EDGAR	POLES JRC
6 EU standards, 3 US standards	6 engine technologies – Conventional, Plug-in hybrid, Full-electric, Hydrogen fuel cell, Other fuel cell

EDGAR-POLES JRC "TNR" matrix is also build based on EDGAR level 4 combination of sector/subsector/fuel/technology. In POLES JRC three are the main subsectors within non-road transport: Air domestic (AIRDOM), Rail (RAIL) and Navigation (NAV). In POLES JRC category AIRDOM the aggregation of EDGAR subsectors Domesic air transport (DAT) and Road surface wear (RSW) is allocated (see Table 18). Other transport ("TNR.PIP" and TNR.OTH" in EDGAR) does not exist in POLES JRC so no mapping is provided.

POLES JRC does not estimate emissions from road surface wear subsector. However, the model can provide the activity data for this subsector which can be compared with historic EDGAR activity data. POLES JRC will provide the allocation of total value for emissions and activity data for international aviation (IAT) and shipping (SEA).

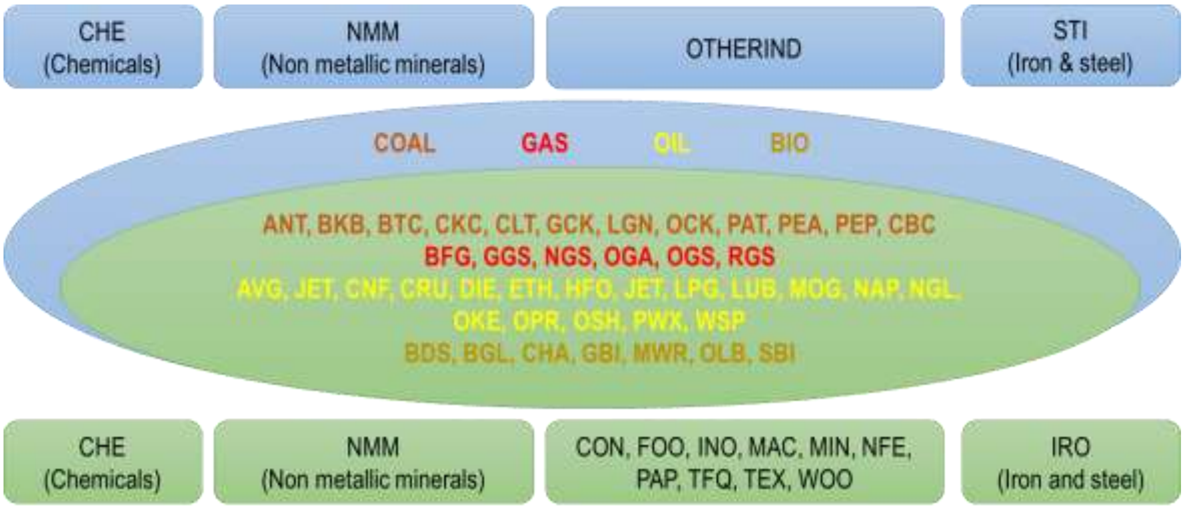
Table 18. EDGAR-POLES JRC mapping structure for non road transport by subsector and fuel

POLES subsector	AIRDOM	RAIL	NAV
POLES fuel	OIL	COAL, OIL	COAL, GAS, OIL, BIO
EDGAR subsector emissions	DAT	RAI	ILW
EDGAR subsector activity data	RSW, DAT		
EDGAR fuel	AVG, DIE, GJE, HFO, JET, LPG, MOG, OKE, OPR BGL, RGS, SBI, WSP	ANT, BKB, BTC, CKC, GCK, GGS, IWS, LGN, OCK, PAT, PEA, PEP, SBC BDS, DIE, HFO, LPG, LUB, MOG, OKE, OPR, PCK, WSP	BTC, CKC, LGN, OCK, SBC DIE, HFO, LPG, LUB, NGS MOG, OKE, OPR, WSP BDS, BGL

4.1.3 EDGAR-POLES **JRC "IND" matrix**

EDGAR-POLES JRC "IND" matrix is based on EDGAR level 4 combination of sector/subsector/fuel/technology. As shown in Figure 10 POLES JRC provides the aggregation in four main subsectors: Chemicals (CHE), Non-metallic minerals (NMM), Iron and Steel (STI) and Other industry (OTHERIND). The aggregation of EDGAR subsectors is needed under the POLES JRC subsector "Other industry". Subsectors as Construction, Food, Machinery. Mining will be aggregated here.

Figure 10. Mapping structure for industry by subsectors and fuel type (EDGAR[7] below- POLES JRC above)



4.1.4 EDGAR-**POLES JRC "RCO" matrix**

EDGAR-POLES JRC "RCO" matrix is based on EDGARb level 4 combination of sector/subsector/fuel/technology. Five subsectors are included in EDGAR database for this sector: Residential (RES), Commercial and public services (COM), Agriculture/Forestry (AGR)[8], Fishing (FSH) and Other not specified (OTH) (see Figure 11).

POLES JRC in the other side responds with Use of fuels in Agriculture (AGR), Residential (RES) and Services (SER). In this mapping work the EDGAR codes on Other not specified (OTH) are not assigned to any of POLES JRC codes. Mapping for "AGR" has been done based on the fuel use. For POLES JRC "RES" and "SER" subsectors the mapping has been done for space heating &cooling (SH) and waster heating & cooking (WH).

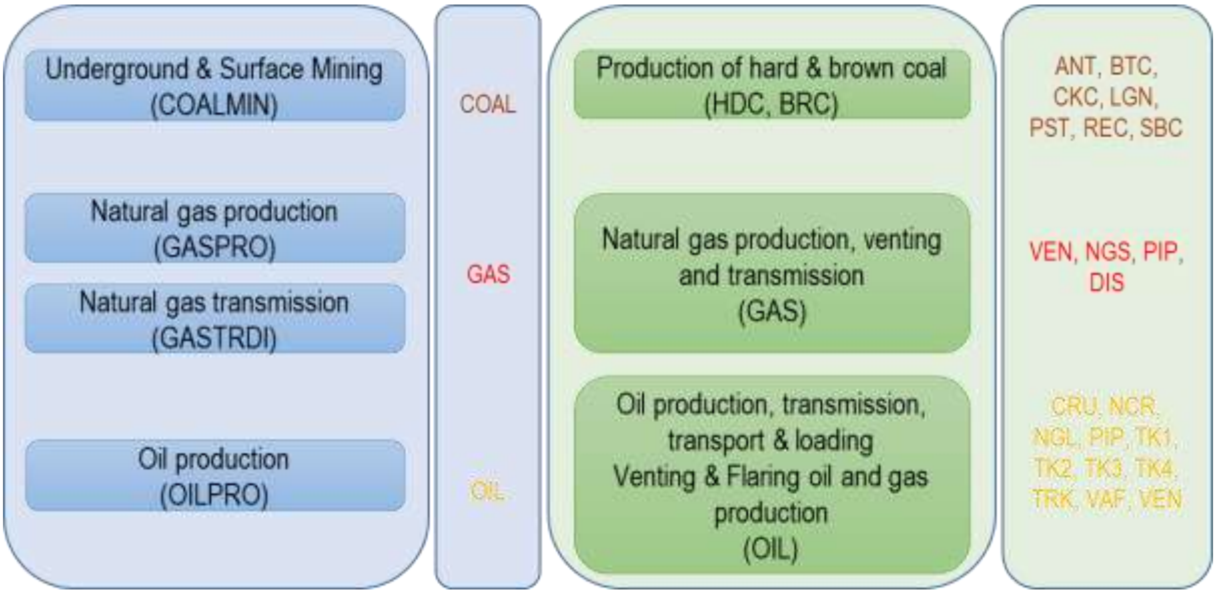
Figure 11. Matching structure for residential sector by subsectors/fuel type (EDGAR[7] below- POLES JRC above)

(7) Refer to Annex 2 for EDGAR sectors/subsectors codes
(8) In EDGAR database the fuel use in agriculture is included in residential sector and not in agriculture sector.

4.1.5 EDGAR-**POLES JRC** "TRF**", "REF"** and **"**PRO**" matrix**

EDGAR-POLES JRC "PRO" matrix includes emissions sourced from fuel production and transmissions. In POLES JRC the abatement applied in the estimation of these emissions are already included using MACC curves. From EDGAR side abatement measures included in the estimation of emission from coal production are those applied for methane during the process of recovery in underground mining. Estimation of emissions from fuel transformation does not exist in POLES JRC so this category is omitted when creating the mapping structure showed in Figure 12. In the case of emissions from distribution of losses in transformation process the mapping with IPCC category 1.B.2 of EDGAR was not possible as for POLES JRC more detailed sector categorisation is needed.

Figure 12. EDGAR (right) – POLES JRC (left) mapping structure for fuel production & transmission



EDGAR-POLES JRC "TRF" matrix is splitted in two: one related to fugitive emissions (herafter "TRF FUG") and the other related to transformation in industry sector (hereafter "TRF IND"). The mapping in "TRF FUG" includes only CH_4. Regarding the "TRF IND" the mapping includes only the manufacture of solid fuels calculating the emissions from coking process (Table 19). The CO_2 emissions from transformation industry in the "TRF" matrix includes only coking and petroleum refinery.

Table 19. EDGAR-POLES JRC mapping structure for transformation in industry by subsector and fuel

POLES code	MSF COKING
PLOES fuel	COAL
EDGAR subsector	EBF, EBF, ECK, EGW, ELQ, EMI, ENO, EPA
EDGAR fuel	ANT, BGF, BKB, BTC, CKC, CLT, GCK, GGS, LGN, OCK, OGS, PAT, PEA, SBC

EDGAR-POLES JRC "REF" matrix is splitted in two: one related to fugitive emissions (hereafter "REF FUG") and the other related to oil refinery in industry sector (herafter "REF IND"). In POLES JRC the "REF IND" includes mapping only for emissions from petroleum refineries. The respective subsector in EDGAR is that of fuel combustion petroleum refinery (CMB) (see Table 20). CH_4 and N_2O emissions from fuel transformation in petroleum refinery ("REF EVA" in EDGAR) are taken into account as residual category in "ENE" matrix.

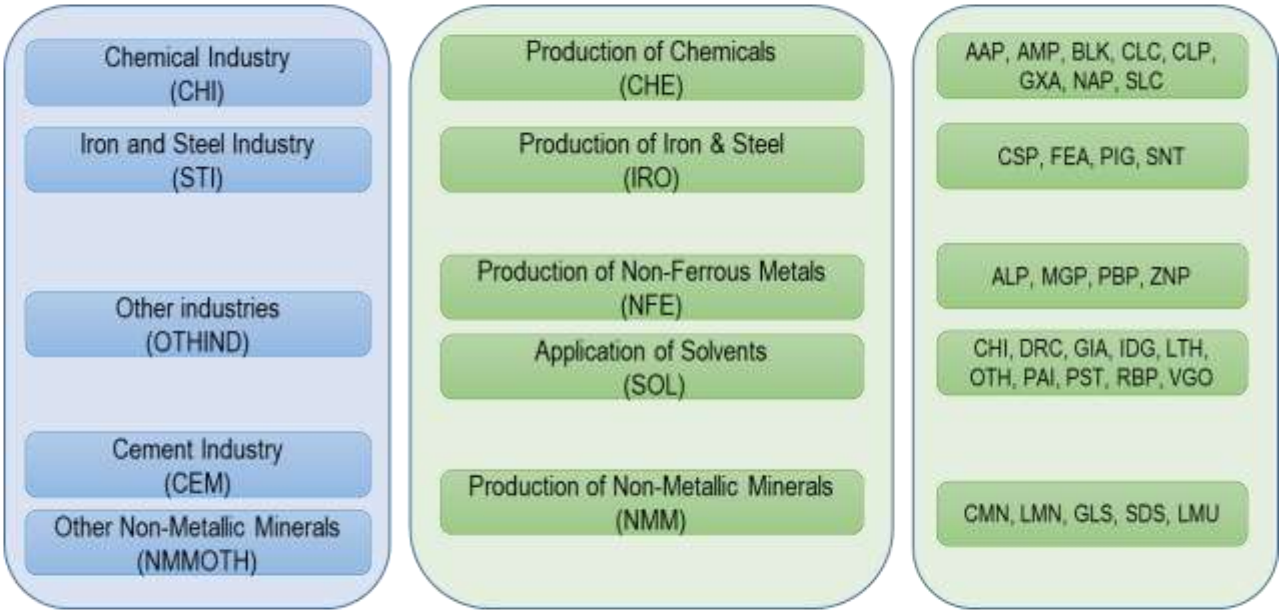
Table 20. EDGAR-POLES JRC mapping structure for oil refinery in industry sector and fuel

POLES code	REF OIL
PLOES fuel	OIL
EDGAR subsector	CMB
EDGAR fuel	AVG, BIT, CRU, DIE, ETH, GJE, HFO, JET, LPG, LUBMOG, NAP, NGL, OKE, OPR, PCK, PWX, RFG, RGS, WSP

4.2 EDGAR-POLES JRC process emissions during production matrix

EDGAR-POLES JRC matrixes in process emissions during production are build up to the level of process codes. Here below the mapping structure based on the allocation of respective subsectors process codes. In POLES JRC no use of fuels is included in the respective codes. From EDGAR side as shown in Figure 13 the aggregation of several subsectors and fuels is needed when mapping is done for CO_2, non-CO_2 and air pollutant. Under POLES JRC other industries (OTHIND) emissions and activity data will be provided for the EDGAR subsectors on production of non-metallic metals (NFE) and application of solvents (SOL). The EDGAR subsector production of non-metallic minerals (NMM) will receive inputs on emissions and activity data from POLES JRC cement industry (CEM) and other non-metallic minerals (NMMOTH). Estimation of CO_2 emissions from the non-energy use of fuels (NEU in EDGAR) is not applicable in POLES JRC.

Figure 13. EDGAR-POLES JRC mapping structure for process emissions by process codes and subsectors



For CH_4 the mapping includes production of chemicals and that of iron and steel. However, this estimation is considered as POLES JRC residual category. Mapping of air pollutants in production of chemicals and non-ferrous and solvent application will be only at sector level.

For F-gases the mapping will not include the production of nitrogen trifluoride (NF_3) since this is not available in POLES JRC. For hydrofluorocarbons (HFCs)-all components, the mapping in EDGAR side is done for semiconductors, domestic refrigeration, production and consumption of HFCs, closed and open cell foam, commercial refrigeration, industrial refrigeration, fire protection, consumption in flat panel display production, mobile and stationary air conditioning, use in solvents and transportation of refrigeration.

In case of perfluorcarbons (PFCs)-all components, the EDGAR mapping includes among other subsectors the aluminium production (primary), semiconductors, consumption for accelerators, fire-estinguishers, use in solvent, consumption in flat panel display and solar cells.

In EDGAR the SF_6 mapping includes codes of its production, foundries (aluminium and magnesium, PV solar cells production, consumption for accelerators, production of sounproff windows, consumption in flat panel display production, consumption for electrical equipments manufacturing, consumption for sport shoes and others and consumption for GIS Stock emissions from leakage and maintenance.

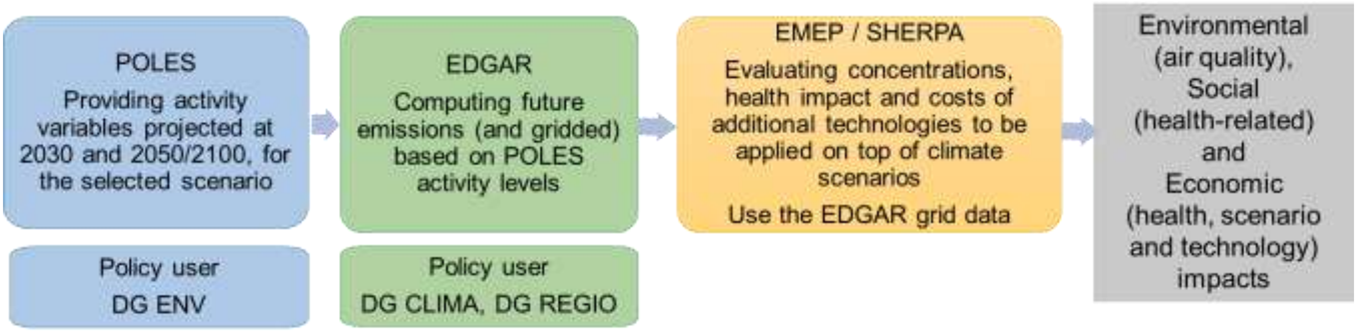
4.3 EDGAR-POLES JRC agriculture and waste matrix

EDGAR-POLES JRC matrix for agriculture sector will provide only the allocation of total value for GHG and air pollutants. In POLES JRC emissions of CH_4 from agriculture includes both manure management (cattle as main livestock) and agricultural soils (rice as main category). N_2O emissions cover both fertilisers use and manure management (cattle). In case of air pollutants the totals of emissions and activity data are provided by POLES JRC which includes in this sector also the emissions of pollutants from wild fires. For waste sector only totals of CO_2, CH_4, N_2O and AP emissions and activity data will be provided.

5 EDGAR - POLES JRC platform

The concept on which the development of an EDGAR-POLES JRC platform proposed is shown in Figure 14. This concept takes into account the role that each of the components of this platform will play when a scenario analysis will be developed either for GHG and air pollutant emissions. POLES JRC will provide activity data following the same matrix structure as those for the emissions.

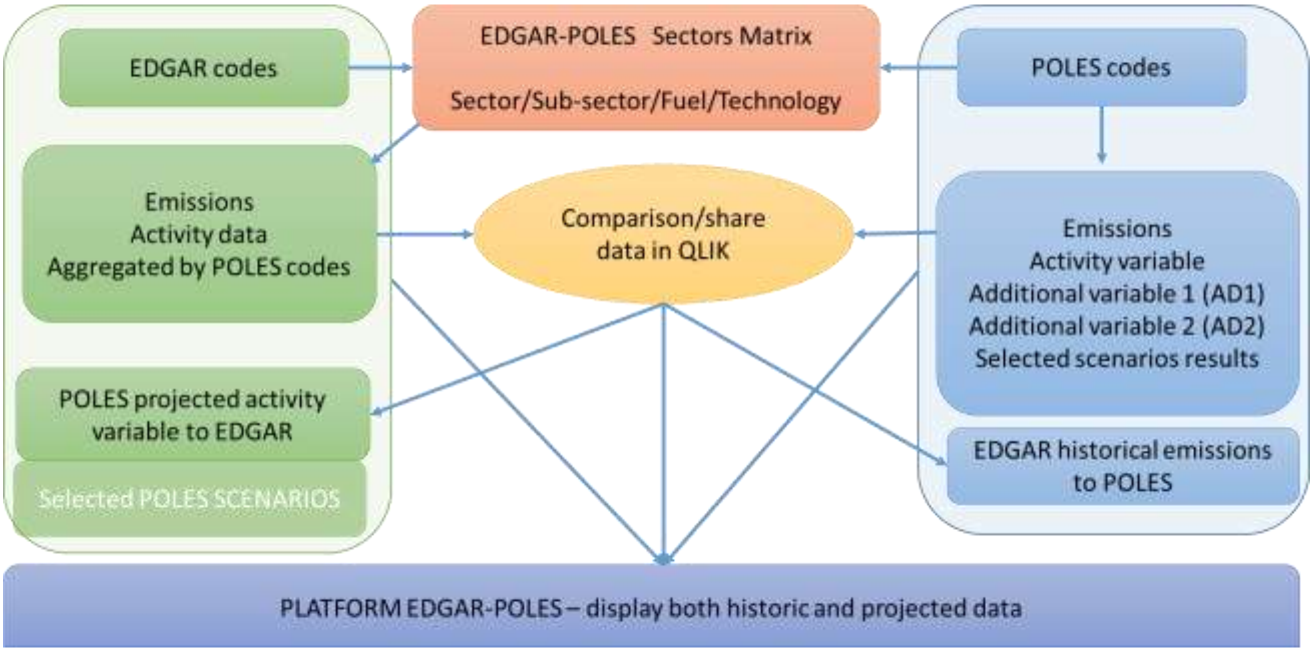
Figure 14. The concept of building an EDGAR-POLES JRC platform



The final aim of the EDGAR-POLES JRC platform is to provide to the users the possibility to visualize the indicators through an interactive and customizable interface using maps, charts, and tables. The EDGAR-POLES JRC platform will serve as an information tool that sustains the analysis of emission trends and future scenarios to identify unexpected and emerging signals in emissions and technologies in all countries/regions included in the EDGAR-POLES JRC matrixes. The platform aims to present comprehensive and comparable greenhouse gas emissions data both historic and projections.

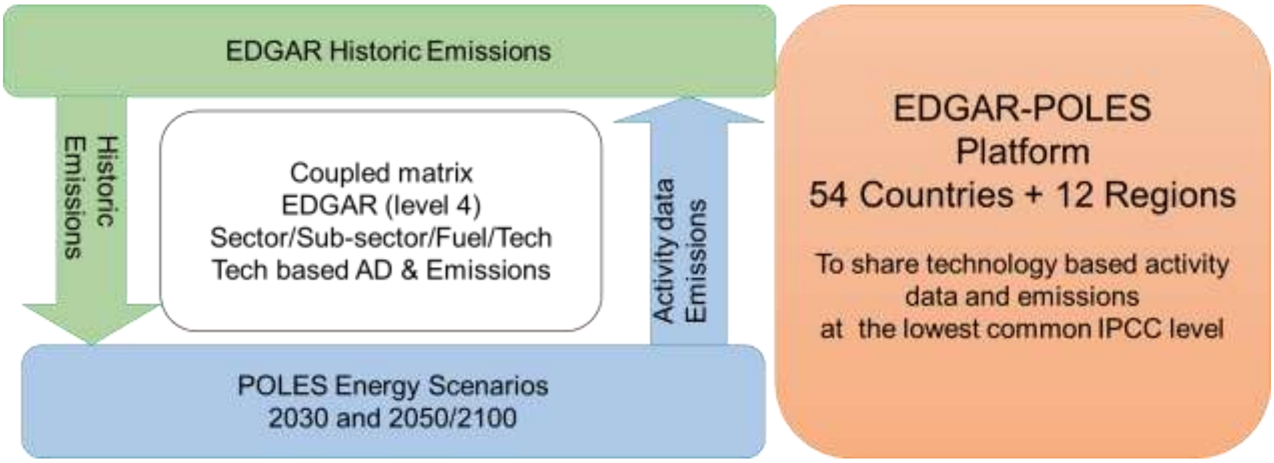
The data sharing/comparison/analysis of emissions and activity data between EDGAR and POLES JRC is based on the in-house QLIK business software (here after as QLIK tool). QLIK tool can manage data structured being useful to implement a data archive. QLIK tool presents data in context discovering significant and meaningful patterns, multi perspective, comparison, multivariate analysis and visualisations can be embedded in the webpage. Figure 15 illustrates the role that QLIK tool will play in the preparation of final output for the EDGAR-POLES JRC platform.

Figure 15. Data sharing/comparison/analysing for EDGAR-POLES JRC within QLIK tool



Selected POLES JRC scenarios results on emissions as well as the projected activity data will be available for EDGAR. For sectors as energy additional activity data will be provided by POLES JRC taking into account the role of carbon capture and storage (CCS) deployment. Figure 16 shows what will be included in QLIK tool that can then be used as an input for the EDGAR-POLES JRC platform.

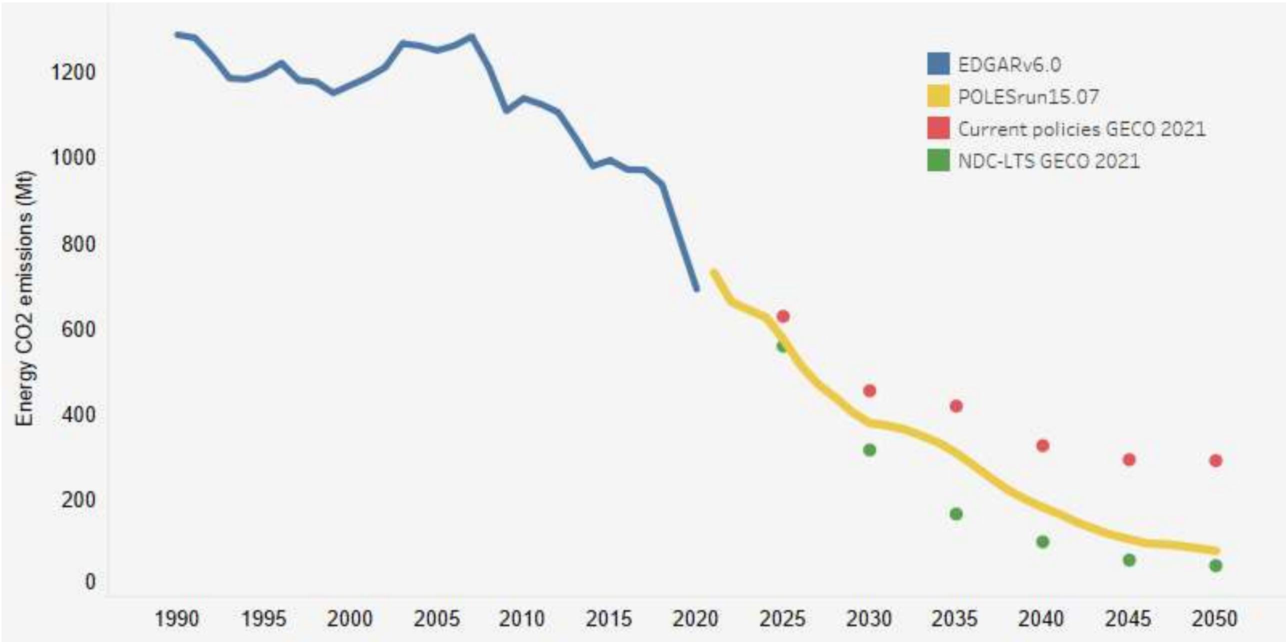
Figure 16. QLIK tool for EDGAR-POLES JRC platform



A uniqe EDGAR file will be prepared including all mapped sectors/subsectors/fuels/technologies combinations in order to provide to users the possibility of several visualisations where historic data can be compared, historic data and projections can be visualise.

QLIK tool is expected to provide visualisations that include both historic emissions as estimated bt EDGAr and emission projections comin from POLES JRC model. In Figure 17[9] an example of QLIK took output on energy CO_2 emissions (in POLES JRC country domain) as estimated by EDGAR and projected by POLES JRC for period 1990-2050. Scenario data are sourced from JRC GECO 2021[10] report [9]. The NDC-LTS scenario includes the stated Nationally Determined Contributions and the Long-Term Climate Strategies submitted by the UNFCCC parties. In Current Policies scenario it is assumed that all policies in place are already implemented.

Figure 17. Energy CO_2 emissions for 1990-2050: EDGAR historic, POLES JRC, GECO Current Policies & NDC-LTS



([9]) The data from POLES JRC used during the mapping excersise are included in this figure for illustrative purposes.
([10]) Scenarios data are sourced from GECO 2021 visualisation https://joint-research-centre.ec.europa.eu/geco-2021/geco-visualisation_en

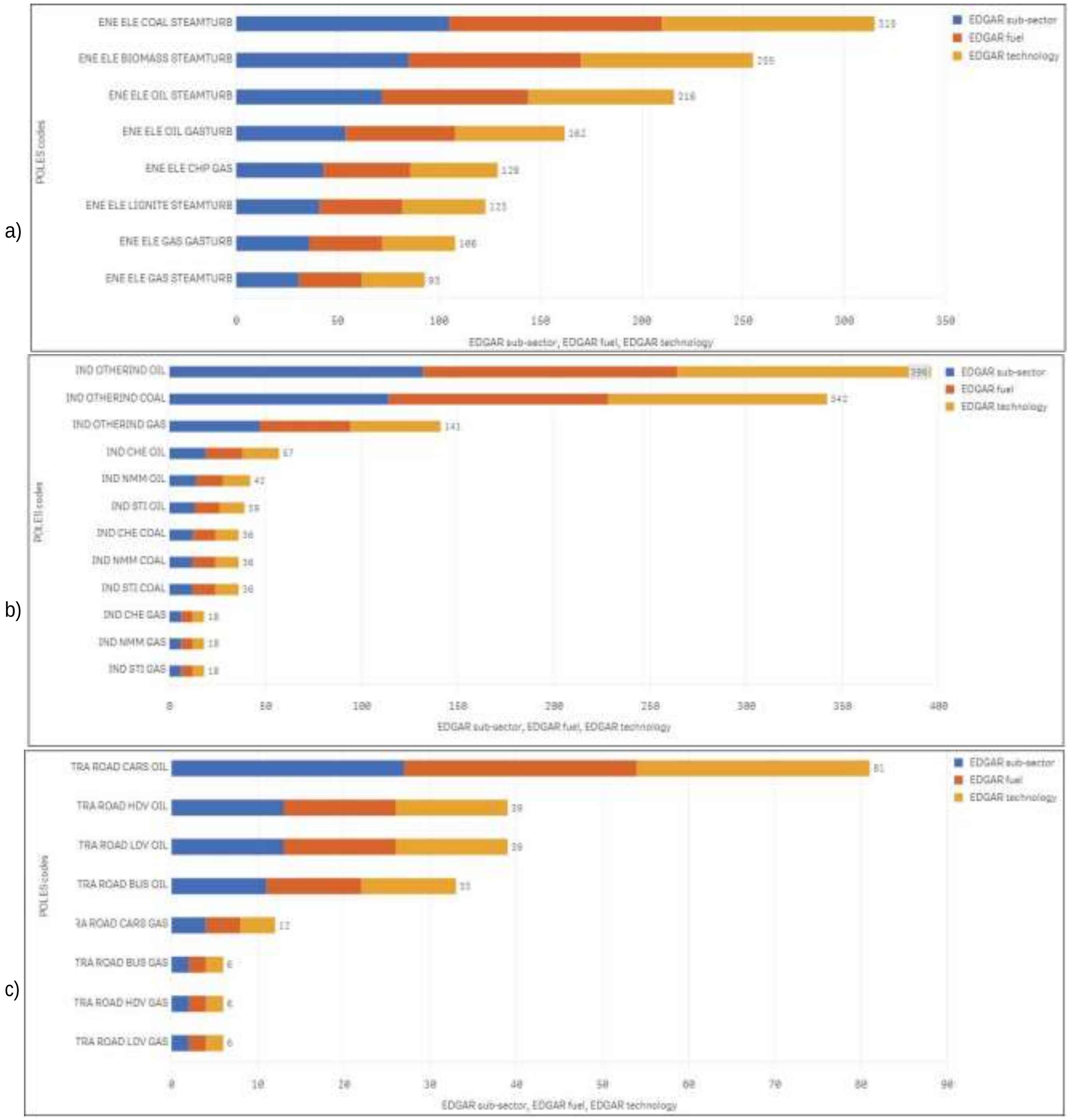
6 EDGAR-POLES JRC mapping results examples

To illustrate the work done on the mapping between EDGAR and POLES JRC here below some info on the matrixes created as well as some examples of results on emissions and activity data in energy and transport sectors covering period from 1990 to 2019 are shown in this chapter. The data have been processes, analysed, compared and visualized using the in-house QLIK tool.

6.1 EDGAR-POLES JRC matrixes

The aggregation of EDGAR codes to map the POLES JRC codes is shown for some of the matrixes created in "ENE", "IND" and "TRO" matrixes (see Figure 18).

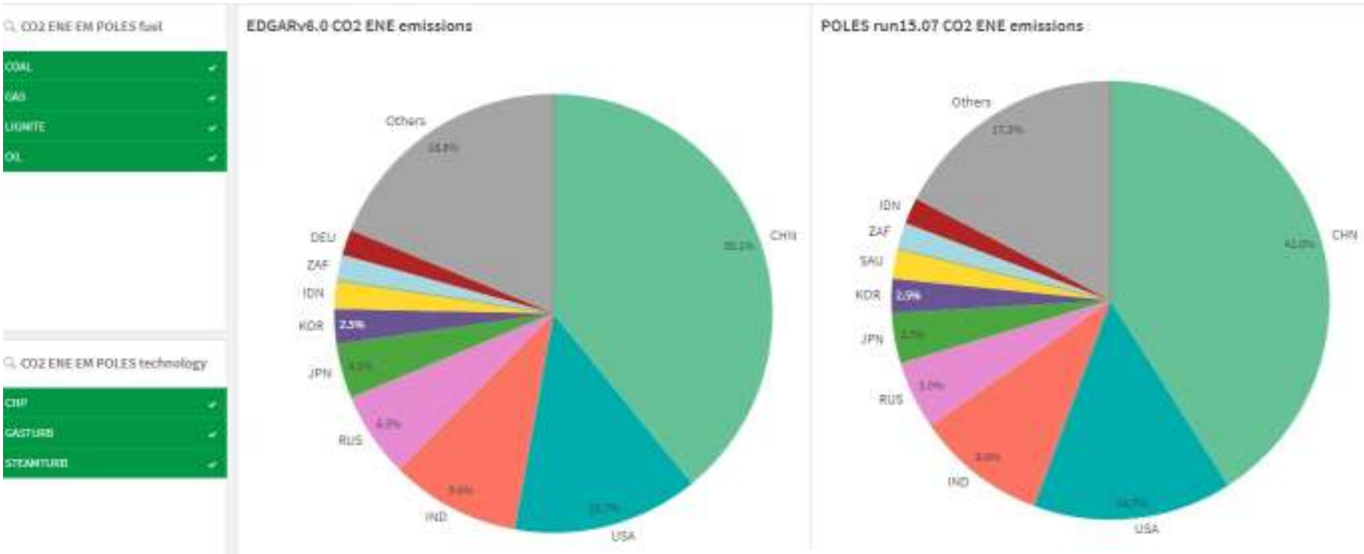
Figure 18. EDGAR codes aggregation by subsector/fuel/technology as in POLES JRC: a) "ENE", b) "IND" and c) "TRO" matrixes



6.2 Fossil CO_2 and other greenhouse gases

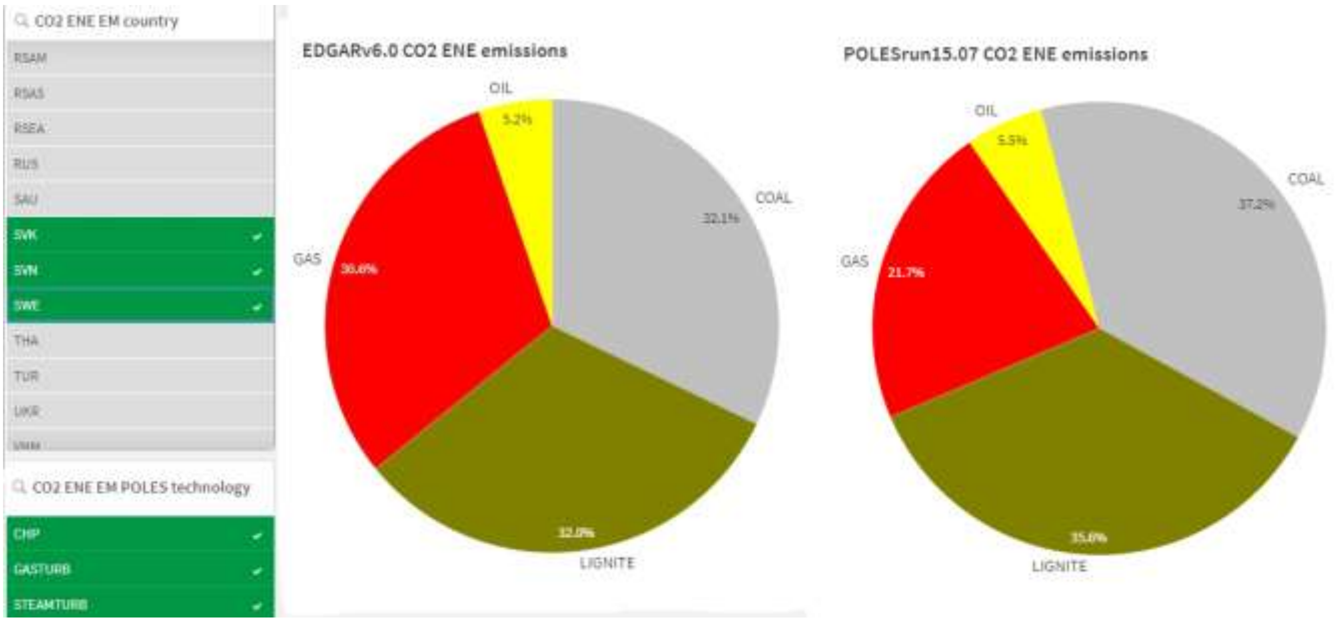
In Figure 19 the 2019 energy fossil CO_2 emissions by country (POLES regions excluded) sourced from both EDGAR and POLES JRC are shown. All fuels and technologies are grouped as in POLES JRC structure.

Figure 19. Energy fossil CO_2 emissions by country as in EDGAR (left) and POLES JRC (right), 2019



In Figure 20 the results of mapping between EDGAR database calculations and POLES JRC modelling for EU27 energy sector in year 2018 are shown. The difference observed is coming due to the fact that internal combustion do not exist in POLES JRC and as such this contribution is not included in EDGAR data used for this comparison.

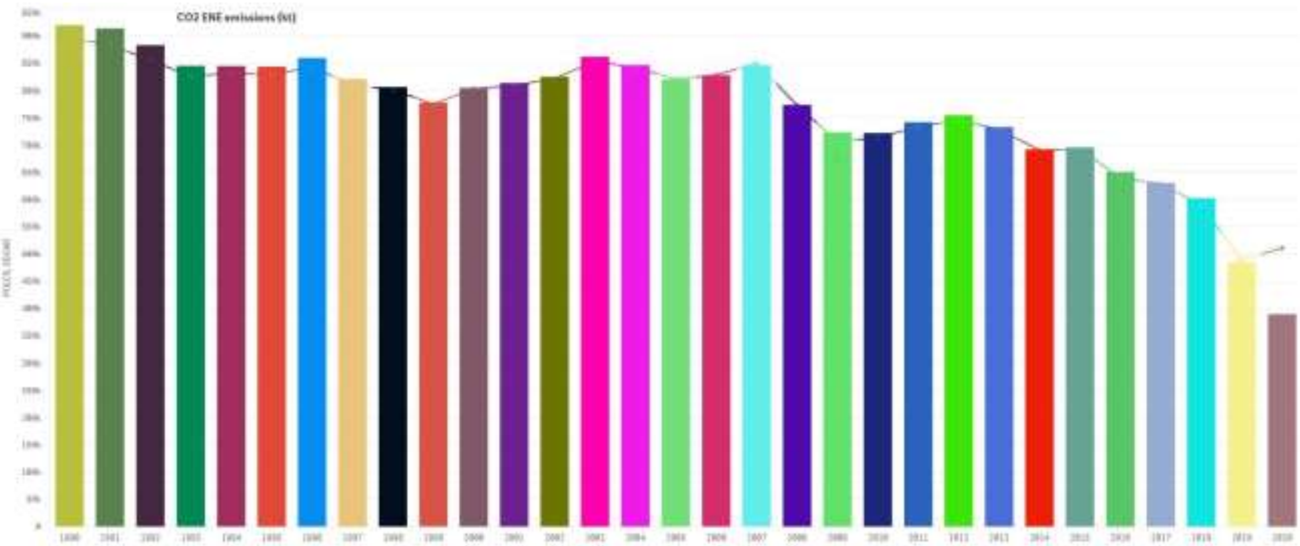
Figure 20. EU27 energy fossil CO_2 emissions by fuel as in EDGAR (left) and POLES JRC (right), 2018



Time series of EDGAR and POLES JRC for EU27 CO_2 energy emissions from coal and lignite is shown in Figure 21. In the comparison[11] of these global CO_2 energy emissions for the solid fuels, the relative[12] differences stay between +4% and -1.5%.

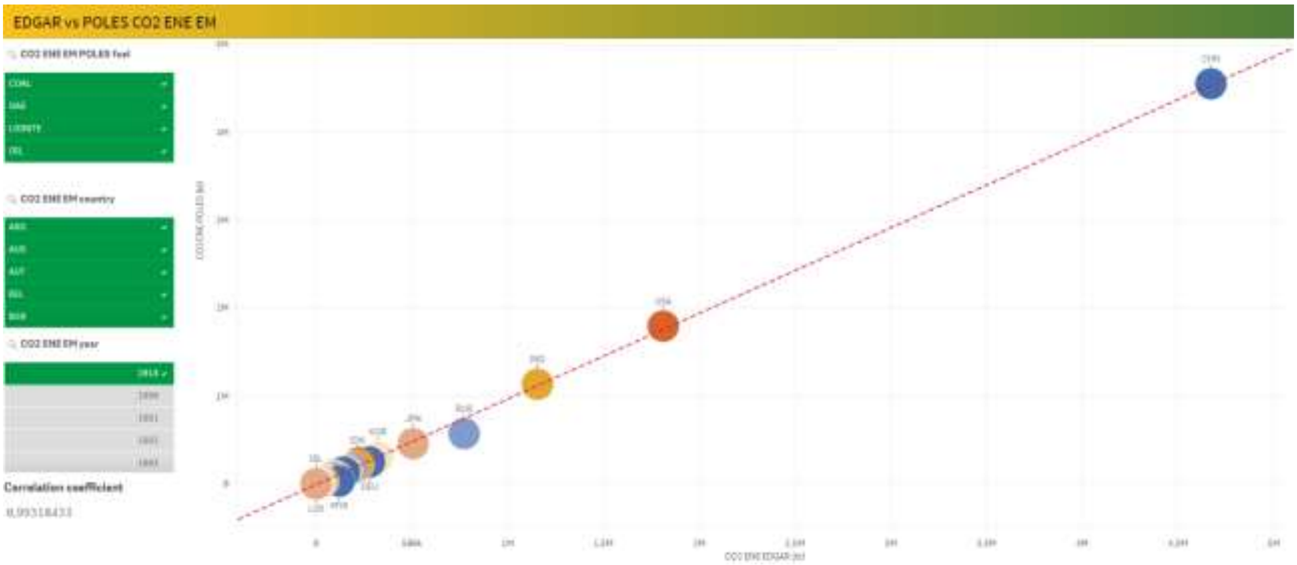
When looking to each fuel separately larger differences are found. In global level differences of CO_2 emissions from coal stand between +5% and -1%. In the case of lignite these differences stand between +5% and -3%. For fossil oil the differences are between +3% and -15%. Larger differences are found for gas fuel due to the issue of ICO. For EU27 the based-fuel differences stands between +8% and -5% for coal, +6% and -3% for lignite, +22% for oil and between +6% and -1%.

Figure 21. EU27 coal and lignite CO_2 energy emissions as in EDGAR and POLES JRC , (1990-2020), in kt



In country basis the correlation betwwen EDGAR and POLES JRC taking all fuel into account is shown in Figure 22. As shown in this figure the correlation factor for the energy CO_2 emissions of EU27 countries between EDGAR and POLES JRC for year 2018 is at 0.993.

Figure 22. Correlation EDGAR - POLES JRC energy CO_2 emissions by country of POLES JRC domain, 2018



([11]) EDGAR CO_2 energy emissions versus POLES JRC CO_2 energy emissions.
([12]) Uncertainty of emissions is not incuded when calculating the relative differences between EDGAR and POLES JRC.

The comparison of activity data between EDGAR and POLES JRC (with CCS) over period 1990-2020 is shown in Figures 23 and 24. As explained above the differences between historical trends of EDGAR and POLES JRC activity data for CO_2 emissions in energy sector is due to the issue of internal combustion. Figure 23 illustrates this case showing how the trend of CO_2 energy emissions from coal, lignite and oil compares with the respective historic trend of POLES JRC.

Figure 23. Activity data for CO_2 energy emissions (no gas) - EDGAR (bar) and POLES JRC (line), (1990 – 2020), in TJ

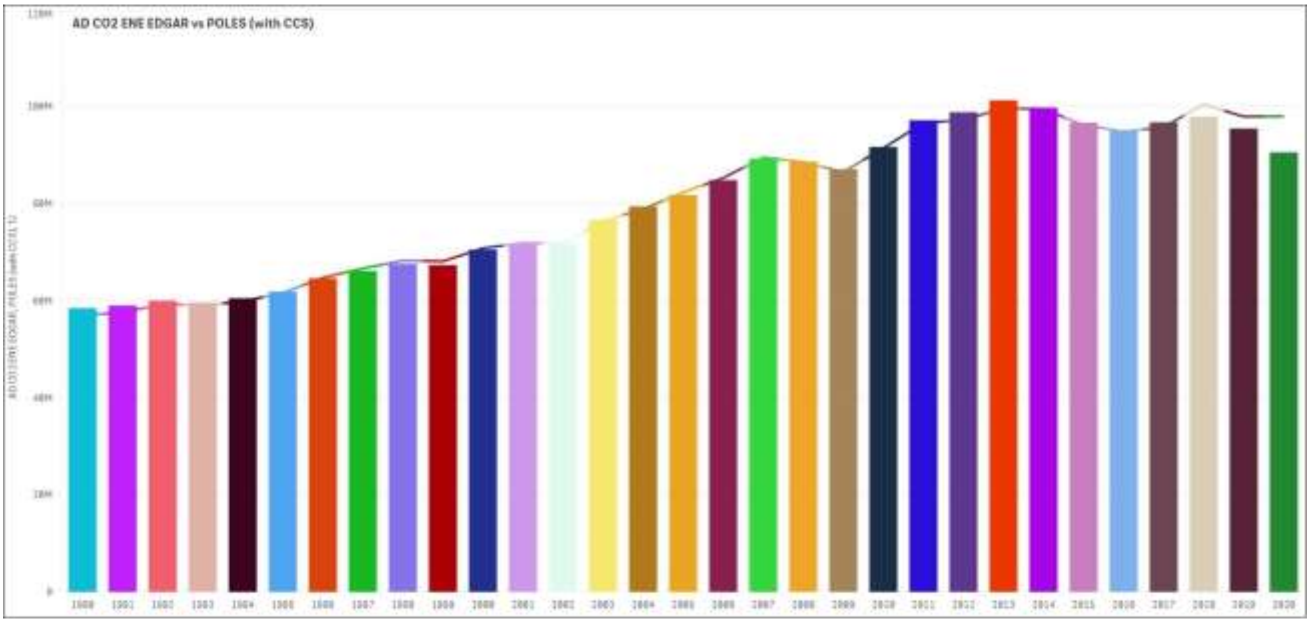
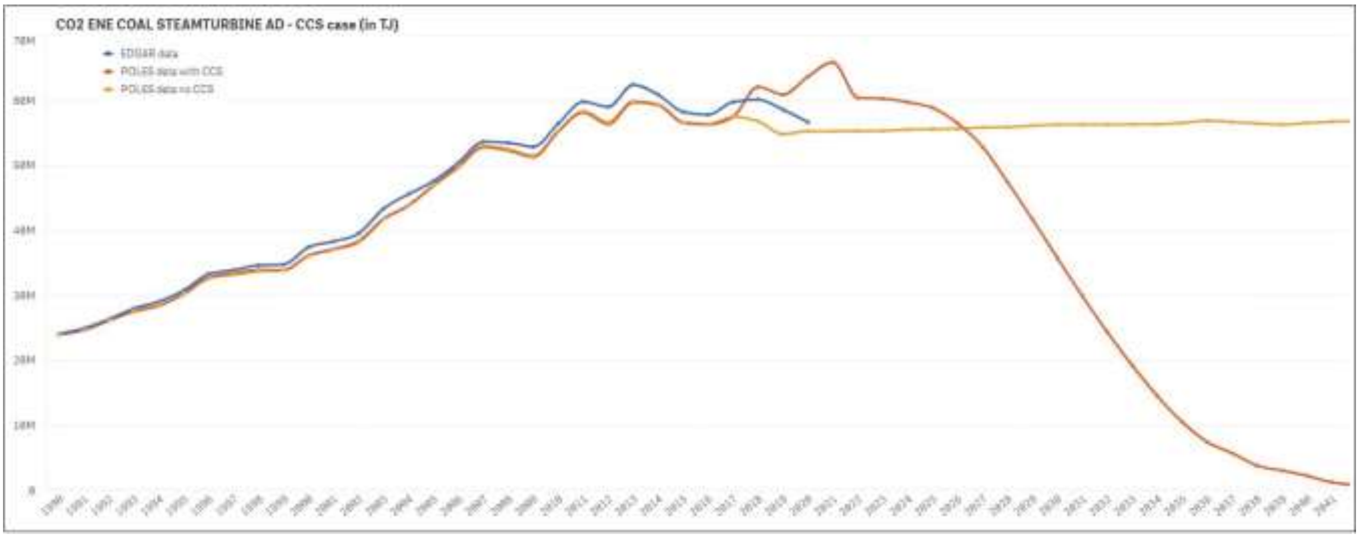


Figure 24 illustrates the case of CCS application in the activity data[13] provided by POLES JRC for USA, Germany, China, France and Japan. Without the effect of CCS the projected activity data would have been nearly stable up to 2050.

Figure 24. Activity data for energy CO_2 emissions in USA, Germany, China, France, Japan – coal use in steamturbine CCS case, 1990-2040, (in TJ)



Comparison of activity data for the estimation of CO_2 emissions from energy sector (coal, lignite and oil) for POLES JRC country domain is shown in Figure 25. Relative differences for this domain and three fossil fuels (no gas) remain below ±3%. When analysing relative differences for EU27 domain relative differences stay below ±4%. On fuel basis the differences stand between +5% and -1% for coal, to -18% for lignite and oil. For the EU27 the comparison for the three

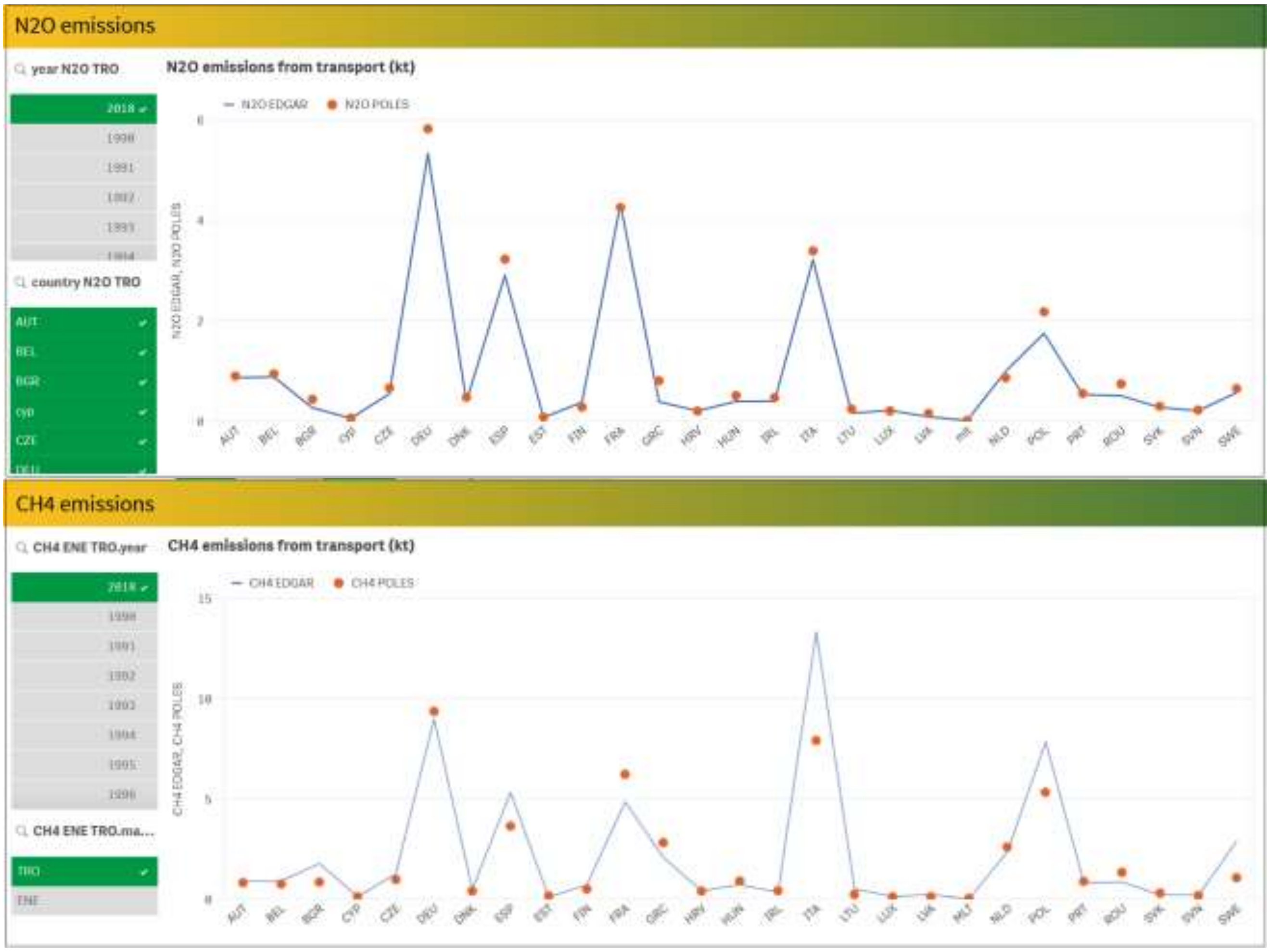
(13) The sum of activity data for these five countries is presented since the trend of both activity data with and w/o CCS follows the same trend in each of these countries.

fuels stood at +£% and fuel based comparison reveals that the difference for coal stood between +8% and -5%, for lignite at -8% and for oil between +16% and -5%.

Figure 25. Relative changes in energy activity data (coal, lignite, oil): EDGAR vs POLES (with CCS), 1990-2018, (%)

The comparison by country total values of N_2O and CH_4 emissions in the EU27 transport sector is shown in Figure 26. It can be seen that a good agreement exist in several EU27 countries for both N_2O and CH_4 emissions coming from this sector.

Figure 26. N_2O and CH_4 emissions from transport sector in each EU27 countries, 2018, in kt



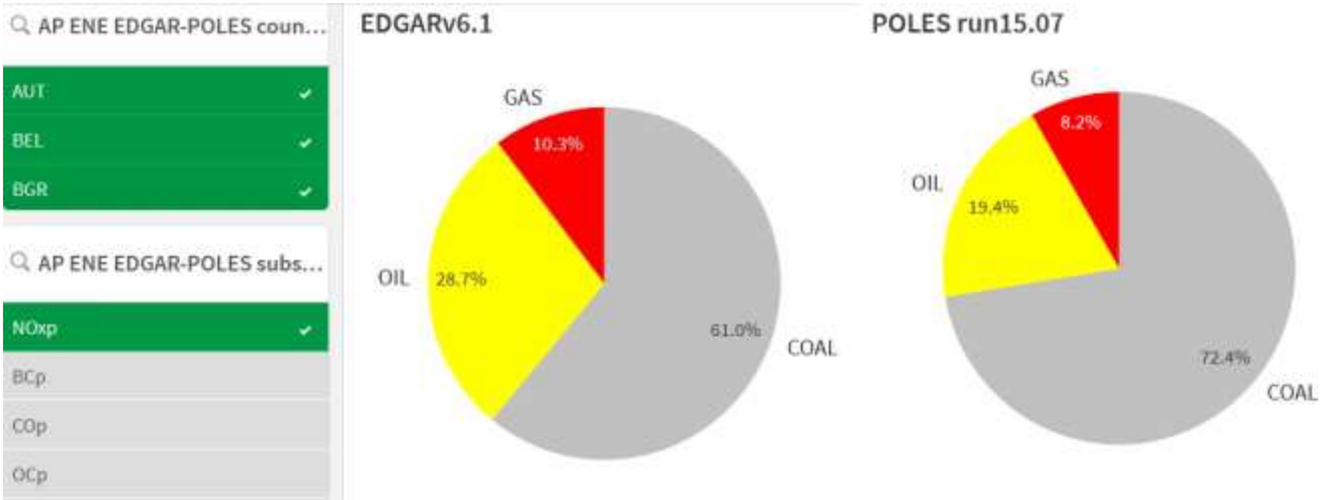
6.3 Air pollutants

Some results on mapping air pollutant emissions between EDGAR and POLES JRC covering energy sector are presented below.

The mapping for air pollutants has been done by total sector and by fuel. In the case of air pollutant larger differences are observed when the comparison is fuel based as well as sector based. These differences are linked with the type of air pollutant and fuel. In the estimation of air pollutant emissions the end of pipe/abatement measures for technologies and emission factors play an important role.

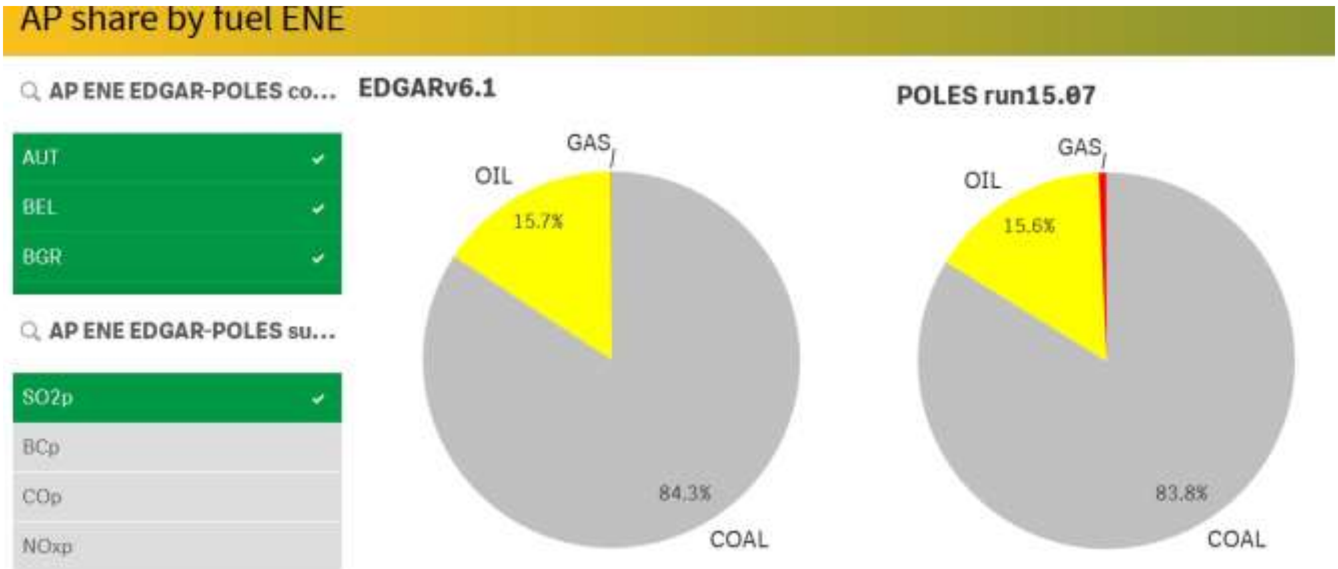
As shown in Figure 27 differences are observed in the contribution of fossil fuels in the NOx emissions from energy sector in the EU27 domain.

Figure 27. EU27 energy NOx emissions by fuel as in EDGARv6.1 (left) and POLES JRC (right), 1990



In the case of EU27 SO_2 emissions from energy sector shown in Figure 28 for year 2015, the share of fossil fuels (coal, oil and gas), the differences are not those observed for NOx energy emissions. However, it was found that moving through years these differences might be considerable. The same was found also for other pollutants.

Figure 28. EU27 energy SO_2 emissions by fuel as in EDGARv6.1 (left) and POLES JRC (right), 2015



In Figure 29 the SO_2 eenergy missions in each EU27 country as estimated by EDGAR and POLES JRC are shown. As seen in several countries we have found a good match between EDGAr and POLES JRC. However, there are several countries in the EU27 and global domain where the differences exists.

Figure 29. SO_2 emissions from energy sector in each EU27 countries, 1990, in kt

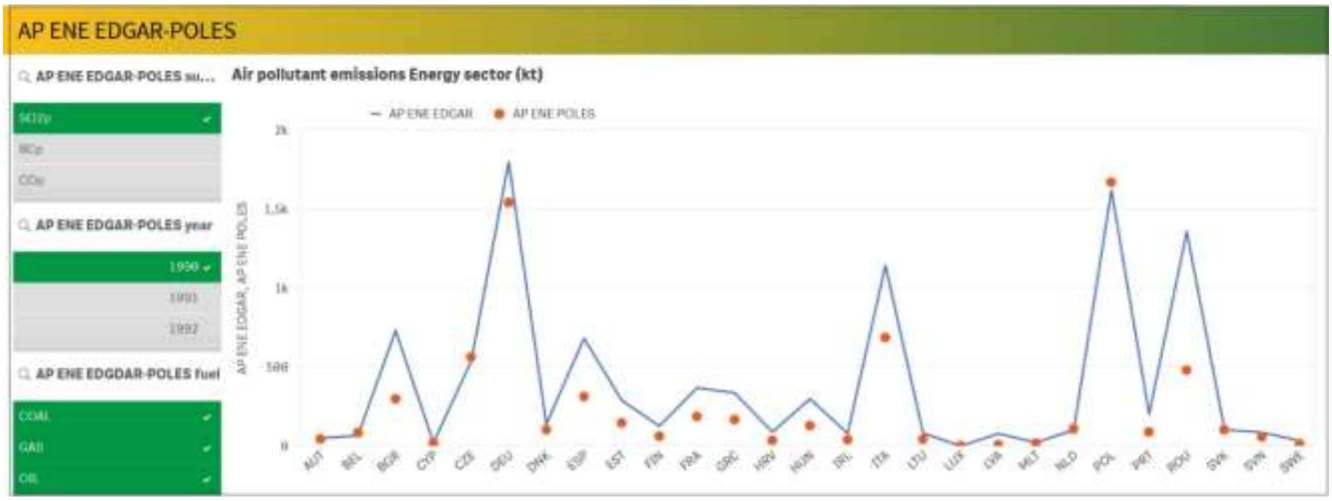


Figure 30 shows how the year-to-year differences of SO_2 energy emissions from oil for both EDGAR and POLES JRC are found for period 1990-2018. It can be seen that in certain years we found nearly the same absolute differences in EDGAR and in POLES JRC as well as different absolute differences in other years.

Figure 30. Year-to-year absolute differences in SO_2 energy emissions from oil: EDGAR and POLES JRC, 1990-2018, in kt

7 Discussions and Conclusions

The objective of this report is to provide the relevant information on the possible mapping between EDGAR and POLES JRC bringing the attention on the harmonisation and issues that exist between these two in-house data sources.

The aim of this work was to map the in-house data sources EDGAR database and POLES JRC model to set the basis for the development of an EDGAR and POLES JRC communication platform. The platform will provide scenarios analysis that will be developed either for GHG and air pollutant emissions.

EDGAR emissions will be associated to POLES JRC projections that will provide energy and emissions results for a Reference, NDC-LTS and 1.5C Scenario. Mapping with EDGAR database has been performed at the possible "lowest" level that combines four EDGAR category combinations sector/subsector/fuel/technology. However, due to the availability of estimation from POLES JRC side this mapping level was not possible to be applied for all sectors in the EDGAR database.

The granularity of mapping in energy sector is more coarse on POLES JRC side since the model makes use of energy balance for three main fossil fuels: coal, gas and oil that are included in three main technologies: steam turbine, gas turbine and combine heat and power. Several EDGAR fuels and subsectors as well are needed to be aggregated. The EDGAR internal combustion technology doesn't exist in POLES JRC. One of the options is to align this technology to the POLES JRC gas turbine technology. On the other side EDGAR lacks of CCS and combined technology.

In manufacturing industry sector again the mapping level is based on EDGAR combination of four levels sector/subsector/fuel/technology. A one-by-one match is possible only for chemical, non-metall and iron & steel subsectors. The remaining ten subsectors should be aggregated.

In residential sector the EDGAR aggregation at subsector level is needed for agriculture and fishing which will be mapped at agriculture subsector of POLES JRC. Other not specified subsector is not assigned to any of th POLES JRC codes as the model do not have it. Several EDGAR fuels are aggregated to the three fuels existing in POLES JRC.

Mapping in transport sector includes mainly that of road transport and non-road transport. We find the same types of vehicles in road transport sector in both EDGAR and POLES JRC. The aggregation of EDGAR fuels in gas, oil and bio fuels of POLES JRC is necessary. For non-road transport three EDGAR subsectors are mapped with the respective POLES JRC. The issue in this subsector is the missing of POLES JRC emissions for road surface wear subsector. The model can provide the activity data for this subsector which can be compared with historic EDGAR activity data. The projected activity data can be used in EDGAR for the emissions estimation. For CH_4 and N_2O POLES JRC will provide only totals by sector whereas for air pollutants mapping will reach the sector and fuel level.

Estimation of emissions from fuel transformation does not exist in POLES JRC so this category is omitted from mapping. In the sector of process emissions during production, mapping is done one-by-one for some of the process codes.

Mapping in agriculture is possible only at sector level since POLES JRC baseline emissions and mitigation potentials are sources from specialized models as IIASA GLOBIOM model.

Some of the conclusions we can make on mapping process between EDGAR and POLES JRC can be summarized as in following:

- Mapping results show that a good alignment of categories, subsectors and fuels can be reached in power, industry, transport and residential sectors. As expected a good aligment can be reached for CO_2 emissions in power sector,
- Mapping for methane and nitrous oxide depends to the fact that the estimation of these GHG in POLES JRC is treated as a residual estimation process. Total values on sector basis are available from POLES JRC model.
- POLES JRC will provide activity data for all EDGAR sectors even in cases when emissions might be not available because the model does not estimate those. POLES JRC activity data for energy sector includes the effect of policies as reported by countries whe fulfilling their obligations to UNFCCC,
- Mapping of air pollutants is done only on fuel-based and sector-based providing not the expected resulst even in the energy sector,

- POLES JRC air pollutant emissions and activity data can be used also as a benchmark for EDGAR emissions trends. More, POLES JRC will provide the projected activity data for each air pollutant by fuel and by sector.
- Mapping is performed for F-gases in the process emissions during production EDGAR main process
- The differences between EDGAR and POLES JRC are found in gas use in energy sector, in totals of CH_4 and N_2O and in the air pollutant estimation.

The way forward

- The work on further development of EDGAR-POLES JRC platform can continue with the aim to refine more the level of mapping between these two in-house data sources when the mapping is on the coarse level. For example on EDGAR side we have gas turbine technology and from POLES we have gas turbine, combined cycle and combined cycle with CCS. This match will require efforts from both sides to improve modelling, alignment and enhancement,
- Application of POLES JRC projections growth rates for both emissions and activity data, to its data in order to produce its own projections. This work will require efforts to define the growth rates for each technology and fuel that under the mapping work has been aggregated due to the coarse structure of POLES JRC model,
- Energy consumption in pipelines (in other transport) could be derived in POLES (a development task),
- Further development of the EDGAR-POLES JRC platform with the aim to develop and provide GHG emission scenario analyses taking into account different policy pathways will contribute to the definition of long-term EU climate targets and their impact assessment.

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List of abbreviations and definitions

AFOLU	Agriculture, Forestry and Land Use
AWMS	Animal Waste Management System
CCS	Carbon capture and storage
CHP	Combined Heat and Power
CO_2	Carbon dioxide
CH4	Methane
EDGAR	Emission Database for Global Atmospheric Research
GAINS	Greenhouse Gas and Air Pollution Interactions and Synergies model
GDP	Gross Domestic Product
GECO	Global Energy and Climate Outlook
GHG	Greenhouse gas
GLOBIOM	Global Biosphere Management Model
IEA	International Energy Agency
IIASA	International Institute for Applied Statistical Analysis
IPCC	Intergovernmental Panel on Climate Change
LULUCF	Land Use, Land Use Change and Forestry
LTS	Long-Term Climate Strategies
MACC	Marginal Abatement Cost Curve
NDC	Nationally Determined Contributions
POLES	Prospective Outlook on Long-term Energy Systems

BC	Black carbon
CH_4	Methane
CO	Carbon monoxide
CO_2	Carbon dioxide
HCFC	Hydrochlorofluorocarbon
HFC	Hydrofluorocarbon
NF_3	Nitrogen trifluoride
NH_3	Ammonia
NMVOC	Non-methane volatile organic compound
NOx	Nitrogen oxide
N_2O	Nitrous oxide
OC	Organic carbon
PFC	Perfluorcarbon
SF_6	Sulphur hexafluoride

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Annex 1. EDGAR fuel codes

Type	Subtype	Fuel name	Code	Carrier group
Solid fuels and products	Hard coal	Anthracite	ANT	Coal
	Hard coal	Other Bituminous Coal	BTC	Bituminous
	Hard coal	Coking Coal	CKC	Bituminous
	Hard coal	Coal Tar	CLT	Coal product (for NEU)
	Hard coal	Gas Coke	GCK	Coal product
	Hard coal	Hard Coal (if no detail)	HDC	Coal
	Hard coal	Coke Oven Coke	OCK	Coal product
	Hard coal	Patent Fuel	PAT	Coal product
	Hard coal	Sub-Bituminous Coal	SBC	Sub-bituminous
	Brown coal	BKB/Peat Briquettes	BKB	Coal product
	Brown coal	Brown Coal (if no detail)	BRC	Brown coal/Peat
	Brown coal	Lignite/Brown Coal	LGN	Brown coal/Peat
	Peat	Peat	PEA	Brown coal/Peat
	Peat	Peat product (Briquettes)	PEP	Brown coal/Peat
	Solid waste	Municipal Waste (non-renew)	MWN	Waste (no biomass)
Oil and oil products	Heavy oils	Bitumen	BIT	Oil product
	Heavy oils	Crude/NGL/Feedstock (if no detail)	CNF	Crude oil subtype
	Heavy oils	Crude Oil	CRU	
	Heavy oils	Gas/Diesel Oil	DIE	
	Heavy oils	Residual Fuel Oil	HFO	
	Heavy oils	Lubricants	LUB	used in NEU
	Heavy oils	Other Hydrocarbons	NCR	
	Heavy oils	Petroleum Coke	PCK	used in NEU
	Heavy oils	Paraffin Waxes	PWX	used in NEU
	Heavy oils	Refinery Feedstock	RFD	Crude oil subtype
	Heavy oils	Orimulsion	ORI	
	Light oils	Additives/Blending Components	ADD	Crude oil subtype
	Light oils	Aviation Gasoline	AVG	
	Light oils	Ethane	ETH	
	Light oils	Gasoline Type Jet Fuel	GJE	
	Light oils	Kerosene Type Jet Fuel	JET	
	Light oils	Liquefied Petroleum Gases (LPG)	LPG	
	Light oils	Motor Gasoline	MOG	
	Light oils	Naphtha	NAP	Used in NEU
	Light oils	Natural Gas Liquids	NGL	Crude oil subtype
	Light oils	Kerosene	OKE	
	Light oils	Non-specified Petroleum Products	OPR	
	Light oils	Shale oil	OSH	Light tight oil
	Light oils	White Spirit & SBP	WSP	Used in NEU
Gaseous fuels and products	Natural gas	Natural Gas	NGS	
	Derived gases	Blast Furnace Gas	BFG	Coal product
	Derived gases	Gas Works Gas	GGS	Coal product
	Derived gases	Elec/Heat Output from Non-spec. Manuf. Gases	MNG	Product of misc. FF
	Derived gases	Coke Oven Gas	OGS	Coal product
	Derived gases	Refinery Gas	RGS	Oil product
	Derived gases	Oxygen Steel Furnace Gas	OGA	
Biomass Fuels (short cycle for CO_2)	Solid biomass	Charcoal	CHA	Wood product
	Solid biomass	Dung	DNG	
	Solid biomass	Industrial Waste	IWS	Waste
	Solid biomass	Municipal Waste (Renew)	MWR	Waste
	Solid biomass	Non-specified Combust. Renewables + Wastes	NSF	
	Solid biomass	Primary Solid Biomass (non-specified)	SBI	
	Solid biomass	Vegetal waste	VWS	
	Solid biomass	Wood	WOD	
	Liquid biomass	Biodiesel	BDS	
	Liquid biomass	Biogasoline	BGL	
	Liquid biomass	Bagasse	BGS	Sugar cane product
	Liquid biomass	Black Liquor	BLI	Pulp product
	Liquid biomass	Liquid Biomass	LBI	Bioethanol, biodiesel
	Liquid biomass	Other Liquid Biofuels	OLB	
	Gaseous biomass	Biogas	GBI	Landfills, WWTP, digester

Annex 2. EDGAR sectors and subsectors codes

Fuel combustion and production	
Energy Industries (ENE)	Manufactory Industry (IND)
Auto produced electricity (AEL)	Chemicals (combustion) (CHE)
Auto produced heat plants (AHE)	Construction (combustion) (CON)
Auto-produced cogeneration (AHP)	Food and tobacco (combustion) (FOO)
Public electricity production (PEL)	Iron and steel (combustion) (IRO)
Public district heating (DHE)	Machinery (combustion) (MAC)
Public cogeneration (CHP)	Mining (combustion) (MIN)
	Non-ferrous metals (combustion) (NFE)
Road Transport (TRO)	Non-metallic minerals (combustion) (NMM)
Transport - road (ROA)	Paper, pulp and print (combustion) (PAP)
Evaporation (EVP)	Transport equipment (combustion) (TEQ)
Road surface wear (RSW)	Textiles (combustion) (TEX)
Road vehicle tyre and brake wear (TYR)	Wood and wood products (combustion) (WOO)
Non Road Transport (TNR)	Non-specified industry (IND)
Domestic air transport (DAT)	
Inland water ways (ILW)	Transformation Industry (TRF)
Non-specified non-road transport (OTH)	Fuel combustion: Blast Furnaces (EBF)
Pipeline transport (PIP)	Fuel combustion: BKB plants (EBK)
International air transport (IAT)	Fuel combustion: Gasification plants (EBO)
International marine bunkers (SEA)	Fuel combustion: Charcoal production (ECH)
	Fuel combustion: Coke ovens (ECK)
Residential (RCO)	Fuel combustion: Gas works (EGW)
Agriculture/Forestry (AGR)	Fuel combustion: Liquefaction/Regasification plant (ELN)
Commercial & Public service (COM)	Fuel combustion: Coal liquefaction (ELQ)
Fishing (FSH)	Fuel combustion: Energy in coal mines (EMI)
Non-specified (OTH)	Fuel combustion: Non-specified transformation (ENO)
Residential (RCO)	Fuel combustion: Oil & Gas extraction (EOG)
	Fuel combustion: Patent fuel plants (EPA)
Fuel production/transmission (PRO)	Fuel transformation: Blast Furnaces (TBF)
Brown coal production (BRC)	Fuel transformation: BKB plants (TBK)
Gas production, transmission & venting from production (GAS)	Fuel transformation: Blending of natural gas (TBN)
Hard coal production (HDC)	Fuel transformation: Charcoal (TCH)
Oil production transmission, loading, venting & flaring (OIL)	Fuel transformation: Coke ovens (TCK)
	Fuel transformation: Natural gas into oil in (GLT) plant (TGL)
Oil Refineries (REF)	Fuel transformation: Gas works (TGW)
Fuel combustion petroleum refineries (CMB)	Fuel transformation: Coal liquefaction (TQL)
Fuel transformation petroleum refineries (EVA)	Fuel transformation: Distribution losses (TLQ)
	Fuel transformation: Non-specified (TNO)
	Fuel transformation: Patent fuel plants (PAT)
	Fuel transformation: Petrochemical plant (TPE)
Agriculture and Waste	
Agriculture	Waste/Waste Water handling
Agricultural soils (AGS)	Solid waste disposal (SWD)
Animal waste as fertilizer (AWS)	Solid waste incineration (INC)
Crop residues (CRP)	Solid waste disposed to landfills (LDF)
Histosols (HIS)	Other waste handling (OTH)
Liming (LMN)	Waste water handling (WWT)
Nitrogen-fixing crops (NFC)	Domestic waste water (DOM)
Nitrogen fertilizers (NFE)	Industrial waste water (IND)
Rice cultivation (RIC)	
CO_2 from urea fertilization (URE)	
Livestock in pasture	
Agriculture waste burning (AWB)	
Crop residues (CRP)	
Enteric fermentation (ENF)	
Livestock number	
Manure management (MNM)	
Livestock number	

Process emissions during production and application		
Production of chemicals (CHE)		Production and use of other products PRU)
Adipic acid production (AAP)		Aerosols (AER)
Ammonia production (AMP)		Accellerators/HEP (ACC)
Bulks chemical production (BLK)		Closed cell foam (CCF)
Calcium carbide production (CLC)		Production, application of CFC (CFC)
Caprolactam production (CLP)		Commercial refrigeration (COM)
Glyoxal production (GXA)		Domestic refrigeration (DOM)
Nitric acid production (NAP)		PFC use in fire extinguishers (FEX)
N-fertilizer production (NFP)		Flat Panel Display production (FPD)
Sulphuric acid production (SAP)		Production, application of HCFC (HFC)
Silicon carbide production (SLC)		PFC use in accelerators/High Energy Physics (HEP)
		Industrial refrigeration (IND)
Production of iron and steel (IRO)		Mobile Air Conditioning (MAC)
Crude steel production (CSP)		Consumption for miscellaneous (MIS)
Ferro Ally production (FEA)		Open cell foam (OCF)
Pigment iron production (PIG)		Electrical equipment manufacturing (OEM)
Sinter production (SNT)		Production and use of other products (OTH)
		Production, application of PFC & HCFC (PFC)
Non energy use of fuels (NEU)		Production PV solar cells (PVP)
Non energy use: Industry (IND)		PFC use in refrigeration (REF)
Non energy use: Tansport (TRA)		Stationary air conditioning (SAC)
Non energy use: Other (OTH)		Semiconductor production (SCO)
		Use in solvents (SOL)
Production of non-ferrous metals (NFE)		Use in sport shoes and other (SPO)
Aluminium production (primary) (ALP)		Transport refrigeration (TRA)
Copper production (primary) (CUP)		Tyres (TYR)
Magnesium production (primary) (MGP)		SF6 consumption unaccounted for elsewhere UAE)
Lead production (primary) (PBP)		GIS Stock emissions from leakage and maintenance (UTL)
Zinc production (primary) (ZNP)		
Molybdenum production (OTH)		
Production of non-metallic minerals (NMM)		
Cement production (CMN)		
Glass production (GLS)		
Lime production (LMN)		
Limestone and Dolomite Use (LMU)		

Annex 3. Electricity and Heat mapping

Table 21. Detailed mapping EDGAR-POLES JRC for electricity and heat - IPCC 1.A.1.a.(i,ii,iii)

Final Category	Species & Variables	POLES		EDGAR				Additional Variables	Comment	Issues discussed
		Fuels	Technology	Fuels	Technology	Main Sector	Sub-Sectors			
Electricity - CO_2 total power sector	CO_2: ELE TOTGHG	coal, oil, gas	• all	• all	• all	• ENE	• AEL • AHE • AHP • CHP • DHE • PEL • POW		• POLES: CO_2 emissions total power sector. • POLES: Biomass emissions not included	• Mapping (biomass emissions not to included)
Electricity - CH_4 total power & industry sector	CH_4: ELE TOTGHG	coal, oil, gas	• all	• all	• all	• ENE	• AEL • AHE • AHP • CHP • DHE • PEL • POW		• POLES: CH_4 emissions in power & industry sector (residual CH_4 emissions). • POLES: base emissions modelled by a (i) change of an activity variable (elasticity exponent, activity variable: oil consumption road transport); - (ii) trend. • Actual emisisons: MACC applied to base emissions	• Mapping covers power, industry, and some other parts.
Electricity - N_2O total power & industry sector	N_2O: ELE TOTGHG	coal, oil, gas	• all	• all	• all	• ENE	• AEL • AHE • AHP • CHP • DHE • PEL • POW		• POLES: N_2O emissions in power & industry sector (residual N_2O emissions). • POLES: base emissions	• Mapping covers power, industry, and some other parts.

Final Category	Species & Variables	POLES		EDGAR				Additional Variables	Comment	Issues discussed
		Fuels	Technology	Fuels	Technology	Main Sector	Sub-Sectors			
									modelled by a (i) change of an activity variable (elasticity exponent, activity variable: oil consumption road transport); - (ii) trend. • Actual emissions: MACC applied to base emissions	
Electricity - Steam turbines using coal	CO_2, AV, $CCSCO_2$, AV $CCSCO_2$: ELE COAL STEAMTURB	Coal	• Conventional coal (sub-critical & super-critical) • Advanced coal (ultra-critical) • Integrated gasification combined cycle • CCS retrofitted: Conventional coal (sub-critical & super-critical) • CCS: Advanced coal (ultra-critical) • CCS: Integrated gasification combined cycle	• ANT • BTC • CHA • CKC • CLT • GCK • OCK • PAT • SBC	• fluidized bed • pulverized coal dry • bottom boiler • grate firing	• ENE	• AEL • PEL • POW • CHP • AHP • AHE • DHE	• $CCSCO_2$: captured CO_2 emissions (CCS). • AV $CCSCO_2$: Final energy consumption coal corresponding to captured CO_2 emissions	• CHP, AHP, DHE are included -as in POLES CHP applies only to gas. • AHE included as heat is not explicitly distinguished in energy balances (Heat & Power).	• Development: -Technology Alignment - EDGAR lack of CCS
Electricity - Steam turbines using lignite	CO_2, AV, $CCSCO_2$, AV $CCSCO_2$: ELE LIGNITE STEAMTURB	Lignite	• Conventional lignite • CCS retrofitted: Conventional lignite	• BKB • LGN • PEA	• fluidized bed • pulverized coal dry bottom boiler • grate firing	• ENE	• AEL • PEL • POW • CHP • AHP	• $CCSCO_2$: captured CO_2 emissions (CCS). • AV $CCSCO_2$: Final energy consumption	• CHP, AHP, DHE are included -as in POLES CHP applies only to gas.	• Development: -Technology Alignment - EDGAR lack of CCS

Final Category	Species & Variables	POLES		EDGAR				Additional Variables	Comment	Issues discussed
		Fuels	Technology	Fuels	Technology	Main Sector	Sub-Sectors			
							• AHE • DHE	lignite corresponding to captured CO_2 emissions	• AHE included as heat is not explicitly distinguished in energy balances (Heat & Power).	
Electricity - Steam turbines using biomass	CO_2BIO, AV, CCSCO_2BIO, AV CCSCO_2BIO: ELE BIOMASS STEAMTURB	Biomass	• Biomass thermal conventional, • Biomass gasification (Not biogas from anaerobic digestion!) • CCS biomass combustion (retrofitted) • CCS biomass gasification	• IWS • MWN • MWR • NSF • SBI	• fluidized bed • pulverized coal dry bottom boiler • grate firing	• ENE	• AEL • PEL • POW • CHP • AHP • AHE • DHE	• CCSCO_2BIO: captured emissions (CCS) from biomass (negative emissions) • AV CCSCO_2BIO : Final energy biomass consumption corresponding to captured CO_2 emissions	• CO_2 emissions from biomass combustion using boiler & steamturbine in electricity sector. • AHE included as heat is not explicitly distinguished in energy balances (Heat & Power). • POLES boiler & steamturbine technologies: (i) biomass thermal conventional, (ii) biomass gasification (not biogas from anaeorbic digestion!), (iii) CCS biomass combustion (retrofitted) and (iv) CCS biomass gasification (not biogas from anaeorbic digestion!). • CHP, AHP, DHE are included -as in	• Mapping of EDGAR fuels: biogas, other liquid biofuels, biodiesel • Development: -Technology Alignment - Waste separate? - EDGAR lack of CCS

Final Category	Species & Variables	POLES		EDGAR				Additional Variables	Comment	Issues discussed
		Fuels	Technology	Fuels	Technology	Main Sector	Sub-Sectors			
									POLES CHP applies only to gas. • AHE included as heat is not explicitly distinguished in energy balances (Heat & Power).	
Electricity - Steam turbines using oil	CO_2, AV: ELE OIL STEAMTURB	Oil	• Conventional steam turbine using oil (sub-critical & super-critical)	• BKB • LGN • PEA • BIT • CRU • DIE • HFO • JET • LUB • MOG • NAP • NCR • NGL • OKE • OPR • PCK	• boiler for gas/liquid of any size	• ENE	• AEL • PEL • POW • CHP • AHP • AHE • DHE		• CHP, AHP, DHE are included -as in POLES CHP applies only to gas. • AHE included as heat is not explicitly distinguished in energy balances (Heat & Power). • EDGAR fuels bioliquids (OLB, BDS) not inlcuded	• Mapping of EDGAR technology: internal combustion engine • Development: -Technology Alignment - EDGAR lack of CCS
Electricity - Steam turbines using gas	CO_2, AV: ELE GAS STEAMTURB	Natural gas	• Conventional steam turbine using gas (sub-critical & super-critical)	• BFG • ETH • GGS • LPG • NGS • OGS • RGS	• boiler for gas/liquid of any size	• ENE	• AEL • PEL • POW • AHE		• CHP, AHP, DHE not included as CHP for gas exists in POLES • AHE included as heat is not explicitly distinguished in energy balances (Heat & Power).	• Mapping of EDGAR technology: internal combustion engine • Development: -Technology Alignment - EDGAR lack of CCS

Final Category	Species & Variables	POLES		EDGAR				Additional Variables	Comment	Issues discussed
		Fuels	Technology	Fuels	Technology	Main Sector	Sub-Sectors			
									• EDGAR fuel biogas (GBI) not included	
Electricity - Gas turbines using oil	CO_2, AV: ELE OIL GASTURB	Oil	• Gas turbine (open cycle)	• CRU • DIE • HFO • JET • MOG • NAP • NCR • NGL • OKE • OPR • OSH • PCK	• gas turbine	• ENE	• AEL • PEL • POW • CHP • AHP • AHE • DHE		• CHP, AHP, DHE are included -as in POLES CHP applies only to gas. • EDGAR fuels bioliquids (OLB, BDS) not included	•
Electricity - Gas turbines using gas	CO_2, AV, $CCSCO_2$, AV $CCSCO_2$: ELE GAS GASTURB	Natural gas	• Gas turbine (open cycle) • Combine cycle gas turbine • CCS: Combine cycle gas turbine	• BFG • GGS • LPG • NGS • OGA • OGS • RGS	• gas turbine	• ENE	• AEL • PEL • POW • AHE	• $CCSCO_2$: captured CO_2 emissions (CCS). • AV $CCSCO_2$: Final energy consumption gas corresponding to captured CO_2 emissions	• CHP, AHP, DHE not included • EDGAR fuel biogas (GBI) not included	• Development: - EDGAR lacks combined cycle - EDGAR lacks of CCS
Electricity - CHP using gas	CO_2, AV: ELE CHP GAS	gas	• several technologies (stylized approach)	• NGS • BFG • OCK • OGS • GGS	• BO0 • FB0 • GF0 • GT0 • IC0 • PD0	• ENE	• CHP • AHP • DHE	•	• CHP in POLES refers to district heating in residential, services and other industries. • CHP in POLES uses only gas. • EDGAR fuel biogas (GBI) not included	• Discuss mapping
AP electricity - total	AP_group_tot: ELE TOT AP	all	• all	• all	• all	• ENE	• all	•	•	• Discuss

Final Category	Species & Variables	POLES		EDGAR				Additional Variables	Comment	Issues discussed
		Fuels	Technology	Fuels	Technology	Main Sector	Sub-Sectors			
AP electricity - coal	AP_group_fuel, ELE COAL AP:	• coal	• all	• several solid fuels	• power sector	• ENE	• all	•	•	• Discuss
AP electricity - oil	AP_group_fuel, ELE OIL AP:	• oil	• all	• several oil/petrol fuels	• power sector	• ENE	• all	•	•	• Discuss
AP electricity - gas	AP_group_fuel, ELE GAS AP:	• gas	• all	• several gaseous fuels	• power sector	• ENE	• all	•	•	• Discuss
AP electricity - biomass	AP_group_fuel, ELE BIOMASS AP:	• coal, lignite	• all	• several bio	• power sector	• ENE	• all	•	• biofuels not taken into account in POLES for power sector	• Discuss

Annex 4. Manufacturing Industries mapping

Table 22. Detailed mapping EDGAR-POLES JRC for manufacturing industries - IPCC 1.A.2

Final Category	Species & Variables	POLES		EDGAR				Additional Variables	Comment	Issues discussed
		Fuels	Technology	Fuels	Technology	Main Sector	Sub-Sectors			
Non-Metal Mineral Industry - using coal	CO2, AV, CCSCO2: IND NMM COAL	• coal	• stylized	• ANT • BKB • BTC • CKC • CLT • GCK • LGN • OCK • PAT • PEA • PEP • SBC	• NSF	• IND	• CHE	•	• CCSCO2BIO: Captured CO2 from biomass (negative emissions)	•
Non-Metal Mineral Industry - using oil	CO2, AV: IND NMM OIL	• oil	• stylized	• BIT • CRU • DIE • HFO • LPG • LUB • MOG • NAP • NGL • OKE • OPR • OSH • PCK • WSP •	• NSF	• IND	• NMM	•	•	•
Non-Metal Mineral Industry - using natural gas	CO2, AV: IND NMM GAS	• gas	• stylized	• BFG • GGS • NGS • OGA • OGS	• NSF	• IND	• NMM	•		•

Final Category	Species & Variables	POLES		EDGAR				Additional Variables	Comment	Issues discussed
		Fuels	Technology	Fuels	Technology	Main Sector	Sub-Sectors			
				• RGS •						
Non-Metal Mineral Industry - using biomass	CO_2, AV, CCSCO2BIO: IND NMM BIO	• biomass	• stylized	• BDS • CHA • GBI • MWR • OLB • SBI	• NSF	• IND	• NMM	•	• CCSCO2BIO: Captured CO_2 from biomass (negative emissions)	•
Industry - chemical sector using coal	CO_2, AV, CCSCO2: IND CHE COAL	• coal	• stylized	• ANT • BKB • BTC • CKC • CLT • GCK • LGN • OCK • PAT • PEA • PEP • SBC	• NSF	• IND	• CHE	• CCSCO2BIO: Captured CO_2 from biomass (negative emissions)	• Non-energy use in chemical sector not not included	•
Industry - chemical sector using oil	CO_2, AV: IND CHE OIL	• oil	• stylized	• AVG • BIT • CRU • DIE • ETH • HFO • JET • LPG • LUB • MOG • NAP • NGL • OKE • OPR • PCK • PWX	• NSF	• IND	• CHE	•	• Non-energy use in chemical sector not not included	•

Final Category	Species & Variables	POLES		EDGAR				Additional Variables	Comment	Issues discussed
		Fuels	Technology	Fuels	Technology	Main Sector	Sub-Sectors			
				• WSP						
Industry - chemical sector using natural gas	CO2, AV: IND CHE GAS	• gas	• stylized	• BFG • GGS • NGS • OGA • OGS • RGS	• NSF	• IND	• CHE	•	• Non-energy use in chemical sector not not included	•
Industry - chemical sector using biomass	CO2, AV, CCSCO2BIO: IND CHE BIO	• biomass	• stylized	• BDS • CHA • GBI • MWR • OLB • SBI	• NSF	• IND	• CHE	•	• Non-energy use in chemical sector not not included • CCSCO2BIO: Captured CO2 from biomass (negative emissions)	•
		•	•	•	•	•	•	•	•	•
Industry - iron & steel sector using coal	CO2, AV, CCSCO2: IND STI COAL	• coal	• blast furnace, EAF, CCS primary route	• ANT • BKB • BTC • CKC • CLT • GCK • LGN • OCK • PAT • PEA • PEP • SBC	• NSF	• IND	• IRO	• CCSCO2: Captured CO2	•	•
Industry - iron & steel sector using oil	CO2, AV: IND STI OIL	• oil	• stylized	• BIT • CRU • DIE • HFO • LPG • LUB	• NSF	• IND	• IRO	•	•	•

Final Category	Species & Variables	POLES		EDGAR				Additional Variables	Comment	Issues discussed
		Fuels	Technology	Fuels	Technology	Main Sector	Sub-Sectors			
				• MOG • NAP • NGL • OKE • OPR • PCK • WSP						
Industry - iron & steel sector using natural gas	CO_2, AV: IND STI GAS	• gas	• stylized	• BFG • GGS • NGS • OGA • OGS • RGS	• NSF	• IND	• IRO	•	•	•
Industry - iron & steel sector using biomass	CO_2, AV, CCSCO2BIO: IND STI BIO	• biomass	• stylized	• BDS • BGL • CHA • GBI • MWR • OLB • SBI	• NSF	• IND	• IRO	•	• CCSCO2BIO: Captured CO_2 from biomass (negative emissions)	•
		•	•	•	•	•	•	•	•	•
Industry other industrial sectors sectors using coal	CO_2, AV, CCSCO2: IND OTHERIND COAL	• coal	• stylized	• ANT • BKB • BTC • CKC • CLT • GCK • LGN • OCK • PAT • PEA • PEP • SBC	• NSF	• IND	• CON • FOO • INO • MAC • MIN • NFE • PAP • TEQ • TEX • WOO	• CCSCO2: Captured CO_2	•	•
Industry - other industrial	CO_2, AV: IND OTHERIND OIL	• oil	• stylized	• AVG • BIT	• NSF	• IND	• CON • FOO	•	•	•

Final Category	Species & Variables	POLES		EDGAR				Additional Variables	Comment	Issues discussed
		Fuels	Technology	Fuels	Technology	Main Sector	Sub-Sectors			
sectors sectors using oil				• CRU • DIE • ETH • HFO • JET • LPG • LUB • MOG • NAP • NGL • OKE • OPR • OSH • PCK • PWX • WSP			• INO • MAC • MIN • NFE • PAP • TEQ • TEX • WOO			
Industry - other industrial sectors sectors using natural gas	CO_2, AV: IND OTHERIND GAS	• gas	• stylized	• BFG • GGS • NGS • OGA • OGS • RGS	• NSF	• IND	• CON • FOO • INO • MAC • MIN • NFE • PAP • TEQ • TEX • WOO	•	•	•
Industry - other industrial sectors sectors using biomass	CO_2, AV, CCSCO2BIO: IND OTHERIND BIO	• biomass	• stylized	• BDS • BGL • BGS • BLI • CHA • GBI • MWR • OLB • SBI	• NSF	• IND	• CON • FOO • INO • MAC • MIN • NFE • PAP • TEQ • TEX • WOO	•	• CCSCO2BIO: Captured CO_2 from biomass (negative emissions)	•

Annex 5. Transport mapping

Table 23. Detailed mapping EDGAR-POLES JRC for transport sector - IPCC 1.A.3

Final Category	Species & Variables	POLES		EDGAR				Additional Variables	Comment	Issues discussed
		Fuels	Technology	Fuels	Technology	Main Sector	Sub-Sectors			
CO_2 total transport sector	CO_2: TRA TOT GHG	• oil (fossil & synth) • gas (fossil & synth) • coal	• all	• all	• all	• TRO, TNR	• all, apart from EVP, TYR, RSW	•	• POLES: emissions from biomass/biofuel not included	• discuss perimeter
CH_4 total transport sector	CH_4: TRA TOT GHG		• all	• all	• all	• TRO, TNR	• all, apart from EVP, TYR, RSW		• POLES: base emissions modelled by a (i) change of an activity variable (elasticity exponent, activity variable: oil consumption road transport); - (ii) trend. • Actual emissions: MACC applied to base emissions	• Discuss differences in modelling and how to align approaches. • How modelled in EDGAR? • What emisison factors are used in EDGAR?
N_2O total transport sector	N_2O: TRA TOT GHG		• all	• all	• all	• TRO, TNR	• all, apart from EVP, TYR, RSW		• POLES: base emissions modelled by a (i) change of an activity variable (elasticity exponent, activity variable: oil consumption road transport); - (ii) trend. • Actual emissions: MACC applied to base emissions	• Discuss differences in modelling and how to align approaches. • How modelled in EDGAR? • What emission factors are used in EDGAR?

Final Category	Species & Variables	POLES		EDGAR				Additional Variables	Comment	Issues discussed
		Fuels	Technology	Fuels	Technology	Main Sector	Sub-Sectors			
Air transport - domestic	CO2, AV, CO2BIO: TRA AIRDOM OIL	• oil (fossil) • synth. oil (efuel) • biofuels	• domestic air freight • domestic air passengers	• AVG • DIE • GJE • HFO • JET • LPG • MOG • OKE	• CDS • CRS • LTO • SPS	TNR	DAT	• CO2BIO: TRA AIRDOM OIL	• CO2 emissions do not account emission from biofuels; • CO2BIO accounts for biofuel CO2 emissions	• Biofuels not included in EDGAR; whereas in POLES taken into account.
Road transport - heavy duty vehicles oil	CO2, AV: TRA ROD HDV OIL	• oil (fossil) • synth. oil (efuel)	• conventional ICE trucks • hybrid trucks	• AVG • BIT • DIE • HFO • JET • LPG • LUB • MOG • NAP • NGL • OKE • OPR • WSP	• HD0	TRO	ROA	•	•	•
Road transport - heavy duty vehicles using gas	CO2, AV: TRA ROD HDV GAS	• natural gas (fossil) • synth. gas (efuel)	• conventional ICE trucks	• NGS • RGS	• HD0	TRO	ROA	•	•	•
Road transport - heavy duty vehicles using biofuels	CO2, AV: TRA ROD HDV BIO	• biofuels	• conventional ICE trucks • hybrid trucks	• BDS • BGL • GBI • OLB	• HD0	• TRO	• ROA		•	•
Road transport - light duty vehicles using oil	CO2, AV: TRA ROD LDV OIL	• oil (fossil) • synth. oil (efuel)	• conventional ICE light duty vehicles	• AVG • BIT • DIE • HFO	• LD0	• TRO	• ROA		•	•

Final Category	Species & Variables	POLES		EDGAR				Additional Variables	Comment	Issues discussed
		Fuels	Technology	Fuels	Technology	Main Sector	Sub-Sectors			
			• hybrid light duty vehicles	• JET • LPG • LUB • MOG • NAP • NGL • OKE • OPR • WSP						
Road transport - light duty vehicles using gas	CO2, AV: TRA ROD LDV GAS	• natural gas (fossil) • synth. gas (efuel)	• conventional ICE light duty vehicles • hybrid light duty vehicles	• NGS • RGS	• LD0	• TRO	• ROA		•	•
Road transport - light duty vehicles using biofuels	CO2BIO, AV: TRA ROD LDV BIO	biofuels	• conventional ICE light duty vehicles • hybrid light duty vehicles	• BDS • BGL • GBI • OLB	• LD0	• TRO	• ROA		•	•
Road transport - cars & motorcycles using oil	CO2, AV: TRA ROD CARS OIL	• oil (fossil) • synth. oil (efuel)	• conventional ICE cars • hybrid cars	• AVG • BIT • DIE • HFO • JET • LPG • LUB • MOG • NAP • NGL • OKE • OPR • WSP	• PC0 • MP0	• TRO	• ROA		• POLES: includes motorcycles & mopeds • POLES: potential development account separately for motorcycles & mopeds	•
Road transport - cars &	CO2, AV: TRA ROD CARS GAS	• natural gas (fossil)	• conventional ICE cars • hybrid cars	• NGS • RGS	• PC0 • PC0 • MP0	• TRO	• ROA		• POLES: includes motorcycles & mopeds	•

Final Category	Species & Variables	POLES		EDGAR				Additional Variables	Comment	Issues discussed
		Fuels	Technology	Fuels	Technology	Main Sector	Sub-Sectors			
motorcycles using gas		• synth. gas (efuel)							• POLES: potential development account separately for motorcycles & mopeds	
Road transport - cars & motorcycles using biofuels	CO2BIO, AV: TRA ROD CARS BIO	biofuels	• conventional ICE cars • hybrid cars	• BDS • BGL • GBI • OLB	• PC0 • MP0	• TRO	• ROA		• POLES: includes motorcycles & mopeds • POLES: potential development account separately for motorcycles & mopeds	•
Road transport - buses using oil	CO2, AV: TRA ROD BUS OIL	• oil (fossil) • synth. oil (efuel)	• conventional ICE buses • hybrid buses	• AVG • BIT • DIE • HFO • JET • LPG • LUB • MOG • NGL • OKE • OPR	• BS0	• TRO	• ROA		•	•
Road transport - buses using gas	CO2, AV: TRA ROD BUS GAS	• natural gas (fossil) • synth. gas (efuel)	• conventional ICE buses	• NGS	• BS0	• TRO	• ROA		•	•
Road transport - buses using biofuels	CO2, AV: TRA ROD BUS BIO	• biofuels	• conventional ICE buses • hybrid buses	• BDS • BGL • GBI • OLB	• BS0	• TRO	• ROA		•	•
Rail transport - coal	CO2, AV: TRA RAIL COAL	• coal	• rail freight	• ANT • BKB	• NSF	• TNR	• RAI			• EDGAR: freight & passengers differentiation?

Final Category	Species & Variables	POLES		EDGAR				Additional Variables	Comment	Issues discussed
		Fuels	Technology	Fuels	Technology	Main Sector	Sub-Sectors			
			• rail passengers	• BTC • CKC • GCK • GGS • IWS • LGN • OCK • PAT • PEA • PEP • SBC						• POLES does not take into account solid biomass (SBI).
Rail transport - oil	CO2, AV: TRA RAIL OIL	• oil	• rail freight • rail passengers	• BDS • DIE • HFO • LPG • LUB • MOG • OKE • OPR • WSP	• NSF	• TNR	• RAI		• POLES does not take into account bio fuels.	• EDGAR: freight & passengers differentiation?
Navigation - domestic - using oil	CO2, AV: TRA NAV OIL	oil	• dom. navigation	• DIE • HFO • LPG • LUB • MOG • OKE • OPR • WSP	• NSF	• TNR	• ILW			• POLES: consider renaming OTT in code.
Navigation - domestic - using gas	CO2, AV: TRA NAV GAS	natural gas	• dom. navigation	• NGS	• NSF	• TNR	• ILW			• POLES: consider renaming OTT in code.
Navigation - domestic - using coal	CO2, AV: TRA NAV COAL	coal	• dom. navigation	• BTC • CKC • LGN • OCK	• NSF	• TNR	• ILW			• POLES: consider renaming OTT in code.

Final Category	Species & Variables	POLES		EDGAR				Additional Variables	Comment	Issues discussed
		Fuels	Technology	Fuels	Technology	Main Sector	Sub-Sectors			
				• SBC						
Navigation - domestic - using biofuels	CO2BIO, AV: TRA NAV BIO	biomass	• dom. navigation	• BDS • BGL	• NSF	• TNR	• ILW			• No match for solid biomass (SBI) as not existing in POLES • POLES: consider renaming OTT in code.
Other transport - all fuels	• not existing	• not existing	• not existing	• many	• NSF	• TNR	• PIP, OTH		• EDGAR Includes oil & gas pipeline transport.	• POLES: other transport does not exist • POLES Developmen: Check energy consumption pipelines in POLES
AP transport total	AP_group_tot: TRA TOT AP	• all	• all	• all	• all	• TRO, TNR	• all		•	• Check if POLES inlcudes tyre, surf & brake APs? Adapt mapping accordingly.
AP transport-road transport - heavy oil	AP_group_fuel, AV: TRA ROADOILH AP	• heavy oil (i.e. diesel) • origin: fossil, synthesized or bioliquids.	• all in road transport	• many	• all in road transport	• TRO	• ROA		• Note: slightly different AP namings EDGAR vs. POLES	• Discuss
AP transport-road transport - light oil	AP_group_fuel, AV: TRA ROADOILL AP	• light oil (i.e. gasoline) • origin: fossil, synthesized	• all in road transport	• many	• all in road transport	• TRO	• ROA		• Note: slightly different AP namings EDGAR vs. POLES	• Discuss

Final Category	Species & Variables	POLES		EDGAR				Additional Variables	Comment	Issues discussed
		Fuels	Technology	Fuels	Technology	Main Sector	Sub-Sectors			
		or bioliquids.								
AP transport-road transport - gas	AP_group_fuel, AV: TRA ROADGAS AP	• natural gas • origin: fossil, synthesized • no biogas	• all in road transport	• many	• all in road transport	• TRO	• ROA		• Note: slightly different AP namings EDGAR vs. POLES	• Discuss
AP total transport-coal	AP_group_fuel, AV: TRA COAL AP	• coal • no solid biomass	• all, but without road transport	• many	• all, but without road transport	• TNR	• all		• Note: slightly different AP namings EDGAR vs. POLES	• Discuss
AP total transport - oil - rail & domestic navigation	AP_group_fuel, AV: TRA RAILNAV AP	• oil products in rail & navigation • origin: fossil, synthesized • no bioliquids	• rail & domestic navigation	• many	•	• TNR	• RAI, ILW		• Note: slightly different AP namings EDGAR vs. POLES	• Discuss
AP total transport-oil-domestic air transport	AP_group_fuel, AV: TRA AIRDOM AP	• oil products for air transport • origin: fossil, synthesized • no bioliquids	• domestic air transport	• many	•	• TNR	• DAT		• Note: slightly different AP namings EDGAR vs. POLES • POLES: domestic air transport includes passengers & freight	• Discuss
AP total transport-natural gas	AP_group_fuel, AV: TRA GAS AP	• natural gas • no biogas	• all, but without road transport	• NGS	•	• TNR	• all		• Note: slightly different AP namings EDGAR vs. POLES	• Discuss
NMVOC of gasoline evaporation	AV: TRA ROAD OIL -> (NMVOC)	• oil (fossil) • synth. oil (efuel)	• not applicable	• BSO • HDO • LDO • PCO • MCO	• MOG	• TRO	• EVP		• Merely AV can be mapped for this subset.	• Mapping for VOC emisions not possible. • AV variable useful?

Final Category	Species & Variables	POLES		EDGAR				Additional Variables	Comment	Issues discussed
		Fuels	Technology	Fuels	Technology	Main Sector	Sub-Sectors			
										?
Tyre and brake wear - heavy duty vehicles	AV: TRA ROAD HDV TYREBREAK -> (PM, BC)	not applicable	• conventional ICE HDV • hybrid HDV • eHDV • fuel cell HDV	• AVG • BDS • BGL • DIE • GBI • HFO • JET • MOG • NAP • NGL • NGS • OKE • OLB • OPR • RGS	• HD0	• TRO	• TYR		• AV in G*tkm: Total tkm of goods transported by HDV. Capturing all POLES technologies.	• Mapping? • Why different fuel sets (tyre vs surface wear)?
Road surface wear - heavy duty vehicles	AV: TRA ROAD HDV SURF -> (PM)	not applicable	• conventional ICE HDV • hybrid HDV • eHDV fuel cell HDV	• BDS • BGL • BIT • DIE • GBI • HFO • JET • LPG • LUB • MOG • NAP • NGL • NGS • OKE • OLB • OPR • RGS • SBI • WSP	• HD0	• TRO	• RSW		• AV in G*tkm: Total tkm of goods transported by HDV. Capturing all POLES technologies.	• Mapping? • Why different fuel sets (tyre vs surface wear)?

Final Category	Species & Variables	POLES		EDGAR				Additional Variables	Comment	Issues discussed
		Fuels	Technology	Fuels	Technology	Main Sector	Sub-Sectors			
Tyre and brake wear - light duty vehicles	AV: TRA ROAD LDV TYREBREAK -> (PM, BC)	not applicable	• conventional ICE LDV • hybrid LDV • eHDV • fuel cell LDV	• AVG • BDS • BGL • DIE • GBI • HFO • JET • MOG • NAP • NGL • NGS • OKE • OLB • OPR • RGS	• LD0	• TRO	• TYR		• AV in G*tkm: Total tkm of goods transported by LDV. Capturing all POLES technologies.	• Mapping? • Why different fuel sets (tyre vs surface wear)?
Road surface wear - light duty vehicles	AV: TRA ROAD LDV SURF -> (PM)	not applicable	• conventional ICE LDV • hybrid LDV • eHDV • fuel cell LDV	• BDS • BGL • BIT • DIE • GBI • HFO • JET • LPG • LUB • MOG • NAP • NGL • NGS • OKE • OLB • OPR • RGS • WSP	• LD0	• TRO	• RSW		• AV in G*tkm: Total tkm of goods transported by LDV. Capturing all POLES technologies.	• Mapping? • Why different fuel sets (tyre vs surface wear)?
Tyre and brake wear - buses	AV: TRA ROAD BUS TYREBREAK	• not applicable	• conventional ICE buses • hybrid buses	• AVG • BDS • BGL	• BS0	• TRO	• TYR		• AV in G*Pkm in order to capture all 4 types of	• Mapping? • Why different fuel sets (tyre

Final Category	Species & Variables	POLES		EDGAR				Additional Variables	Comment	Issues discussed
		Fuels	Technology	Fuels	Technology	Main Sector	Sub-Sectors			
	-> (PM, BC)		• ebuses • fuel cell buses	• DIE • GBI • HFO • JET • MOG • NGL • NGS • OKE • OLB • OPR • RGS					buses in POLES (e.g. ebuses, fuel cell buses).	vs surface wear)?
Road surface wear - buses	AV: TRA ROAD BUS SURF -> (PM)	• not applicable	• conventional ICE buses • hybrid buses • ebuses • fuel cell buses	• BDS • BGL • BIT • DIE • GBI • HFO • JET • LPG • LUB • MOG • NGL • NGS • OKE • OLB • OPR • RGS	• BSO	• TRO	• RSW		• AV in G*Pkm in order to capture all 4 types of buses in POLES (e.g. ebuses, fuel cell buses).	• Mapping? • Why different fuel sets (tyre vs surface wear)?
Tyre and brake wear - cars	AV: TRA ROAD CARS TYREBREAK -> (PM, BC)	not applicable	• conventional ICE cars • hybrid cars • eV (cars) • fuel cell cars	• AVG • BDS • BGL • DIE • GBI • HFO • JET • MOG • NAP	• PCO	• TRO	• TYR		• AV in G*veh*km: Total vehicle kilometers for cars. Capturing all POLES technologies.	• Mapping? • Why different fuel sets (tyre vs surface wear)?

Final Category	Species & Variables	POLES		EDGAR				Additional Variables	Comment	Issues discussed
		Fuels	Technology	Fuels	Technology	Main Sector	Sub-Sectors			
				• NGL • NGS • OKE • OLB • OPR • RGS						
Road surface wear - cars	AV: TRA ROAD CARS SURF -> (PM)	not applicable	• conventional ICE cars • hybrid cars • eV (cars) • fuel cell cars	• BDS • BGL • BIT • DIE • GBI • HFO • JET • LPG • LUB • MOG • NAP • NGL • NGS • OKE • OLB • OPR • RGS • WSP	• PC0	• TRO	• RSW		• AV in G*veh*km: Total vehicle kilometers for cars. Capturing all POLES technologies.	• Mapping? • Why different fuel sets (tyre vs surface wear)?
Tyre and brake wear - motorcycles	AV: TRA ROAD MCYCLES TYREBREAK -> (PM, BC)	not applicable	• conventional ICE motorcycles • hybrid motorcycles • electirc motorcycles • fuel cell motorcycles	• AVG • BGL • GBI • MOG • NAP • NGL • NGS	• MC0	• TRO	• TYR		• AV in G*veh*km: vehicle km for motorcycles. Capturing all POLES technologies. • EDGAR: includes motorcycles & mopeds. POLES no differentiation made: only motorcycles.	• Mapping? • Why different fuel sets (tyre vs surface wear)?

Final Category	Species & Variables	POLES		EDGAR				Additional Variables	Comment	Issues discussed
		Fuels	Technology	Fuels	Technology	Main Sector	Sub-Sectors			
Road surface wear - motorcycles	AV: TRA ROAD MCYCLES SURF -> (PM)	not applicable	• conventional ICE motorcycles • hybrid motorcycles • electirc motorcycles • fuel cell motorcycles	• BGL • GBI • LPG • MOG • NAP • NGL • NGS • WSP	• MCO	• TRO	• RSW		• AV in G*veh*km: vehicle km for motorcycles. Capturing all POLES technologies. • EDGAR: includes motorcycles & mopeds. POLES no differentiation made: only motorcycles.	• Mapping? • Why different fuel sets (tyre vs surface wear)?

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