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Table S 1 SNAP activities for which a 4th level sectorial disaggregation is performed and associated categories

SNAP activity	Description	4th level categories
SNAP010203	District heating - Combustion plants < 50 MW (boilers)	- Fuel category: Natural gas, biomass
SNAP020103 / SNAP020202	Commercial and institutional - Combustion plants < 50 MW (boilers) / Residential - Combustion plants < 50 MW (boilers)	- Fuel category: Natural gas, coal, liquified petroleum gas, solid biomass and others*
SNAP020104	Commercial and institutional - Combustion plants (turbines)	- Fuel category: Natural gas and others*
SNAP020105	Commercial and institutional - Combustion plants (stationary engines)	- Fuel category: Natural gas and others*
SNAP020302	Agri./forest/aqua. - Combustion plants >= 20 and < 50 MW (boilers)	- Facility category: animal farms, aquiculture facilities
SNAP020304	Agri./forest/aqua. - Stationary engines	- Facility category: animal farms, irrigation systems
SNAP070700	Automobile tyre and brake wear	- Vehicle category: light duty vehicles, high duty vehicles - Driving pattern: urban, rural, interurban
SNAP070800	Road abrasion	- Vehicle category: light duty vehicles, high duty vehicles - Driving pattern: urban, rural, interurban
SNAP100101 / SNAP100102 / SNAP100103 / SNAP100104 / SNAP100105 / SNAP100106	Fertilised agricultural lands, including: Permanent crops / Arable land crops / Rice field / Market gardening / Grassland / Fallows	- Crop category: Wheat, barley, rye, oats, corn, triticale, potatoes, sunflower, rapeseed (+ 100 more categories)** - Fertilizer category: Inorganic N-fertilizers, animal manure applied to soils, crop residues applied to soils, sewage sludge applied to soils, other organic fertilisers applied to soils
SNAP100904	Manure management regarding Nitrogen compounds	- Animal category: Dairy cows, other cattle, laying hens, broilers, other poultry, fattening pigs and sows, goats, ovine, horses, mules and asses
* Includes fuel oil, gasoil, kerosene and biogas ** Complete list provided in Table S3 and S4 (same tables where the map between crops and EURO CROPMAP and CLC categories is provided, respectively)		

Table S 2 Mapping between SNAP and CNAE categories proposed for the PRTR industrial facilities

SNAP code	CNAE category	
010104	35.19	Electricity production from other sources
030103	8.12	Extraction of gravel and sand; extraction of clay and kaolin
	10.11	Processing and preserving of meat
	10.12	Processing and preserving of poultry meat
	10.13	Production of meat and poultry meat products
	10.32	Manufacture of fruit and vegetable juice
	10.39	Other processing and preserving of fruit and vegetables
	10.54	Operation of dairies and cheese making
	10.91	Manufacture of prepared feeds for farm animals
	15.11	Tanning and dressing of leather; dressing and dyeing of fur
	18.12	Other printing and printing services
	20.12	Manufacture of dyes and pigments
	20.13	Manufacture of other basic inorganic chemicals
	20.14	Manufacture of other basic organic chemicals
	20.15	Manufacture of fertilisers and nitrogen compounds
	20.51	Manufacture of explosives
	20.59	Manufacture of other chemical products n.e.c.
	21.10	Manufacture of basic pharmaceutical products
	21.20	Manufacture of pharmaceutical preparations
	24.10	Manufacture of basic iron and steel and of ferro-alloys
	24.20	Manufacture of tubes, pipes, hollow profiles and related fittings, of steel
	24.32	Cold rolling of narrow strip
	24.34	Cold drawing of wire
	24.42	Aluminium production
	24.53	Casting of light metals
	24.54	Casting of other non-ferrous metals
	25.72	Manufacture of locks and hinges
	25.73	Manufacture of tools
	29.10	Manufacture of motor vehicles
	29.32	Manufacture of other parts and accessories for motor vehicles
	30.11	Building of ships and floating structures
	30.30	Manufacture of air and spacecraft and related machinery
	37.00	Collection and treatment of wastewater
	38.21	Treatment and disposal of non-hazardous waste
	38.22	Recovery of sorted materials
	38.31	Sorting and classification of materials
	63.11	Data processing, hosting and related activities
030204	23.62	Manufacture of plaster products for construction purposes
	23.52	Manufacture of lime and plaster
030303	24.51	Casting of iron

SNAP code	CNAE category	
030311	23.51	Manufacture of cement
030314	23.13	Manufacture of hollow glass
	23.11	Manufacture of flat glass
030320	22.31	Manufacture of ceramic tiles and flags
	23.32	Manufacture of bricks, tiles and construction products, in baked clay
040207	24.52	Casting of steel
040508	20.16	Manufacture of plastics in primary forms
040602	17.11	Manufacture of pulp
040625	10.81	Manufacture of sugar
040623	7.29	Extraction of other non-ferrous metal ores
060404	10.44	Manufacture of other oils and fats
091005	38.32	Recovery of sorted materials

Table S 3 Spatial proxies, relative weights and corresponding references assigned to each SNAP activity. “–” indicates that no emissions are reported by the SEI for the corresponding SNAP code.

SNAP activity	SNAP description	Spatial proxy (reference year)	Relative weight (reference year)	Sources of information
SNAP 01: Combustion in energy and transformation industries				
010101	Public power plants: boilers ≥ 300 MW _t	Emissions entirely derived from the LPS database (2023)	Not applicable	MITECO (2025)
010102	Public power plants: boilers ≥ 50 and < 300 MW _t	LPS and PRTR databases (2023) Biomass plants catalogue (2024) Industrial land use (2018)	LPS, PRTR, industrial land use: Not applicable Biomass plants: installed thermal capacity [MW _t] (2024)	LPS: MITECO (2025) PRTR: PRTR-España (2025b) Biomass plants: Proxy: PRETOR (MITECO, 2024a) Weight: integrated environmental permits for each installation (PRTR-España, 2025b) Industrial land use: CLMS (2020)
010103	Public power plants: boilers < 50 MW _t	LPS and PRTR databases (2023) Biogas and biomass plants catalogue (2024) Industrial land use (2018)	LPS, PRTR, industrial land use: Not applicable Biogas and biomass plants: installed electrical capacity [MW _e] (2024)	LPS: MITECO (2025) PRTR: PRTR-España (2025b) Biogas and biomass plants Proxy and weight: PRETOR (MITECO, 2024a) and several reports (MAPA, 2023b; MITECO, 2024b; EPSAR, 2024; Agencia Andaluza de la Energía, 2023) Industrial land use: CLMS (2020)
010104	Public power plants: gas turbines	Emissions entirely derived from the LPS database (2023)	Not applicable	MITECO (2025)
010105	Public power plants: stationary engines	LPS and PRTR databases (2023) Biogas plants (2024) Industrial land use (2018)	LPS, PRTR, industrial land use: Not applicable Biogas plants: installed electrical capacity [MW _e] (2024)	LPS: MITECO (2025) PRTR: PRTR-España (2025b) Biogas plants: Proxy and weight: PRETOR (MITECO, 2024a) and several reports (MAPA, 2023b; MITECO, 2024b; EPSAR, 2024; Agencia Andaluza de la Energía, 2023) Industrial land use: CLMS (2020)
010201	District heating plants: boilers ≥ 300 MW _t	-	-	-
010202	District heating plants: boilers ≥ 50 and < 300 MW _t	-	-	-
010203_biomass	District heating plants: biomass boilers < 50 MW _t	Biomass district heating plants catalogue (2024)	Total installed capacity [MW] (2024)	ADHAC (2024)

SNAP activity	SNAP description	Spatial proxy (reference year)	Relative weight (reference year)	Sources of information
010203_natural_gas	District heating plants: natural gas boilers < 50 MW _t	Natural gas district heating plants catalogue (2024)		
010204	District heating plants: gas turbines	-	-	-
010205	District heating plants: stationary engines	-	-	-
010301	Petroleum and/or gas refining plants: boilers ≥ 300 MW _t	Emissions entirely derived from the LPS database (2023)	Not applicable	MITECO (2025)
010302	Petroleum and/or gas refining plants: boilers ≥ 50 and < 300 MW _t			
010303	Petroleum and/or gas refining plants: boilers < 50 MW _t			
010304	Petroleum and/or gas refining plants: gas turbines	Emissions entirely derived from the LPS database (2023)	Not applicable	MITECO (2025)
010305	Petroleum and/or gas refining plants: stationary engines	-	-	-
010306	Petroleum and/or gas refining plants: process furnaces	Emissions entirely derived from the LPS database (2023)	Not applicable	MITECO (2025)
010401	Solid fuel transformation plants: boilers ≥ 300 MW _t	-	-	-
010402	Solid fuel transformation plants: boilers ≥ 50 and 300 MW _t	-	-	-
010403	Solid fuel transformation plants: boilers < 50 MW _t	Industrial land use (2018)	Not applicable	CLMS (2020)
010404	Solid fuel transformation plants: gas turbines	-	-	-
010405	Solid fuel transformation plants: stationary engines	Industrial land use (2018)	Not applicable	CLMS (2020)
010406	Solid fuel transformation plants: coke oven furnaces	LPS and PRTR databases (2023)	Not applicable	LPS: MITECO (2025) PRTR: PRTR-España (2025b)
010407	Solid fuel transformation plants: other (coal gasification, liquefaction...)	-	-	-
010501	Coal mining, oil/gas extraction, pipeline compressors: boilers ≥ 300 MW _t	-	-	-

SNAP activity	SNAP description	Spatial proxy (reference year)	Relative weight (reference year)	Sources of information
010502	Coal mining, oil/gas extraction, pipeline compressors: boilers $\geq$ 50 and $> 300 \text{ MW}_t$	-	-	-
010503	Coal mining, oil/gas extraction, pipeline compressors: boilers $<$ 50 MW_t	LPS database (2023) and industrial land use (2018)	Not applicable	LPS: MITECO (2025) Industrial land use: CLMS (2020)
010504	Coal mining, oil/gas extraction, pipeline compressors: gas turbines	LPS database (2023) and industrial land use (2018)	Not applicable	LPS: MITECO (2025) Industrial land use: CLMS (2020)
010505	Coal mining, oil/gas extraction, pipeline compressors: stationary engines			
010506	Coal mining, oil/gas extraction, pipeline compressors: pipeline compressors			
SNAP 02: Non-industrial combustion plants				
020101	Commercial and institutional plants Boilers $\geq 300 \text{ MW}_t$	-	-	-
020102	Commercial and institutional plants Boilers ≥ 50 and < 300 MW_t	-	-	-
020103_biomass	Commercial and institutional plants Boilers $< 50 \text{ MW}_t$. Fuel: biomass	Population type: rural (2020) Municipal boundaries (2018)	Regional indicators of household biomass use, according to the information available in each CCAA (Comunidad Valenciana: 2008; Cataluña: 2023; País Vasco: 2021; Rest: 2021)	Population type: Schiavina et al. (2023b) Municipal boundaries: IGN (2023a) Household biomass use indicators: Institut Valencià d'Estadística (2024); Institut Català d'Energia (2025); Instituto Vasco de Estadística (2022); Instituto para la Diversificación y Ahorro de la Energía (2025)
020103_coal	Commercial and institutional plants Boilers $< 50 \text{ MW}_t$. Fuel: coal	Population type: rural, suburban and urban (2020)	Not applicable	Schiavina et al. (2023b)
020103_lpg	Commercial and institutional plants Boilers $< 50 \text{ MW}_t$. Fuel: liquid petroleum gas	Population density (2020) Municipal boundaries (2018)	Relative energy consumption for heating by province (2017)	Population density: Schiavina et al. (2023a) Municipal boundaries: IGN (2023a) Energy consumption: Cuchi et al. (2017)

SNAP activity	SNAP description	Spatial proxy (reference year)	Relative weight (reference year)	Sources of information
020103_natural_gas	Commercial and institutional plants Boilers < 50 MW _t . Fuel: natural gas	Population density (2020) Municipal boundaries (2018)	List of municipalities with access to natural gas (2018) Relative energy consumption for heating by province (2017)	Population density: Schiavina et al. (2023a) Municipal boundaries: IGN (2023a) List of municipalities with access to natural gas: CNMC (2018) Energy consumption: Cuchi et al. (2017)
020103_others	Commercial and institutional plants Boilers < 50 MW _t . Fuel: others	Population type: rural (2020) Municipal boundaries (2018)	Relative energy consumption for heating by province (2017)	Population type: Schiavina et al. (2023b) Municipal boundaries: IGN (2023a) Energy consumption: Cuchi et al. (2017)
020104_natural_gas	Commercial and institutional plants Stationary gas turbines Fuel: natural gas	Population density (2020) Municipal boundaries (2018)	List of municipalities with access to natural gas (2018) Relative energy consumption for heating by province (2017)	Population density: Schiavina et al. (2023a) Municipal boundaries: IGN (2023a) List of municipalities with access to natural gas: CNMC (2018) Energy consumption: Cuchi et al. (2017)
020104_others	Commercial and institutional plants Stationary gas turbines Fuel: others	Population type: rural (2020) Municipal boundaries (2018)	Relative energy consumption for heating by province (2017)	Population type: Schiavina et al. (2023b) Municipal boundaries: IGN (2023a) Energy consumption: Cuchi et al. (2017)
020105_natural_gas	Commercial and institutional plants Stationary engines Fuel: natural gas	Population density (2020) Municipal boundaries (2018)	List of municipalities with access to natural gas (2018) Relative energy consumption for heating by province (2017)	Population density: Schiavina et al. (2023a) Municipal boundaries: IGN (2023a) List of municipalities with access to natural gas: CNMC (2018) Energy consumption: Cuchi et al. (2017)
020105_others	Commercial and institutional plants Stationary engines Fuel: others	Population type: rural (2020) Municipal boundaries (2018)	Relative energy consumption for heating by province (2017)	Population type: Schiavina et al. (2023b) Municipal boundaries: IGN (2023a) Energy consumption: Cuchi et al. (2017)
020106	Commercial and institutional plants Other stationary equipments	-	-	-
020201	Residential plants. Boilers $\geq$ 50 MW _t	-	-	-

SNAP activity	SNAP description	Spatial proxy (reference year)	Relative weight (reference year)	Sources of information
020202_biomass	Residential plants. Boilers < 50 MW _t . Fuel: biomass	Population type: rural (2020) Municipal boundaries (2018)	Regional indicators of household biomass use, according to the information available in each CCAA (Comunidad Valenciana: 2008; Cataluña: 2023; País Vasco: 2021; Rest: 2021)	Population type: Schiavina et al. (2023b) Municipal boundaries: IGN (2023a) Household biomass use indicators: Institut Valencià d'Estadística (2024); Institut Català d'Energia (2025); Instituto Vasco de Estadística (2022); Instituto para la Diversificación y Ahorro de la Energía (2025)
020202_lpg	Residential plants. Boilers < 50 MW _t . Fuel: liquid petroleum gas	Population density (2020) Municipal boundaries (2018)	Relative energy consumption for heating by province (2017)	Population density: Schiavina et al. (2023a) Municipal boundaries: IGN (2023a) Energy consumption: Cuchi et al. (2017)
020202_natural_gas	Residential plants. Boilers < 50 MW _t . Fuel: natural gas	Population density (2020) Municipal boundaries (2018)	List of municipalities with access to natural gas (2018) Relative energy consumption for heating by province (2017)	Population density: Schiavina et al. (2023a) Municipal boundaries: IGN (2023a) List of municipalities with access to natural gas: CNMC (2018) Energy consumption: Cuchi et al. (2017)
020202_others	Residential plants. Boilers < 50 MW _t . Fuel: others	Population type: rural (2020) Municipal boundaries (2018)	Relative energy consumption for heating by province (2017)	Population type: Schiavina et al. (2023b) Municipal boundaries: IGN (2023a) Energy consumption: Cuchi et al. (2017)
020203	Residential plants. Stationary gas turbines	-	-	-
020204	Residential plants. Stationary engines	-	-	-
020205_biomass	Residential plants. Other equipments Fuel: biomass	Population type: rural (2020) Municipal boundaries (2018)	Regional indicators of household biomass use, according to the information available in each CCAA (Comunidad Valenciana: 2008; Cataluña: 2023; País Vasco: 2021; Rest: 2021)	Population type: Schiavina et al. (2023b) Municipal boundaries: IGN (2023a) Household biomass use indicators: Institut Valencià d'Estadística (2024); Institut Català d'Energia (2025); Instituto Vasco de Estadística (2022); Instituto para la Diversificación y Ahorro de la Energía (2025)
020301	Plants in agriculture, forestry and aquaculture. Boilers ≥ 50 MW _t	-	-	-

SNAP activity	SNAP description	Spatial proxy (reference year)	Relative weight (reference year)	Sources of information
020302_aquaculture	Plants in agriculture, forestry and aquaculture. Boilers < 50 MW _t . Installation type: aquaculture	Inland aquaculture facilities (2024) Industrial land use (2018)	Not applicable*	Inland aquaculture facilities: MAPA (2024) Land use: CLMS (2020)
020302_farms	Plants in agriculture, forestry and aquaculture. Boilers < 50 MW _t . Installation type: farms	Livestock farms (2018) Land use: grasslands (2018)	Not applicable*	Farms: MAPA (2023a) Land use: CLMS (2020)
020303	Plants in agriculture, forestry and aquaculture. Stationary gas turbines	-	-	-
020304_farms	Plants in agriculture, forestry and aquaculture. Stationary engines Installation type: farms	Livestock farms (2018) Land use: grasslands (2018)	Not applicable*	Farms: MAPA (2023a) Land use: CLMS (2020)
020304_irrigation_system	Plants in agriculture, forestry and aquaculture. Stationary engines Installation type: irrigation systems	Land use: permanent crops and fruit plantations (2018)	Not applicable	CLMS (2020)
020305	Plants in agriculture, forestry and aquaculture. Other stationary equipments	-	-	-
SNAP 03: Industrial combustion plants				
030101	Boilers ≥ 300 MW _t	-	-	-
030102	Boilers < 300 and ≥ 50 MW _t	Emissions entirely derived from the LPS and PRTR databases (2023)	Not applicable	LPS: MITECO (2025) PRTR: PRTR-España (2025b)
030103	Boilers < 50 MW _t	LPS and PRTR databases (2023) Industrial land use (2018)	Not applicable	LPS: MITECO (2025) PRTR: PRTR-España (2025b) Industrial land use: CLMS (2020)
030104	Gas turbines	LPS and PRTR databases (2023) Industrial land use (2018)	Not applicable	LPS: MITECO (2025) PRTR: PRTR-España (2025b) Industrial land use: CLMS (2020)
030105	Stationary engines	LPS and PRTR databases (2023) Industrial land use (2018)	Not applicable	LPS: MITECO (2025) PRTR: PRTR-España (2025b) Industrial land use: CLMS (2020)
030106	Other stationary equipments	-	-	-

SNAP activity	SNAP description	Spatial proxy (reference year)	Relative weight (reference year)	Sources of information
030203	Blast furnaces cowpers	LPS database (2023) Industrial land use (2018)	Not applicable	LPS: MITECO (2025) Industrial land use: CLMS (2020)
030204	Plaster furnaces	PRTR database (2023) Industrial land use (2018) Plaster furnaces (2022)	Not applicable*	LPS: MITECO (2025) PRTR: PRTR-España (2025b) Industrial land use: CLMS (2020) Plaster furnaces: HERMESv3 bottom-up (Guevara et al., 2020)
030205	Other furnaces	LPS database (2023) Industrial land use (2018)	Not applicable	LPS: MITECO (2025) Industrial land use: CLMS (2020)
030301	Sinter and pelletizing plants	Emissions entirely derived from the LPS database (2023)	Not applicable	LPS: MITECO (2025)
030302	Reheating furnaces steel and iron	Emissions entirely derived from the LPS and PRTR databases (2023)	Not applicable	LPS: MITECO (2025) PRTR: PRTR-España (2025b)
030303	Grey iron foundries	PRTR database (2023) Industrial land use (2018) Grey iron foundries CNAE 24.51 (2021)	Not applicable*	PRTR: PRTR-España (2025b) Industrial land use: CLMS (2020) Grey iron foundries: ARDÁN (2023)
030304	Primary lead production	-	-	-
030305	Primary zinc production	Emissions entirely derived from the LPS database (2023)	Not applicable	LPS: MITECO (2025)
030306	Primary copper production	Emissions entirely derived from the LPS database (2023)	Not applicable	LPS: MITECO (2025)
030307	Secondary lead production	Emissions entirely derived from the LPS database (2023)	Not applicable	LPS: MITECO (2025)
030308	Secondary zinc production	LPS database (2023) Industrial land use (2018)	Not applicable	LPS: MITECO (2025) Industrial land use: CLMS (2020)
030309	Secondary copper production	Industrial land use (2018)	Not applicable	Industrial land use: CLMS (2020)
030310	Secondary aluminium production	Emissions entirely derived from the PRTR database (2023)	Not applicable	PRTR: PRTR-España (2025b)
030311	Cement	Emissions entirely derived from the LPS and PRTR databases (2023)	Not applicable	LPS: MITECO (2025) PRTR: PRTR-España (2025b)
030312	Lime	LPS and PRTR databases (2023) Industrial land use (2018)	Not applicable	LPS: MITECO (2025) PRTR: PRTR-España (2025b) Industrial land use: CLMS (2020)
030313	Asphalt concrete plants	Asphalt concrete plants (2022) Industrial land use (2018)	Not applicable*	Asphalt concrete plants: HERMESv3 bottom-up (Guevara et al., 2020) Industrial land use: CLMS (2020)
030314	Flat glass	Emissions entirely derived from the LPS database (2023)	Not applicable	LPS: MITECO (2025)

SNAP activity	SNAP description	Spatial proxy (reference year)	Relative weight (reference year)	Sources of information
030315	Container glass	Emissions entirely derived from the LPS database (2023)	Not applicable	LPS: MITECO (2025)
030316	Glass wool (except binding)	LPS database (2023) Industrial land use (2018)	Not applicable	LPS: MITECO (2025) Industrial land use: CLMS (2020)
030317	Other glass (including special glass)	LPS and PRTR databases (2023) Industrial land use (2018)	Not applicable	LPS: MITECO (2025) PRTR: PRTR-España (2025b) Industrial land use: CLMS (2020)
030318	Mineral wool	Emissions entirely derived from the LPS database (2023)	Not applicable	LPS: MITECO (2025)
030319	Bricks and tiles	Emissions entirely derived from the PRTR database (2023)	Not applicable	PRTR: PRTR-España (2025b)
030320	Fine ceramics material	Emissions entirely derived from the PRTR database (2023)	Not applicable	PRTR: PRTR-España (2025b)
030321	Paper-mill industry (drying processes)	LPS database (2023) Paper-mill industries CNAE 17.11 y 17.12 (2022) Industrial land use (2018)	Not applicable*	LPS: MITECO (2025) Industrial land use: CLMS (2020) Paper-mill industries: ARDÁN (2023)
030322	Alumina production	Emissions entirely derived from the LPS database (2023)	Not applicable	LPS: MITECO (2025)
030323	Magnesium production (dolomite treatment)	-	-	-
030324	Nickel production (thermal process)	-	-	-
030325	Enamel production	-	-	-
030326	Other processes with contact	Emissions entirely derived from the LPS database (2023)	Not applicable	LPS: MITECO (2025)
SNAP 04: Industrial processes without combustion				
040101	Petroleum products processing	Emissions entirely derived from the LPS database (2023)	Not applicable	LPS: MITECO (2025)
040102	Fluid catalytic cracking CO boilers	Emissions entirely derived from the LPS database (2023)	Not applicable	LPS: MITECO (2025)
040103	Sulphur recovery plants	Emissions entirely derived from the LPS database (2023)	Not applicable	LPS: MITECO (2025)
040104	Storage & handling of products in refinery	Emissions entirely derived from the LPS database (2023)	Not applicable	LPS: MITECO (2025)
040201	Coke oven (door leakage and extinction)	LPS database (2023) Industrial land use (2018)	Not applicable	LPS: MITECO (2025) Industrial land use: CLMS (2020)

SNAP activity	SNAP description	Spatial proxy (reference year)	Relative weight (reference year)	Sources of information
040202	Blast furnace charging	Emissions entirely derived from the LPS database (2023)	Not applicable	LPS: MITECO (2025)
040203	Pig iron tapping	Emissions entirely derived from the LPS database (2023)	Not applicable	LPS: MITECO (2025)
040204	Solid smokeless fuel	-	-	-
040205	Open hearth furnace steel plant	-	-	-
040206	Basic oxygen furnace steel plant	Emissions entirely derived from the LPS database (2023)	Not applicable	LPS: MITECO (2025)
040207	Electric furnace steel plant	Emissions entirely derived from the LPS and PRTR databases (2023)	Not applicable	LPS: MITECO (2025) PRTR: PRTR-España (2025b)
040208	Rolling mills	Emissions entirely derived from the LPS and PRTR databases (2023)	Not applicable	LPS: MITECO (2025) PRTR: PRTR-España (2025b)
040209	Sinter and pelletizing plants (except combustion 030301)	Emissions entirely derived from the LPS database (2023)	Not applicable	LPS: MITECO (2025)
040301	Aluminium production (electrolysis)	Emissions entirely derived from the LPS database (2023)	Not applicable	LPS: MITECO (2025)
040302	Ferro alloys	LPS database (2023) Industrial land use (2018)	Not applicable	LPS: MITECO (2025) Industrial land use: CLMS (2020)
040303	Silicium production	Emissions entirely derived from the LPS database (2023)	Not applicable	LPS: MITECO (2025)
040304	Magnesium production (except 030323)	-	-	-
040305	Nickel production (except 030324)	-	-	-
040306	Allied metal manufacturing	-	-	-
040307	Galvanizing	-	-	-
040308	Electroplating	-	-	-
040309	Other processes in non-ferrous metal industries	LPS and PRTR databases (2023) Industrial land use (2018)	Not applicable	LPS: MITECO (2025) PRTR: PRTR-España (2025b) Industrial land use: CLMS (2020)
040401	Sulphuric acid	Emissions entirely derived from the LPS and PRTR databases (2023)	Not applicable	LPS: MITECO (2025) PRTR: PRTR-España (2025b)
040402	Nitric acid	Emissions entirely derived from the LPS database (2023)	Not applicable	LPS: MITECO (2025)

SNAP activity	SNAP description	Spatial proxy (reference year)	Relative weight (reference year)	Sources of information
040403	Ammonia	LPS database (2023) Industrial land use (2018)	Not applicable	LPS: MITECO (2025) Industrial land use: CLMS (2020)
040404	Ammonium sulphate	Industrial land use (2018)	Not applicable	Industrial land use: CLMS (2020)
040405	Ammonium nitrate	LPS database (2023) Industrial land use (2018)	Not applicable	LPS: MITECO (2025) Industrial land use: CLMS (2020)
040406	Ammonium phosphate	-	-	-
040407	NPK fertilisers	LPS and PRTR databases (2023) Industrial land use (2018)	Not applicable	LPS: MITECO (2025) PRTR: PRTR-España (2025b) Industrial land use: CLMS (2020)
040408	Urea	Emissions entirely derived from the LPS database (2023)	Not applicable	LPS: MITECO (2025)
040409	Carbon black	Emissions entirely derived from the LPS database (2023)	Not applicable	LPS: MITECO (2025)
040410	Titanium dioxide	Titanium dioxide pigment manufacturing plants (2023)	Annual revenue per facility (2021)	ARDÁN (2023)
040411	Graphite	-	-	-
040412	Calcium carbide production	Calcium carbide manufacturing plants CNAE 20.13 (2021)	Annual revenue per facility (2021)	ARDÁN (2023)
040413	Chlorine production	-	-	-
040414	Phosphate fertilizers	-	-	-
040415	Storage and handling of inorganic chemical products	-	-	-
040416	Other processes in inorganic chemical industries	PRTR database (2023) Industrial land use (2018)	Not applicable	PRTR: PRTR-España (2025b) Industrial land use: CLMS (2020)
040501	Ethylene	Emissions entirely derived from the LPS database (2023)	Not applicable	LPS: MITECO (2025)
040502	Propylene	PRTR database (2023) Manufacture of organic chemical products CNAE 20.14 (2021) Industrial land use (2018)	Annual revenue per facility (2021)	PRTR: PRTR-España (2025b) Manufacture of organic chemical products: ARDÁN (2023) Industrial land use: CLMS (2020)
040503	1,2 dichloroethane (except 040505)	-	-	-

SNAP activity	SNAP description	Spatial proxy (reference year)	Relative weight (reference year)	Sources of information
040504	Vinylchloride (except 040505)	Industrial land use (2018)	Not applicable	Industrial land use: CLMS (2020)
040505	1,2 dichloroethane + vinylchloride (balanced process)	-	-	-
040506	Polyethylene low density	PRTR database (2023) Industrial land use (2018)	Not applicable	PRTR: PRTR-España (2025b) Industrial land use: CLMS (2020)
040507	Polyethelene high density	Plastics manufacturing plants in primary forms CNAE 20.16 (2021)	Annual revenue per facility (2021)	ARDÁN (2023)
040508	Polyvinylchloride	PRTR database (2023) Manufacturing plants of other chemical products n.e.c. CNAE 20.59 (2021)	Annual revenue per facility (2021)	PRTR: PRTR-España (2025b) ARDÁN (2023)
040509	Polypropylene	Plastics manufacturing plants in primary forms CNAE 20.16 (2021) Industrial land use (2018)	Annual revenue per facility (2021)	ARDÁN (2023) Industrial land use: CLMS (2020)
040510	Styrene	Plastics manufacturing plants in primary forms CNAE 20.16 (2021)	Annual revenue per facility (2021)	ARDÁN (2023)
040511	Polystyrene	-	-	-
040512	Styrene butadiene	Manufacturing plants of other chemical products n.e.c. CNAE 20.59 (2021) Industrial land use (2018)	Annual revenue per facility (2021)	ARDÁN (2023) Industrial land use: CLMS (2020)
040513	Styrene-butadiene latex	Synthetic rubber manufacturing plants in primary forms CNAE 20.17 (2021)	Annual revenue per facility (2021)	ARDÁN (2023)
040514	Styrene-butadiene rubber (SBR)	Industrial land use (2018)	Not applicable	Industrial land use: CLMS (2020)
040515	Acrylonitrile butadiene styrene (ABS) resins	PRTR database (2023) Plastics manufacturing plants in primary forms CNAE 20.16 (2021)	Annual revenue per facility (2021)	PRTR: PRTR-España (2025b) ARDÁN (2023)
040516	Ethylene oxyde	Manufacturing plants of other basic organic chemical products CNAE 20.14 (2021)	Annual revenue per facility (2021)	ARDÁN (2023)
040517	Formaldehyde	Manufacturing plants of other chemical products n.e.c. CNAE 20.59 (2021)	Annual revenue per facility (2021)	ARDÁN (2023)
040518	Ethylbenzene	Organic chemical manufacturing plants CNAE 20.14 (2021)	Annual revenue per facility (2021)	ARDÁN (2023)

SNAP activity	SNAP description	Spatial proxy (reference year)	Relative weight (reference year)	Sources of information
040519	Phthalic anhydride	Organic chemical manufacturing plants CNAE 20.14 (2021)	Annual revenue per facility (2021)	ARDÁN (2023)
040520	Acrylonitrile	-	-	-
040521	Adipic acid	-	-	-
040522	Storage & handling of organic chemical products	-	-	-
040523	Glyoxylic acid	-	-	-
040525	Pesticide production	-	-	-
040526	Production of persistent organic compounds	-	-	-
040527	Other processes in organic chemical industries (phytosanitary...)	Industrial land use (2018)	Not applicable	Industrial land use: CLMS (2020)
040601	Chipboard	Corrugated paper and cardboard manufacturing plants, paper and cardboard packaging and container manufacturing plants CNAE 17.21 (2021)	Annual revenue per facility (2021)	ARDÁN (2023)
040602	Paper pulp (kraft process)	Emissions entirely derived from the LPS database (2023)	Not applicable	LPS: MITECO (2025)
040603	Paper pulp (acid sulphite process)	-	-	-
040604	Paper pulp (neutral sulphite semi-chemical process.)	-	-	-
040605	Bread	PRTR database (2023) Bread and fresh pastry manufacturing plants CNAE 10.71 (2021) Industrial land use (2018)	Annual revenue per facility (2021)	PRTR: PRTR-España (2025b) ARDÁN (2023) Industrial land use: CLMS (2020)
040606	Wine	Wine production plants CNAE 11.02 (2021) Industrial land use and vineyards (2018)	Annual revenue per facility (2021)	ARDÁN (2023) Industrial land use and vineyards: CLMS (2020)
040607	Beer	PRTR database (2023) Beer manufacturing plants CNAE 11.05 (2021) Industrial land use (2018)	Annual revenue per facility (2021)	PRTR: PRTR-España (2025b) ARDÁN (2023) Industrial land use: CLMS (2020)

SNAP activity	SNAP description	Spatial proxy (reference year)	Relative weight (reference year)	Sources of information
040608	Spirits	Plants for distillation, rectification and blending of alcoholic beverages CNAE 11.01 (2021) Industrial land use (2018)	Annual revenue per facility (2021)	ARDÁN (2023) Industrial land use: CLMS (2020)
040610	Asphalt roofing materials	Industrial land use (2018)	Not applicable	Industrial land use: CLMS (2020)
040611	Road paving with asphalt	Land use of continuous and discontinuous urban fabric, and road and railway networks and associated land (2018)	Not applicable	Land uses: CLMS (2020)
040612	Cement (decarbonizing)	Emissions entirely derived from the LPS database (2023)	Not applicable	LPS: MITECO (2025)
040613	Glass (decarbonizing)	LPS database (2023) Industrial land use (2018)	Not applicable	LPS: MITECO (2025) Industrial land use: CLMS (2020)
040614	Lime (decarbonizing)	LPS database (2023) Industrial land use (2018)	Not applicable	LPS: MITECO (2025) Industrial land use: CLMS (2020)
040615	Batteries manufacturing	-	-	-
040616	Extraction of mineral ores	-	-	-
040617	Other (including asbestos products manufacturing)	LPS database (2023) Plants of other extractive industries n.e.c. CNAE 08.99 (2021) Industrial land use (2018)	Annual revenue per facility (2021)	LPS: MITECO (2025) Plants of other extractive industries: ARDÁN (2023) Industrial land use: CLMS (2020)
040618	Limestone and dolomite use	LPS database (2023) Manufacturing and processing plants for other glass, including technical glass CNAE 23.19 (2021) Industrial land use (2018)	Annual revenue per facility (2021)	LPS: MITECO (2025) Manufacturing and processing plants for other glass: ARDÁN (2023) Industrial land use: CLMS (2020)
040619	Soda ash production and use	Emissions entirely derived from the LPS database (2023)	Not applicable	LPS: MITECO (2025)
040620	Woodworking	-	-	-
040623	Quarrying	PRTR database (2023) Extraction of gravel and sand, extraction of clay and kaolin CNAE 08.12 Mineral extraction sites land use (2018)	Annual revenue per facility (2021)	PRTR: PRTR-España (2025b) ARDÁN (2023) Mineral extraction sites land use: CLMS (2020)

SNAP activity	SNAP description	Spatial proxy (reference year)	Relative weight (reference year)	Sources of information
040624	Construction and demolition	Population density (2020)	Not applicable	Schiavina et al., 2023a
040625	Sugar production	Emissions entirely derived from the LPS database (2023)	Not applicable	LPS: MITECO (2025)
040801	Production of halocarbons - subproducts	-	-	-
040802	Production of halocarbons - fugitive emissions	-	-	-
040803	Production of halocarbons - others	-	-	-
040804	Production of sulphur hexafluoride - subproducts	-	-	-
040805	Production of sulphur hexafluoride - fugitive emissions	-	-	-
040806	Production of sulphur hexafluoride - others	-	-	-
040900	Storage, handling and transport of mineral products	Mineral extraction sites land use (2018)	Not applicable	CLMS (2020)
SNAP 05: Extraction and distribution of fossil fuels and geothermal energy				
050101	Open cast mining	-	-	-
050102	Underground mining	Underground mining (2020)	Not applicable*	Lagos (2020)
050103	Storage of solid fuel	-	-	-
050201	Land-based activities	Emissions entirely derived from the LPS database (2023)	Not applicable	LPS: MITECO (2025)
050202	Off-shore activities	-	-	-
050301	Land-based desulfuration	-	-	-
050302	Land-based activities (other than desulfuration)	LPS database (2023) Exploitation concessions and underground storage (2020)	Not applicable*	LPS: MITECO (2025) Exploitation concessions and underground storage: CNMC (2024a)
050303	Off-shore activities	-	-	-
050401_mar	Liquid fuel distribution (except gasoline distribution): maritime terminals	Maritime terminals (2024)	Total crude oil throughput [tonnes] (2009)	HERMESv3 bottom-up (Guevara et al., 2020) y Google Maps (2024)

SNAP activity	SNAP description	Spatial proxy (reference year)	Relative weight (reference year)	Sources of information
050401_ref	Liquid fuel distribution (except gasoline distribution): refineries	Refineries (2024)	Refinery capacity [ktonnes] (2024)	Spatial proxy: HERMESv3 bottom-up (Guevara et al., 2020) Weight: (CORES, 2024a)
050402	Other handling and storage (including pipeline)	Industrial land use (2018)	Not applicable	CLMS (2020)
050501	Refinery dispatch station	Emissions entirely derived from the LPS database (2023)	Not applicable	LPS: MITECO (2025)
050502	Transport and depots (except 050503)	Emissions entirely derived from the LPS database (2023)	Not applicable	LPS: MITECO (2025)
050503	Service stations (including refuelling of cars)	Service stations (2024)	Not applicable*	MINETAD (2024)
050601	Gas distribution networks: pipelines	LPS database (2023) Pipelines (2020)	Not applicable*	LPS: MITECO (2025) Pipelines: HERMESv3 bottom-up (Guevara et al., 2020) y IDEIB (2020)
050603	Gas distribution networks: distribution networks	Population density (2020)	Not applicable	Schiavina et al. (2023a)
SNAP 06: Use of solvents and other products				
060101	Manufacture of automobiles	Emissions entirely derived from the LPS database (2023)	Not applicable	LPS: MITECO (2025)
060102	Car repairing	Vehicle repair shops (2023)	Not applicable*	HERMESv3 bottom-up (Guevara et al., 2020) y ARDÁN (2023)
060103	Construction and buildings (except 060107)	Land use: continuous urban fabric, discontinuous urban fabric and construction sites (2018)	Not applicable	CLMS (2020)
060104	Domestic use (except 060107)	Population density (2020)	Not applicable	Schiavina et al. (2023a)
060105	Coil coating	Industrial land use (2018)	Not applicable	CLMS (2020)
060106	Boat building	Boat building facilities (2023)	Annual revenue per facility (2023)	HERMESv3 bottom-up (Guevara et al., 2020) y ARDÁN (2023)
060107	Wood	Industrial land use (2018)	Not applicable	CLMS (2020)
060108	Other industrial paint application	PRTR database (2023) Industrial land use (2018)	Not applicable	PRTR: PRTR-España (2025b) Land use: CLMS (2020)
060109	Other nonindustrial paint application	Land use: continuous urban fabric, discontinuous urban fabric and construction sites (2018)	Not applicable	CLMS (2020)
060201	Metal degreasing	LPS and PRTR databases (2023) Industrial land use (2018)	Not applicable	LPS: MITECO (2025) PRTR: PRTR-España (2025b) Land use: CLMS (2020)

SNAP activity	SNAP description	Spatial proxy (reference year)	Relative weight (reference year)	Sources of information
060202	Dry cleaning	Washing and cleaning of textiles and leather garments CNAE 96.01 (2023)	Annual revenue per facility (2023)	ARDÁN (2023)
060203	Electronic components manufacturing	-	-	-
060204	Other industrial cleaning	Emissions entirely derived from the LPS database (2023)	Not applicable	LPS: MITECO (2025)
060301	Polyester processing	Industrial land use (2018)	Not applicable	CLMS (2020)
060302	Polyvinylchloride processing	PRTR database (2023) Industrial land use (2018)	Not applicable	PRTR: PRTR-España (2025b) CLMS (2020)
060303	Polyurethane foam processing	PRTR database (2023) Industrial land use (2018)	Not applicable	PRTR: PRTR-España (2025b) CLMS (2020)
060304	Polystyrene foam processing	Industrial land use (2018)	Not applicable	CLMS (2020)
060305	Rubber processing	PRTR database (2023) Facilities under CNAE codes 20.17 – Manufacture of synthetic rubber in primary forms, 22.19 – Manufacture of other rubber products, 22.11 – Manufacture of tyres and tubes, rubber, retreading and rebuilding (2023) Land use: continuous urban fabric, discontinuous urban fabric and industrial (2018)	Rubber processing facilities: Annual revenue per facility (2023)	PRTR: PRTR-España (2025b) Rubber processing facilities: ARDÁN (2023) Land use: CLMS (2020)
060306	Pharmaceutical products manufacturing	PRTR database (2023) Facilities under CNAE codes 21.10 – Manufacture of basic pharmaceutical products, 21.20 – Manufacture of pharmaceutical preparations (2023) Land use: continuous urban fabric, discontinuous urban fabric and industrial (2018)	Pharmaceutical products manufacturing: Annual revenue per facility (2023)	PRTR: PRTR-España (2025b) Pharmaceutical products manufacturing: ARDÁN (2023) Land use: CLMS (2020)

SNAP activity	SNAP description	Spatial proxy (reference year)	Relative weight (reference year)	Sources of information
060307	Paints manufacturing	PRTR database (2023) Facilities under CNAE code 20.30 – Manufacture of paints, varnishes and similar coatings, inks and mastics (2023)	Paint manufacturing facilities: Annual revenue per facility (2023)	PRTR: PRTR-España (2025b) Paints manufacturing facilities: ARDÁN (2023)
060308	Inks manufacturing	Facilities under CNAE code 20.30 – Manufacture of paints, varnishes and similar coatings, inks and mastics (2023)	Inks manufacturing facilities: Annual revenue per facility (2023)	PRTR: PRTR-España (2025b) Inks manufacturing facilities: ARDÁN (2023)
060309	Glues manufacturing	Facilities under CNAE code 20.52 – Manufacture of glues, 20.59 – Manufacture of other chemical products n.e.c. (2023) Land use: continuous urban fabric, discontinuous urban fabric and industrial (2018)	Annual revenue per facility (2023)	Glues manufacturing facilities: ARDÁN (2023) Land use: CLMS (2020)
060310	Asphalt blowing	-	-	-
060311	Adhesive, magnetic tapes, films & photographs manufacturing	-	-	-
060312	Textile finishing	-	-	-
060313	Leather tanning	Facilities under CNAE code 15.11 – Preparation, tanning and dressing of leather; dressing and dyeing of fur (2023)	Annual revenue per facility (2023)	ARDÁN (2023)
060314	Other chemicals products manufacturing or processing	-	-	-
060401	Glass wool enduction	Facilities for the manufacture of glass wool insulation (2019)	Not applicable*	HERMESv3 bottom-up (Guevara et al., 2020)
060402	Mineral wool enduction	Facilities for the manufacture of rock wool insulation (2019)	Not applicable*	HERMESv3 bottom-up (Guevara et al., 2020)
060403	Printing industry	PRTR database (2023) Facilities under CNAE codes 18.11 – Printing of newspapers; 18.12 – Other printing and related service activities (2023)	Printing facilities: Annual revenue per facility (2023)	PRTR: PRTR-España (2025b) Printing facilities: ARDÁN (2023)

SNAP activity	SNAP description	Spatial proxy (reference year)	Relative weight (reference year)	Sources of information
060404	Fat, edible and not edible oil extraction	PRTR database (2023) Facilities under CNAE codes 10.43 – Manufacture of olive oil; 10.44 – Manufacture of oils and fats (2023) Land use: discontinuous urban fabric and industrial (2018)	Facilities for the extraction of fats and oils: Annual revenue per facility (2023)	PRTR: PRTR-España (2025b) Facilities for the extraction of fats and oils: ARDÁN (2023) Land use: CLMS (2020)
060405	Application of glues and adhesives	Population density (2020)	Not applicable	Schiavina et al. (2023a)
060406	Preservation of wood	Industrial land use (2018)	Not applicable	CLMS (2020)
060407	Underseal treatment and conservation of vehicles	Emissions entirely derived from the LPS database (2023)	Not applicable	LPS: MITECO (2025)
060408	Domestic solvent use (other than paint application)	Population density (2020)	Not applicable	Schiavina et al. (2023a)
060409	Vehicles dewaxing	-	-	-
060411	Domestic use of pharmaceutical products	-	-	-
060412	Other (preservation of seeds...)	-	-	-
060501	Anaesthesia	Population density (2020)	Not applicable	Schiavina et al. (2023a)
060502	Refrigeration and air condition equipment using halocarbons	-	-	-
060503	Refrigeration and air condition equipment using other products than halocarbons	Population density (2020)	Not applicable	Schiavina et al. (2023a)
060504	Foam blowing (except 060304)	-	-	-
060505	Fire extinguishers	-	-	-
060506	Aerosol cans	-	-	-
060507	Electrical equipment (except 060203)	-	-	-
060508	Other use of HFC, N ₂₀ , NH ₃ , PFC and SF ₆	Land use: continuous urban fabric, discontinuous urban fabric and industrial (2018)	Not applicable	CLMS (2020)
060601	Fireworks	Population density (2020)	Not applicable	Schiavina et al. (2023a)

SNAP activity	SNAP description	Spatial proxy (reference year)	Relative weight (reference year)	Sources of information
060602	Tobacco consumption	Population density (2020)	Not applicable	Schiavina et al. (2023a)
060603	Footwear wear	-	-	-
SNAP 07: Road transport				
070101	Combustion emissions: Passenger cars: highway driving	Interurban and rural roads (see Table S 4 for details)	Light-duty vehicles AADT [vehicles/day] (see Table S 4 for details)	See Table S 4 for details
070102	Combustion emissions: passenger cars, rural driving			
070201	Combustion emissions: light-duty vehicles < 3,5 t, highway driving			
070202	Combustion emissions: light-duty vehicles < 3,5 t, rural driving			
070301	Combustion emissions: heavy-duty vehicles > 3,5 t and buses, highway driving		Heavy-duty vehicles AADT [vehicles/day] (see Table S 4 for details)	
070302	Combustion emissions: heavy-duty vehicles > 3,5 t and buses, rural driving			
070501	Combustion emissions: motorcycles > 50 cm³, highway driving		Motorcycles AADT [vehicles/day] (see Table S 4 for details)	
070502	Combustion emissions: motorcycles > 50 cm³, rural driving			
070103	Combustion emissions: passenger cars, urban driving	Urban roads (2024) in municipalities > 10.000 inhabitants (2023)	Weighting factors by road type (2022)	Spatial proxy: OpenStreetMap collaborators (2024) Weighting factors by road type: Mu et al. (2022) Municipality layer: MITECO (2024c)
070203	Combustion emissions: light-duty vehicles < 3,5 t, urban driving			
070303	Combustion emissions: heavy-duty vehicles > 3,5 t and buses, urban driving			
070400	Combustion emissions: mopeds and motorcycles < 50 cm³			
070503	Combustion emissions: motorcycles > 50 cm³, urban driving			
070600	Gasoline evaporation from vehicles	Population layer GHS-POP (2020)	Population density [number of inhabitants per cell] (2020)	Schiavina et al. (2023a)

SNAP activity	SNAP description	Spatial proxy (reference year)	Relative weight (reference year)	Sources of information
070700_IR_light	Automobile tyre and brake wear: light-duty vehicles, highway and rural driving	Rural and interurban roads (see Table S 4 for details)	Light-duty vehicles AADT [vehicles/day] (see Table S 4 for details)	See Table S 4 Error! Reference source not found. for details
070700_IR_heavy	Automobile tyre and brake wear: heavy-duty vehicles, highway and rural driving		Heavy-duty vehicles AADT [vehicles/day] (see Table S 4 for details)	
070800_IR_light	Road surface wear: light-duty vehicles, highway and rural driving	Rural and interurban roads (see Table S 4 for details)	Light-duty vehicles AADT [vehicles/day] (see Table S 4 for details)	See Error! Reference source not found. for details
070800_IR_heavy	Road surface wear: heavy-duty vehicles, highway and rural driving		Heavy-duty vehicles AADT [vehicles/day] (see Table S 4 for details)	
070700_U_light	Automobile tyre and brake wear: light-duty vehicles, urban driving	Urban roads (2024) in municipalities > 10.000 inhabitants (2023)	Weighting factors by road type (2022)	Spatial proxy: OpenStreetMap collaborators (2024) Weighting factors by road type: Mu et al. (2022) Municipality layer: MITECO (2024c)
070700_U_heavy	Automobile tyre and brake wear: heavy-duty vehicles, urban driving			
070800_U_light	Road surface wear: light-duty vehicles, urban driving			
070800_U_heavy	Road surface wear: heavy-duty vehicles, urban driving			
SNAP 08: Other mobile sources and machinery				
080100	Military	Spanish Army units (2023)	Depending on the availability of land for manoeuvres and mobile military equipment at each installation	MINISDEF (2024)
080201	Shunting locs	Rail infrastructure sidings and stations (2023)	Not applicable*	IGN (2023b)
080202	Rail-cars	-	-	-
080203	Locomotives	Non-electrified railway lines (2023)	Not applicable*	IGN (2023b)
080301	Sailing boats with auxiliary engines	-	-	-

SNAP activity	SNAP description	Spatial proxy (reference year)	Relative weight (reference year)	Sources of information
080302	Motorboats / workboats	-	-	-
080303	Personal watercraft	-	-	-
080304	Inland goods carrying vessels	-	-	-
080402	National sea traffic within emep area	SNAP activity not included in HERMES_Δ		
080403	National fishing	SNAP activity not included in HERMES_Δ		
080404	International sea traffic (international bunkers)	SNAP activity not included in HERMES_Δ		
080501	Domestic airport traffic (LTO cycles - < 1000 m)	Spanish airports (2023)	Number of international operations per airport (2023)	AENA (2024)
080502	International airport traffic (LTO cycles - < 1000 m)	Spanish airports (2023)	Number of national operations per airport (2023)	AENA (2024)
080503	Domestic cruise traffic (> 1000 m)	SNAP activity not included in HERMES_Δ		
080504	International cruise traffic (> 1000 m)	SNAP activity not included in HERMES_Δ		
080600	Agriculture	Land use: rainfed cropland, permanently irrigated land, fruit and berry plantations, annual crops associated with permanent crops, and complex cultivation patterns	Not applicable	CLMS (2020)
080700	Forestry	Land use: broadleaf forests, coniferous forests and mixed forests	Not applicable	CLMS (2020)
080800	Industry	Land use: industrial	Not applicable	CLMS (2020)
081000	Other off-road	Land use: continuous urban fabric, discontinuous urban fabric and industrial (2018)	Not applicable	CLMS (2020)
SNAP 09: Waste treatment and disposal				
090201	Incineration of domestic or municipal wastes	Emissions entirely derived from the LPS database (2023)	Not applicable	LPS: MITECO (2025)
090202	Incineration of industrial wastes (except flaring)	Emissions entirely derived from the LPS and PRTR databases (2023)	Not applicable	LPS: MITECO (2025) PRTR: PRTR-España (2025b)

SNAP activity	SNAP description	Spatial proxy (reference year)	Relative weight (reference year)	Sources of information
090203	Flaring in oil refinery	Emissions entirely derived from the LPS database (2023)	Not applicable	LPS: MITECO (2025)
090204	Flaring in chemical industries	LPS database (2023) Chemical industry flaring map (2023)	Not applicable*	LPS: MITECO (2025) Chemical industry flaring map: MITECO (2019b)
090205	Incineration of sludges from waste water treatment	LPS database (2023) Population density (2020)	Not applicable	LPS: MITECO (2025) Population density: Schiavina et al. (2023a)
090206	Flaring in gas and oil extraction	Emissions entirely derived from the LPS database (2023)	Not applicable	LPS: MITECO (2025)
090207	Incineration of hospital wastes	-	-	-
090208	Incineration of waste oil	-	-	-
090209	Accidental fires	Land use: industrial, construction sites and urban green areas (2018)	Not applicable	CLMS (2020)
090401	Managed waste disposal on land	Map of controlled landfills (2021)	Total waste input per landfill [tonnes] (2020)	MITECO (2024b) y PRTR-España (2025b)
090402	Unmanaged waste disposal on land	Land use: landfills (2018) Population density (2020)	Not applicable	Land use: CLMS (2020) Population density: Schiavina et al. (2023a)
090403	Other solid waste disposal sites	-	-	-
090700	Open burning of agricultural wastes (except 100300)	SNAP activity not included in HERMES Δ		
090901	Incineration of corpses	Map of funeral service providers (2021) Population density (2020)	Not applicable*	Map of funeral service providers: Panasef – Asociación Nacional de Servicios Funerarios (2021) Population density: Schiavina et al. (2023a)
090902	Incineration of carcasses	-	-	-
091001	Waste water treatment in industry	LPS and PRTR databases (2023) Industrial land use (2018)	Not applicable	LPS: MITECO (2025) PRTR: PRTR-España (2025b) Land use: CLMS (2020)
091002	Waste water treatment in residential/commercial sectors	Map of wastewater treatment plants (2020)	Capacity per wastewater treatment plant [population equivalent]	EEA (2023)

SNAP activity	SNAP description	Spatial proxy (reference year)	Relative weight (reference year)	Sources of information
091003	Sludge spreading	Agricultural plots for the application of WWTP sludge (2018) Land use: continuous urban fabric, discontinuous urban fabric and industrial (2018)	Amount of sludge applied to each agricultural plot [tonnes of dry matter] (2018)	Agricultural plots: MITECO (2020) Land use: CLMS (2020)
091005	Compost production	PRTR database (2023) Map of composting plants (2020)	Total amount of waste for composting (2020)	PRTR: PRTR-España (2025b) MITECO (2021)
091006	Biogas production	Biogas plants catalogue (2024)	Installed electrical capacity [MW _e] (2024)	PRETOR (MITECO, 2024a) and several reports (MAPA, 2023b; MITECO, 2024b; EPSAR, 2024; Agencia Andaluza de la Energía, 2023)
091007	Latrines	-	-	-
091008	Other production of fuel (refuse derived fuel)	-	-	-
SNAP 10: Agriculture				
100101	Cultures with fertilisers: permanent crops	Land use: codes 13, 15, 16, 17, 18, 19, 20 (2018) Crop map: code 290 (2018)	Not applicable	Land use: CLMS (2020) Crop map: d'Andrimont et al. (2021)
100102	Cultures with fertilisers: arable land crops	Land use: codes 12, 13, 18, 19, 26 (2018) Crop map: codes 100, 211, 212, 213, 214, 215, 216, 217, 218, 219, 221, 222, 223, 230, 231, 232, 233, 240, 250, 500 (2018)	Not applicable	Land use: CLMS (2020) Crop map: d'Andrimont et al. (2021)
100103	Cultures with fertilisers: rice field	Crop map: codes 100 y 217 (2018)	Not applicable	Crop map: d'Andrimont et al. (2021)
100104	Cultures with fertilisers: market gardening	Land use: codes 13, 16, 19, 20 (2018) Crop map: codes 222, 240 (2018)	Not applicable	Land use: CLMS (2020) Crop map: d'Andrimont et al. (2021)
100105	Cultures with fertilisers: grasslands	Land use: code 18 (2018) Crop map: codes 216, 219, 240, 250, 500 (2018) REGA livestock facilities (2018)	REGA livestock facilities: number of animals by animal type per farm (2018)	Land use: CLMS (2020) Crop map: d'Andrimont et al. (2021) REGA livestock facilities: MAPA (2023a)
100106	Cultures with fertilisers: fallows	Land use: code 12 (2018) Crop map: codes 290 (2018)	Not applicable	Land use: CLMS (2020) Crop map: d'Andrimont et al. (2021)
100201 - 100206	Cultures without fertilisers	-	-	-

SNAP activity	SNAP description	Spatial proxy (reference year)	Relative weight (reference year)	Sources of information
100301 - 100305	Stubble burning	SNAP activity not included in HERMES_Δ		
100401 - 100412	Enteric fermentation	REGA livestock facilities (2018)	Number of animals by animal type per farm (2018)	MAPA (2023a)
100501 - 100512	Manure management regarding organic compounds	REGA livestock facilities (2018)	Number of animals by animal type per farm (2018)	MAPA (2023a)
100601	Use of pesticides and limestone: agriculture	Land use: codes 12, 18, 19, 20 (2018)	Not applicable	Land use: CLMS (2020)
100602	Use of pesticides and limestone: forestry	-	-	-
100603	Use of pesticides and limestone: horticulture	-	-	-
100604	Use of pesticides and limestone: lakes	-	-	-
100901	Manure management regarding nitrogen compounds: anaerobic lagooning	-	-	-
100902	Manure management regarding nitrogen compounds: liquid manure systems	-	-	-
100903	Manure management regarding nitrogen compounds: solid storage and dry stacking	-	-	-
100904	Manure management regarding nitrogen compounds: others	REGA livestock facilities (2018)	Number of animals by animal type per farm (2018)	MAPA (2023a)

Table S 4 Information sources by competent authority and territorial entity used to develop the spatial proxies for highway and rural driving patterns. “–” indicates that the corresponding territorial entity has no roads managed by the respective competent authority.

Competent authority	Territorial entity	Spatial proxy: data sources and reference year		Relative weight: data sources and reference year	
State (MITMA – Ministry of Transport and Sustainable Mobility)	Ceuta	IGN (2023b)	2023	Ciudad Autónoma de Ceuta (2011)	2010
	Melilla			Ciudad Autónoma de Melilla (2013)	2003
	Balearic Islands, Canary Islands and Basque Country	-			
	Rest of CCAA	MITMA (2023)			2021
Autonomous Communities	Andalusia	Junta de Andalucía (2022)			2021
	Aragon	Gobierno de Aragón (2023)			2021
	Cantabria	Gobierno de Cantabria (2024)			2021
	Catalonia	Generalitat de Catalunya (2024)			2021
	Valencian Community	Generalitat Valenciana (2023)			2021
	Extremadura	Junta de Extremadura (2023)			2021
	Galicia	Xunta de Galicia (2023)			2021
	Community of Madrid	Comunidad de Madrid (2024)			2021
	Region of Murcia	Región de Murcia (2023)			2021
	Castile-La Mancha	IGN (2023b)	2023	Gobierno de Castilla-La Mancha (2022)	2021
	Castile and León			Junta de Castilla y León (2022)	2021
	Ceuta			Ciudad Autónoma de Ceuta (2011)	2010
	Melilla			Ciudad Autónoma de Melilla (2013)	2003
	Navarre			Gobierno de Navarra (2022)	2021
	Asturias			MITMA (2024b y 2024c)	2021
	La Rioja				
	Balearic Islands, Canary Islands and Basque Country	-			
Provincial Councils	Andalusia	IGN (2023b)	2023	MITMA (2024b y 2024c)	2021
	Aragon				
	Castile-La Mancha				

Competent authority	Territorial entity	Spatial proxy: data sources and reference year		Relative weight: data sources and reference year	
	Castile and León				
	Valencian Community				
	Extremadura				
	Galicia				
	Catalonia (Girona, Lleida, Tarragona)				
	Catalonia (Barcelona)	Diputació de Barcelona (2024)			2021
Provincial Councils	Balearic Islands: Mallorca	IGN (2023b)	2023	Consell de Mallorca (2023)	2021
	Balearic Islands: Menorca			Consell Insular de Menorca (2022)	2021
	Balearic Islands: Eivissa			Consell Insular d'Eivissa (2021), Cantisano Mulero (2022) y Consell Insular d'Eivissa (2016)	2019 y 2012 (en ausencia de datos de 2019)
	Balearic Islands: Formentera	IGN (2023b)	2023	MITMA (2024b y 2024c)	2021
	Canary Islands: El Hierro	IGN (2023b)	2023	Cabildo El Hierro (2011)	2009
	Canary Islands: Fuerteventura			Cabildo de Fuerteventura (2022)	2022
	Canary Islands: Gran Canaria			Cabildo de Gran Canaria (2022)	2021
	Canary Islands: La Palma			Cabildo Insular de La Palma (2022)	2011-2013
	Canary Islands: Lanzarote			Cabildo de Lanzarote (2023)	2021
	Canary Islands: La Gomera			MITMA (2024b y 2024c)	2021
	Canary Islands: Tenerife	Cabildo Insular de Tenerife (2023a)	2023	Cabildo Insular de Tenerife (2022)	2021
	Basque Country: Araba	IGN (2023b)	2023	Diputación Foral de Álava (2022)	2021
	Basque Country: Gipuzkoa			Diputación Foral de Gipuzkoa (2024)	2021
	Basque Country: Biscay	Diputación Foral de Bizkaia (2023a)			2022
	Asturias, Cantabria, Ceuta, Community of Madrid, Melilla, Region of Murcia, Navarre, La Rioja	-			

Table S 5 Mapping between the SEI crop categories considered as input in HERMES_A and the EUCROPMAP categories

EUCROPMAP categories		SEI crop categories
211	Common wheat	Wheat
212	Durum wheat	
213	Barley	Barley
214	Rye	Rye
215	Oats	Oats
216	Maize	Maize
217	Rice	Rice
218	Triticale	Triticale
219	Other cereals	Sorghum, winter cereals, other cereals
221	Potatoes	Potatoes
222	Sugar beet	Table beet, sugar beet
223	Other roots crops	Carrot, flowers and ornamental plants, other tubers, cabbage and head cabbage, kale, asparagus, onion, garlic
230	Other non-permanent industrial crops	Other industrial crops, hops, sugar cane, flax, cotton, leek, tobacco
231	Sunflower	Sunflower
232	Rape and turnip rape	Rape, turnip and others
233	Soya	Soya
240	Dry pulses, vegetables and flowers	Green pea, green broad bean, vetch, chickpea, dry pea, bitter vetch, dry broad bean, green bean, dry bean, lentil, lupin, other legumes, cabbage and head cabbage, kale, asparagus, celery, lettuce, spring onion, leek, radish, endive, spinach, chard, chicory and others, pumpkin and courgette, cucumber, aubergine, tomato, pepper, artichoke, cauliflower, garlic, onion, other vegetables, flowers and ornamental plants, cardoon, carrot, turnip and others, gherkin, tomato
250	Other fodder crops (excluding temporary grasslands)	Sainfoin, alfalfa, forage maize, forage vetch, clover, sulla, other cereals, sorghum, winter cereals
290	Bare arable land	Open woodland, woody woodland, pasture wasteland, fallow land, other woody crops
500	Grassland (permanent and temporary)	Mixed grasslands, pastures, forage sorghum, other forage grasses, forage pumpkin, other forage crops, forage cabbage, other forage legumes

Table S 6 Mapping between SEI crop categories considered as input in HERMES_A and the CLC land use categories

CLC land use categories		SEI crop categories
211	Non-irrigated arable land	Fallow land
212	Permanently irrigated land	Avocado, almond, hazelnut, sweet and sour cherry, plum, fig, lemon, apple, peach, quince, walnut, other non-citrus fruits, pear, strawberry, other woody crops, table vineyard, wine vineyard
		Chard, garlic, artichoke, lupin, celery, oats, aubergine, pumpkin and courgette, sugar cane, barley, onion, spring onion, rye, winter cereals, cabbage and head cabbage, cauliflower, endive, spinach, flowers and ornamental plants, chickpea, dry pea, dry bean, green bean, lettuce, lentil, maize, turnip and others, other vegetables, other cereals, other industrial crops, other tubers, potato, cucumber, pepper, leek, radish, table beet, tobacco, tomato, wheat, triticale, vetch, carrot, strawberry, melon, watermelon, olive grove for table olives, olive grove for olive oil production, table vineyard, wine vineyard
221	Vineyards	Table vineyard, wine vineyard
222	Fruit trees and berry plantations	Avocado, almond, hazelnut, sweet and sour cherry, plum, fig, lemon, apple, peach, quince, walnut, other non-citrus fruits, pear, apricot, cherimoya, mandarin, orange, loquat, other citrus fruits, strawberry, melon, watermelon, banana
223	Olive groves	Olive grove for olive oil production, olive grove for table olives, table vineyard, wine vineyard
231	Pastures	Alfalfa, forage cabbage, forage maize, other forage grasses, other legumes, other forage legumes, other forage crops, pastures, forage sorghum, forage vetch, other woody crops
241	Annual crops associated with permanent crops	Olive grove for olive oil production
		Chard, garlic, artichoke, lupin, celery, oats, aubergine, pumpkin and courgette, sugar cane, barley, onion, spring onion, rye, winter cereals, cabbage and head cabbage, cauliflower, endive, spinach, flowers and ornamental plants, chickpea, dry pea, dry bean, green bean, lettuce, lentil, maize, turnip and others, other vegetables, other cereals, other industrial crops, other tubers, potato, cucumber, pepper, leek, radish, table beet, tobacco, tomato, wheat, triticale, vetch, carrot, strawberry, melon, watermelon
242	Complex cultivation patterns	Avocado, almond, hazelnut, sweet and sour cherry, plum, fig, lemon, apple, peach, quince, walnut, other non-citrus fruits, pear, strawberry, other woody crops
		Olive grove for table olives, olive grove for olive oil production
321	Natural grassland	Natural meadows

Table S 7 Summary of monthly profiles for each SNAP activity, including data sources and information on NUTS2 dependence

SNAP activity	SNAP description	Activity data (reference year, if applicable)	Source of information	NUTS2 dependence
SNAP 01: Combustion in energy and transformation industries				
010101	Public power plants: boilers ≥ 300 MW _t	Monthly electricity generation by fuel/technology and by region (2022-2023)	REE (2024a)	✓
010102	Public power plants: boilers ≥ 50 and < 300 MW _t	Monthly electricity generation by fuel/technology and by region (2022-2023)	REE (2024a)	✓
		Monthly electricity generation from biomass (2023)	ENTSO-E (2024)	
010103	Public power plants: boilers < 50 MW _t	Monthly electricity generation by fuel/technology and by region (2022-2023)	REE (2024a)	✓
		Monthly electricity generation from biomass (2023)	ENTSO-E (2024)	
010104	Public power plants: gas turbines	Monthly electricity generation by fuel/technology and by region (2022-2023)	REE (2024a)	✓
010105	Public power plants: stationary engines	Monthly electricity generation by fuel/technology and by region (2022-2023)	REE (2024a)	✓
		Monthly electricity generation from biomass (2023)	ENTSO-E (2024)	
010203_biomass	District heating plants: biomass boilers < 50 MW _t	Monthly NO _x profile for GNFR C in Spain from CAMS-REG-TEMPOv4.1 by CCAA Flat profile for the Canary Islands	Guevara et al. (2021, 2025)	✓
010203_natural_gas	District heating plants: natural gas boilers < 50 MW _t			
010301	Petroleum and/or gas refining plants: boilers ≥ 300 MW _t	Monthly gross refinery production (2023)	CORES (2025a)	✗
010302	Petroleum and/or gas refining plants: boilers ≥ 50 and < 300 MW _t			
010303	Petroleum and/or gas refining plants: boilers < 50 MW _t			
010304	Petroleum and/or gas refining plants: gas turbines			
010306	Petroleum and/or gas refining plants: process furnaces			
010403	Solid fuel transformation plants: boilers < 50 MW _t	Monthly coke production (2015–2017, due to lack of more recent data)	MITECO (2019a)	✗
010405	Solid fuel transformation plants: stationary engines			
010406	Solid fuel transformation plants: coke oven furnaces			
010503	Coal mining, oil/gas extraction, pipeline compressors: boilers < 50 MW _t	Flat profile	Not applicable	✗

SNAP activity	SNAP description	Activity data (reference year, if applicable)	Source of information	NUTS2 dependence
010504	Coal mining, oil/gas extraction, pipeline compressors: gas turbines			
010505	Coal mining, oil/gas extraction, pipeline compressors: stationary engines			
010506	Coal mining, oil/gas extraction, pipeline compressors: pipeline compressors			
SNAP 02: Non-industrial combustion plants				
020103_biomass	Commercial and institutional plants Boilers < 50 MW _t . Fuel: biomass	Monthly PM _{2.5} profile for GNFR C in Spain from CAMS-REG-TEMPOv4.1 by CCAA	Guevara et al. (2021, 2025)	✓
020103_coal	Commercial and institutional plants Boilers < 50 MW _t . Fuel: coal	Flat profile for the Canary Islands		
020103_lpg	Commercial and institutional plants Boilers < 50 MW _t . Fuel: liquid petroleum gas	Monthly NO _x profile for GNFR C in Spain from CAMS-REG-TEMPOv4.1 by CCAA Flat profile for the Canary Islands	Guevara et al. (2021, 2025)	✓
020103_natural_gas	Commercial and institutional plants Boilers < 50 MW _t . Fuel: natural gas			
020103_others	Commercial and institutional plants Boilers < 50 MW _t . Fuel: others			
020104_natural_gas	Commercial and institutional plants Stationary gas turbines Fuel: natural gas			
020104_others	Commercial and institutional plants Stationary gas turbines Fuel: others			
020105_natural_gas	Commercial and institutional plants Stationary engines Fuel: natural gas			
020105_others	Commercial and institutional plants Stationary engines Fuel: others			
020202_biomass	Residential plants. Boilers < 50 MW _t . Fuel: biomass	Monthly PM _{2.5} profile for GNFR C in Spain from CAMS-REG-TEMPOv4.1 by CCAA Flat profile for the Canary Islands	Guevara et al. (2021, 2025)	✓

SNAP activity	SNAP description	Activity data (reference year, if applicable)	Source of information	NUTS2 dependence
020202_lpg	Residential plants. Boilers < 50 MW _t . Fuel: liquid petroleum gas	Monthly NO _x profile for GNFR C in Spain from CAMS-REG-TEMPOv4.1 by CCAA Flat profile for the Canary Islands	Guevara et al. (2021, 2025)	✓
020202_natural_gas	Residential plants. Boilers < 50 MW _t . Fuel: natural gas			
020202_others	Residential plants. Boilers < 50 MW _t . Fuel: others			
020205_biomass	Residential plants. Other equipments Fuel: biomass	Monthly PM _{2.5} profile for GNFR C in Spain from CAMS-REG-TEMPOv4.1 by CCAA Flat profile for the Canary Islands	Guevara et al. (2021, 2025)	✓
020302_aquaculture	Plants in agriculture, forestry and aquaculture. Boilers < 50 MW _t . Installation type: aquaculture	Flat profile	Not applicable	✗
020302_farms	Plants in agriculture, forestry and aquaculture. Boilers < 50 MW _t . Installation type: farms	Monthly PM _{2.5} profile for GNFR C in Spain from CAMS-REG-TEMPOv4.1 by CCAA Flat profile for the Canary Islands	Guevara et al. (2021, 2025)	✓
020304_farms	Plants in agriculture, forestry and aquaculture. Stationary engines Installation type: farms			
020304_irrigation_system	Plants in agriculture, forestry and aquaculture. Stationary engines Installation type: irrigation systems	Flat profile	Not applicable	✗
SNAP 03: Industrial combustion plants				
030102	Boilers < 300 and ≥ 50 MW _t	Monthly electricity generation from cogeneration by region (2023)	REE (2024a)	✗
030103	Boilers < 50 MW _t			
030104	Gas turbines			
030105	Stationary engines			
030203	Blast furnaces coppers	Monthly steel production (2023)	UNESID (2024)	✗

SNAP activity	SNAP description	Activity data (reference year, if applicable)	Source of information	NUTS2 dependence
030204	Plaster furnaces	Monthly electricity demand in the manufacture of other non-metallic mineral products (2023)	REE (2024b)	X
030205	Other furnaces	Asturias: monthly steel production (2023) Galicia: monthly electricity demand in the metallurgical industry, manufacture of iron, steel and ferroalloy products (2023)	Asturias: UNESID (2024) Galicia: REE (2024b)	X
030301	Sinter and pelletizing plants	Monthly steel production (2023)	UNESID (2024)	X
030302	Reheating furnaces steel and iron	Monthly recycled steel production (2023)	UNESID (2024)	X
030303	Grey iron foundries	Monthly electricity demand in the manufacture of fabricated metal products, except machinery and equipment (2023)	REE (2024b)	X
030305	Primary zinc production			
030306	Primary copper production			
030307	Secondary lead production			
030308	Secondary zinc production			
030309	Secondary copper production			
030310	Secondary aluminium production			
030311	Cement	Monthly cement production by region (2023)	MINTUR (2024)	✓
030312	Lime	Monthly electricity demand in the manufacture of other non-metallic mineral products (2023)	REE (2024b)	X
030313	Asphalt concrete plants			
030314	Flat glass			
030315	Container glass			
030316	Glass wool (except binding)			
030317	Other glass (including special glass)			
030318	Mineral wool			
030319	Bricks and tiles			

SNAP activity	SNAP description	Activity data (reference year, if applicable)	Source of information	NUTS2 dependence
030320	Fine ceramics material			
030321	Paper-mill industry (drying processes)	Monthly electricity demand in the paper industry (2023)	REE (2024b)	X
030322	Alumina production	Monthly electricity demand in the metallurgical industry, manufacture of iron, steel and ferroalloy products (2023)	REE (2024b)	X
030326	Other processes with contact	Monthly electricity demand in the manufacture of fabricated metal products, except machinery and equipment (2023)	REE (2024b)	X
SNAP 04: Industrial processes without combustion				
040101	Petroleum products processing	Monthly gross refinery production (2023)	CORES (2025a)	X
040102	Fluid catalytic cracking CO boilers			
040103	Sulphur recovery plants			
040104	Storage & handling of products in refinery			
040201	Coke oven (door leakage and extinction)	Monthly steel production (2023)	UNESID (2024)	X
040202	Blast furnace charging			
040203	Pig iron tapping			
040206	Basic oxygen furnace steel plant			
040207	Electric furnace steel plant			
040208	Rolling mills			
040209	Sinter and pelletizing plants (except combustion 030301)			
040301	Aluminium production (electrolysis)	Monthly electricity demand in the metallurgical industry, manufacture of iron, steel and ferroalloy products (2023)	REE (2024b)	X
040302	Ferro alloys			
040303	Silicium production	Monthly electricity demand in the manufacture of other non-metallic mineral products (2023)	REE (2024b)	X
040309	Other processes in non-ferrous metal industries	Monthly electricity demand in the metallurgical industry, manufacture of iron, steel and ferroalloy products (2023)	REE (2024b)	X

SNAP activity	SNAP description	Activity data (reference year, if applicable)	Source of information	NUTS2 dependence
040401	Sulphuric acid	Monthly electricity demand in the chemical industry (2023)	REE (2024b)	X
040402	Nitric acid			
040403	Ammonia			
040404	Ammonium sulphate			
040405	Ammonium nitrate			
040407	NPK fertilisers			
040408	Urea			
040409	Carbon black			
040410	Titanium dioxide			
040412	Calcium carbide production			
040416	Other processes in inorganic chemical industries			
040501	Ethylene			
040502	Propylene			
040504	Vinylchloride (except 040505)			
040506	Polyethylene low density			
040507	Polyethelene high density			
040508	Polyvinylchloride			
040509	Polypropylene			
040510	Styrene			

SNAP activity	SNAP description	Activity data (reference year, if applicable)	Source of information	NUTS2 dependence
040512	Styrene butadiene			
040513	Styrene-butadiene latex			
040514	Styrene-butadiene rubber (SBR)			
040515	Acrylonitrile butadiene styrene (ABS) resins			
040516	Ethylene oxyde			
040517	Formaldehyde			
040518	Ethylbenzene			
040519	Phthalic anhydride			
040527	Other processes in organic chemical industries (phytosanitary...)	Monthly electricity demand in the chemical industry (2023)	REE (2024b)	X
040601	Chipboard	Monthly electricity demand in the paper industry (2023)	REE (2024b)	X
040602	Paper pulp (kraft process)			
040605	Bread	Monthly electricity demand in the food industry (2023)	REE (2024b)	X
040606	Wine	Monthly electricity demand in beverage manufacturing (2023)	REE (2024b)	X
040607	Beer			
040608	Spirits			
040610	Asphalt roofing materials	Monthly electricity demand in the manufacture of other non-metallic mineral products (2023)	REE (2024b)	X
040611	Road paving with asphalt	Monthly electricity demand in construction (2023)	REE (2024b)	X
040612	Cement (decarbonizing)	Monthly cement production by region (2023)	MINTUR (2024)	✓
040613	Glass (decarbonizing)	Monthly electricity demand in the manufacture of other non-metallic mineral products (2023)	REE (2024b)	X
040614	Lime (decarbonizing)			
040617	Other (including asbestos products manufacturing)			

SNAP activity	SNAP description	Activity data (reference year, if applicable)	Source of information	NUTS2 dependence
040618	Limestone and dolomite use			
040619	Soda ash production and use			
040623	Quarrying	Monthly electricity demand in other extractive industries (2023)	REE (2024b)	X
040624	Construction and demolition	Number of public tenders in construction by CCAA (climatology 2015-2023)	MITMA (2024a)	✓
040625	Sugar production	Monthly electricity demand in the food industry (2023)	REE (2024b)	X
040900	Storage, handling and transport of mineral products	Monthly electricity demand in mining support activities (2023)	REE (2024b)	X
SNAP 05: Extraction and distribution of fossil fuels and geothermal energy				
050102	Underground mining	Monthly electricity demand in the extraction of anthracite, hard coal and lignite (2023)	REE (2024b)	X
050201	Land-based activities	Domestic natural gas production by installation (2023)	CORES (2024b)	✓
050302	Land-based activities (other than desulfuration)	La Rioja: domestic natural gas production by installation (2023) Andalucía: monthly electricity demand in crude oil and natural gas extraction (2023)	La Rioja: CORES (2024b) Andalucía: REE (2024b)	✓
050401_mar	Liquid fuel distribution (except gasoline distribution): maritime terminals	Monthly gross refinery production (2023)	CORES (2025a)	X
050401_ref	Liquid fuel distribution (except gasoline distribution): refineries			
050402	Other handling and storage (including pipeline)			
050501	Refinery dispatch station			
050502	Transport and depots (except 050503)	Monthly gasoline consumption by CCAA (2023)	CORES (2025b)	✓
050503	Service stations (including refuelling of cars)			
050601	Gas distribution networks: pipelines	Natural gas consumption at a pressure > 60 bar (2023)	CORES (2024c)	X
050603	Gas distribution networks: distribution networks	Natural gas consumption at a pressure < 4 bar (2023)	CORES (2024c)	X

SNAP activity	SNAP description	Activity data (reference year, if applicable)	Source of information	NUTS2 dependence
SNAP 06: Use of solvents and other products				
060101	Manufacture of automobiles	Temperature-dependent parametrisation associated to evaporative NMVOC emissions from large painted or coated surface	Wu et al., 2024	X
060102	Car repairing			
060103	Construction and buildings (except 060107)			
060104	Domestic use (except 060107)			
060105	Coil coating			
060106	Boat building			
060107	Wood			
060108	Other industrial paint application			
060109	Other nonindustrial paint application			
060201	Metal degreasing	Monthly electricity demand in the manufacture of fabricated metal products, except machinery and equipment (2023)	REE (2024b)	X
060202	Dry cleaning	Monthly electricity demand in other personal services (2023)	REE (2024b)	X
060204	Other industrial cleaning	Monthly electricity demand in other manufacturing industries (2023)	REE (2024b)	X
060301	Polyester processing	Monthly electricity demand in the chemical industry (2023)	REE (2024b)	X
060302	Polyvinylchloride processing			
060303	Polyurethane foam processing			
060304	Polystyrene foam processing			
060305	Rubber processing	Monthly electricity demand in the manufacture of rubber and plastic products (2023)	REE (2024b)	X
060306	Pharmaceutical products manufacturing	Monthly electricity demand in pharmaceutical manufacturing (2023)	REE (2024b)	X
060307	Paints manufacturing	Monthly electricity demand in the chemical industry (2023)	REE (2024b)	X
060308	Inks manufacturing			

SNAP activity	SNAP description	Activity data (reference year, if applicable)	Source of information	NUTS2 dependence
060309	Glues manufacturing			
060313	Leather tanning	Monthly electricity demand in the leather and footwear industry (2023)	REE (2024b)	X
060401	Glass wool enduction	Monthly electricity demand in the manufacture of other non-metallic mineral products (2023)	REE (2024b)	X
060402	Mineral wool enduction			
060403	Printing industry	Monthly electricity demand in printing and reproduction of recorded media (2023)	REE (2024b)	X
060404	Fat, edible and not edible oil extraction	Monthly electricity demand in the food industry (2023)	REE (2024b)	X
060405	Application of glues and adhesives	Monthly electricity demand in other manufacturing industries (2023)	REE (2024b)	X
060406	Preservation of wood	Flat profile	Not applicable	X
060407	Underseal treatment and conservation of vehicles	Monthly electricity demand in the sale and repair of motor vehicles and motorcycles (2023)	REE (2024b)	X
060408	Domestic solvent use (other than paint application)	Flat profile	Not applicable	X
060501	Anaesthesia			
060503	Refrigeration and air condition equipment using other products than halocarbons			
060508	Other use of HFC, N ₂₀ , NH ₃ , PFC and SF ₆	Monthly electricity demand in the food industry (2023)	REE (2024b)	X
060601	Fireworks	Flat profile	Not applicable	X
060602	Tobacco consumption	Monthly cigarette sales by CCAA (2023)	MIHAC (2024)	✓
SNAP 07: Road transport				
070101	Combustion emissions: Passenger cars: highway driving	Balearic Islands: monthly gasoline and diesel consumption (2022) Canary Islands: monthly light-duty vehicle counts on roads in Tenerife Island (2022) Navarra: monthly light-duty vehicle counts on roads in Navarre (2022) Basque Country: monthly light-duty vehicle counts on	Balearic Islands: CORES (2025b) Canary Islands: Cabildo Insular de Tenerife (2023b) Navarra: Gobierno de Navarra (2023)	✓
070102	Combustion emissions: passenger cars, rural driving			
070201	Combustion emissions: light-duty vehicles < 3,5 t, highway driving			
070202	Combustion emissions: light-duty vehicles < 3,5 t, rural driving			
070501	Combustion emissions: motorcycles > 50 cm ³ , highway driving			

SNAP activity	SNAP description	Activity data (reference year, if applicable)	Source of information	NUTS2 dependence
070502	Combustion emissions: motorcycles > 50 cm ³ , rural driving	roads in Álava, Biscay and Gipuzkoa (2022)	Basque Country: Diputación Foral de Álava (2023), Diputación Foral de Bizkaia (2023b), Diputación Foral de Gipuzkoa (2024) Rest of CCAA: MITMA (2024d)	
070700_IR_light	Automobile tyre and brake wear: light-duty vehicles, highway and rural driving	Rest of CCAA: monthly light-duty vehicle counts on the State Road Network (2022)		
070800_IR_light	Road surface wear: light-duty vehicles, highway and rural driving			
070301	Combustion emissions: heavy-duty vehicles > 3,5 t and buses, highway driving	Monthly heavy-duty vehicle counts on the State Road Network (2023)	MITMA (2024e)	✓
070302	Combustion emissions: heavy-duty vehicles > 3,5 t and buses, rural driving			
070700_IR_heavy	Automobile tyre and brake wear: heavy-duty vehicles, highway and rural driving			
070800_IR_heavy	Road surface wear: heavy-duty vehicles, highway and rural driving			
070103	Combustion emissions: passenger cars, urban driving	Balearic Islands: municipal mobility in Palma de Mallorca (2023) Rest of CCAA: city congestion level aggregated at CCAA level (2022)	Balearic Islands: MITMA (2025) Rest of CCAA: TomTom (2023)	✓
070203	Combustion emissions: light-duty vehicles < 3,5 t, urban driving			
070303	Combustion emissions: heavy-duty vehicles > 3,5 t and buses, urban driving			
070400	Combustion emissions: mopeds and motorcycles < 50 cm ³			
070503	Combustion emissions: motorcycles > 50 cm ³ , urban driving			
070700_U_light	Automobile tyre and brake wear: light-duty vehicles, urban driving			
070700_U_heavy	Automobile tyre and brake wear: heavy-duty vehicles, urban driving			
070800_U_light	Road surface wear: light-duty vehicles, urban driving			
070800_U_heavy	Road surface wear: heavy-duty vehicles, urban driving			
070600	Gasoline evaporation from vehicles	Canary Islands: flat profile Rest of CCAA: monthly NMVOC profile for GNFR F4 in Spain from CAMS-REG-TEMPOv4.1, aggregated at CCAA level	Canary Islands: not applicable Rest of CCAA: Guevara et al. (2021, 2025)	✓

SNAP activity	SNAP description	Activity data (reference year, if applicable)	Source of information	NUTS2 dependence
SNAP 08: Other mobile sources and machinery				
080100	Military	Monthly profile reported in the EMEP/CORINAIR Emissions Inventory Guide for military mobile machinery	EEA (2002)	×
080201	Shunting locs	Flat profile	Not applicable	×
080203	Locomotives	Monthly passengers transported by rail (2023)	MITMA (2024g)	×
080501	Domestic airport traffic (LTO cycles - < 1000 m)	Total domestic air traffic operations by airport (2023)	AENA (2024)	✓
080502	International airport traffic (LTO cycles - < 1000 m)	Total international air traffic operations by airport (2023)	AENA (2024)	✓
080600	Agriculture	Canary Islands, Ceuta and Melilla: monthly electricity demand in agriculture (2023)	Canary Islands, Ceuta and Melilla: REE (2024b)	✓
		Rest of CCAA: monthly gasoil B consumption by CCAA (2023)	Rest of CCAA: CNMC (2024c)	
080700	Forestry	Canary Islands, Ceuta and Melilla: monthly electricity demand in forestry and forest exploitation (2023)	Canary Islands, Ceuta and Melilla: REE (2024b)	✓
		Rest of CCAA: monthly gasoil B consumption by CCAA (2023)	Rest of CCAA: CNMC (2024c)	
080800	Industry	Ceuta and Melilla: national monthly industrial production index (2023)	INE (2024a)	✓
		Rest of CCAA: monthly industrial production index by CCAA (2023)		
081000	Other off-road	Monthly turnover index by CCAA (2023)	INE (2024b)	✓
SNAP 09: Waste treatment and disposal				
090201	Incineration of domestic or municipal wastes	Monthly electricity generation (renewable and non-renewable waste) by region (climatology 2022–2024)	REE (2024a)	✓
090202	Incineration of industrial wastes (except flaring)	Monthly electricity demand in decontamination activities and other waste management services (2023)	REE (2024b)	×
090203	Flaring in oil refinery	Monthly gross refinery production (2023)	CORES (2025a)	×
090204	Flaring in chemical industries	Monthly national industrial production index (2023)	INE (2024c)	×
090205	Incineration of sludges from waste water treatment	Flat profile	Not applicable	×

SNAP activity	SNAP description	Activity data (reference year, if applicable)	Source of information	NUTS2 dependence
090206	Flaring in gas and oil extraction	In-country natural gas production, national total (2023)	CORES (2024b)	X
090209	Accidental fires	Flat profile	Not applicable	X
090401	Managed waste disposal on land			
090402	Unmanaged waste disposal on land			
090901	Incineration of corpses	Estimated number of monthly deaths by CCAA (2023)	INE (2024d)	✓
091001	Waste water treatment in industry	Monthly electricity demand in wastewater collection and treatment (2023)	REE (2024b)	X
091002	Waste water treatment in residential/commercial sectors	Flat profile	Not applicable	X
091003	Sludge spreading			
091005	Compost production			
091006	Biogas production	National biogas production (2023)	CORES (2024b)	X
SNAP 10: Agriculture				
100101	Cultures with fertilisers: permanent crops	Agricultural operations (NFR 3Dc): monthly NH ₃ profile for GNFR L from CAMS-REG-TEMPOv4.1 Rest: crop- and NUTS2-dependent profiles from the dynamical fertiliser ammonia emission parametrisation described in Guevara et al. (2020)	Agricultural operations: Guevara et al., (2021, 2025) Rest: Guevara et al. (2020)	✓
100102	Cultures with fertilisers: arable land crops			
100103	Cultures with fertilisers: rice field	Agricultural operations (NFR 3Dc): monthly NH ₃ profile for GNFR L from CAMS-REG-TEMPOv4.1 Rest: monthly cycle of methane concentrations at an atmospheric station in the Ebro Delta (climatology 2013–2019)	Agricultural operations: Guevara et al., (2021, 2025) Curcoll et al. (2025)	X

SNAP activity	SNAP description	Activity data (reference year, if applicable)	Source of information	NUTS2 dependence
100104	Cultures with fertilisers: market gardening	Agricultural operations (NFR 3Dc): monthly NH ₃ profile for GNFR L from CAMS-REG-TEMPOv4.1 Rest: crop- and NUTS2-dependent profiles from the dynamical fertiliser ammonia emission parametrisation described in Guevara et al. (2020)	Agricultural operations: Guevara et al., (2021, 2025) Rest: Guevara et al. (2020)	✓
100105	Cultures with fertilisers: grasslands	Agricultural operations (NFR 3Dc): monthly NH ₃ profile for GNFR L from CAMS-REG-TEMPOv4.1 Urine and dung deposited by grazing animals (NFR 3Da3): monthly NH ₃ profile for GNFR K from CAMS-REG-TEMPOv4.1 Rest: crop- and NUTS2-dependent profiles from the dynamical fertiliser ammonia emission parametrisation described in Guevara et al. (2020)	Agricultural operations and urine and dung deposited by grazing animals: Guevara et al., (2021, 2025) Rest: Guevara et al. (2020)	✓
100106	Cultures with fertilisers: fallows	Monthly NH ₃ profile for GNFR L from CAMS-REG-TEMPOv4.1	Guevara et al. (2021, 2025)	✗
100301 - 100305	Stubble burning	Flat profile	Not applicable	✗
100401 - 100412	Enteric fermentation	Monthly NH ₃ profile for GNFR K from CAMS-REG-TEMPOv4.1	Guevara et al. (2021, 2025)	✗
100501 - 100512	Manure management regarding organic compounds	Flat profile	Not applicable	✗
100601	Use of pesticides and limestone: agriculture	Monthly NH ₃ profile for GNFR K from CAMS-REG-TEMPOv4.1	Guevara et al. (2021, 2025)	✗
100904	Manure management regarding nitrogen compounds: others			

Table S 8 Summary of weekly profiles for each SNAP activity, including data sources and information on NUTS2 dependence

SNAP activity	SNAP description	Activity data (reference year, if applicable)	Source of information	NUTS2 dependence
SNAP 01: Combustion in energy and transformation industries				
010101	Public power plants: boilers ≥ 300 MW _t	Electricity generation by day of the week, by fuel/technology and by region (2022-2023)	REE (2024a)	✓
010102	Public power plants: boilers ≥ 50 and < 300 MW _t	Electricity generation by day of the week, by fuel/technology and by region (2022-2023)	REE (2024a)	✓
010103	Public power plants: boilers < 50 MW _t		ENTSO-E (2024)	
010104	Public power plants: gas turbines	Electricity generation by day of the week, by fuel/technology and by region (2022-2023)	REE (2024a)	✓
010105	Public power plants: stationary engines	Electricity generation by day of the week, by fuel/technology and by region (2022-2023)	REE (2024a)	✓
		Electricity generation by day of the week from biomass (2023)	ENTSO-E (2024)	
010203_biomass	District heating plants: biomass boilers < 50 MW _t	Weekly NO _x profile for GNFR C in Spain from CAMS-REG-TEMPOv4.1	Guevara et al. (2021, 2025)	✗
010203_natural_gas	District heating plants: natural gas boilers < 50 MW _t			
010301	Petroleum and/or gas refining plants: boilers ≥ 300 MW _t	Weekly NO _x profile for GNFR B in Spain from CAMS-REG-TEMPOv4.1 (FW_mean)	Guevara et al. (2021, 2025)	✗
010302	Petroleum and/or gas refining plants: boilers ≥ 50 and < 300 MW _t			
010303	Petroleum and/or gas refining plants: boilers < 50 MW _t			
010304	Petroleum and/or gas refining plants: gas turbines			
010306	Petroleum and/or gas refining plants: process furnaces			
010403	Solid fuel transformation plants: boilers < 50 MW _t			
010405	Solid fuel transformation plants: stationary engines			
010406	Solid fuel transformation plants: coke oven furnaces			
010503	Coal mining, oil/gas extraction, pipeline compressors: boilers < 50 MW _t	Flat profile	Not applicable	✗

SNAP activity	SNAP description	Activity data (reference year, if applicable)	Source of information	NUTS2 dependence
010504	Coal mining, oil/gas extraction, pipeline compressors: gas turbines			
010505	Coal mining, oil/gas extraction, pipeline compressors: stationary engines			
010506	Coal mining, oil/gas extraction, pipeline compressors: pipeline compressors			
SNAP 02: Non-industrial combustion plants				
020103_biomass	Commercial and institutional plants Boilers < 50 MW _t . Fuel: biomass	Weekly NO _x profile for GNFR C in Spain from CAMS-REG-TEMPOv4.1 Flat profile for Canary Islands	Guevara et al. (2021, 2025)	X
020103_coal	Commercial and institutional plants Boilers < 50 MW _t . Fuel: coal			
020103_lpg	Commercial and institutional plants Boilers < 50 MW _t . Fuel: liquid petroleum gas			
020103_natural_gas	Commercial and institutional plants Boilers < 50 MW _t . Fuel: natural gas			
020103_others	Commercial and institutional plants Boilers < 50 MW _t . Fuel: others			
020104_natural_gas	Commercial and institutional plants Stationary gas turbines Fuel: natural gas			
020104_others	Commercial and institutional plants Stationary gas turbines Fuel: others			
020105_natural_gas	Commercial and institutional plants Stationary engines Fuel: natural gas			

SNAP activity	SNAP description	Activity data (reference year, if applicable)	Source of information	NUTS2 dependence
020105_others	Commercial and institutional plants Stationary engines Fuel: others			
020202_biomass	Residential plants. Boilers < 50 MW _t . Fuel: biomass	Weekly profile used in the MetVed model for residential biomass combustion Flat profile for Canary Islands	Lopez-Aparicio et al. (2022)	X
020202_lpg	Residential plants. Boilers < 50 MW _t . Fuel: liquid petroleum gas	Weekly NO _x profile for GNFR C in Spain from CAMS-REG-TEMPOv4.1 Flat profile for Canary Islands	Guevara et al. (2021, 2025)	X
020202_natural_gas	Residential plants. Boilers < 50 MW _t . Fuel: natural gas			
020202_others	Residential plants. Boilers < 50 MW _t . Fuel: others			
020205_biomass	Residential plants. Other equipments Fuel: biomass	Weekly profile used in the MetVed model for residential biomass combustion Flat profile for Canary Islands	Lopez-Aparicio et al. (2022)	X
020302_aquaculture	Plants in agriculture, forestry and aquaculture. Boilers < 50 MW _t . Installation type: aquaculture	Flat profile	Not applicable	X
020302_farms	Plants in agriculture, forestry and aquaculture. Boilers < 50 MW _t . Installation type: farms			
020304_farms	Plants in agriculture, forestry and aquaculture. Stationary engines Installation type: farms			
020304_irrigation_system	Plants in agriculture, forestry and aquaculture. Stationary engines Installation type: irrigation systems			
SNAP 03: Industrial combustion plants				
All SNAP activities		Weekly NO _x profile for GNFR B in Spain from CAMS-REG-TEMPOv4.1	Guevara et al. (2021, 2025)	X
SNAP 04: Industrial processes without combustion				
All SNAP activities		Weekly NO _x profile for GNFR B in Spain from CAMS-REG-TEMPOv4.1	Guevara et al. (2021, 2025)	X
SNAP 05: Extraction and distribution of fossil fuels and geothermal energy				

SNAP activity	SNAP description	Activity data (reference year, if applicable)	Source of information	NUTS2 dependence
050102	Underground mining	Flat profile	Not applicable	X
050201	Land-based activities			
050302	Land-based activities (other than desulfuration)			
050401_mar	Liquid fuel distribution (except gasoline distribution): maritime terminals			
050401_ref	Liquid fuel distribution (except gasoline distribution): refineries			
050402	Other handling and storage (including pipeline)			
050501	Refinery dispatch station			
050502	Transport and depots (except 050503)			
050503	Service stations (including refuelling of cars)	Light-duty vehicle counts by day of the week on the State Road Network (2022)	MITMA (2024f)	✓
050601	Gas distribution networks: pipelines	Gas demand by pipeline by day of the week (2021)	CNMC (2024b)	X
050603	Gas distribution networks: distribution networks	Total gas demand by day of the week (2021)	CNMC (2024b)	X
SNAP 06: Use of solvents and other products				
060101	Manufacture of automobiles	Survey-based weekly patterns reported for commercial use of paints or solvents	Chinkin et al. (2003)	X
060102	Car repairing			
060103	Construction and buildings (except 060107)			
060104	Domestic use (except 060107)	Survey-based weekly patterns reported for residential use of paints or solvents	Chinkin et al. (2003)	X
060105	Coil coating	Survey-based weekly patterns reported for commercial use of paints or solvents	Chinkin et al. (2003)	X
060106	Boat building			
060107	Wood			
060108	Other industrial paint application			
060109	Other nonindustrial paint application			

SNAP activity	SNAP description	Activity data (reference year, if applicable)	Source of information	NUTS2 dependence
060201	Metal degreasing	Survey-based weekly patterns reported for commercial use of paints or solvents	Chinkin et al. (2003)	X
060202	Dry cleaning			
060204	Other industrial cleaning			
060301	Polyester processing	Weekly profile for GNFR B in Spain from CAMS-REG-TEMPOv4.1	Guevara et al. (2021, 2025)	X
060302	Polyvinylchloride processing			
060303	Polyurethane foam processing			
060304	Polystyrene foam processing			
060305	Rubber processing			
060306	Pharmaceutical products manufacturing			
060307	Paints manufacturing			
060308	Inks manufacturing			
060309	Glues manufacturing			
060313	Leather tanning			
060401	Glass wool enduction	Survey-based weekly patterns reported for commercial use of paints or solvents	Chinkin et al. (2003)	X
060402	Mineral wool enduction			
060403	Printing industry			
060404	Fat, edible and not edible oil extraction			
060405	Application of glues and adhesives			
060406	Preservation of wood			
060407	Underseal treatment and conservation of vehicles			
060408	Domestic solvent use (other than paint application)	Survey-based weekly patterns reported for residential use of paints or solvents	Chinkin et al. (2003)	X
060501	Anaesthesia	Flat profile	Not applicable	X

SNAP activity	SNAP description	Activity data (reference year, if applicable)	Source of information	NUTS2 dependence
060503	Refrigeration and air condition equipment using other products than halocarbons			
060508	Other use of HFC, N ₂₀ , NH ₃ , PFC and SF ₆	Weekly profile for GNFR E from CAMS-REG-TEMPOv4.1	Guevara et al. (2021, 2025)	✗
060601	Fireworks	Flat profile	Not applicable	✗
060602	Tobacco consumption	Cigarette consumption by day of the week among daily smokers (climatology)	Shiffman et al. (2014)	✗
SNAP 07: Road transport				
070101	Combustion emissions: Passenger cars: highway driving	Weekly light-duty vehicle counts on the State Road Network (2022)	MITMA (2024f)	✓
070102	Combustion emissions: passenger cars, rural driving			
070201	Combustion emissions: light-duty vehicles < 3,5 t, highway driving			
070202	Combustion emissions: light-duty vehicles < 3,5 t, rural driving			
070501	Combustion emissions: motorcycles > 50 cm ³ , highway driving			
070502	Combustion emissions: motorcycles > 50 cm ³ , rural driving			
070700_IR_light	Automobile tyre and brake wear: light-duty vehicles, highway and rural driving			
070800_IR_light	Road surface wear: light-duty vehicles, highway and rural driving			
070301	Combustion emissions: heavy-duty vehicles > 3,5 t and buses, highway driving	Weekly heavy-duty vehicle counts on the State Road Network (2022)	MITMA (2024f)	✓
070302	Combustion emissions: heavy-duty vehicles > 3,5 t and buses, rural driving			
070700_IR_heavy	Automobile tyre and brake wear: heavy-duty vehicles, highway and rural driving			
070800_IR_heavy	Road surface wear: heavy-duty vehicles, highway and rural driving			
070103	Combustion emissions: passenger cars, urban driving	City congestion level aggregated at CCAA level (2022)	TomTom (2023)	✓
070203	Combustion emissions: light-duty vehicles < 3,5 t, urban driving			
070303	Combustion emissions: heavy-duty vehicles > 3,5 t and buses, urban driving			

SNAP activity	SNAP description	Activity data (reference year, if applicable)	Source of information	NUTS2 dependence
070400	Combustion emissions: mopeds and motorcycles < 50 cm³			
070503	Combustion emissions: motorcycles > 50 cm³, urban driving			
070700_U_light	Automobile tyre and brake wear: light-duty vehicles, urban driving			
070700_U_heavy	Automobile tyre and brake wear: heavy-duty vehicles, urban driving			
070800_U_light	Road surface wear: light-duty vehicles, urban driving			
070800_U_heavy	Road surface wear: heavy-duty vehicles, urban driving			
070600	Gasoline evaporation from vehicles	Flat profile	Not applicable	X
SNAP 08: Other mobile sources and machinery				
080100	Military	Weekly profile reported in the EMEP/CORINAIR Emissions Inventory Guide for military mobile machinery	EEA (2002)	X
080201	Shunting locs	Flat profile	Not applicable	X
080203	Locomotives			
080501	Domestic airport traffic (LTO cycles - < 1000 m)	Average air traffic (number of arrivals and departures) by day of the week and by airport (2023)	EUROCONTROL (2024)	✓
080502	International airport traffic (LTO cycles - < 1000 m)			
080600	Agriculture	Weekly profile reported in the EMEP/CORINAIR Emissions Inventory Guide for agricultural mobile machinery	EEA (2002)	X
080700	Forestry			
080800	Industry	Weekly profile for GNFR B from CAMS-REG-TEMPOv4.1	Guevara et al. (2021, 2025)	X
081000	Other off-road			
SNAP 09: Waste treatment and disposal				
090201	Incineration of domestic or municipal wastes	Weekly electricity generation (renewable and non-renewable waste) by region (climatology 2022–2024)	REE (2024a)	✓
090202	Incineration of industrial wastes (except flaring)	Weekly profile for GNFR B from CAMS-REG-TEMPOv4.1	Guevara et al. (2021, 2025)	X

SNAP activity	SNAP description	Activity data (reference year, if applicable)	Source of information	NUTS2 dependence
090203	Flaring in oil refinery	Flat profile	Not applicable	X
090204	Flaring in chemical industries	Weekly profile for GNFR B from CAMS-REG-TEMPOv4.1	Guevara et al. (2021, 2025)	X
090205	Incineration of sludges from waste water treatment	Flat profile	Not applicable	X
090206	Flaring in gas and oil extraction			
090209	Accidental fires			
090401	Managed waste disposal on land			
090402	Unmanaged waste disposal on land			
090901	Incineration of corpses			
091001	Waste water treatment in industry			
091002	Waste water treatment in residential/commercial sectors			
091003	Sludge spreading			
091005	Compost production			
091006	Biogas production	Weekly profile for GNFR B from CAMS-REG-TEMPOv4.1	Guevara et al. (2021, 2025)	X
SNAP 10: Agriculture				
All SNAP activities		Flat profile	Not applicable	X

Table S 9 Summary of hourly profiles for each SNAP activity, including data sources and information on NUTS2 dependence

SNAP activity	SNAP description	Activity data (reference year, if applicable)	Source of information	NUTS2 dependence
SNAP 01: Combustion in energy and transformation industries				
010101	Public power plants: boilers ≥ 300 MW _t	Hourly electricity generation by fuel/technology (2023)	ENTSO-E (2024)	X
010102	Public power plants: boilers ≥ 50 and < 300 MW _t			
010103	Public power plants: boilers < 50 MW _t			
010104	Public power plants: gas turbines			
010105	Public power plants: stationary engines			
010203_biomass	District heating plants: biomass boilers < 50 MW _t	Hourly NO _x profile for GNFR C in Spain from CAMS-REG-TEMPOv4.1	Guevara et al. (2021, 2025)	X
010203_natural_gas	District heating plants: natural gas boilers < 50 MW _t			
010301	Petroleum and/or gas refining plants: boilers ≥ 300 MW _t	Hourly NO _x profile for GNFR B in Spain from CAMS-REG-TEMPOv4.1 (FW_mean)	Guevara et al. (2021, 2025)	X
010302	Petroleum and/or gas refining plants: boilers ≥ 50 and < 300 MW _t			
010303	Petroleum and/or gas refining plants: boilers < 50 MW _t			
010304	Petroleum and/or gas refining plants: gas turbines			
010306	Petroleum and/or gas refining plants: process furnaces			
010403	Solid fuel transformation plants: boilers < 50 MW _t			
010405	Solid fuel transformation plants: stationary engines			
010406	Solid fuel transformation plants: coke oven furnaces			
010503	Coal mining, oil/gas extraction, pipeline compressors: boilers < 50 MW _t	Flat profile	Not applicable	X
010504	Coal mining, oil/gas extraction, pipeline compressors: gas turbines			
010505	Coal mining, oil/gas extraction, pipeline compressors: stationary engines			
010506	Coal mining, oil/gas extraction, pipeline compressors: pipeline compressors			

SNAP activity	SNAP description	Activity data (reference year, if applicable)	Source of information	NUTS2 dependence
SNAP 02: Non-industrial combustion plants				
020103_biomass	Commercial and institutional plants Boilers < 50 MW _t . Fuel: biomass	Hourly NO _x profile for GNFR C in Spain from CAMS-REG-TEMPOv4.1	Guevara et al. (2021, 2025)	X
020103_coal	Commercial and institutional plants Boilers < 50 MW _t . Fuel: coal			
020103_lpg	Commercial and institutional plants Boilers < 50 MW _t . Fuel: liquid petroleum gas			
020103_natural_gas	Commercial and institutional plants Boilers < 50 MW _t . Fuel: natural gas			
020103_others	Commercial and institutional plants Boilers < 50 MW _t . Fuel: others			
020104_natural_gas	Commercial and institutional plants Stationary gas turbines Fuel: natural gas			
020104_others	Commercial and institutional plants Stationary gas turbines Fuel: others			
020105_natural_gas	Commercial and institutional plants Stationary engines Fuel: natural gas			
020105_others	Commercial and institutional plants Stationary engines Fuel: others			
020202_biomass	Residential plants. Boilers < 50 MW _t . Fuel: biomass			
020202_lpg	Residential plants. Boilers < 50 MW _t . Fuel: liquid petroleum gas	Hourly PM _{2.5} profile for GNFR C in Spain from CAMS-REG-TEMPOv4.1	Guevara et al. (2021, 2025)	X
020202_natural_gas	Residential plants. Boilers < 50 MW _t . Fuel: natural gas			
020202_others	Residential plants. Boilers < 50 MW _t . Fuel: others	Flat profile	Not applicable	X
020205_biomass	Residential plants. Other equipments Fuel: biomass			
020302_aquaculture	Plants in agriculture, forestry and aquaculture. Boilers < 50 MW _t . Installation type: aquaculture			

SNAP activity	SNAP description	Activity data (reference year, if applicable)	Source of information	NUTS2 dependence
020302_farms	Plants in agriculture, forestry and aquaculture. Boilers < 50 MW _t . Installation type: farms	Hourly NO _x profile for GNFR C in Spain from CAMS-REG-TEMPOv4.1	Guevara et al. (2021, 2025)	X
020304_farms	Plants in agriculture, forestry and aquaculture. Stationary engines Installation type: farms			
020304_irrigation_sys tem	Plants in agriculture, forestry and aquaculture. Stationary engines Installation type: irrigation systems			
SNAP 03: Industrial combustion plants				
All SNAP activities		Hourly NO _x profile for GNFR B in Spain from CAMS-REG-TEMPOv4.1	Guevara et al. (2021, 2025)	X
SNAP 04: Industrial processes without combustion				
All SNAP activities		Hourly NO _x profile for GNFR B in Spain from CAMS-REG-TEMPOv4.1	Guevara et al. (2021, 2025)	X
SNAP 05: Extraction and distribution of fossil fuels and geothermal energy				
050102	Underground mining	Flat profile	Not applicable	X
050201	Land-based activities			
050302	Land-based activities (other than desulfuration)			
050401_mar	Liquid fuel distribution (except gasoline distribution): maritime terminals			
050401_ref	Liquid fuel distribution (except gasoline distribution): refineries			
050402	Other handling and storage (including pipeline)			
050501	Refinery dispatch station			
050502	Transport and depots (except 050503)			
050503	Service stations (including refuelling of cars)	Hourly light-duty vehicle counts on the State Road Network (2022)	MITMA (2024f)	✓
050601	Gas distribution networks: pipelines	Hourly NO _x profile for GNFR B in Spain from CAMS-REG-TEMPOv4.1 (FW_mean)	Guevara et al. (2021, 2025)	X
050603	Gas distribution networks: distribution networks			

SNAP activity	SNAP description	Activity data (reference year, if applicable)	Source of information	NUTS2 dependence
SNAP 06: Use of solvents and other products				
060101	Manufacture of automobiles	Hourly profile reported by the MapEire project for industrial and commercial coating applications	MapEire project (https://projects.au.dk/mapeire/ , last access: 15/06/2026)	X
060102	Car repairing			
060103	Construction and buildings (except 060107)			
060104	Domestic use (except 060107)	Weighted average of a collection of domestic natural gas demand archetypes characterised for 13000 homes over 3 years from Great Britain, assuming that the hourly occupancy profile associated to natural gas consumption is highly correlated with the diurnal pattern of domestic use of solvent activities	Pullinger et al., 2024	X
060105	Coil coating	Hourly profile reported by the MapEire project for industrial and commercial coating applications	MapEire project (https://projects.au.dk/mapeire/ , last access: 15/06/2026)	X
060106	Boat building			
060107	Wood			
060108	Other industrial paint application			
060109	Other nonindustrial paint application			
060201	Metal degreasing			
060202	Dry cleaning			
060204	Other industrial cleaning			
060301	Polyester processing	Hourly NO _x profile for GNFR B in Spain from CAMS-REG-TEMPOv4.1 (FW_mean)	Guevara et al. (2021, 2025)	X
060302	Polyvinylchloride processing			
060303	Polyurethane foam processing			
060304	Polystyrene foam processing			
060305	Rubber processing			
060306	Pharmaceutical products manufacturing			

SNAP activity	SNAP description	Activity data (reference year, if applicable)	Source of information	NUTS2 dependence
060307	Paints manufacturing			
060308	Inks manufacturing			
060309	Glues manufacturing			
060313	Leather tanning			
060401	Glass wool enduction	Hourly profile reported by the MapEire project for industrial and commercial coating applications	MapEire project (https://projects.au.dk/mapeire/ , last access: 15/06/2026)	X
060402	Mineral wool enduction			
060403	Printing industry			
060404	Fat, edible and not edible oil extraction			
060405	Application of glues and adhesives			
060406	Preservation of wood			
060407	Underseal treatment and conservation of vehicles			
060408	Domestic solvent use (other than paint application)	Weighted average of a collection of domestic natural gas demand archetypes characterised for 13000 homes over 3 years from Great Britain, assuming that the hourly occupancy profile associated to natural gas consumption is highly correlated with the diurnal pattern of domestic use of solvent activities	Pullinger et al., 2024	X
060501	Anaesthesia	Flat profile	Not applicable	X
060503	Refrigeration and air condition equipment using other products than halocarbons			
060508	Other use of HFC, N ₂ , NH ₃ , PFC and SF ₆	Hourly profile for GNFR E from CAMS-REG-TEMPOv4.1	Guevara et al. (2021, 2025)	X
060601	Fireworks	Flat profile	Not applicable	X
060602	Tobacco consumption	Cigarette consumption by hour on weekdays (climatology)	Zhai et al. (2022)	X
SNAP 07: Road transport				
070101	Combustion emissions: Passenger cars: highway driving	Hourly light-duty vehicle counts on the State Road Network (2022)	MITMA (2024f)	✓

SNAP activity	SNAP description	Activity data (reference year, if applicable)	Source of information	NUTS2 dependence
070102	Combustion emissions: passenger cars, rural driving			
070201	Combustion emissions: light-duty vehicles < 3,5 t, highway driving			
070202	Combustion emissions: light-duty vehicles < 3,5 t, rural driving			
070501	Combustion emissions: motorcycles > 50 cm ³ , highway driving			
070502	Combustion emissions: motorcycles > 50 cm ³ , rural driving			
070700_IR_light	Automobile tyre and brake wear: light-duty vehicles, highway and rural driving			
070800_IR_light	Road surface wear: light-duty vehicles, highway and rural driving			
070301	Combustion emissions: heavy-duty vehicles > 3,5 t and buses, highway driving	Hourly heavy-duty vehicle counts on the State Road Network (2022)	MITMA (2024f)	✓
070302	Combustion emissions: heavy-duty vehicles > 3,5 t and buses, rural driving			
070700_IR_heavy	Automobile tyre and brake wear: heavy-duty vehicles, highway and rural driving			
070800_IR_heavy	Road surface wear: heavy-duty vehicles, highway and rural driving			
070103	Combustion emissions: passenger cars, urban driving	Application of a sigmoid function to city-level congestion, aggregated at CCAA level (2022)	TomTom (2023)	✓
070203	Combustion emissions: light-duty vehicles < 3,5 t, urban driving			
070303	Combustion emissions: heavy-duty vehicles > 3,5 t and buses, urban driving			
070400	Combustion emissions: mopeds and motorcycles < 50 cm ³			
070503	Combustion emissions: motorcycles > 50 cm ³ , urban driving			
070700_U_light	Automobile tyre and brake wear: light-duty vehicles, urban driving			
070700_U_heavy	Automobile tyre and brake wear: heavy-duty vehicles, urban driving			
070800_U_light	Road surface wear: light-duty vehicles, urban driving			
070800_U_heavy	Road surface wear: heavy-duty vehicles, urban driving			

SNAP activity	SNAP description	Activity data (reference year, if applicable)	Source of information	NUTS2 dependence
070600	Gasoline evaporation from vehicles	Flat profile	Not applicable	✗
SNAP 08: Other mobile sources and machinery				
080100	Military	Hourly profile reported in the EMEP/CORINAIR Emissions Inventory Guide for military mobile machinery	EEA (2002)	✗
080201	Shunting locs	Flat profile	Not applicable	✗
080203	Locomotives			
080501	Domestic airport traffic (LTO cycles - < 1000 m)	Hourly profile reported in HERMESv3 bottom-up for air traffic by CCAA	Guevara et al. (2020)	✓
080502	International airport traffic (LTO cycles - < 1000 m)			
080600	Agriculture	Hourly profile reported in HERMESv3 bottom-up for agricultural mobile machinery	Guevara et al. (2020)	✗
080700	Forestry			
080800	Industry	Hourly profile reported in the EMEP/CORINAIR Emissions Inventory Guide for industrial mobile machinery	EEA (2002)	✗
081000	Other off-road			
SNAP 09: Waste treatment and disposal				
090201	Incineration of domestic or municipal wastes	Hourly electricity generation, biomass category (2023)	ENTSO-E (2024)	✗
090202	Incineration of industrial wastes (except flaring)	Hourly profile for GNFR B from CAMS-REG-TEMPOv4.1	Guevara et al. (2021, 2025)	✗
090203	Flaring in oil refinery			
090204	Flaring in chemical industries			
090205	Incineration of sludges from waste water treatment			
090206	Flaring in gas and oil extraction			

SNAP activity	SNAP description	Activity data (reference year, if applicable)	Source of information	NUTS2 dependence
090209	Accidental fires	Flat profile	Not applicable	X
090401	Managed waste disposal on land	Hourly NH ₃ profile for GNFR L from CAMS-REG-TEMPOv4.1	Guevara et al. (2021, 2025)	X
090402	Unmanaged waste disposal on land			
090901	Incineration of corpses	Flat profile	Not applicable	X
091001	Waste water treatment in industry			
091002	Waste water treatment in residential/commercial sectors			
091003	Sludge spreading			
091005	Compost production	Hourly NH ₃ profile for GNFR L from CAMS-REG-TEMPOv4.1	Guevara et al. (2021, 2025)	X
091006	Biogas production			
SNAP 10: Agriculture				
All SNAP activities		Hourly NH ₃ profile for GNFR L from CAMS-REG-TEMPOv4.1	Guevara et al. (2021, 2025)	X

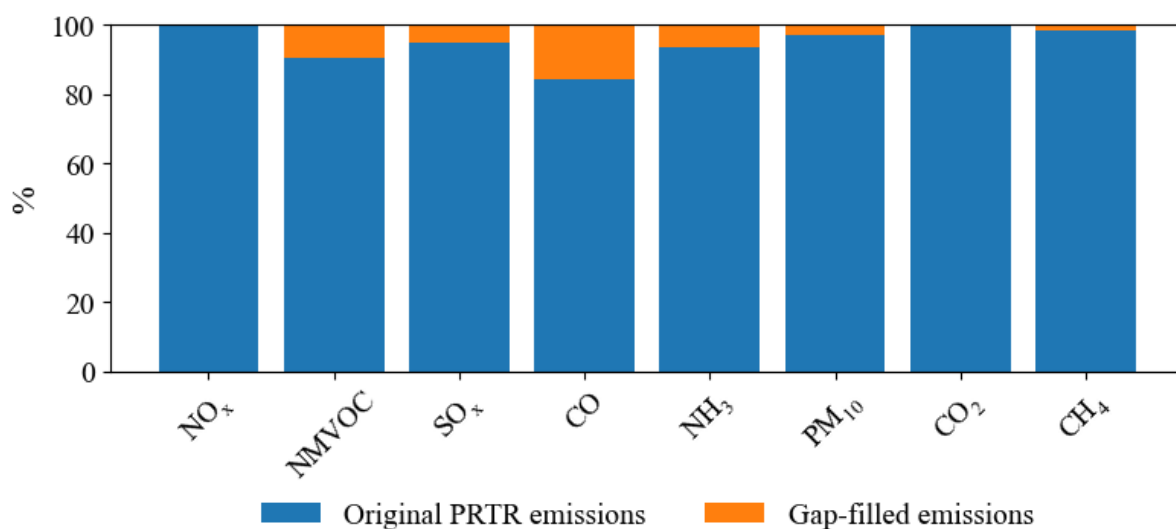


Figure S 1 Contribution of gap-filled emissions to total PRTR emissions considered as input in HERMES_Δ

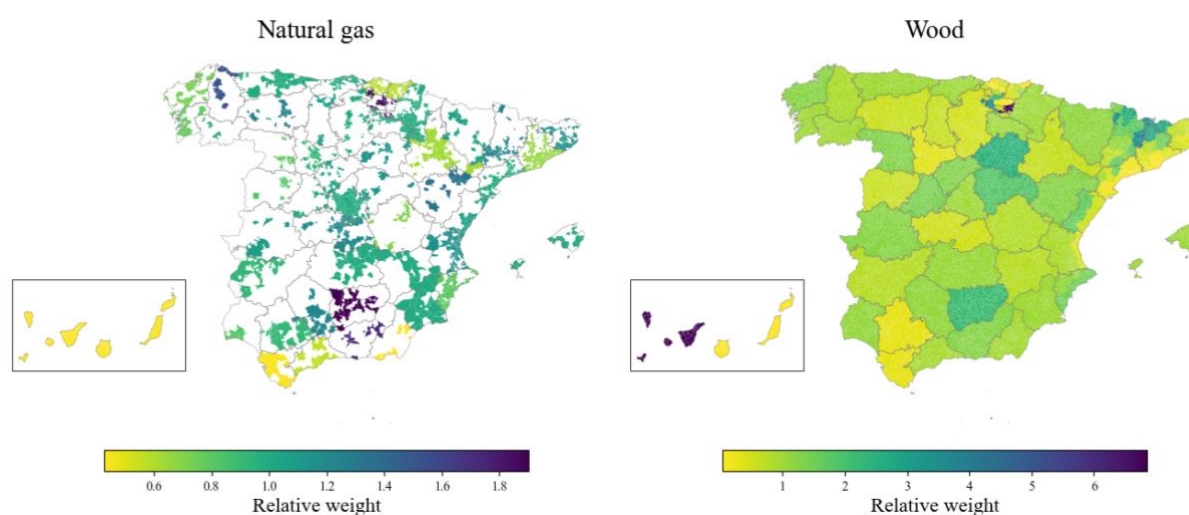


Figure S 2 Map of municipality-level (NUTS4) relative weight factors considered for residential and commercial emissions related to natural gas and wood combustion. This information is considered by HERMES_Δ to rebalance the original GHSL population density information. NUTS-level and fuel-dependent weight factors are derived from information on access to the natural gas distribution network (CNMC, 2018), energy consumption per capita associated to space heating (Cuchi et al., 2017) and residential wood combustion (ICAEN, 2025; IDAE, 2025; IVE, 2024; Eustat, 2022).

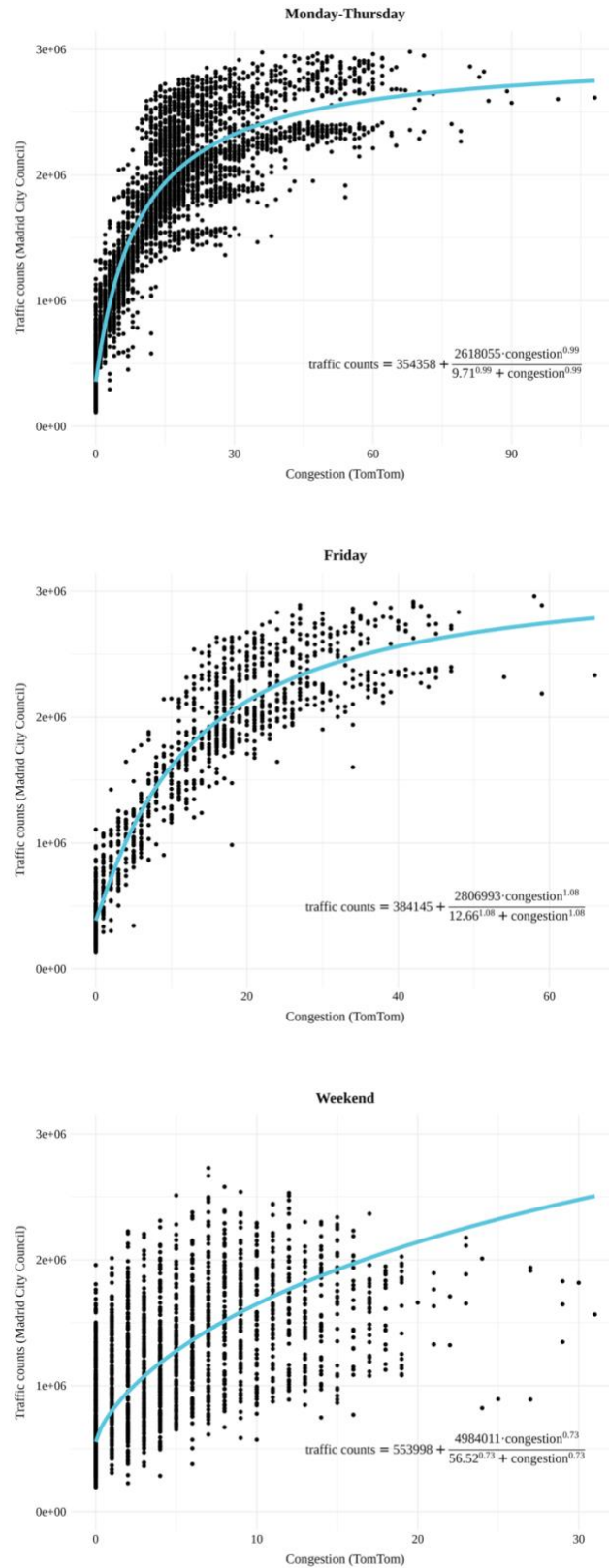


Figure S 3 Representation of sigmoid equations between traffic congestion levels and traffic counts in Madrid for Monday to Thursday day types, Fridays and weekends.

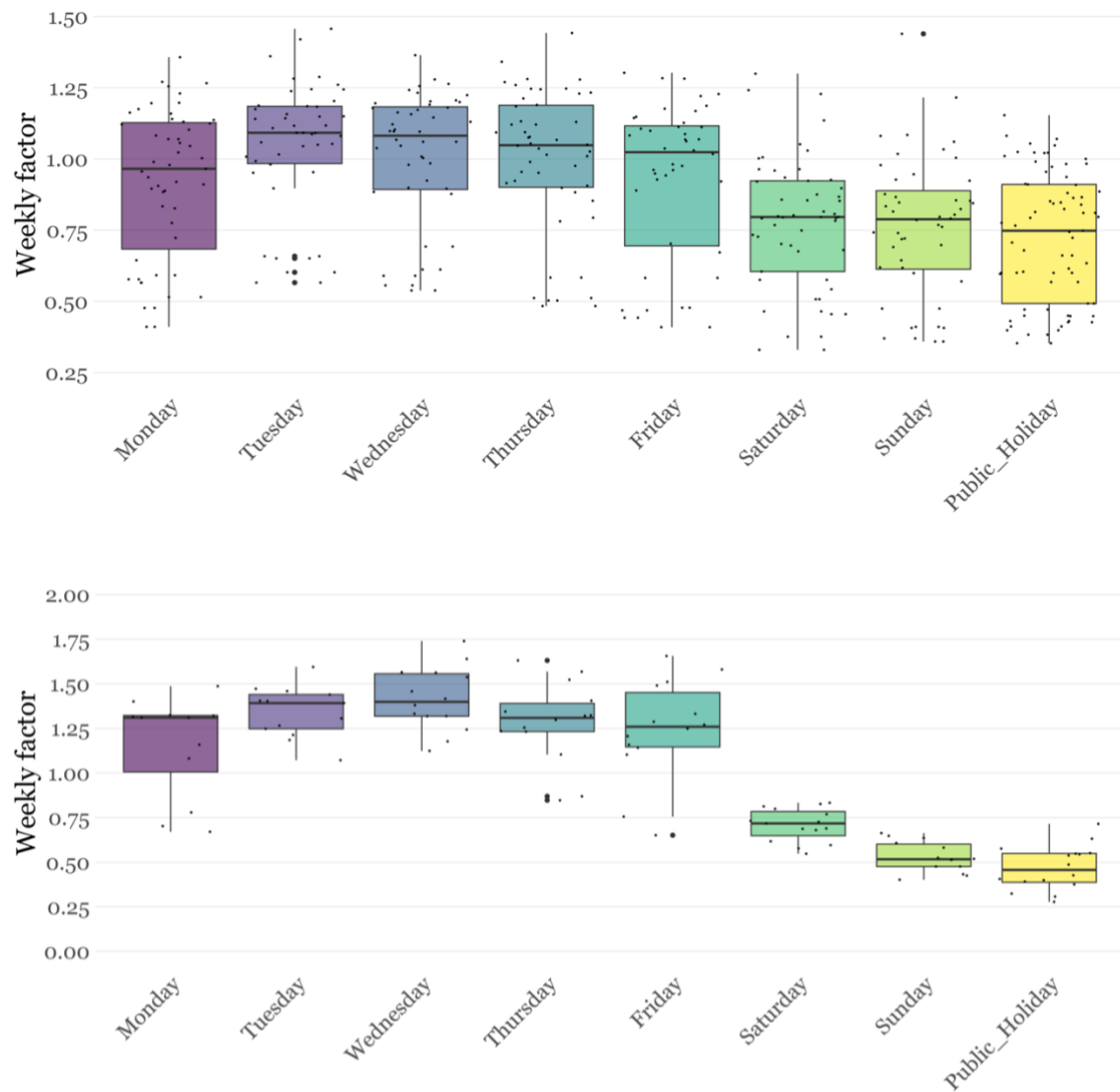


Figure S 4 Weekly profiles constructed for weeks with national holidays for the energy (top) and road transport (bottom) sectors in Spain using 2015-2022 ENTSO-E electricity production statistics (<https://transparency.entsoe.eu/>, last access: 15 May 2026) and 2021-2024 TomTom congestion statistics (<https://www.tomtom.com/traffic-index/>, last access: 15 May 2026).

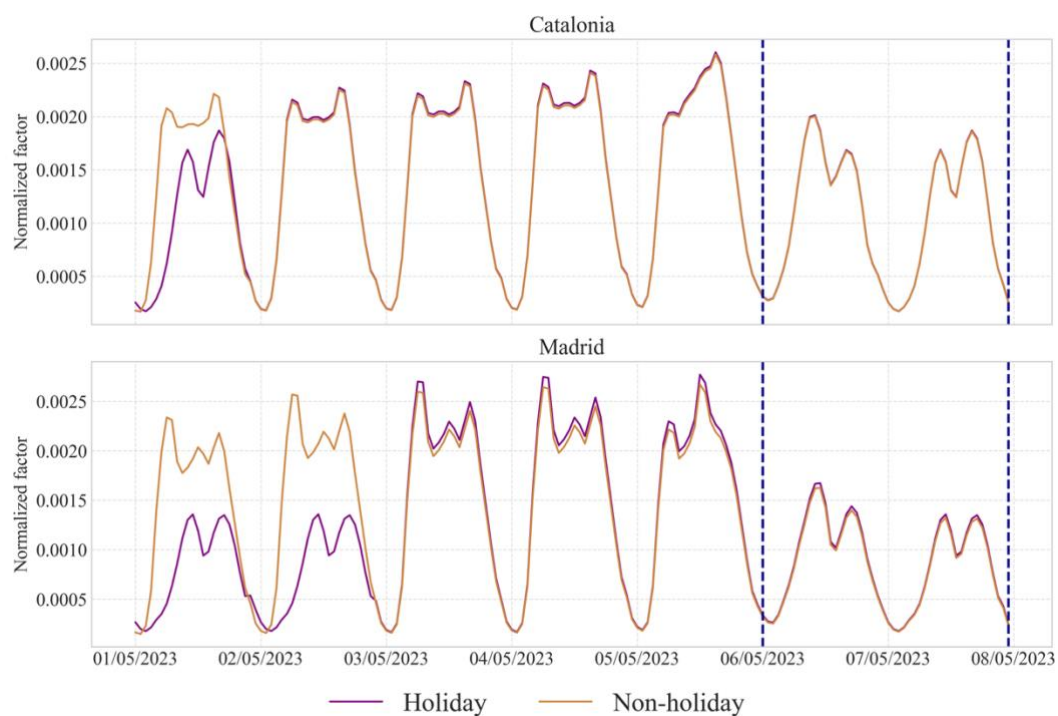


Figure S 5 Normalised hourly temporal factor for the road transport sector estimated by HERMES_Δ for the NUTS2 regions of Catalonia (top) and Madrid (bottom) for the period 1st to 8th of May 2023. Results are presented for the cases where the option of accounting for public holidays is activated (Holiday) and deactivated (non-holiday). When this option is activated, HERMES_Δ treats public national or regional holidays as Sundays. The 1st of May 2023 was a national holiday, while the 2nd of May is a regional holiday in Madrid.

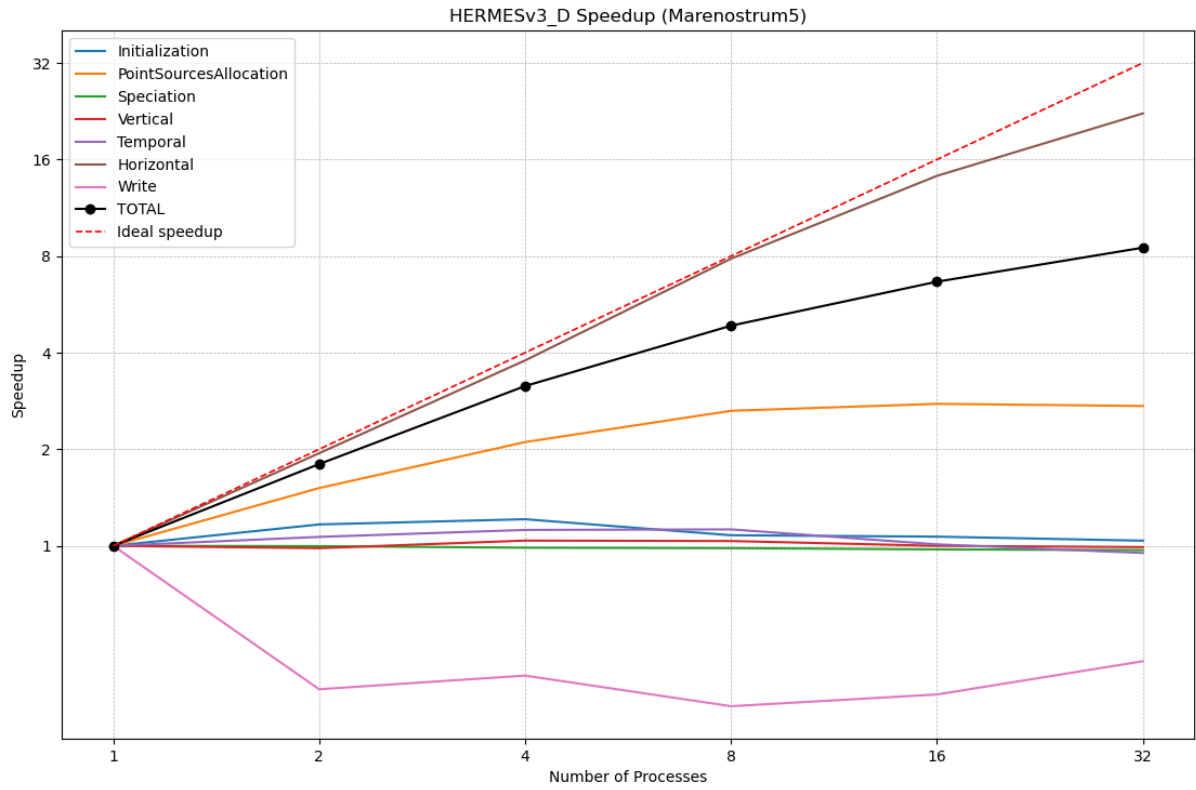


Figure S 6 Speed-up as a function of the number of MPI processes for the HERMES_A workflow on MareNostrum5. The dashed red line represents the ideal linear speed-up. Each curve corresponds to a different processing component, while the black line indicates the total model speed-up. Results are computed from the aggregated execution times obtained from 10 replications after outlier filtering (IQR method, threshold = 1.5). The results shows near-ideal scalability for the horizontal redistribution module and sub-linear behaviour for the overall workflow due to the presence of non-parallel and I/O-bound components.

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