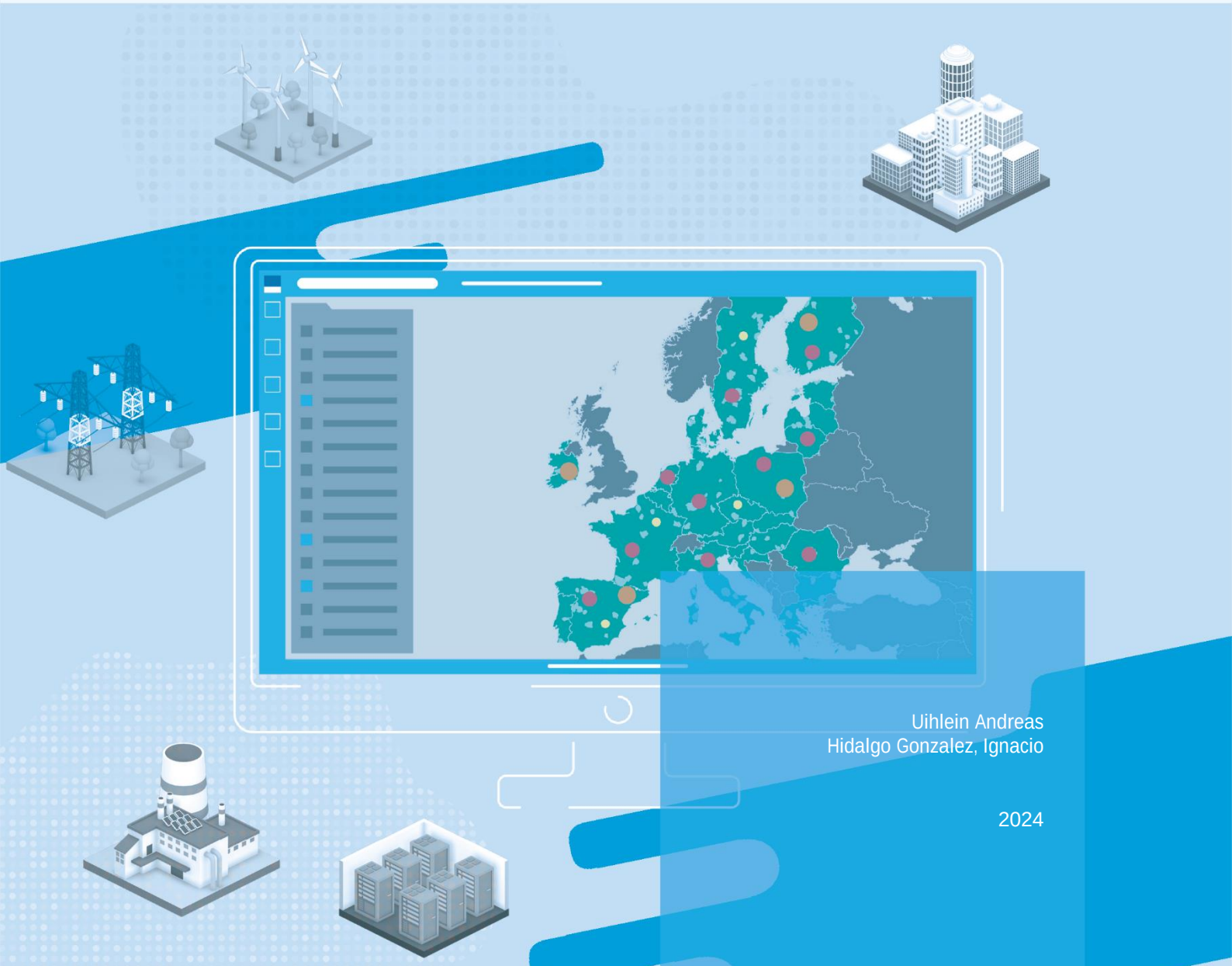
European Commission

Data documentation for the Energy and Industry Geography Lab

Version 1.7



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Abstract

The JRC, together with DG GROW, has developed the Energy and Industry Geography Lab, a tool to map energy, industrial and other infrastructure needed for the industrial transition towards climate-neutrality. The Energy and Industry Geography Lab is a specialised geospatial data management, visualisation and analysis hub and also provides tailor-made access to selected stakeholders to conduct their own analyses.

The Energy and Industry Geography Lab enables the collection, validation, and visualisation of spatial data related to energy, industrial and other relevant infrastructure (e.g. roads, ports), underlying baseline data (e.g. country borders, land cover) and datasets to support the development of renewables. This report documents the datasets and layers included in the Energy and Industry Geography Lab. It describes how data was acquired, and processed before being included in the Energy and Industry Geography Lab.

This report is work in progress and will be continuously updated. The latest version of this document as well as a metadata table for all data sources can always be accessed at: https://ec.europa.eu/energy-industry-geography-lab.

1 Introduction

The Energy and Industry Geography Lab maps the energy, industrial and other infrastructure needed for the industrial transition towards climate-neutrality. It underpins the European Commission's work for the European Green Deal with spatial data and related assessments. The Energy and Industry Geography Lab also provides datasets related to the identification of go-to areas for renewables to support Member States, researchers, infrastructure planners, and the general public, to conduct their own analyses.[1]

The Energy and Industry Geography Lab enables the collection, validation, and visualisation of spatial data related to energy, industrial and other relevant infrastructure (e.g. roads, ports) and the underlying baseline data (e.g. country borders, land cover). It supports the policy making process by providing possibilities for better data management, visual analyses, data exploration, queries, and data export, acting as a specialised geospatial information tool.

This report documents the datasets and layers included in Energy and Industry Geography Lab. It describes how data was acquired, and processed before being included in Energy and Industry Geography Lab. This report is work in progress and will be continuously updated. The latest version of this document as well as the metadata table can always be accessed at: https://ec.europa.eu/energy-industry-geography-lab.

[1] The Energy and Industry Geography Lab supports the "Masterplan for a Competitive Transformation of EU Energy-intensive Industries Enabling a Climate-neutral, Circular Economy by 2050" by mapping energy and non-energy infrastructure and supply, underpinned by technologies for industrial transformation in support of climate-neutral industry (High-Level Group on Energy-intensive Industries, 2019). It also supports Member States to identify renewables "go-to areas" for the rapid deployment of new renewable energy projects as described in the recent Commission Recommendation on accelerating permitting for renewable energy projects and facilitating Power Purchase Agreements.

2 Administrative units and borders

2.1 NUTS information

Eurostat has several datasets related to administrative units[2]. For EIGL, we have chosen the NUTS 2021 geoJSON version at 1:3 million scale. In addition, the NUTS 2013 and 2016 geoJSON data at 1:3 million scale was downloaded as well for data that uses older NUTS versions.

2.2 Exclusive economic zones

This dataset, prepared by Eurostat is a global dataset containing multipart polygon feature classes of the Exclusive Economic Zones.[3]

This dataset was used to display the offshore wind potential from ENSPRESO (Section 11.1.1).

[2] Eurostat GISCO web page: https://ec.europa.eu/eurostat/web/gisco/geodata/reference-data/administrative-units-statistical-units/nuts#nuts21

[3] Data has been edited by GISCO to show areas of dispute or joint sovereignty and to align to the GISCO Countries and NUTS dataset 2021

3 Energy infrastructure – production

3.1 JRC-PPDB-OPEN

The version 1.0 of the JRC-PPDB-OPEN was downloaded[4] from JRC Data Catalogue[5], the Data for the Energy Union collection[6].

The database consists of four tables detailed below (Kanellopoulus et al., 2017):

- JRC_OPEN_UNITS: characteristics of the individual power plant units
- JRC_OPEN_LINKAGES: mapping of the keys and id codes for several datasets
- JRC_OPEN_PERFORMANCE: indicators for a subset of units
- JRC_OPEN_TEMPORAL: yearly statistics for a subset of units

Table 1 Fields in table JRC_OPEN_UNITS

Field	SQL Type	Description
eic_p	varchar(20)	EIC (Energy Identification Code[7]) for the producing unit
eic_g	varchar(20)	EIC (Energy Identification Code) for the generation unit
name_p	text	Production unit name
name_g	text	Generating unit name
capacity_p	text	Production unit capacity, net (MW)
capacity_g	text	Generating unit capacity, net (MW)
type_g	text	ENTSO-E classification for the generation unit[8]
lat	text	Latitude (WGS84)
lon	text	Longitude in the range -180, 180 (WGS84)
country	varchar(40)	Name of the country
NUTS2	text	NUTS2 code according to the NUTS 2016 definition[9]
status_g	text	Status of the generating unit[10]
year_commissioned	text	Year of commissioning
year_decommissioned	text	Year of decommissioning
water_type	text	Water type (Freshwater, Seawater)
cooling_type	text	Type of cooling device[11]
water_withdrawal	float	
water_consumption	float	

Source: JRC 2021

Table 2 Fields in table JRC_OPEN_LINKAGES

Field	SQL Type	Description
eic_p	varchar(20)	EIC (Energy Identification Code) for the producing unit
eic_g	varchar(20)	EIC (Energy Identification Code) for the generation unit
eprtr_facilityID	varchar(10)	Facility ID in E-PRTR
WRI_id	varchar(20)	ID in WRI Power Watch
GEO_id	varchar(20)	ID in Global Energy Observatory
fresna_id	int	ID in FIAS Renewable Energy Systems & Network Analysis

Source: JRC 2021

Table 3 Fields in table JRC_OPEN_PERFORMANCE

Field	SQL Type	Description
eic_p	varchar(20)	EIC (Energy Identification Code) for the producing unit
eic_g	varchar(20)	EIC (Energy Identification Code) for the generation unit
min_load	float	Stable load, % of installed net capacity
ramp_up	float	Ramp-up capability, % of installed net capacity per minute

4 JRC-PPDB-OPEN link: https://data.europa.eu/data/datasets/9810feeb-f062-49cd-8e76-8d8cfd488a05?locale=en (Zenodo download link https://doi.org/10.5281/zenodo.3266807)

5 JRC Data Catalogue: https://data.jrc.ec.europa.eu/

6 The collection Data for Energy Union: https://data.jrc.ec.europa.eu/collection/id-0115

7 https://www.entsoe.eu/data/energy-identification-codes-eic/

8 The ENTSO-E production types are the following: Fossil Peat, Nuclear, Fossil Hard coal, Wind Onshore, Fossil Brown coal/Lignite, Geothermal, Hydro Run-of-river and poundage, Hydro Water Reservoir, Wind Offshore, Hydro Pumped Storage, Other renewable, Solar, Fossil Oil shale, Waste, Fossil Gas, Fossil Coal-derived gas, Fossil Oil, Marine, Other, Biomass

9 https://ec.europa.eu/eurostat/web/nuts/history

10 COMMISSIONED, RESERVE, DECOMMISSIONED, MOTHBALLED and CONSTRUCTION.

11 Types of cooling devices: Air Cooling, Mechanical Draught Tower, Natural Draught Tower, No Cooling, Once-through

Field	SQL Type	Description
ramp_down	float	Ramp-down capability, % of installed net capacity per minute
minimum_up_time	float	Minimum time the unit was in operation during cycling (minute)
minimum_down_time	float	Minimum time the unit was shut down during cycling (minute)
eff	float	Net electrical efficiency of thermal power plants
best_source	text	Source of efficiency estimate

Source: JRC 2021

Table 4 Fields in table JRC_OPEN_TEMPORAL

Field	SQL Type	Description
eic_p	varchar(20)	EIC (Energy Identification Code) for the producing unit
eic_g	varchar(20)	EIC (Energy Identification Code) for the generation unit
type_g	text	Type of generation unit[12]
cyear	Int	Year that the record refers to
Generation	float	Sum of reported generation in the time series in MWh
Cf	float	Capacity factor of plant operation in the published record set
time_coverage	float	Fraction of the total hours in a year covered
co2emitted	float	Kg of CO2 emitted/year based on the reported annual emissions

Source: JRC 2021

The data uploaded to the EIGL database are stored in the table JRC_OPEN_PPDB_JOINED (Table 5).

Table 5 Fields in table JRC_OPEN_PPDB_JOINED

Field	SQL Type	Description
eic_p	varchar(20)	EIC (Energy Identification Code13) for the producing unit
eic_g	varchar(20)	EIC (Energy Identification Code) for the generation unit
name_p	text	Production unit name
name_g	text	Generating unit name
capacity_p	text	Production unit capacity, net (MW)
capacity_g	text	Generating unit capacity, net (MW)
type_g	text	ENTSO-E classification for the generation unit14
lat	text	Latitude (WGS84)
lon	text	Longitude in the range -180, 180 (WGS84)
country	varchar(40)	Name of the country
nuts2	text	NUTS2 code according to the NUTS 2016 definition15
status_g	text	Status of the generating unit16
year_commissioned	text	Year of commissioning
year_decommissioned	text	Year of decommissioning
min_load	float	Stable load, % of installed net capacity
ramp_up	float	Ramp-up capability, % of installed net capacity per minute
ramp_down	float	Ramp-down capability, % of installed net capacity per minute
minimum_up_time	float	Minimum time the unit was in operation during cycling (minute)
minimum_down_time	float	Minimum time the unit was shut down during cycling (minute)
eff	float	Net electrical efficiency of thermal power plants
best_source	text	Source of efficiency estimate
2015_generation	float	Sum of reported generation in the time series in MWh, 2015
2015_cf	float	Capacity factor of plant operation in the published record set, 2015
2015_time_coverage	float	Fraction of the total hours in a year covered, 2015
2015_co2emitted	float	Kg of CO2 emitted/year based on the reported annual emissions, 2015
2016_generation	float	Sum of reported generation in the time series in MWh, 2016
2016_cf	float	Capacity factor of plant operation in the published record set, 2016
2016_time_coverage	float	Fraction of the total hours in a year covered, 2016
2016_co2emitted	float	Kg of CO2 emitted/year based on the reported annual emissions, 2016
2017_generation	float	Sum of reported generation in the time series in MWh, 2017
2017_cf	float	Capacity factor of plant operation in the published record set, 2017
2017_time_coverage	float	Fraction of the total hours in a year covered, 2017
2017_co2emitted	float	Kg of CO2 emitted/year based on the reported annual emissions, 2017
2018_generation	float	Sum of reported generation in the time series in MWh, 2018

[12] Types of generation units are the following: Fossil Hard coal, Fossil Oil, Hydro Run-of-river and poundage, Biomass, Fossil Gas, Fossil Brown coal/Lignite, Hydro Pumped Storage, Hydro Water Reservoir, Fossil Peat, Nuclear, Wind Offshore, Wind Onshore, Fossil Oil shale, Fossil Coal-derived gas, Geothermal, Other, Waste

[13] https://www.entsoe.eu/data/energy-identification-codes-eic/

[14] The ENTSO-E production types are the following: Fossil Peat, Nuclear, Fossil Hard coal, Wind Onshore, Fossil Brown coal/Lignite, Geothermal, Hydro Run-of-river and poundage, Hydro Water Reservoir, Wind Offshore, Hydro Pumped Storage, Other renewable, Solar, Fossil Oil shale, Waste, Fossil Gas, Fossil Coal-derived gas, Fossil Oil, Marine, Other, Biomass

[15] https://ec.europa.eu/eurostat/web/nuts/history

[16] COMMISSIONED, RESERVE, DECOMMISSIONED, MOTHBALLED and CONSTRUCTION.

Field	SQL Type	Description
2018_cf	float	Capacity factor of plant operation in the published record set, 2018
2018_time_coverage	float	Fraction of the total hours in a year covered, 2018
2018_co2emitted	float	Kg of CO2 emitted/year based on the reported annual emissions, 2018

Source: JRC 2021

3.2 JRC hydropower plants

The JRC has developed a hydropower plant database which is available at the JRC data catalogue: https://data.jrc.ec.europa.eu/dataset/52b00441-d3e0-44e0-8281-fda86a63546d.

This dataset was an output of the Energy work package of the Water-Energy-Food-Ecosystems (WEFE) Nexus project at the European Commission's Joint Research Centre (JRC). This dataset has been created for power system modelling purposes and it is based on publicly available sources.

The JRC hydropower plant database will be integrated in JRC-PPDB-OPEN soon.

4 Energy infrastructure – networks

4.1 Power

4.1.1 GridKit based on ENTSO-E

The GridKit datasets are available for download at Github and have been developed by the PyPSA (Python for Power System Analysis) project: https://github.com/PyPSA/pypsa-eur/tree/master/data/entsoegridkit. More information on GridKit is available here: https://github.com/bdw/GridKit.

The GridKit dataset is based on a ENTSO-E map extract from March 2022. It is neither approved nor endorsed by ENTSO-E.

For EIGL, we have selected the following datasets from GridKit: buses, lines, and links.

- Buses: Describes terminals, vertices, or 'nodes' of the system
- Lines: Buses are connected by AC-lines:
- Links: Connections between buses:

For the fields "under construction" and "underground", we replaced 't' and 'f' by 'true' and 'false', respectively.

4.1.2 SciGRID Power

The whole SciGrid Power database was downloaded from https://www.power.scigrid.de/. The version used was the SciGRID conference release Europe complete.

From SciGrid Power, 2 datasets are derived:

- "Raw" data on power infrastructure from OpenStreetMap
- The SciGrid network model

4.1.2.1 Raw data based on OpenStreetMap

The downloaded data was first unzipped. The PBF file: eu_power_160718.osm.pbf has been imported in QGIS and the layers were added to the map.

- The layer 'eu_power_160718 lines' is the layer representing power lines
- The layer 'eu_power_160718 multipolygons' represents bigger power infrastructure, such as offshore wind farms, or substations

The two layers from QGIS have been saved in geoJSON format. Next, some nested geoJSON attributes that have been collected in the field 'other_tags' have been retrieved using a KNIME workflow () .[17] The workflow is named eigl_scigrid_power.knwf and available at: N:\C.7\EIGL\Data\PUBLIC-PUBLIC\SciGridPower.

The results of the workflow have been saved as CSV files. The resulting CSV files have been imported to QGIS and linked to the geojson layers. Finally, the resulting layers have been saved in geoJSON format.

Table 6 Other tags retrieved for the eu_power_lines dataset from SciGRID Power

Tag	Description	Column name in EIGL
voltage	The voltage at which the line is operated. May be semicolon-separated if there are multiple voltages.	voltage
cables	The number of different phase conductors for this power line.	cables
wires	The bundle form factor for each conductor of the power line	Wires
frequency	The frequency in hertz at which the power line is operating. May be semicolon-separated if there are multiple frequencies.	frequency_hz
name	The name of this power line	name
operator	The name of the company which operates this power line	operator
ref	The reference of this power line	reference
length_m	Length of the power line in m	length_m
r_ohmkm	Cable resistance in Ω per km	resistance_ohm_km
x_ohmkm	Cable reactance in Ω per km	reactance_ohm_km

[17] The OSM wiki provides some explanations for commonly used tags: https://wiki.openstreetmap.org/wiki/Tag:power%3Dline

Tag	Description	Column name in EIGL
c_nfkm	Cable capacitance in nF per km	capacitance_nf_km
i_th_max_a	Maximum current thermal limit in Ampere	thermal_limit_a

Source: JRC 2021

4.1.2.2 SciGrid network model

The downloaded data was first unzipped. The two files to include in EIGL are:

- links_eu_power_160718.csvdata
- vertices_eu_power_160718.csvdata

The file "vertices_eu_power_160718.csvdata" contains some errors: In some rows, data that should be in column J (wkt_srid_4326) is in column K. Those errors were corrected.

Also, the file "links_eu_power_160718.csvdata" contains some errors: The wkt_srid_4326 is split due to the fact a comma is used in the SRID definition column:

'SRID=4326;LINESTRING(9.52257601112577 52.3604090734199,9.11321011483187 52.5438533448625)'

Corrections have been made and the ' have been removed from the column. Finally the 2 datasets were exported in geoJSON format for EIGL.

4.2 Gas

4.2.1 SciGRID Gas

The whole SciGRID gas database was downloaded from https://www.gas.scigrid.de/downloads.html.

The 2 datasets used are the IGGIN dataset and the EMAP dataset. The EMAP_Raw dataset results from the digitalisation of the 2019 ENTSOG Transmission Capacity Map. The IGGIN dataset is a collection of open source European gas transport data.

4.2.1.1 EMAP Raw

The downloaded data includes four geoJSON files that have been imported to a QGIS file: Nodes, PipeSegments, Productions, Storages. For 2 layers, additional data was found in nested form in the provided geoJSON files:

- EMAP_Raw_Nodes.geojson
- EMAP_Raw_PipeSegments.geojson

A KNIME workflow was set up to un-nest the information needed. The results of the workflow were saved and the datasets were enriched in QGIS with the un-nested information.

4.2.1.2 IGGIN dataset

The downloaded data includes eight geoJSON files that have been imported to a QGIS file: BorderPoints, Compressors, EntryPoints, InterConnectionPoints, LNGs, Nodes, PipeSegments, and Storages.

All layers included additional data in nested form in the geoJSON files. A KNIME workflow was set up to un-nest the information needed. The results of the workflow were saved and the datasets were enriched in QGIS with the un-nested information.

4.3 Oil infrastructure

During 2022, the JRC has collected publicly available information on oil infrastructure such as refineries, terminals and pipelines. The main sources used are:

- The EIGL industrial dataset (combined ETS-EPRTR dataset)
- Petroleum Economist Ltd, 'Pipeline infrastructure map of Europe & the CIS', 2010. https://geodata.lib.utexas.edu/catalog/princeton-jd473067j
- Oil and Gas Journal, 'World Refinery Survey'. 2018.
- S&P Global Platts news

- IHS Markit news

Two datasets have been included in EIGL: Oil terminals and oil pipelines. The oil terminals dataset includes information on: terminal name and the connection to pipelines (crude/products) and refineries. The oil pipeline dataset includes (if available) data on"

- Number of pipes
- Diameter
- Nominal capacity and observed flow
- Type (crude/products)
- Origin and destination nodes

5 Industrial infrastructure

5.1 Facilities of the energy-intensive industry (ETS and E-PRTR combined)

The JRC has prepared a consolidated dataset of the facilities of the energy-intensive industry. This dataset includes information from both ETS and E-PRTR and matches facilities from both databases. In addition, industry stakeholders has reviewed and contributed to the validation and completion of information.

The dataset also links to other datasets (e.g. power plants database in the case where industrial facilities also include energy generation) and also various commercial sector-specific databases with more technical detail about facilities (e.g. capacity, configurations, age) that are available at JRC C7.

5.2 ETS dataset

DG CLIMA provided the dataset with the installation ID's, activities and addresses. DG CLIMA also enriched the information from ETS:

- NUTS code derived from addresses present in ETS
- NACE code: from national implementation measures which are ETS installation data submitted by EU Member States; not publicly available in the registry

The installations of the EII sectors were filtered according to the NACE codes reported. (see Annex 1).

5.3 E-PRTR dataset

The E-PRTR (European Pollutant Release and Transfer Register) database V3 from December 2020 was downloaded from EEA.[18] Queries were performed for sites, facilities, installations and parts to produce a combined and a consolidated dataset was produced.

Query "Site, Facility, Installation, Part" + sites without facilities or installations (720) + ETS identifiers from "3f2_ETSIdentifiers" + status from "Facilities-details"

The installations of the EII sectors were filtered according to the NACE codes reported. (see Annex 1) as in the case of the EU ETS installation.

5.4 Cement plants (Spatial Finance Initiative)

The Spatial Finance Initiative provides a dataset on global cement facilities here https://www.cgfi.ac.uk/spatial-finance-initiative/geoasset-project/geoasset-databases/. It contains about 3 000 plants and information on owners, plant type, capacity and start year.

For the Energy and Industry Geography Lab, we have selected the European facilities only and performed a matching of the European facilities with the combined E-PRTR/ETS dataset (Section 5.1).

5.5 Steel plants (Spatial Finance Initiative)

The Spatial Finance Initiative provides a dataset on global steel facilities here: https://www.cgfi.ac.uk/spatial-finance-initiative/geoasset-project/geoasset-databases/. It contains about 1 600 plants and information on owners, plant type, capacity and start year.

For the Energy and Industry Geography Lab, we have selected the European facilities only and performed a matching of the European facilities with the combined E-PRTR/ETS dataset (Section 5.1).

[18] https://www.eea.europa.eu/data-and-maps/data/industrial-reporting-under-the-industrial-3

6 Hydrogen infrastructure

6.1 Hydrogen production at NUTS3 level

The JRC has gathered data about hydrogen production plants from various commercial sources (HydrogenTools, 2021; International Energy Agency (IEA), 2021; Powermag, 2021; Yamaguchi et al., 2020)

From those sources, a consolidated dataset has been built that includes current and future hydrogen production facilities. The data collected includes information about the facility type (e.g. captive, merchant, by-product), start and end year of the facility, process and power source used.

Since specific terms and conditions for using the data sources mentioned apply we have produced an aggregated dataset at NUTS3 level.

6.2 Hydrogen production facilities (JRC dataset)

Based on detailed data from various commercial and open sources, the JRC has develop an open dataset of hydrogen production facilities including coordinates and information on company, capacity, start year and type of process.

The dataset includes both facilities that are currently in operation as well as planned facilities. The planned facilities are displayed under the layer group "Future projects and scenarios" (Section 13.1.4).

7 Carbon capture and storage infrastructure

7.1 Carbon capture and storage projects (JRC)

During 2022, the JRC launched and external study contract to collect and review geospatial data on existing and future CO_2 infrastructure. In particular, the following data was collected:

- Existing and planned CCS facilities
- Existing and planned CO_2 pipelines

The data collected includes information about the technical characteristics of the facilities and pipelines (e.g. storage type, capture capacity, transport capacity, etc.), their TRL (e.g. demonstration, advanced development), status (e.g., under construction, operational), the relation to other industries (e.g. CCS facility of a given cement plant, etc.) and location (geographical coordinates and address).

The three datasets developed are available through EIGL:

- CCS storage facilities
- CCS capture facilities
- CO_2 pipelines

7.2 Carbon capture, utilisation and storage projects (CATF)

The Clean Air Task Force (CATF) collects carbon capture projects in the US and Europe. The dataset for Europe was downloaded from: https://www.catf.us/ccstableeurope/. The CATF CCUS database includes data on location, sector, geological formation, status, and year of announcement.

The information about the capacity reported was processed in the following way:

- In case of ranges, only the lower value of the range is used in order to avoid overoptimistic assumptions in EIGL.
- "Unavailable" capacities are considered to be 0 until better information is available.

7.3 CO_2 transport network study (JRC)

The JRC performed a study on a possible future CO_2 transport network. It estimated the evolution of the extent and the investment requirements of the trans-European CO2 transport network from 2025 to 2050 (Tumara et al., 2024).

The study assessed eight different scenarios and the results of the study for all scenarios and the years 2030, 2040, and 2050 are included in the Energy and Industry Geography Lab.

7.4 Potential CO_2 storage (CO2StoP)

The datasets from the CO2 Stop project[19] are available at: https://setis.ec.europa.eu/european-co2-storage-database_en.

For EIGL, we have used the following 3 data layers in KML format:

- Formations2_March12
- StorageUnits_March13
- DaughterUnits_March13

The layers have been imported into a QGIS project and enriched with data from

- Hydrocarbon_Formations.csv
- Hydrocarbon_Storage_Units.csv
- Hydrocarbon_Traps.csv

[19] https://ec.europa.eu/energy/studies/assessment-co2-storage-potential-europe-co2stop_en

Next, some geometries were fixed with the QGIS "Fix Geometries" tool and the Z-value of the layers has been dropped (Drop M/Z values).

8 Transport infrastructure

8.1 Airports

Eurostat has several datasets available at https://ec.europa.eu/eurostat/web/gisco/geodata/reference-data/transport-networks related to airports.

For EIGL, we will use the Airports 2013 1:1 million shapefile. The shapefiles and the DBF files were imported into an ArcGIS Pro project. Next, the dbf files have been linked to the Table AIRP_PT_2013. Unnecessary columns have been removed and the layer was exported as geoJSON file.

8.2 Ports

Eurostat has several datasets at https://ec.europa.eu/eurostat/web/gisco/geodata/reference-data/transport-networks related to ports.

For EIGL, we will use the Ports 2013 1:1 million shapefile. The shapefile PORT_P_2013 and the five DBF files were imported into an ArcGIS Pro project. Next, the dbf files have been linked. Unnecessary columns have been removed and the layer was exported as geoJSON file.

8.3 Road and railroad networks

Eurostat GISCO provides a pan-European dataset called "Transport version 3" which contains railway lines; railway stations; roads; road junctions; level crossings; ferry routes; and customs points.

The following layers have been exported to geoJSON files and used in EIGL:

- Railway stations (1:1 000 000 resolution)
- Railway links (1:3 000 000 resolution)
- Road links (1:4 000 000 resolution)

9 Acceleration areas for renewables

9.1 Natura 2000 and designated areas

9.1.1 Natura 2000

The Natura 2000 data is available for download from the European Environment Agency: https://www.eea.europa.eu/data-and-maps/data/natura-12.

For EIGL, we used the .gpkg (OGC Geopackage) file. An additional column was created based on the sitecode in order to create a URL to the standard data form at the European Environment Agency. An example for such a link is: https://natura2000.eea.europa.eu/Natura2000/SDF.aspx?site=PLB320019.

The type of classification of the Natura 2000 site types is as follows:

- A: SPAs (Special Protection Areas - sites designated under the Birds Directive)
- B: SCIs and SACs (Sites of Community Importance and Special Areas of Conservation - sites designated under the Habitats Directive);
- C: where SPAs and SCIs/SACs boundaries are identical (sites designated under both directives)

The European Environment Agency also provides a dedicated Natura 2000 viewer at: https://natura2000.eea.europa.eu/.

9.1.2 Nationally designated protected areas (CDDA)

The dataset of nationally designated areas (CDDA) is available for download from the European Environment Agency: https://www.eea.europa.eu/data-and-maps/data/nationally-designated-areas-national-cdda-16.

This European inventory of nationally designated protected areas holds information about designated areas and their designation types, which directly or indirectly create protected areas. Version 19 covers data reported until March 2021.

For EIGL, we used the .gpkg (OGC Geopackage) file. Tabular information related to

- DesignatedArea (information on nationally designated sites and designated boundaries reported)
- DesignationType (information about designation types and the national and international legislative instruments)

has not been added yet but will be included in the next update.

9.2 Bird and biodiversity areas

9.2.1 Important bird areas

The data on Important Bird Areas is provided by BirdLife International. It is a collection of data provided by Partners, digitised by the BirdLife Secretariat, or from 3rd parties. The data can be requested here: http://datazone.birdlife.org/site/requestgis and is displayed here: http://datazone.birdlife.org/site/mapsearch.

The Important Bird Areas GIS dataset is available on request for non-commercial use only and the full terms of use are available here: http://datazone.birdlife.org/info/dataterms.

9.2.2 Key biodiversity areas

The data on Key Biodiversity Areas is provided by BirdLife International on behalf of the KBA partnership. The data can be requested here: https://www.keybiodiversityareas.org/kba-data/request

The dataset is available on request for non-commercial use only and the full terms of use are available here: https://www.keybiodiversityareas.org/termsofservice

9.3 Marine environment

9.3.1 Ecologically or biologically significant marine areas

The CBD (Convention on Biological Diversity) secretariat provides information about Ecologically or Biologically Significant Marine Areas at: https://www.cbd.int/ebsa/. The EBSA data was provided through the CBD Secretariat directly.

The EBSAs for the Northeast Atlantic have not been finalised by the CBD COP and are not included yet in the dataset.

9.3.2 Anthropogenic noise

For underwater noise, two datasets have been used from the European Environment Agency:

- Input of impulsive anthropogenic sound in Europe Seas, Jan. 2020
- Input of continuous anthropogenic sound in Europe Seas, Jan. 2020

They are available from: https://sdi.eea.europa.eu/catalogue/marine/eng/catalog.search#/home or directly at.

9.3.2.1 Impulsive anthropogenic sound

"This raster dataset represents input of impulsive anthropogenic sound in Europe Seas. Impulsive sounds are typically brief with a rapid rise time, i.e. a great change in amplitude over a short period of time. The main anthropogenic sources of impulsive underwater noise are typically impact pile driving for inshore and offshore construction, seismic exploration with airguns, explosions and sonar systems."[20]

The TIFF raster file was converted into vector data using ArcGIS PRO.

9.3.2.2 Continuous anthropogenic sound

"This raster dataset represents the input of continuous anthropogenic sound in the European Seas. Continuous anthropogenic underwater noise is found in the entire European marine area and is mainly produced by maritime traffic. As no thresholds for pressure have been agreed yet, even areas of low or infrequent maritime traffic are included as pressures. This dataset uses shipping density as a representation of distribution of continuous underwater noise."[21]

The TIFF raster file was converted into vector data using ArcGIS PRO.

9.3.3 Human pressure on marine species

This dataset presents the potential combined effects of human activities and pressures on marine species and habitats. The dataset is available for downloaded from the EEA.

The GTiff file was reprojected and rasterised into vector cells using QGIS. The human pressure is represented on a continuous scale from 0 to 20. A new column in the attribute table was added to classify the values from 0-20. In a next step, the dissolve function was used to merge all polygons that have the same "value for the potential human pressure.

9.4 Soil

The peatland maps of Europe was obtained from a journal article that presents, for the first time, a comprehensive peatland map for the whole of Europe (Tanneberger et al., 2017). The article and underlying data is accessible at: http://mires-and-peat.net/pages/volumes/map19/map1922.php.

The TIFF raster file was converted into vector data using ArcGIS PRO.

[20] https://sdi.eea.europa.eu/catalogue/marine/eng/catalog.search#/metadata/0ab524a2-fd09-4185-adc8-58998efe8f23

[21] https://sdi.eea.europa.eu/catalogue/marine/eng/catalog.search#/metadata/a86f0051-c971-4492-84b2-eb42aaab5fa9

9.5 Bird tracking data

The Energy and Industry Geography Lab is aiming to offer more data on bird migratory routes and fly paths in future. So far, only data from a pelican tracking study has been included.

9.5.1 Dalmatian pelican tracking data

The Society for the protection of Prespa[22] studied the movement of Dalmatian pelicans between 2012 and 2020. The dataset was also made available on Movebank, which is a database of animal tracking data: https://www.movebank.org/cms/webapp?gwt_fragment=page=studies,path=study9165543.

9.6 Occurrence of threatened species

This dataset was developed by the JRC's Digital Observatory for Protected Areas (DOPA) during 2023-2024. We used spatial datasets on species ranges from the International Union for Conservation of Nature (IUCN) Red List, and Birdlife International (Birdlife International, 2022; IUCN, 2022). Non-spatial information both at global and European level was used to classify:

- Status (e.g. critically endangered, endangered, vulnerable)
- Endemicity
- Threats[23]

The information was processed for (among others) amphibians, reptiles, birds, mammals. The spatial processing identifies both checklist and species richness, within and outside protected areas, globally. Non-protected ranges of species potentially threatened by renewable energy installations were identified globally, cross-referencing this spatial information with the aforementioned tabular attributes on status and threats.

Within the 1013 species for which exist both spatial data and assessment, 97 are declared, at global and/or EU level, potentially threatened by renewable energy plants; 28 are simultaneously threatened OR endemic (at global and/or EU level), and potentially threatened by renewable energy plants (Table 7).

Table 7 Number of species threatened by renewable energy installations

Class	Threatened by renewable energy installations	EU threatened OR Endemic and threatened by renewable energy installations
Amphibians	4	1
Reptiles		
Birds	89	24
Mammals	4	3
Total	97	24

Source: JRC 2024

The final selection includes the 97 species for which the following characteristics are simultaneously valid:

- assessed at EU level
- mapped within one of the taxa-specific European geographic domains
- for which REP are listed among potential threats (at global OR European level).

The richness (by taxon) of the above species is mapped, overlapped with the relevant protection mask derived from (WDPA, 2023).

All the details will be made available soon through a JRC report (Mandrici et al., Forthcoming).

[22] https://www.spp.gr/index.php?option=com_content&view=frontpage&Itemid=1&lang=en
[23] Hierarchical classification scheme from IUCN with 12 classes which includes class: 3.3 Renewable energy

9.7 Industrial and waste water facilities

9.7.1 Waste water treatment plants

Information about the reporting related to the urban waste water treatment directive is available at EEA: https://www.eea.europa.eu/data-and-maps/data/waterbase-uwwtd-urban-waste-water-treatment-directive-7.

The dataset contains data reported by Member States under UWWTD reporting obligations, mainly on: reported period, agglomerations, urban waste water treatment plants, and discharge points.

For EIGL, we were using the UWWTD GIS shapefile: https://cmshare.eea.europa.eu/s/cAbQYKo9JH5E53F.

9.7.2 Facilities of the E-PRTR

This dataset uses the same source as described in Section 9.10.2. However, we display all facilities of the E-PRTR not only the ones of the energy-intensive industries. The facilities have been grouped into six main categories:

- Agriculture, forestry and fishing
- Mining and quarrying
- Manufacturing
- Energy
- Water supply
- Other

9.8 Soil

9.8.1 Peatland maps of Europe

The peatland maps of Europe was obtained from a journal article that presents, for the first time, a comprehensive peatland map for the whole of Europe (Tanneberger et al., 2017). The article and underlying data is accessible at: http://mires-and-peat.net/pages/volumes/map19/map1922.php.

The TIFF raster file was converted into vector data using ArcGIS PRO.

9.9 Bird tracking data

The Energy and Industry Geography Lab is aiming to offer more data on bird migratory routes and fly paths in future. So far, only data from a pelican tracking study has been included.

9.9.1 Dalmatian pelican tracking data

The Society for the protection of Prespa[24] studied the movement of Dalmatian pelicans between 2012 and 2020. The dataset was also made available on Movebank, which is a database of animal tracking data: https://www.movebank.org/cms/webapp?gwt_fragment=page=studies,path=study9165543.

9.10 Industrial and wastewater facilities

9.10.1 Waste water treatment plants

Information about the reporting related to the urban waste water treatment directive is available at EEA: https://www.eea.europa.eu/data-and-maps/data/waterbase-uwwtd-urban-waste-water-treatment-directive-7.

The dataset contains data reported by Member States under UWWTD reporting obligations, mainly on: reported period, agglomerations, urban waste water treatment plants, and discharge points.

For EIGL, we were using the UWWTD GIS shapefile: https://cmshare.eea.europa.eu/s/cAbQYKo9JH5E53F.

[24] https://www.spp.gr/index.php?option=com_content&view=frontpage&Itemid=1&lang=en

9.10.2 Facilities of the E-PRTR (EEA)

For the facilities of the E-PRTR, the same dataset as described in Section (5.3) is used. However, the installations were not filtered but instead grouped by NACE code groups into six main categories:

- Agriculture, forestry and fishing
- Mining and quarrying
- Manufacturing
- Energy
- Water supply
- Other

10 Energy atlas

The JRC has recently developed a high-resolution EU energy atlas. It consists of a series of EU maps with the demand of the main groups of energy products from each category of economic activity, zooming in at an unprecedented level of 1x1 km (Hidalgo Gonzalez and Uihlein, 2023).

The energy atlas is presented in a storymap here: https://energy-industry-geolab.jrc.ec.europa.eu/energy-atlas/ and the datasets are available at: https://data.jrc.ec.europa.eu/dataset/76a6b550-253c-44a4-9a4c-d22079e7bf62.

Selected datasets of the energy atlas have been included in the Energy and Industry Geography Lab.

11 Renewable energy potential

11.1 ENSPRESO – Potential for wind, solar, biomass

11.1.1 ENSPRESO Wind

The ENSPRESO datasets were downloaded from the JRC data catalogue.[25] A selection and cleaning process followed the download.

11.1.1.1 Onshore wind

The following assumptions were made for onshore wind:

- The reference scenario will be displayed at EIGL
- The aggregated potential for all sites with CF>20% will be used (the sum of 20 % < CF < 25 % and CF > 25 %)
- Three layers will be produced: capacity, production and share of land used
- Each layer will also contain the data for the other 2 scenarios (low and high)

Table 8 Columns and data for the layer "Onshore wind potential capacity in GW"

Column code	Column description
nuts2_code_2013	NUTS 2 code
wind_onshore_capacity_gw_medium	Data for reference scenario (Reference - Large turbines)
wind_onshore_capacity_gw_low	Data for low scenario (1200m from settlements)
wind_onshore_capacity_gw_high	Data for high scenario (400m from settlements)

Source: JRC 2021

Table 9 Columns and data for the layer "Onshore wind potential production in TWh"

Column code	Column description
nuts2_code_2013	NUTS 2 code
wind_onshore_production_twh_medium	Data for reference scenario (Reference - Large turbines)
wind_onshore_production_twh_low	Data for low scenario (1200m from settlements)
wind_onshore_production_twh_high	Data for high scenario (400m from settlements)

Source: JRC 2021

Table 10 Columns and data for the layer "Onshore wind land use in % of land"

Column code	Column description
nuts2_code_2013	NUTS 2 code
wind_onshore_land_use_%_medium	Data for reference scenario (Reference - Large turbines)
wind_onshore_land_use_%_low	Data for low scenario (1200m from settlements)
wind_onshore_land_use_%_high	Data for high scenario (400m from settlements)

Source: JRC 2021

From the original file, all the data from the sheet "Raw data" was copied to the cleaning file. Three pivot ables have been constructed that filter the data according to the assumptions.

11.1.1.2 Offshore wind

The following assumptions for offshore wind are taken:

- The reference scenario will be displayed at EIGL
- The aggregated potential for all sites with CF > 20 % will be used (the sum of 20 % < CF < 25 % and CF > 25 %)
- Two layers will be produced: capacity, and production

Each layer will also contain the data for the other 2 scenarios (low and high) and water depth

[25] https://data.jrc.ec.europa.eu/collection/id-00138

Table 11 Columns and data for the layer "Offshore wind potential capacity in GW"

Column code	Column description
nuts2_code	NUTS 2 code
wind_offshore_capacity_gw_medium_total	*Data for reference scenario – total*
wind_offshore_capacity_gw_low_total	Data for low scenario – total
wind_offshore_capacity_gw_high_total	Data for high scenario - total
wind_offshore_capacity_gw_medium_0-30	Data for reference scenario - water depth 0-30m
wind_offshore_capacity_gw_medium_30-60	Data for reference scenario - water depth 30-60m
wind_offshore_capacity_gw_low_0-30	Data for low scenario - water depth 0-30m
wind_offshore_capacity_gw_low_30-60	Data for low scenario - water depth 30-60m
wind_offshore_capacity_gw_high_0-30	Data for high scenario - water depth 0-30m
wind_offshore_capacity_gw_high_30-60	Data for high scenario - water depth 30-60m
wind_offshore_capacity_gw_high_60-100	Data for high scenario - water depth 60-100m
wind_offshore_capacity_gw_high_100-1000	Data for high scenario - water depth 100-1000m
wind_offshore_capacity_gw_high_0-30_12nm	Data for high scenario - water depth 0-30m in 12nm zone
wind_offshore_capacity_gw_high_30-60_12nm	Data for high scenario - water depth 30-60m in 12nm zone
wind_offshore_capacity_gw_high_60-100_12nm	Data for high scenario - water depth 60-100m in 12nm zone

Source: JRC 2021

Table 12 Columns and data for the layer "Offshore wind potential production in TWh"

Column code	Column description
nuts2_code	NUTS 2 code
wind_offshore_production_twh_medium_total	*Data for reference scenario – total*
wind_offshore_production_twh_low_total	Data for low scenario – total
wind_offshore_production_twh_high_total	Data for high scenario - total
wind_offshore_production_twh_medium_0-30	Data for reference scenario - water depth 0-30m
wind_offshore_production_twh_medium_30-60	Data for reference scenario - water depth 30-60m
wind_offshore_production_twh_low_0-30	Data for low scenario - water depth 0-30m
wind_offshore_production_twh_low_30-60	Data for low scenario - water depth 30-60m
wind_offshore_production_twh_high_0-30	Data for high scenario - water depth 0-30m
wind_offshore_production_twh_high_30-60	Data for high scenario - water depth 30-60m
wind_offshore_production_twh_high_60-100	Data for high scenario - water depth 60-100m
wind_offshore_production_twh_high_100-1000	Data for high scenario - water depth 100-1000m
wind_offshore_production_twh_high_0-30_12nm	Data for high scenario - water depth 0-30m in 12nm zone
wind_offshore_production_twh_high_30-60_12nm	Data for high scenario - water depth 30-60m in 12nm zone
wind_offshore_production_twh_high_60-100_12nm	Data for high scenario - water depth 60-100m in 12nm zone

Source: JRC 2021

11.1.2 ENSPRESO Solar

The ENSPRESO datasets were downloaded from the JRC data catalogue.[26] A selection and cleaning process followed the download.

ENSPRESO Solar provides three scenarios for different PV and land efficiency (roofs, facades and open field): 85, 170 and 300 MW/km^2. For EIGL, the results for the 170 MW/km^2 scenario are chosen. It is assumed that 3 % of the available natural areas can be used for solar.

- For EIGL, two layers were produced: potential installed capacity and potential production.
- Data was summed over all 3 types of solar: PV - roof/facades, PV – ground, CSP - before storage
- Each layer also contains the data for the other scenarios (85 Wp/m^2 and 300 MWp/m^2) and according to the three different types

From the original file, all the data from the sheet "NUTS2 170 W per m2 and 3%" was copied and data from the three columns: "PV - roof/facades", "PV - ground", "CSP - before storage" was used per NUTS2 region and a total column was also calculated. Table 13 and Table 14 show the data included in the layers of EIGL.

The medium scenario values (total) were used for displaying the solar potential in EIGL.

Table 13 Columns and data for solar potential capacity in GW

Column code	Column description
nuts2_code_2013	NUTS 2 code
solar_capacity_gw_medium_total	*Data for medium scenario (170 W/m2) – total for all 3 types*

[26] https://data.jrc.ec.europa.eu/collection/id-00138

Column code	Column description
solar_capacity_gw_low_total	Data for low scenario (85 W/m2) – total for all 3 types
solar_capacity_gw_high_total	Data for high scenario (300 W/m2) – total for all 3 types
solar_capacity_gw_medium_pv_roof	Data for medium scenario (170 W/m2) – roof & façade PV
solar_capacity_gw_low_pv_roof	Data for low scenario (85 W/m2) – roof & façade PV
solar_capacity_gw_high_pv_roof	Data for high scenario (300 W/m2) – roof & façade PV
solar_capacity_gw_medium_pv_ground	Data for medium scenario (170 W/m2) – ground PV
solar_capacity_gw_low_pv_ground	Data for low scenario (85 W/m2) – ground PV
solar_capacity_gw_high_pv_ground	Data for high scenario (300 W/m2) – ground PV
solar_capacity_gw_medium_csp	Data for medium scenario (170 W/m2) – CSP
solar_capacity_gw_low_csp	Data for low scenario (85 W/m2) – CSP
solar_capacity_gw_high_csp	Data for high scenario (300 W/m2) – CSP

Source: JRC, 2021.

Table 14 Columns and data for solar potential production in TWh

Column code	Column description
nuts2_code_2013	NUTS 2 code
solar_production_twh_medium_total	*Data for medium scenario (170 W/m2) – total for all 3 types*
solar_production_twh_low_total	Data for low scenario (85 W/m2) – total for all 3 types
solar_production_twh_high_total	Data for high scenario (300 W/m2) – total for all 3 types
solar_production_twh_medium_pv_roof	Data for medium scenario (170 W/m2) – roof & façade PV
solar_production_twh_low_pv_roof	Data for low scenario (85 W/m2) – roof & façade PV
solar_production_twh_high_pv_roof	Data for high scenario (300 W/m2) – roof & façade PV
solar_production_twh_medium_pv_ground	Data for medium scenario (170 W/m2) – ground PV
solar_production_twh_low_pv_ground	Data for low scenario (85 W/m2) – ground PV
solar_production_twh_high_pv_ground	Data for high scenario (300 W/m2) – ground PV
solar_production_twh_medium_csp	Data for medium scenario (170 W/m2) – CSP
solar_production_twh_low_csp	Data for low scenario (85 W/m2) – CSP
solar_production_twh_high_csp	Data for high scenario (300 W/m2) – CSP

Source: JRC, 2021.

11.1.3 ENSPRESO Biomass

The ENSPRESO datasets were downloaded from the JRC data catalogue.[27] A selection and cleaning process followed the download. ENSPRESO considers three main sources of biomass:

- Agriculture sector energy sources considered are energy crops and residues (primary, secondary and solid). "Energy crops" refers to those crops whose primary target is the production of end-use energy carriers: sugar, starchy and oily crops, energy maize silage for biogas, and lignocellulosic biomass. "Primary residues" includes the dry and wet manure coming from cattle than can be gasified. "Secondary residues" refers to olive pits while "solid agricultural" gathers the waste obtained from pruning of permanent crops (namely orchards, vineyards, olives, citrus, nuts) and the straw and stubbles residues.
- Biomass from the forestry sector is classified into roundwood production and primary and secondary residues. The roundwood used for energy purposes is considered. "Primary residues" are logging residues and other pre-commercial thinnings, while the "secondary residues" covers woodchips and pellets, sawdust and black liquor.
- Finally, the waste sector produces energy biomass in the primary and tertiary residues categories. The primary residues consist of residues from landscape care management, roadside verges and abandoned lands. The tertiary residues cover biomass residues from different industries and municipal solid waste.

The following assumptions were made during the processing of the data:

- Three scenarios are considered: High, Medium and Low bioenergy availability scenarios. They differ in assumptions related to land use, agricultural practices, and protected areas.
- Medium scenario will be displayed
- Only the 2030 scenario will be used (in line with ENSPRESO solar and wind)
- Commodities have been aggregated to 3 groups (Table 15)

[27] https://data.jrc.ec.europa.eu/collection/id-00138

- Only information on NUTS2 level will be used; i.e. sludge and municipal waste is not considered

Table 15 Commodities, description and EIGL groups for ENSPRESO Biomass

Commodity	Description	Group
MINBIOAGRW1	Agricultural waste	Agriculture and landscape residues
MINBIOGAS1	Manure solid, liquid	Agriculture and landscape residues
MINBIOFRSR1a	Residues from landscape care	Agriculture and landscape residues
MINBIOCRP11	Bioethanol barley, wheat, grain maize, oats, other cereals and rye	Energy crops
MINBIOCRP21	Sugar from sugar beet	Energy crops
MINBIOCRP31	Miscanthus, switchgrass, RCG	Energy crops
MINBIOCRP41	Willow	Energy crops
MINBIOCRP41a	Poplar	Energy crops
MINBIOLIQ1	Sunflower, soya seed	Energy crops
MINBIORPS1	Rape seed	Energy crops
MINBIOFRSR1	Fuelwood residues	Forestry
MINBIOWOO	FuelwoodRW	Forestry
MINBIOWOOa	C&P_RW	Forestry
MINBIOWOOW1	Secondary Forestry residues - woodchips	Forestry
MINBIOWOOW1a	Sawdust	Forestry
~~MINBIOMUN1~~	~~Municipal waste~~	~~ONLY NUTS0~~
~~MINBIOSLU1~~	~~Sludge~~	~~ONLY NUTS0~~

Source: JRC, 2021.

A selection and cleaning process followed the download. From the original file, all the data from the sheet *"ENER - NUTS2 BioCom E"* was copied. ENSPRESO Biomass not only provides three scenarios but also potentials for different years and commodities. For EIGL, the results for 2030 were filtered. The medium total potential will be displayed in EIGL and additional columns will provide more details (according to scenario and biomass type).

Table 16 Layer: Biomass potential production in TWh

Column code	Column description
nuts2_code_2013	NUTS 2 code
biomass_production_twh_medium_total	*Data for medium scenario – total for all 3 groups*
biomass_production_twh_low_total	Data for low scenario – total for all 3 groups
biomass_production_twh_high_total	Data for high scenario – total for all 3 groups
biomass_production_twh_medium_agri&landscape _residues	Data for medium scenario –agri&landscape_residues
biomass_production_twh_low_agri&landscape _residues	Data for low scenario – agri&landscape_residues
biomass_production_twh_high_agri&landscape _residues	Data for high scenario – agri&landscape_residues
biomass_production_twh_medium_energy_crops	Data for medium scenario – energy_crops
biomass_production_twh_low_energy_crops	Data for low scenario – energy_crops
biomass_production_twh_high_energy_crops	Data for high scenario – energy_crops
biomass_production_twh_medium_forestry	Data for medium scenario – forestry
biomass_production_twh_low_forestry	Data for low scenario – forestry
biomass_production_twh_high_forestry	Data for high scenario – forestry

Source: JRC, 2021.

At the end, an adjustment had to be made for regions UKI1 and UKI2. ENSPRESO Biomass is using NUTS 2013. However, it still includes data for UKI1, UKI2 which are from NUTS2010. In NUTS 2013, UKI1 was split into UKI3 (Inner London – West) and UKI4 (Inner London - East) and UKI2 was split into UKI5 (Outer London - East and North East), UKI6 (Outer London - South), and UKI7 (Outer London - West and North West).

In EIGL, we just divided the Biomass potential equally amongst the regions in question; anyhow the biomass potential in UKI1 and UKI2 is very small.

11.2 EMHIRES

11.2.1 EMHIRES Wind

The EMHIRES datasets are available for download at: https://setis.ec.europa.eu/EMHIRES-datasets (Gonzalez Aparicio et al., 2016). For EIGL, we have chosen the following dataset: "30 years of wind power capacity factors at NUTS 2 level" for wind energy:

http://setis.ec.europa.eu/sites/default/files/EMHIRES_DATA/EMHIRES_WIND_NUTS2_June2019.zip

An aggregation step to compute yearly average and the total 30-year average values per NUTS2 area was performed.

11.2.2 EMHIRES Solar

The EMHIRES datasets are available for download at: https://setis.ec.europa.eu/EMHIRES-datasets (Gonzalez Aparicio et al., 2017). For EIGL, we have chosen the following dataset: "30 years of hourly solar power capacity factors at NUTS 2 level" for solar energy:

https://setis.ec.europa.eu/sites/default/files/EMHIRES_DATA/Solar/EMHIRESPV_NUTS2_level.zip

An aggregation step to compute yearly average and the total 30-year average values per NUTS2 area was performed.

At the end, an adjustment had to be made for regions UKI1 and UKI2. EMHIRES is using NUTS 2013.

NUTS2010 used to have the 2 regions UKI1 (Inner London) and UKI2 (Outer London). In NUTS 2013, UKI1 was split into UKI3 (Inner London – West) and UKI4 (Inner London - East) and UKI2 was split into UKI5 (Outer London - East and North East), UKI6 (Outer London - South), and UKI7 (Outer London - West and North West). EMHIRES has 2 rows for UKI3UKI4 and UKI5UKI6 which indicates the old NUTS regions of London. The values for UKI3UKI4 and UKI5UKI6 were kept for all regions.

The regions DEE1, DEE2 and DEE3 have been abandoned and are now all merged into DEE0 (whole Saxony-Anhalt). Also, here, we kept the same value for all regions.

12 Communication infrastructure

12.1 Broadband and mobile telecommunication network

12.1.1 Broadband network performance

Ookla provides an open access dataset at: https://github.com/teamookla/ookla-open-data which contains information about global broadband network performance:

https://ookla-open-data.s3.amazonaws.com/shapefiles/performance/type=fixed/year=2020/quarter=1/2020-01-01_performance_fixed_tiles.zip

The Ookla dataset includes information on average download and upload speed as latency (Table 17). The spatial resolution of the dataset is about 610 x 610 meters and for each cell, the number of tests and unique devices is given as well.

Table 17 Datasets of Ookla broadband performance data

Field Name	Type	Description
avg_d_kbps	Integer	The average download speed of all tests performed in the tile, represented in kilobits per second.
avg_u_kbps	Integer	The average upload speed of all tests performed in the tile, represented in kilobits per second.
avg_lat_ms	Integer	The average latency of all tests performed in the tile, represented in milliseconds
tests	Integer	The number of tests taken in the tile.
devices	Integer	The number of unique devices contributing tests in the tile.
quadkey	Text	The quadkey representing the tile.

Source: JRC, 2021.

We constructed a bounding box for Europe in order to select the European features only. An intersection of the two layers has been performed in order to select the features within the "Europe" box. Next, a spatial join has been executed with a 20 km x 20 km grid layer.

The following data fields have been removed after the spatial join:

- All id fields
- All name fields
- All quadkey fields
- All test fields
- All devices fields

For the rest of the fields, only the count, max, min, mean, median were kept. For performance reasons, the Ookla datasets were split in 9 areas to reduce data loading times in EIGL.

12.1.2 Mobile network performance

Ookla provides an open access dataset at: https://github.com/teamookla/ookla-open-data which contains information about global mobile network performance:

https://ookla-open-data.s3.amazonaws.com/shapefiles/performance/type=mobile/year=2020/quarter=1/2020-01-01_performance_mobile_tiles.zip

The Ookla dataset includes information on average download and upload speed as latency as in the case of the broadband network (Table 17). The spatial resolution of the dataset is about 610 x 610 meters and for each cell, the number of tests and unique devices is given as well.

We constructed a bounding box for Europe in order to select the European features only. An intersection of the two layers has been performed in order to select the features within the "Europe" box. Next, a spatial join has been executed with a 20 km x 20 km grid layer.

The following data fields have been removed after the spatial join:

- All id fields

- All name fields
- All quadkey fields
- All test fields
- All devices fields

For the rest of the fields, only the count, max, min, mean, median were kept. For performance reasons, the Ookla datasets were split in 9 areas to reduce data loading times in EIGL.

13 Future projects and scenarios

13.1 Clean technology projects

13.1.1 Green steel tracker

Information about the Green Steel Tracker is available here: https://www.industrytransition.org/green-steel-tracker/.

For EIGL, the dataset was downloaded from https://industrytransition.org/content/uploads/2021/11/green-steel-tracker-211108.xlsx.

For EIGL, column names have been slightly adapted. For all the EU projects of the green steel tracker, information about the matching ETS/EPRTR facilities have been added in the following two columns:

- E-PRTR_Site_INSPIRE_ID
- comment_eigl

13.1.2 Cembureau

Cembureau, the European Cement Association, produced a map with innovation projects in the cement industry available at: https://www.cembureau.eu/about-our-industry/innovation/map-of-innovation-projects/. The map shows the current decarbonisation projects in the cement sector across Europe.

The data from the map was provided by Cembureau and the projects were matched to the ETS/E-PRTR combined dataset of the EII and the SFI Cement database. Thefollowing columns were added to the dataset:

- latitude
- longitude
- SFI_uid
- E-PRTR_Site_INSPIRE_ID
- EIGL_Comment

13.1.3 Clean hydrogen alliance project pipeline at NUTS2

Information about the project pipeline of the European Clean Hydrogen Alliance is available here: https://ec.europa.eu/growth/industry/strategy/industrial-alliances/european-clean-hydrogen-alliance/project-pipeline_en.

DG GROW provided information about the number of projects per NUTS2 region. For EIGL, for the time being, only the number of projects per NUTS2 region is displayed. For this, all the data at national level has been removed from the dataset.

13.1.4 Planned hydrogen production facilities (JRC dataset)

Based on detailed data from various commercial and open sources, the JRC has developed an open dataset of hydrogen production facilities including coordinates and information on company, capacity, start year and type of process.

The dataset includes both facilities that are currently in operation as well as planned facilities. The facilities in operation are displayed under the layer group "Hydrogen infrastructure" (Section 6.2).

13.2 Infrastructure plans

13.2.1 TYNDP

Information about the ten-year net development plan is available here: https://tyndp.entsoe.eu/maps-data. An additional map with the data and more information is available here: https://tyndp2020-project-platform.azurewebsites.net/projectsheets/. The data for EIGL was provided by ENTSO-E directly.

EIGL displays currently the 23 storage projects of TYNDP 2022 (https://tyndp2022-project-platform.azurewebsites.net/projectsheets/storage) and 141 transmission projects (https://tyndp2022-project-platform.azurewebsites.net/projectsheets/transmission).

13.2.2 Hydrogen backbone study

In 2020, Guidehouse produced a study on a possible future European hydrogen backbone (Wang et al., 2020). This study was updated in 2022 (Rossum et al., 2022) and complemented with online maps (https://ehb.eu/page/european-hydrogen-backbone-maps). The dataset was provided by the EHB consortium to the EIGL.

13.3 Industrial decarbonisation

13.3.1 Aidres study

The Aidres study (Advancing industrial decarbonization by assessing the future use of renewable energies in industrial processes) was commissioned by DG ENER. The project developed a geographical database at the level of NUTS3 granularity combining statistical and modelled information on the type of current technology, industrial and geographical parameters per installation and current (2020) and future (2030/2050) final energy vectors. The database also covers direct and indirect emissions and carbon capture, and the related costs for the energy intensive industries in six sectors within the EU27.

More information about the study is available here: https://op.europa.eu/en/publication-detail/-/publication/577d820d-5115-11ee-9220-01aa75ed71a1 and the database can be access from the JRC data catalogue at: https://data.jrc.ec.europa.eu/dataset/14914982-70a9-4d1d-a2fc-cdee4a1d833d.

In EIGL, a couple of overview tables at NUTS2 and NUTS3 level are presented covering:

- Total industrial energy demand in the reference year (2020) and 2050
- Industrial electricity demand in the reference year (2020) and 2050
- Industrial hydrogen demand in the reference year (2020) and 2050
- Industrial natural gas demand in the reference year (2020) and 2050
- Industrial carbon capture in the reference year (2020) and 2050

Detailed information about the study and methodology is available in the technical documentation (Clymans et al., 2023a, 2023b).

13.4 Energy scenarios

The Commission has developed policy scenarios for delivering the European Green Deal. Starting from the Reference Scenario 2020, and building upon the Climate Target Plan analysis, three scenarios have been produced for various initiatives of the European Green Deal policy package presented in July 2021.

The datasets are available for download at: https://energy.ec.europa.eu/data-and-analysis/energy-modelling/policy-scenarios-delivering-european-green-deal_en. A flat data file was produced for EIGL for all scenarios and all countries and several layers were compiled for selected indicators:

- Policy indicators
    - Energy consumption in the residential sector
    - RES in gross final energy consumption
- Economic indicators
- Energy expenditure of households
- Final energy consumption by fuel
    - Final energy consumption – renewables
    - Final energy consumption – power
    - Final energy consumption – gas

    - Final energy consumption – other fossil fuels
    - Final energy consumption – heat
    - Final energy consumption – hydrogen
- Final energy consumption by sector
    - Total energy demand in transport
    - Final energy demand in the energy-intensive industries

The energy scenario data is presented at country level for the mix-cp scenario and for 2020 and 2030 only.

14 Resources and raw materials

14.1 Mines and minerals

14.1.1 Mines

Data on European mines are provided by GEUS (Geological Survey of Denmark and Greenland (GEUS). The dataset is an adapted version of EuroGeoSurveys' European Geological Data Infrastructure (EGDI) Mineral Resources dataset developed by GeoERA project Mineral Intelligence for Europe (MintelI4EU).

For EIGL, we only included mines targeting critical or strategic raw materials in 2023.[28] In a next step, commodities were classified in the following groups (modified from Promine):

- Iron and ferro-alloy metals: (vanadium, manganese), niobium, tungsten, (cobalt, nickel)
- Special and rare metals: (beryllium, tantalum, hafnium), (REEs, Scandium) (Lithium), (Germanium, Gallium), (bismuth), (antimony, arsenic), (titanium), (magnesium)
- Precious metals: PGM
- Base metals: Bauxite/aluminium, copper
- Minerals for chemical use: baryte, borate/boron, fluorspar, strontium, phosphate rock/phosphorous
- Special and other industrial rocks and minerals: Natural graphite, feldspar, silicon, coal (not specified)

Finally, the mines were grouped by activity status:

- Operating (including the attributes: operating, operating continuously, operating intermittently)
- Not operating (including the attributes: historic, abandoned, not operating, closed, care and maintenance)
- Under development (including the attributes: Pending approval, retention, under development, feasibility, construction)

14.1.2 Mineral occurrences

The dataset for mineral occurrences was provided by GEUS (Geological Survey of Denmark and Greenland (GEUS). The dataset is an adapted version of EuroGeoSurveys' European Geological Data Infrastructure (EGDI) dataset developed by GeoERA project Mineral Intelligence for Europe (MintelI4EU).

As for the mines, only mineral occurrences targeting critical or strategic raw materials in 2023 were considered. The mineral occurrences were again grouped by commodity

- Iron and ferro-alloy metals: (vanadium, manganese), niobium, tungsten, (cobalt, nickel)
- Special and rare metals: (beryllium, tantalum, hafnium), (REEs, Scandium) (Lithium), (Germanium, Gallium), (bismuth), (antimony, arsenic), (titanium), (magnesium)
- Precious metals: PGM
- Minerals for chemical use: baryte, borate/boron, fluorspar, strontium, phosphate rock/phosphorous
- Special and other industrial rocks and minerals: Natural graphite, feldspar, silicon, coal (not specified)

14.2 Waste heat and heat sources

The sEEnergies project aims to quantify and operationalise the potentials for energy efficiency in buildings, transport and industry, combining this bottom-up knowledge with temporal and spatial analyses to develop an innovative, holistic and research-based modelling approach. Data from the sEEnergies project is being made available at: https://s-eenergies-open-data-euf.hub.arcgis.com/.

14.2.1 Excess heat potential

The sEEnergies project georeferenced EU28 industrial sites with quantified annual excess heat volumes within main some main industrial sectors. In total, the dataset covers 1842 georeferenced industrial sites in the EU within six energy-intensive industrial sectors. The annual excess heat volumes from fuel combustion are quantified for three different levels of cooling temperatures (Level 1: 25 degrees Celsius, Level 2: 55 degrees

[28] The list of critical raw materials in 2023 is available at: https://single-market-economy.ec.europa.eu/sectors/raw-materials/areas-specific-interest/critical-raw-materials_en

Celsius. and Level 3: 95 degrees Celsius), and for two scenarios: (1) at current rate of internal heat recovery, and (2) at maximum rate of internal heat recovery.

The documentation and methodology of the dataset is described in (Fleiter et al., 2019) and can be found at: https://zenodo.org/record/4785411/. The dataset itself can be downloaded at: https://s-eenergies-open-data-euf.hub.arcgis.com/datasets/a6a1e8e95514413a90bbb2e40515fdb2_0/explore?location=40.642985%2C6.679068%2C4.60.

For displaying the excess heat potential of industrial sites, we classify them according to industry sector and we are using excess heat level 1 to categorise the circle size.

14.2.2 District heating areas

This dataset from the sEEnergies project includes polygons derived from heat demand densities at or above 500 GJ/ha from the Heat Roadmap Europe 4 raster dataset on heat demand densities. The dataset was created by extracting all hectare grid cells from the Heat Roadmap Europe 4 heat demand density raster with values of 500 GJ/ha and above (heat demand density classes 3, 4, and 5), converting this raster data subset into a polygon layer, and adding various attributes from other sources, mainly data on current district heating systems from the Halmstad University District Heating and Cooling database.

The documentation and methodology of the dataset is described in (Fleiter et al., 2019) and can be found at: https://zenodo.org/record/4785411/. The dataset itself can be downloaded at: https://s-eenergies-open-data-euf.hub.arcgis.com/datasets/b62b8ad79f0e4ae38f032ad6aadb91a0_0/explore?location=51.557830%2C7.406363%2C9.24.

14.2.3 Waste heat point sources

The ReUseHeat partners Halmstad University and Aalborg University have mapped European Union's urban waste heat (Moreno et al., 2022). The dataset is an update of the original deliverable 1.4 "Accessible urban waste heat" (Persson et al., 2020). This European Waste Heat Map is available at: https://aau.maps.arcgis.com/apps/webappviewer/index.html?id=789b7faef30148bda20d320de9455919.

15 Emissions and waste

15.1 EDGAR Air pollutants

The EDGAR datasets are available for download at: https://edgar.jrc.ec.europa.eu/emissions_data_and_maps

For EIGL, we have chosen datasets for the following pollutants from the dataset Air Pollutants - v5.0_AP 1970-2015 (Gases and Aerosols):

- NO_X
- $PM_{2.5}$
- SO_2

The NETCFD files for the last available year (2015) were downloaded from the following websaite: https://edgar.jrc.ec.europa.eu/emissions_data_and_maps.

All the NETCFD files have been added as to an ArcGIS PRO project Data was loaded as "multidimensional raster layers" In a next step, a vector dataset with a lower resolution (20 km x 20 km grid) has been produced because of performance issues.

For the 20 km x 20 km grid cells, zonal statistics have been calculated for count, sum, and mean values over the raster data.

The emission gridmaps from EDGAR are expressed in ton substance / 0.1degree x 0.1degree / year for the .txt files and in kg substance /m^2 /s for the .nc files. This means the mean value calculated per 20 km x 20 km grid cell indicates emissions of kg substance per m^2 and second.

Additional columns have been calculated to convert the values to more appropriate levels for display. The original column _mean has been renamed to _mean_kg_m2_s in order to indicate the units.

- NO_X: column nox_kg_m2_yr expresses the emissions in kg per m^2 and year
- SO_2: column so2_kg_m2_yr expresses the emissions in kg per m^2 and year
- $PM_{2.5}$: column pm25_kg_m2_yr expresses the emissions in kg per m^2 and year

15.2 EDGAR GHG emissions

The EDGAR datasets are available for download at: https://edgar.jrc.ec.europa.eu/emissions_data_and_maps

For EIGL, we have chosen datasets for the following greenhouse gases from the dataset Greenhouse Gases - v6.0_GHG 1970-2018 (CO2,CH4,N2O,F-gases):

- CH_4
- CO_2_excl_short-cycle_org_C
- N_2O

Data treatment was similar to EDGAR air pollutants. Additional columns produced are:

- CH_4: column ch4_g_m2_yr expresses the emissions in g per m^2 and year
- N_2O: column n2o_kg_m2_yr expresses the emissions in kg per m^2 and year
- CO_2: new column co2_t_km2_yr expresses the emissions in t per km^2 and year

16 Land cover and land use

16.1 LUISA Base Map

For land use, the LUISA base map FROM JRC B.3 was used in EIGL (Cristian and Batista e Silva, 2021). In addition to the original data at high resolution, we are using an aggregated dataset at 10 km x 10 km resolution for the Energy and Industry Geography Lab. This datasets includes the land use share in % per class for each 10 km x 10 km cell.

We have first simplified and reduced the number of land use classes (Table 18). Next, we have summed over the individual land use categories from LUISA and calculated a simplified aggregated land use class (see table below) and the main land use per grid cell.

The EIGL uses the main land use class per grid cell in the visualisation. The detailed dataset is available upon request or can be accessed here: https://data.jrc.ec.europa.eu/collection/luisa.

Table 18 Land use categories from LUISA and aggregated classes in EIGL

Code	Label	Aggregated classes
1111	High density urban fabric	Urban fabric
1121	Medium density urban fabric	Urban fabric
1122	Low density urban fabric	Urban fabric
1123	Isolated or very low density urban fabric	Urban fabric
1130	Urban vegetation	Urban fabric
1210	Industrial or commercial units	Industrial/commercial
1221	Road and rail networks and associated land	Transport infrastructure
1222	Major stations	Transport infrastructure
1230	Port areas	Transport infrastructure
1241	Airport areas	Transport infrastructure
1242	Airport terminals	Transport infrastructure
1310	Mineral extraction sites	Other
1320	Dump sites	Other
1330	Construction sites	Other
1410	Green urban areas	Other
1421	Sport and leisure green	Other
1422	Sport and leisure built-up	Other
2110	Non irrigated arable land	Agriculture
2120	Permanently irrigated land	Agriculture
2130	Rice fields	Agriculture
2210	Vineyards	Agriculture
2220	Fruit trees and berry plantations	Agriculture
2230	Olive groves	Agriculture
2310	Pastures	Agriculture
2410	Annual crops associated with permanent crops	Agriculture
2420	Complex cultivation patterns	Agriculture
2430	Land principally occupied by agriculture	Agriculture
2440	Agro-forestry areas	Agriculture
3110	Broad-leaved forest	Forest
3120	Coniferous forest	Forest
3130	Mixed forest	Forest
3210	Natural grassland	Grassland
3220	Moors and heathland	Other vegetation
3230	Sclerophyllous vegetation	Other vegetation
3240	Transitional woodland shrub	Other vegetation
3310	Beaches, dunes and sand plains	Beach, sand, rock
3320	Bare rock	Beach, sand, rock
3330	Sparsely vegetated areas	Other vegetation
3340	Burnt areas	Other
3350	Glaciers and perpetual snow	Other
4000	Wetlands	Water body
5110	Water courses	Water body
5120	Water bodies	Water body

Code	Label	Aggregated classes
5210	Coastal lagoons	Water body
5220	Estuaries	Water body
5230	Sea and ocean	Water body

Source: JRC, 2021.

17 Socio-economic data

17.1 Population

17.1.1 Population by NUTS3 region

Eurostat has several datasets at https://ec.europa.eu/eurostat/web/main/data/database related to regional population. For EIGL, we have chosen the following dataset: "Population on 1 January by age group, sex and NUTS 3 region (demo_r_pjangrp3)". Download was done through the dataset browser.

A selection and cleaning process followed the download. Data on NUTS0 level and NUTS1 level was removed and columns with flags were removed as well. Rows with XXX (extra-NUTS regions) were also removed. Two regions in Norway (without data) were also removed, because they are referring to old NUTS regions: NO061, NO062.

The dataset for EIGL includes the 2019 population numbers.

17.1.2 Population (10 km x 10 km grid)

Eurostat has several datasets at https://ec.europa.eu/eurostat/web/gisco/geodata/reference-data/population-distribution-demography/geostat related to population density/grids. For EIGL, the 2018 shapefile has been used. A grid layer of the population data has been produced at 10 x 10 km resolution.

17.2 Gross domestic product (GDP) and gross value added (GVA)

17.2.1 Gross domestic product at NUTS3 level

Eurostat has several datasets at https://ec.europa.eu/eurostat/web/main/data/database related to regional gross domestic product. For EIGL, we have chosen the following dataset: "Gross domestic product (GDP) at current market prices by NUTS 3 regions (nama_10r_3gdp)" for GDP.

Download was done through the dataset browser. A selection and cleaning process followed the download. Data on NUTS0 level, NUTS1 level and NUTS2 level was removed. Columns with flags were removed as well. Rows with ZZZ (extra-NUTS regions) were also removed.

Since data for 2019 was not complete, EIGL will display 2018 data.

17.2.2 Gross value added at NUTS3

Eurostat has several datasets at https://ec.europa.eu/eurostat/web/main/data/database related to regional gross value added. For EIGL, we have chosen the following dataset: "Gross value added at basic prices by NUTS 3 regions (nama_10r_3gva)" for GVA.

Download was done through the dataset browser. A selection and cleaning process followed the download. Data on NUTS0 level, NUTS1 level and NUTS2 level was removed. Columns with flags were removed as well. Rows with ZZZ (extra-NUTS regions) were also removed.

Since data for 2019 was not complete, EIGL will display 2018 data.

17.3 Employment

17.3.1 Eurostat employment data

Eurostat has several datasets at https://ec.europa.eu/eurostat/web/main/data/database related to regional employment. For EIGL, we have chosen the following dataset: "Employment by sex, age, economic activity and NUTS 2 regions (NACE Rev. 2) (1 000) (lfst_r_lfe2en2)". Download was done through the dataset browser.

A selection and cleaning process followed the download. Data on NUTS0 level and NUTS1 level was removed. Columns with flags were removed as well.

The dataset for EIGL includes the 2019 employment numbers in 1000.

17.3.2 Jobs at risk in coal regions

The JRC has published a series of reports related to Coal Regions in Transition:

- (Ruiz Castello et al., 2021): Recent Trends in Coal and Peat Regions in the Western Balkans and Ukraine, EUR 30837 EN, Publications Office of the European Union, Luxembourg, 2021
- (Alves Dias et al., 2021): Recent trends in EU coal, peat and oil shale regions, EUR 30618 EN, Publications Office of the European Union, Luxembourg, 2021
- (Alves Dias et al., 2018): EU coal regions: opportunities and challenges ahead, EUR 29292 EN. Publications Office of the European Union, Luxembourg, 2018

From those sources, a consolidated dataset has been built that includes regional data related to coal regions in transition.

An aggregated dataset (on jobs at risk) was produced at NUTS2 level.

17.4 CINTRAN

The CINTRAN (= Carbon Intensive Regions in Transition) project (https://coaltransitions.org/projects/cintran/) studies the patterns and dynamics of decarbonisation at the regional level as well as the conditions of a region's capacity to adapt to the related structural changes. CINTRAN is a 4-year programme of research and stakeholder engagement, funded by Horizon 2020.

17.4.1 Net migration rate 2019

The Vienna Institute for International Economic Studies (wiiw) has developed a database on net migration rates in European regions. The dataset was an output the Carbon Intensive Regions in Transition project (CINTRAN). It is based on publicly available sources. The net migration is calculated as the difference between total population change and natural change (i.e. births - deaths). It is net migration in percent of total regional population.

17.4.2 Socio-economic risk indices

E3 Modelling has developed different socio-economic risk indices. They display information on regions exposure, sensitivity, vulnerability and socio-economic risk regarding decarbonisation. The indices are composed as follows:

Table 19 Socio-economics risk indices from CINTRAN

Index	Description
exposure	Normalized share of energy jobs
hazard	Change in activity of fossil fuel production sectors in 2050
sensitivity	Composed by unemployment rate, GDP per capita and Income per capita
adaptive capacity	Composed by investment per capita, Regional Competitiveness Index and Population beyond 50 years old indicators
vulnerability	Composed by Sensitivity and Adaptive capacity indicators
socioeconomic risk index	Composed by Hazard, Exposure and Vulnerability indicators
energy jobs 2015	Energy employment share in 2015
unemployment rate in percent 2015	Unemployment rate in 2015
gdp eur per capita 2015	GDP per capita in 2015
households eur per capita income 2015	Households per capita income in 2015
regional competitiveness index 2019	Regional Competitiveness Index in 2019
per capita investments 2015	Per capita investments in 2015
population beyond 50 in percent 2015	Share of population beyond 50 in 2015

Source: CINTRAN, 2022.

- Socio-economic sensitivity to decarbonisation: Sensitivity describes the degree to which a system or species is affected, either adversely or beneficially, by climate variability or change. Sensitivity in this context is composed by unemployment rate, GDP per capita and Income per capita.

- Socio-economic adaptive capacity to decarbonisation: Adaptive capacity is defined as the ability of systems, institutions, humans and other organisms to adjust to potential damage, to take advantage of opportunities or to respond to consequences. Adaptive Capacity in this context is composed by investment per capita, Regional Competitiveness Index and Population beyond 50 years old indicators.
- Socio-economic vulnerability to decarbonisation: Vulnerability is considered as the propensity or predisposition to be adversely affected, which encompasses a variety of concepts and elements including sensitivity or susceptibility to harm and lack of capacity to cope and adapt. Vulnerability is composed by Sensitivity and Adaptive Capacity Indicators.
- Socio-economic risk to decarbonisation: The Socioeconomic Risk Index is an aggregated indicator defined as the potential for adverse consequences for human systems (e.g. job losses due to the low-carbon transition), recognizing the diversity of values and objectives associated with such systems. In this context, risk is associated to Risk is composed by Hazard, Exposure and Vulnerability Indicators.
- Hazard: In the socio-economic context of this analysis, hazard relates to the potential occurrence of a policy-induced event or trend that may cause adverse socioeconomic implications such as a loss of jobs, in particular associated with the expected decline in fossil fuel activities in EU regions due to the low carbon transition.
- Exposure: In the socio-economic context of this analysis, exposure is defined as the presence of jobs that could be adversely affected by the low carbon transition and is measured by the level of employment in the carbon-intensive sectors.

The dataset was an output for the Carbon Intensive Regions in Transition project (CINTRAN). It is based on publicly available sources.

Reference: Vrontisi et al. (forthcoming). Towards a just transition: Identifying EU regions at a socio-economic risk of the low-carbon transition.

17.4.3 Coping strategies inventory (= regional response to decarbonisation)

The University of Sussex has developed a database on coping actions taken by different actors in carbon intensive regions. The dataset was an output the Carbon Intensive Regions in Transition project (CINTRAN). It is based on publicly available sources.

The whole inventory of coping strategies can be found here: https://coaltransitions.org/tools/inventory/.

18 Climate and weather

The EIGL includes datasets related to climate. Datasets on weather will be included soon in EIGL.

18.1 Weather data

The EIGL will contain weather data. The two main sources that will be used are E-OBS (gridded datasets for Europe) from the Royal Netherlands Meteorological Institute (KNMI) and Copernicus data sets.[29,30]

18.2 Climate data

With regards to climate data, the EIGL includes a layer with a climate classification. The current dataset used is a high-resolution map using Köppen-Geiger categories.[31] Data can be downloaded here: http://www.gloh2o.org/koppen/.

For EIGL, the datasets at a spatial resolution of 0.0083°, approximately 1 km at the equator were used. First, the TIF (raster) files were transformed to vector layers and a legend has been joined to the layers.

[29] https://www.ecad.eu/download/ensembles/download.php
[30] https://climate.copernicus.eu/
[31] https://www.nature.com/articles/sdata2018214

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List of abbreviations

CATF	Clean Air Task Force
CBD	Convention on Biological Diversity
CDDA	Nationally designated protected area (Common Database on Designated Areas)
CF	Capacity factor
EBSA	Ecologically or Biologically Significant Marine Areas
EEA	European Environment Agency
EIGL	Energy and Industry Geography Lab
EII	Energy-intensive industry
ENTSO-E	European Network of Transmission System Operators for Electricity
ENTSO-G	European Network of Transmission System Operators for Gas
E-PRTR	European Pollutant Release and Transfer Register
ETS	Emissions Trading System
GDP	Gross domestic product
GISCO	Geographic Information System of the Commission
GVA	Gross value added
JRC	Joint Research Centre
NACE	Nomenclature statistique des activités économiques dans la Communauté européenne
NUTS	Nomenclature of Territorial Units for Statistics (French: Nomenclature des unités territoriales statistiques)
PBF	Protocolbuffer Binary Format
SAC	Special Areas of Conservation
SCI	Sites of Community Importance
SPA	Special Protection Areas
WEFE	Water-Energy-Food-Ecosystems

List of tables

Annexes

Annex 1. Correspondence of NACE codes and sectors of the energy intensive industries

NACE code	EIGL sector	Description
23.51	Cement	Manufacture of cement
23.61	Cement	Manufacture of concrete products for construction purposes
23.62	Cement	Manufacture of plaster products for construction purposes
23.63	Cement	Manufacture of ready-mixed concrete
23.64	Cement	Manufacture of mortars
23.65	Cement	Manufacture of fibre cement
23.69	Cement	Manufacture of other articles of concrete, plaster and cement
23.70	Cement	Cutting, shaping and finishing of stone
23.91	Cement	Production of abrasive products
23.99	Cement	Manufacture of other non-metallic mineral products n.e.c.
23.20	Ceramics & Refractory	Manufacture of refractory products
23.31	Ceramics & Refractory	Manufacture of ceramic tiles and flags
23.32	Ceramics & Refractory	Manufacture of bricks, tiles and construction products, in baked clay
23.41	Ceramics & Refractory	Manufacture of ceramic household and ornamental articles
23.42	Ceramics & Refractory	Manufacture of ceramic sanitary fixtures
23.43	Ceramics & Refractory	Manufacture of ceramic insulators and insulating fittings
23.44	Ceramics & Refractory	Manufacture of other technical ceramic products
23.49	Ceramics & Refractory	Manufacture of other ceramic products
20.11	Chemicals	Manufacture of industrial gases
20.12	Chemicals	Manufacture of dyes and pigments
20.13	Chemicals	Manufacture of other inorganic basic chemicals
20.14	Chemicals	Manufacture of other organic basic chemicals
20.16	Chemicals	Manufacture of plastics in primary forms
20.17	Chemicals	Manufacture of synthetic rubber in primary forms
20.20	Chemicals	Manufacture of pesticides and other agrochemical products
20.30	Chemicals	Manufacture of paints, varnishes and similar coatings, printing ink and mastics
20.41	Chemicals	Manufacture of soap and detergents, cleaning and polishing preparations
20.42	Chemicals	Manufacture of perfumes and toilet preparations
20.51	Chemicals	Manufacture of explosives
20.52	Chemicals	Manufacture of glues
20.53	Chemicals	Manufacture of essential oils
20.59	Chemicals	Manufacture of other chemical products n.e.c.
20.60	Chemicals	Manufacture of man-made fibres
21.10	Chemicals	Manufacture of basic pharmaceutical products
21.20	Chemicals	Manufacture of pharmaceutical preparations
22.11	Chemicals	Manufacture of rubber tyres and tubes; retreading and rebuilding of rubber tyres
22.19	Chemicals	Manufacture of other rubber products
22.21	Chemicals	Manufacture of plastic plates, sheets, tubes and profiles
22.22	Chemicals	Manufacture of plastic packinggoods
22.23	Chemicals	Manufacture of builders' ware of plastic
22.29	Chemicals	Manufacture of other plastic products
24.10	Steel	Manufacture of basic iron and steel and of ferro-alloys
20.15	Fertilizers	Manufacture of fertilisers and nitrogen compounds
23.11	Glass	Manufacture of flat glass
23.12	Glass	Shaping and processing of flat glass
23.13	Glass	Manufacture of hollow glass
23.14	Glass	Manufacture of glass fibres
23.19	Glass	Manufacture and processing of other glass, including technical glassware
23.52	Lime	Manufacture of lime and plaster
24.41	Non-ferrous metals	Precious metals production
24.42	Non-ferrous metals	Aluminium production
24.43	Non-ferrous metals	Lead, zinc and tin production
24.44	Non-ferrous metals	Copper production
24.45	Non-ferrous metals	Other non-ferrous metal production
24.46	Non-ferrous metals	Processing of nuclear fuel
24.53	Non-ferrous metals	Casting of light metals
24.54	Non-ferrous metals	Casting of other non-ferrous metals
17.11	Pulp & paper	Manufacture of pulp
17.12	Pulp & paper	Manufacture of paper and paperboard
17.21	Pulp & paper	Manufacture of corrugated paper and paperboard and of containers of paper and paperboard
17.22	Pulp & paper	Manufacture of household and sanitary goods and of toilet requisites
17.23	Pulp & paper	Manufacture of paper stationery
17.24	Pulp & paper	Manufacture of wallpaper
17.29	Pulp & paper	Manufacture of other articles of paper and paperboard

NACE code	EIGL sector	Description
19.10	Refining	Manufacture of coke oven products
19.20	Refining	Manufacture of refined petroleum products
24.10	Steel	Manufacture of basic iron and steel and of ferro-alloys
24.20	Steel	Manufacture of tubes, pipes, hollow profiles and related fittings, of steel
24.31	Steel	Cold drawing of bars
24.32	Steel	Cold rolling of narrow strip
24.33	Steel	Cold forming or folding
24.34	Steel	Cold drawing of wire
24.51	Steel	Casting of iron
24.52	Steel	Casting of steel
35.11	Production of electricity	Production of electricity
35.21	Production of gas	Manufacture of gas
35.30	Production of steam	Steam and air conditioning supply
36.00	Water treatment	Water collection, treatment and supply

Source: JRC, 2021.

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