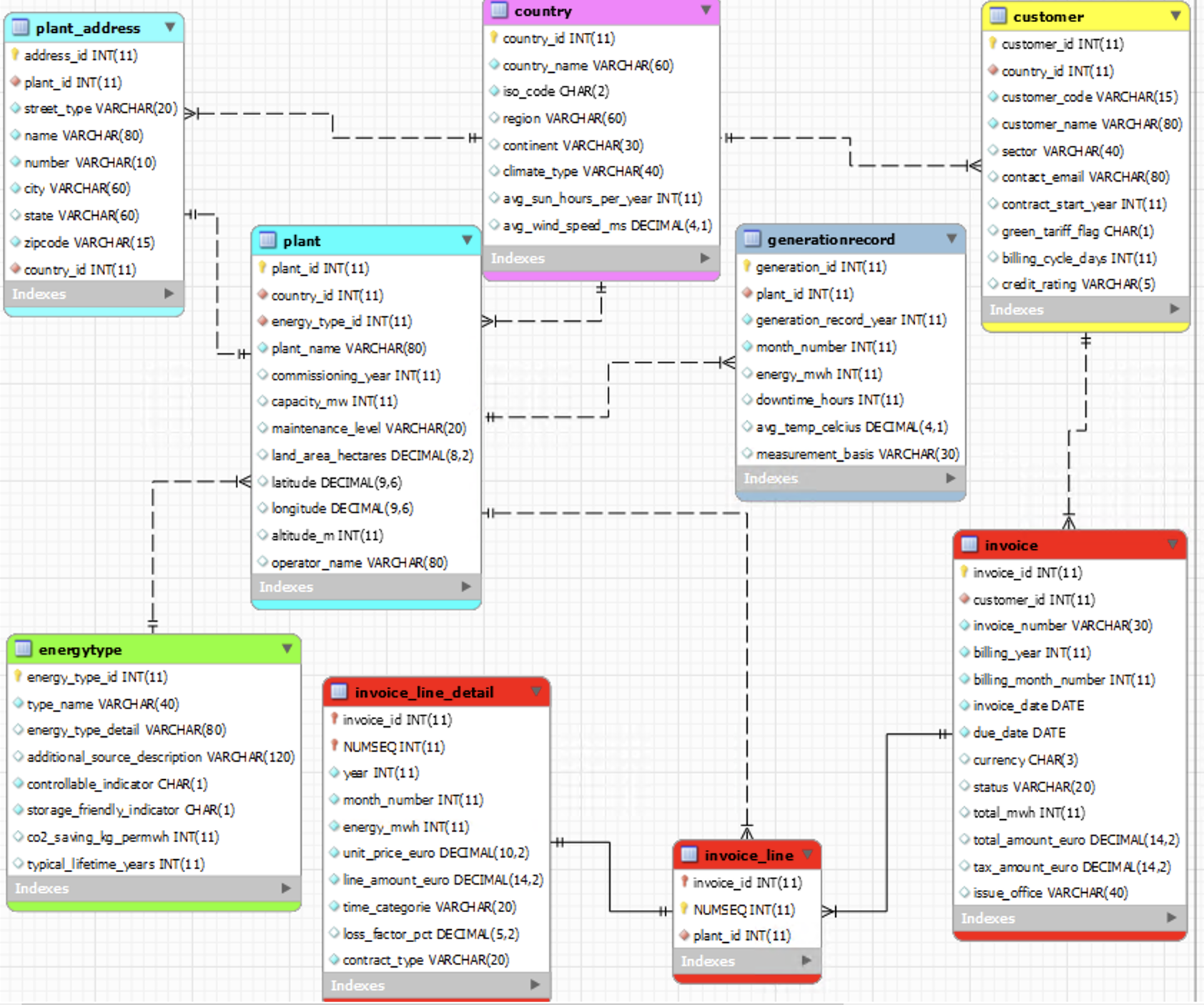
**Group 2: Renewable Energy Farms Database Model**

**QUESTION 1: Entity Relation Diagram (ERD) – Please see attached .mwb file**



**QUESTION 2: DDL & DML Statements**

CREATE SCHEMA `renewable\_energy\_farms` ;

***DDL:***

CREATE TABLE Country (

country\_id INT NOT NULL PRIMARY KEY,

country\_name VARCHAR(60) NOT NULL,

iso\_code CHAR(2) NOT NULL,

region VARCHAR(60),

continent VARCHAR(30),

climate\_type VARCHAR(40),

avg\_sun\_hours\_per\_year INT,

avg\_wind\_speed\_ms DECIMAL(4,1)

);

CREATE UNIQUE INDEX ux\_country\_name ON Country(country\_name);

CREATE UNIQUE INDEX ux\_country\_iso ON Country(iso\_code);

CREATE TABLE EnergyType (

energy\_type\_id INT NOT NULL PRIMARY KEY,

type\_name VARCHAR(40) NOT NULL,

energy\_type\_detail VARCHAR(80),

additional\_source\_description VARCHAR(120),

controllable\_indicator CHAR(1) NOT NULL,

storage\_friendly\_indicator CHAR(1) NOT NULL,

co2\_saving\_kg\_permwh INT,

typical\_lifetime\_years INT

);

CREATE UNIQUE INDEX ux\_energy\_type

ON EnergyType(type\_name, energy\_type\_detail);

CREATE TABLE Plant (

plant\_id INT NOT NULL PRIMARY KEY,

country\_id INT NOT NULL,

energy\_type\_id INT NOT NULL,

plant\_name VARCHAR(80) NOT NULL,

commissioning\_year INT,

capacity\_mw INT,

maintenance\_level VARCHAR(20),

land\_area\_hectares DECIMAL(8,2),

latitude DECIMAL(9,6),

longitude DECIMAL(9,6),

altitude\_m INT,

operator\_name VARCHAR(80),

FOREIGN KEY (country\_id) REFERENCES Country(country\_id),

FOREIGN KEY (energy\_type\_id) REFERENCES EnergyType(energy\_type\_id)

);

CREATE UNIQUE INDEX ux\_plant\_name ON Plant(plant\_name);

CREATE TABLE Plant\_Address (

address\_id INT NOT NULL PRIMARY KEY,

plant\_id INT NOT NULL UNIQUE,

street\_type VARCHAR(20) NOT NULL,

name VARCHAR(80) NOT NULL,

number VARCHAR(10) NOT NULL,

city VARCHAR(60) NOT NULL,

state VARCHAR(60),

zipcode VARCHAR(15) NOT NULL,

country\_id INT NOT NULL,

FOREIGN KEY (plant\_id) REFERENCES Plant(plant\_id),

FOREIGN KEY (country\_id) REFERENCES Country(country\_id)

);

CREATE TABLE GenerationRecord (

generation\_id INT NOT NULL PRIMARY KEY,

plant\_id INT NOT NULL,

generation\_record\_year INT NOT NULL,

month\_number INT NOT NULL,

energy\_mwh INT,

downtime\_hours INT,

avg\_temp\_celcius DECIMAL(4,1),

measurement\_basis VARCHAR(30),

FOREIGN KEY (plant\_id) REFERENCES Plant(plant\_id)

);

CREATE UNIQUE INDEX ux\_gen\_unique

ON GenerationRecord(plant\_id, generation\_record\_year, month\_number);

CREATE TABLE Customer (

customer\_id INT NOT NULL PRIMARY KEY,

country\_id INT NOT NULL,

customer\_code VARCHAR(15) NOT NULL,

customer\_name VARCHAR(80) NOT NULL,

sector VARCHAR(40),

contact\_email VARCHAR(80),

contract\_start\_year INT,

green\_tariff\_flag CHAR(1),

billing\_cycle\_days INT,

credit\_rating VARCHAR(5),

FOREIGN KEY (country\_id) REFERENCES Country(country\_id)

);

CREATE UNIQUE INDEX ux\_customer\_code ON Customer(customer\_code);

CREATE UNIQUE INDEX ux\_customer\_email ON Customer(contact\_email);

CREATE TABLE Invoice (

invoice\_id INT NOT NULL PRIMARY KEY,

customer\_id INT NOT NULL,

invoice\_number VARCHAR(30) NOT NULL,

billing\_year INT NOT NULL,

billing\_month\_number INT NOT NULL,

invoice\_date DATE NOT NULL,

due\_date DATE NOT NULL,

currency CHAR(3),

status VARCHAR(20),

total\_mwh INT,

total\_amount\_euro DECIMAL(14,2),

tax\_amount\_euro DECIMAL(14,2),

issue\_office VARCHAR(40),

FOREIGN KEY (customer\_id) REFERENCES Customer(customer\_id)

);

CREATE UNIQUE INDEX ux\_invoice\_number ON Invoice(invoice\_number);

CREATE TABLE Invoice\_Line (

invoice\_id INT NOT NULL,

NUMSEQ INT NOT NULL,

plant\_id INT NOT NULL,

PRIMARY KEY (invoice\_id, NUMSEQ),

FOREIGN KEY (invoice\_id) REFERENCES Invoice(invoice\_id),

FOREIGN KEY (plant\_id) REFERENCES Plant(plant\_id)

);

CREATE TABLE Invoice\_Line\_Detail (

invoice\_id INT NOT NULL,

NUMSEQ INT NOT NULL,

year INT NOT NULL,

month\_number INT NOT NULL,

energy\_mwh INT NOT NULL,

unit\_price\_euro DECIMAL(10,2) NOT NULL,

line\_amount\_euro DECIMAL(14,2) NOT NULL,

time\_categorie VARCHAR(20) NOT NULL,

loss\_factor\_pct DECIMAL(5,2),

contract\_type VARCHAR(20) NOT NULL,

PRIMARY KEY (invoice\_id, NUMSEQ),

FOREIGN KEY (invoice\_id, NUMSEQ)

REFERENCES Invoice\_Line(invoice\_id, NUMSEQ)

);

**DML**  
INSERT INTO Country (

country\_id, country\_name, iso\_code, region, continent,

climate\_type, avg\_sun\_hours\_per\_year, avg\_wind\_speed\_ms

)

VALUES

(1001,'Spain','ES','Southwestern Europe','Europe','Mediterranean',2850,5.6),

(1002,'Portugal','PT','Southwestern Europe','Europe','Atlantic Coast',2600,6.2),

(1003,'France','FR','Western Europe','Europe','Oceanic',2000,4.8),

(1004,'Germany','DE','Central Europe','Europe','Temperate',1650,4.7),

(1005,'Norway','NO','Northern Europe','Europe','Subarctic',1400,7.5),

(1006,'Italy','IT','Southern Europe','Europe','Mediterranean',2700,4.9),

(1007,'Greece','GR','Southern Europe','Europe','Mediterranean',2900,5.3),

(1008,'Netherlands','NL','Western Europe','Europe','Temperate',1550,5.9),

(1009,'Sweden','SE','Northern Europe','Europe','Cold temperate',1450,6.5),

(1010,'United Kingdom','GB','Western Europe','Europe','Oceanic',1550,5.7),

(1011,'Ireland','IE','Western Europe','Europe','Oceanic',1500,6.3),

(1012,'Denmark','DK','Northern Europe','Europe','Temperate',1600,7.0),

(1013,'Poland','PL','Central Europe','Europe','Continental',1650,4.5),

(1014,'Switzerland','CH','Central Europe','Europe','Alpine',1700,3.8),

(1015,'Morocco','MA','North Africa','Africa','Semi-arid',3100,4.9);

INSERT INTO EnergyType (

energy\_type\_id, type\_name, energy\_type\_detail, additional\_source\_description,

controllable\_indicator, storage\_friendly\_indicator,

co2\_saving\_kg\_permwh, typical\_lifetime\_years

)

VALUES

(2001,'Solar','Solar PV – Utility','Large ground-mounted photovoltaic fields','N','Y',450,25),

(2002,'Solar','Solar CSP – Tower','Concentrated solar tower with molten salt','Y','Y',470,30),

(2003,'Solar','Solar Rooftop','Distributed rooftop PV on buildings','N','Y',440,20),

(2004,'Solar','Solar Hybrid + Battery','Solar PV co-located with grid-scale battery','Y','Y',460,28),

(2005,'Wind','Wind – Onshore','Onshore wind turbine clusters','N','N',420,22),

(2006,'Wind','Wind – Offshore','Offshore wind farm in coastal waters','N','N',430,25),

(2007,'Wind','Wind – High Altitude','Kite or drone-based high altitude wind','N','N',415,20),

(2008,'Water','Hydro – Reservoir','Dam and reservoir based hydroelectric plant','Y','Y',500,40),

(2009,'Water','Hydro – Run-of-River','River-following hydro without big dams','Y','Y',480,35),

(2010,'Water','Tidal – Stream','Subsea tidal stream turbines','Y','Y',510,30),

(2011,'Biomass','Biomass – Solid Fuel CHP','Wood chip combined heat and power plant','Y','Y',380,20),

(2012,'Biomass','Biomass – Biogas','Biogas from anaerobic digestion of organic waste','Y','Y',390,18),

(2013,'Biomass','Waste-to-Energy','Municipal solid waste incineration with energy recovery','Y','Y',400,25),

(2014,'Geothermal','Geothermal – Hot Water','Medium depth geothermal hot water systems','Y','Y',510,28),

(2015,'Geothermal','Geothermal – Enhanced','Enhanced / stimulated geothermal reservoir systems','Y','Y',530,32);

(2016, 'Solar', 'Solar PV – Tracking Single-Axis', 'PV with horizontal single-axis trackers', 'N','Y',445,26),

(2017, 'Solar', 'Solar PV – Tracking Dual-Axis', 'PV with dual-axis solar tracking', 'N','Y',455,25),

(2018, 'Solar', 'Solar Thermal – Parabolic Trough', 'Concentrated trough-based thermal collectors', 'Y','Y',470,32),

(2019, 'Solar', 'Solar Thermal – Fresnel', 'Linear Fresnel concentrator technology', 'Y','Y',465,28),

(2020, 'Solar', 'Agrovoltaics – Elevated Arrays', 'Dual-use agriculture + solar PV systems', 'N','Y',440,24),

(2021, 'Solar', 'Floating Solar – Reservoir', 'Floating PV arrays on inland water bodies', 'N','Y',450,22),

(2022, 'Wind', 'Wind – Low Wind Speed Turbines', 'Optimized for low-speed wind regions', 'N','N',410,20),

(2023, 'Wind', 'Wind – High Turbulence Turbines', 'Designed for turbulent mountainous terrain', 'N','N',415,20),

(2024, 'Wind', 'Wind – Vertical Axis Turbines', 'Vertical axis wind turbine designs', 'N','N',395,18),

(2025, 'Wind', 'Wind – Hybrid Wind-Battery', 'Wind farm co-located with grid battery system', 'N','Y',425,23),

(2026, 'Wind', 'Wind – Offshore Floating (Deep Sea)', 'Floating turbines for deep-water sites', 'N','N',440,25),

(2027, 'Wind', 'Wind – Urban Micro-turbines', 'Small urban rooftop or street-level turbines', 'N','N',380,15),

(2028, 'Water', 'Hydro – Micro Hydro Rural', 'Small hydro for rural electrification', 'Y','Y',470,35),

(2029, 'Water', 'Hydro – Pumped Storage Hybrid', 'Hydro pumped-storage with renewables integration', 'Y','Y',520,45),

(2030, 'Water', 'Hydro – Cavern Pressure Turbines', 'High-pressure underground hydro designs', 'Y','Y',510,40),

(2031, 'Water', 'Hydro – Arch Gravity Dam', 'Hydro facility based on arch-gravity dam design', 'Y','Y',500,50),

(2032, 'Water', 'Wave – Oscillating Water Column', 'Wave power using trapped air compression', 'N','Y',480,28),

(2033, 'Water', 'Wave – Point Absorber Buoys', 'Floating buoy wave energy converters', 'N','Y',485,30),

(2034, 'Biomass', 'Biomass – Torrefied Pellets', 'High-efficiency torrefied wood pellet plants', 'Y','Y',395,22),

(2035, 'Biomass', 'Biomass – Fast Pyrolysis', 'Converts biomass into bio-oil via pyrolysis', 'Y','Y',410,18),

(2036, 'Biomass', 'Biomass – Gasification CHP', 'Combined heat and power using syngas', 'Y','Y',405,20),

(2037, 'Biomass', 'Biomass – Anaerobic Lagoon Digesters', 'Biogas from lagoon-based digesters', 'Y','Y',385,17),

(2038, 'Biomass', 'Biomass – Sewage Sludge Biogas', 'Biogas from wastewater treatment facilities', 'Y','Y',390,15),

(2039, 'Biomass', 'Biomass – Landfill Gas Recovery', 'Electricity from captured landfill methane', 'Y','Y',375,15),

(2040, 'Geothermal', 'Geothermal – Dry Steam', 'High-temperature dry steam wells', 'Y','Y',530,30),

(2041, 'Geothermal', 'Geothermal – Flash Binary Hybrid', 'Combination flash & binary cycle', 'Y','Y',515,32),

(2042, 'Geothermal', 'Geothermal – Supercritical Wells', 'Ultra-high-temperature deep wells', 'Y','Y',540,35),

(2043, 'Geothermal', 'Geothermal – District Loop', 'Low-temp heat for city district networks', 'Y','Y',505,25),

(2044, 'Geothermal', 'Geothermal – Enhanced Fracturing', 'EGS with engineered permeability', 'Y','Y',520,33),

(2045, 'Geothermal', 'Geothermal – Ground Source Heat Pumps', 'Shallow geothermal heat exchange', 'Y','Y',300,20);

INSERT INTO Plant (

plant\_id, country\_id, energy\_type\_id, plant\_name,

commissioning\_year, capacity\_mw, maintenance\_level,

land\_area\_hectares, latitude, longitude, altitude\_m, operator\_name

)

VALUES

(3001,1001,2001,'La Mancha Solar Belt',2016,220,'Low',260.50,39.300000,-3.000000,700,'Sol Iberica'),

(3002,1001,2005,'Aragon Wind Plains',2014,150,'Medium',145.00,41.100000,-0.900000,450,'Viento SA'),

(3003,1001,2008,'Ebro Hydro Reservoir',2008,280,'Medium', 85.00,42.100000,-0.500000,300,'Hydra Spain'),

(3004,1002,2001,'Algarve Solar Park',2018,200,'Low',180.00,37.100000,-8.400000,120,'Luz Portugal'),

(3005,1002,2006,'Porto Offshore Wind',2020,260,'High',150.00,41.150000,-8.600000, 50,'Atlantic Winds'),

(3006,1003,2002,'Provence CSP Tower',2019,250,'Medium',210.00,43.500000, 5.400000, 60,'CSP France'),

(3007,1003,2005,'Normandy Wind Farm',2013,180,'Low',130.00,49.000000, 0.100000, 40,'France WindCo'),

(3008,1004,2009,'Black Forest Run-of-River',2009,160,'Medium', 70.00,48.000000, 8.200000,400,'Hydro Deutschland'),

(3009,1004,2014,'Berlin Deep Geothermal',2021,100,'Very Low',25.00,52.520000,13.400000, 50,'GeoHeat DE'),

(3010,1006,2003,'Turin Rooftop Solar Cluster',2020, 95,'Low', 35.00,45.070000, 7.680000, 240,'Solar Italia'),

(3011,1007,2004,'Aegean Solar-Storage Hub',2022,140,'Very Low', 40.00,37.800000,23.700000, 15,'Helios Storage GR'),

(3012,1008,2006,'North Sea Offshore Hub NL',2017,280,'Medium',170.00,53.500000, 4.000000, 10,'NordSea Wind NL'),

(3013,1009,2011,'Svea Biomass CHP',2015,110,'Medium', 50.00,59.300000,18.000000, 30,'Nordic BioPower'),

(3014,1005,2010,'Bergen Tidal Stream',2018,140,'Low', 35.00,60.390000, 5.320000, 10,'Fjord Energy'),

(3015,1005,2013,'Trondheim Waste-to-Energy',2016,210,'Medium', 55.00,63.430000,10.400000, 35,'WastePower NO');

(3016,1001,2001,'Castilla Solar Extension',2019,180,'Low',210.00,39.800000,-3.500000,650,'Sol Iberica II'),

(3017,1001,2005,'Navarra Wind Hills',2015,140,'Medium',130.00,42.700000,-1.600000,520,'Viento Norte SA'),

(3018,1001,2008,'Segura Valley Hydro',2010,160,'Medium', 75.00,38.000000,-1.200000,300,'Hydra Sur'),

(3019,1002,2001,'Tagus Solar Farm',2020,190,'Low',190.00,39.400000,-8.100000,150,'Luz Tejo'),

(3020,1002,2006,'Atlantic Offshore Array',2021,270,'High',155.00,41.300000,-9.000000, 40,'Atlantic Winds II'),

(3021,1002,2011,'Coimbra Biomass CHP',2016,110,'Medium', 55.00,40.200000,-8.400000, 35,'BioCentro PT'),

(3022,1003,2002,'Languedoc CSP Field',2020,230,'Medium',200.00,43.700000, 3.500000, 70,'CSP Sud France'),

(3023,1003,2005,'Brittany Wind East',2012,170,'Low',135.00,48.200000,-2.800000, 60,'France WindCo East'),

(3024,1003,2012,'Garonne Biogas Hub',2018,100,'Low', 45.00,44.800000, 0.600000, 40,'BioDigest Sud'),

(3025,1004,2009,'Rhine Run-of-River II',2011,150,'Medium', 68.00,48.600000, 7.800000,380,'Hydro Rhein'),

(3026,1004,2014,'Munich Deep Geothermal',2022,105,'Very Low',27.00,48.150000,11.580000, 55,'GeoHeat Bayern'),

(3027,1004,2007,'Harz High Altitude Wind',2023, 60,'Low', 22.00,51.800000,10.700000, 70,'SkyWind Harz'),

(3028,1005,2010,'Stavanger Tidal Stream',2019,130,'Low', 33.00,58.970000, 5.730000, 15,'Fjord Energy West'),

(3029,1005,2014,'Oslo GeoLoop Plant',2021, 90,'Very Low',28.00,59.930000,10.750000, 85,'NordGeo Loop'),

(3030,1005,2013,'Bodo Waste-to-Energy',2017,205,'Medium',53.00,67.280000,14.400000, 30,'WastePower North'),

(3031,1001,2003,'Tarifa Onshore Wind',2014,160,'Low',120.00,36.000000,-5.600000,120,'Viento Estrecho'),

(3032,1001,2014,'Madrid Geo Campus',2023, 80,'Very Low',20.00,40.450000,-3.700000, 60,'GeoCampus ES'),

(3033,1002,2003,'Serra Onshore Wind',2013,150,'Low',115.00,41.700000,-7.800000,200,'Ventus Serra'),

(3034,1003,2010,'Normandy Tidal Pilot',2022, 85,'Low', 30.00,49.600000,-1.700000, 10,'Maree France'),

(3035,1004,2001,'Brandenburg Solar Park',2018,210,'Low',195.00,52.400000,13.100000, 40,'Sonnen DE'),

(3036,1005,2005,'Telemark Run-of-River',2010,155,'Medium', 72.00,59.400000, 8.600000,320,'Hydro Telemark'),

(3037,1002,2013,'Porto Waste-to-Energy',2015,190,'Medium',52.00,41.200000,-8.650000, 25,'LixoEnergia'),

(3038,1003,2011,'Bordeaux Biomass CHP',2016,115,'Medium', 58.00,44.850000,-0.600000, 35,'BioSud Ouest'),

(3039,1001,2002,'Murcia CSP Hybrid',2021,240,'Medium',205.00,37.900000,-1.100000,210,'CSP Levante'),

(3040,1001,2010,'Cantabria Tidal Demo',2020, 75,'Low', 28.00,43.450000,-3.800000, 5,'Marea Norte'),

(3041,1004,2006,'Baltic Offshore Wind DE',2019,260,'High',160.00,54.000000,14.000000, 20,'Ostsee Wind'),

(3042,1005,2003,'Nordfjord Onshore Wind',2014,145,'Low',118.00,61.900000, 6.200000,180,'Fjord Wind'),

(3043,1002,2004,'Evora Solar-Battery Hub',2022,175,'Medium',140.00,38.600000,-7.900000,200,'Luz & Storage'),

(3044,1003,2004,'Lyon Solar Storage Park',2023,185,'Medium',150.00,45.750000, 4.850000,250,'Soleil Stocke'),

(3045,1005,2004,'Oslo Battery Solar Field',2024,160,'Medium',130.00,59.930000,10.800000, 70,'NordSun Storage');

INSERT INTO Plant\_Address (

address\_id, plant\_id, street\_type, name, number,

city, state, zipcode, country\_id

)

VALUES

(9001,3001,'ROAD','La Mancha Solar Road','12','Ciudad Real','Castile-La Mancha','13001',1001),

(9002,3002,'AVENUE','Aragon Wind Avenue','45','Zaragoza','Aragon','50001',1001),

(9003,3003,'ROAD','Ebro Hydro Road','8','Zaragoza','Aragon','50015',1001),

(9004,3016,'STREET','Castilla Solar Park Road','18','Toledo','Castile-La Mancha','45001',1001),

(9005,3017,'HILL','Navarra Wind Hill','22','Pamplona','Navarra','31001',1001),

(9006,3018,'ROAD','Segura Valley Hydro Road','11','Murcia','Region of Murcia','30006',1001),

(9007,3031,'ROAD','Tarifa Wind Road','14','Tarifa','Andalusia','11380',1001),

(9008,3032,'CAMPUS','Madrid Geothermal Campus','7','Madrid','Community of Madrid','28040',1001),

(9009,3039,'ROAD','Levante Solar Road','14','Murcia','Region of Murcia','30007',1001),

(9010,3040,'PORT','Cantabria Tidal Port','32','Santander','Cantabria','39001',1001),

(9011,3004,'ROAD','Algarve Solar Road','20','Faro','Algarve','8001-001',1002),

(9012,3005,'WAY','Atlantic Offshore Way','52','Porto','Norte','4000-101',1002),

(9013,3019,'BOULEVARD','Tagus Solar Boulevard','55','Santarem','Santarem','2000-010',1002),

(9014,3020,'ROAD','Atlantic Array Road','12','Porto','Norte','4100-110',1002),

(9015,3021,'STREET','Coimbra Biomass Street','44','Coimbra','Centro','3000-200',1002),

(9016,3033,'ROAD','Serra Wind Park Road','8','Vila Real','Norte','5000-222',1002),

(9017,3037,'ROAD','Porto Waste Energy Road','33','Porto','Norte','4100-605',1002),

(9018,3043,'ROAD','Evora Solar Battery Road','77','Evora','Alentejo','7000-202',1002),

(9019,3006,'ROAD','Provence CSP Road','42','Aix-en-Provence','Provence-Alpes-Cote dAzur','13100',1003),

(9020,3007,'LANE','Normandy Wind Lane','17','Caen','Normandy','14000',1003),

(9021,3022,'ROAD','Languedoc Solar Road','55','Montpellier','Occitanie','34000',1003),

(9022,3023,'ROAD','Brittany Wind Road','88','Rennes','Brittany','35000',1003),

(9023,3024,'AVENUE','Garonne Biogas Avenue','14','Bordeaux','Nouvelle-Aquitaine','33000',1003),

(9024,3034,'STREET','Cherbourg Tidal Street','6','Cherbourg','Normandy','50100',1003),

(9025,3038,'ROAD','Bordeaux Biomass Road','9','Bordeaux','Nouvelle-Aquitaine','33800',1003),

(9026,3044,'ROAD','Lyon Solar Storage Road','9','Lyon','Auvergne-Rhone-Alpes','69002',1003),

(9027,3008,'ROAD','Black Forest Hydro Road','19','Freiburg','Baden-Wuerttemberg','79098',1004),

(9028,3009,'STREET','Berlin Geothermal Street','8','Berlin','Berlin','10115',1004),

(9029,3025,'ROAD','Rhine River Hydro Road','44','Duesseldorf','North Rhine-Westphalia','40210',1004),

(9030,3026,'STREET','Munich Geothermal Street','11','Munich','Bavaria','80339',1004),

(9031,3027,'RIDGE','Harz Wind Ridge','2','Goslar','Lower Saxony','38640',1004),

(9032,3035,'ROAD','Brandenburg Solar Road','30','Potsdam','Brandenburg','14467',1004),

(9033,3041,'ROAD','Baltic Offshore Road','20','Rostock','Mecklenburg-Vorpommern','18055',1004),

(9034,3010,'STREET','Turin Rooftop Solar Street','21','Torino','Piemonte','10121',1006),

(9035,3011,'AVENUE','Aegean Solar Avenue','5','Athens','Attica','11742',1007),

(9036,3012,'WAY','North Sea Offshore Way','3','Rotterdam','Zuid-Holland','3011AA',1008),

(9037,3013,'ROAD','Svea Biomass Road','16','Stockholm','Stockholm','11120',1009),

(9038,3014,'WAY','Bergen Tidal Way','12','Bergen','Vestland','5003',1005),

(9039,3015,'STREET','Trondheim Energy Street','9','Trondheim','Trondelag','7011',1005),

(9040,3028,'ROAD','Stavanger Tidal Road','20','Stavanger','Rogaland','4006',1005),

(9041,3029,'STREET','Oslo GeoLoop Street','14','Oslo','Oslo','0181',1005),

(9042,3030,'ROAD','Bodo Waste Energy Road','50','Bodo','Nordland','8003',1005),

(9043,3036,'ROAD','Telemark Hydro Road','29','Skien','Vestfold og Telemark','3715',1005),

(9044,3042,'HILL','Nordfjord Wind Hill','77','Nordfjordeid','Vestland','6770',1005),

(9045,3045,'ROAD','Oslo Solar Battery Road','18','Oslo','Oslo','0250',1005);

INSERT INTO GenerationRecord (

generation\_id, plant\_id, generation\_record\_year, month\_number,

energy\_mwh, downtime\_hours, avg\_temp\_celcius, measurement\_basis

)

VALUES

(4001,3001,2024,0,78000,70,19.5,'metered'),

(4002,3002,2024,0,54000,50,14.2,'metered'),

(4003,3003,2023,0,70000,45,12.5,'metered'),

(4004,3004,2024,0,65000,55,20.0,'metered'),

(4005,3005,2024,0,88000,60,11.8,'metered'),

(4006,3006,2022,0,39000,48,16.0,'metered'),

(4007,3007,2024,0,72000,58,27.0,'metered'),

(4008,3008,2021,0,47000,44,10.5,'metered'),

(4009,3009,2024,0,52000,30, 9.0,'metered'),

(4010,3010,2024,0,43000,25,15.5,'metered'),

(4011,3011,2020,0,36000,35,18.0,'metered'),

(4012,3012,2024,0,76000,40, 9.8,'metered'),

(4013,3013,2025,0,41000,28, 7.0,'metered'),

(4014,3014,2024,0,69000,32, 8.5,'metered'),

(4015,3015,2023,0,61000,38, 6.5,'metered');

(4101,3016,2024,0,62000,40,19.0,'metered'),

(4102,3017,2024,0,51000,52,13.8,'metered'),

(4103,3018,2024,0,58000,48,15.0,'metered'),

(4104,3019,2024,0,60000,45,20.5,'metered'),

(4105,3020,2024,0,89000,62,11.5,'metered'),

(4106,3021,2024,0,35000,50,16.3,'metered'),

(4107,3022,2024,0,71000,55,26.5,'metered'),

(4108,3023,2024,0,49000,42,10.2,'metered'),

(4109,3024,2024,0,33000,34,14.8,'metered'),

(4110,3025,2024,0,64000,39, 9.2,'metered'),

(4111,3026,2024,0,46000,18, 6.3,'metered'),

(4112,3027,2024,0,30000,22, 7.5,'metered'),

(4113,3028,2024,0,72000,32, 8.4,'metered'),

(4114,3029,2024,0,31000,16, 5.7,'metered'),

(4115,3030,2024,0,59000,37, 6.2,'metered'),

(4116,3031,2024,0,55000,44,17.8,'metered'),

(4117,3032,2024,0,28000,20,14.5,'metered'),

(4118,3033,2024,0,54000,46,12.9,'metered'),

(4119,3034,2024,0,36000,26,11.0,'metered'),

(4120,3035,2024,0,67000,41, 9.8,'metered'),

(4121,3036,2024,0,63000,36, 7.2,'metered'),

(4122,3037,2024,0,52000,38,15.6,'metered'),

(4123,3038,2024,0,34000,33,13.9,'metered'),

(4124,3039,2024,0,75000,58,22.1,'metered'),

(4125,3040,2024,0,29000,24,13.0,'metered'),

(4126,3041,2024,0,86000,63,10.4,'metered'),

(4127,3042,2024,0,56000,47, 8.6,'metered'),

(4128,3043,2024,0,61000,43,21.3,'metered'),

(4129,3044,2023,0,45000,40,19.5,'metered'),

(4130,3045,2023,0,43000,38,18.7,'metered');

INSERT INTO Customer (

customer\_id, country\_id, customer\_code, customer\_name,

sector, contact\_email, contract\_start\_year,

green\_tariff\_flag, billing\_cycle\_days, credit\_rating

)

VALUES

(5001,1001,'ES-UTIL','IberiaGrid Utility','Utility','billing@iberiagrid.es',2012,'Y',30,'A'),

(5002,1002,'PT-MET','Lisboa Metro','Transport','metro@lisbon.pt',2018,'Y',30,'A-'),

(5003,1003,'FR-IND','Hexagon Industries','Industrial','energy@hexind.fr',2015,'N',45,'BBB'),

(5004,1004,'DE-DATA','Rhine DataHub','DataCenter','ops@rhinedata.de',2020,'Y',30,'A'),

(5005,1005,'NO-PORT','Nordic Ports','Transport','contact@nport.no',2017,'Y',30,'A-'),

(5006,1006,'IT-RETL','ItalGreen Retail Group','Retail','energy@italgreen.it',2019,'Y',45,'BBB'),

(5007,1007,'GR-PORT','Hellenic Port Authority','Transport','power@piraeusport.gr',2016,'Y',30,'BBB+'),

(5008,1008,'NL-IND','NorthSea Industrial Park','Industrial','energy@nsi-park.nl',2014,'N',60,'BBB+'),

(5009,1009,'SE-UTIL','Svea City Utility','Utility','billing@sveautil.se',2011,'Y',30,'A'),

(5010,1010,'UK-RETL','BritRetail Energy Buyers','Retail','procurement@britretail.co.uk',2013,'Y',30,'BBB'),

(5011,1011,'IE-DATA','Atlantic Data Hub','DataCenter','noc@atlanticdata.ie',2021,'Y',30,'A-'),

(5012,1012,'DK-TRANS','Copenhagen Metro Power','Transport','power@cphmetro.dk',2018,'Y',30,'A-'),

(5013,1013,'PL-IND','Vistula Steel Works','Industrial','energy@vistulasteel.pl',2010,'N',45,'BBB'),

(5014,1014,'CH-BANK','Alpine Bank HQ','Financial','facilities@alpinebank.ch',2016,'Y',30,'A'),

(5015,1015,'MA-GRID','Maghreb Grid Operator','Utility','[control@maghrebgrid.ma](mailto:control@maghrebgrid.ma)',2014,'N',30,'BB+');

(5016,1001,'ES-RAIL','Renfe Green Rail','Transport','energy@renfe.es',2016,'Y',30,'A-'),

(5017,1001,'ES-HOTEL','Iberia Hotel Chain','Hospitality','energy@iberhotel.es',2014,'Y',45,'BBB+'),

(5018,1001,'ES-MALL','Madrid Retail Malls','Retail','power@madridmalls.es',2012,'N',60,'BBB'),

(5019,1002,'PT-DATA2','Porto Cloud Center','DataCenter','noc@portocloud.pt',2019,'Y',30,'A'),

(5020,1002,'PT-UTIL2','Lisbon City Utility','Utility','billing@lisutil.pt',2011,'Y',30,'A-'),

(5021,1002,'PT-HOSP','Porto Hospital Group','Healthcare','energy@portohosp.pt',2013,'Y',60,'BBB+'),

(5022,1003,'FR-PORT2','Marseille Port Authority','Transport','power@marseilleport.fr',2010,'Y',30,'BBB+'),

(5023,1003,'FR-DATA2','Lyon Data Campus','DataCenter','noc@lyondata.fr',2018,'Y',30,'A-'),

(5024,1003,'FR-UNIV','Université de Bordeaux','Education','energy@u-bordeaux.fr',2015,'Y',30,'A'),

(5025,1004,'DE-IND2','Ruhr Industrial Park','Industrial','energy@ruhrind.de',2011,'N',60,'BBB'),

(5026,1004,'DE-PORT','Port of Hamburg','Transport','power@hamburg-port.de',2009,'Y',30,'A-'),

(5027,1004,'DE-HOSP2','Munich Hospital Network','Healthcare','energy@munichhosp.de',2016,'Y',45,'A'),

(5028,1005,'NO-UTIL2','Bergen City Utility','Utility','billing@bergenutil.no',2012,'Y',30,'A'),

(5029,1005,'NO-RAIL','Nordic Railways','Transport','energy@nordrail.no',2013,'Y',30,'A-'),

(5030,1005,'NO-RETL','Oslo Retail Group','Retail','energy@oslo-retail.no',2014,'N',45,'BBB+'),

(5031,1001,'ES-MEDIA','Iberia Media Group','Media','energy@iberiamedia.es',2017,'Y',30,'BBB+'),

(5032,1002,'PT-BANK','Lisbon Green Bank','Financial','energy@lgbank.pt',2018,'Y',30,'A'),

(5033,1003,'FR-BANK','Paris Sustainable Bank','Financial','energy@psbank.fr',2019,'Y',30,'A'),

(5034,1004,'DE-TECH','Berlin Tech Campus','Technology','power@berlintech.de',2020,'Y',30,'A-'),

(5035,1005,'NO-TECH','Oslo AI Campus','Technology','energy@osloai.no',2021,'Y',30,'A'),

(5036,1001,'ES-HEALTH2','Andalucia Health Service','Healthcare','energy@andalhealth.es',2011,'Y',60,'BBB+'),

(5037,1002,'PT-AGRI','Alentejo Agro Coop','Agriculture','energy@alentejoagri.pt',2010,'N',60,'BBB'),

(5038,1003,'FR-AGRI','Bretagne Agro Coop','Agriculture','energy@bretagneagri.fr',2012,'N',60,'BBB'),

(5039,1004,'DE-LOG','Rhine Logistics Hub','Logistics','energy@rhinelog.de',2013,'Y',45,'BBB+'),

(5040,1005,'NO-LOG','Nordic Logistics','Logistics','energy@nordlog.no',2016,'Y',45,'A-'),

(5041,1001,'ES-UNI2','Universitat de Barcelona','Education','energy@ub.edu',2008,'Y',30,'A'),

(5042,1002,'PT-UNI2','Universidade de Lisboa','Education','energy@ulisboa.pt',2009,'Y',30,'A-'),

(5043,1003,'FR-METRO','Nice Metro System','Transport','power@nicemetro.fr',2017,'Y',30,'BBB+'),

(5044,1004,'DE-MALL2','Frankfurt Retail Malls','Retail','energy@ffm-malls.de',2015,'N',60,'BBB'),

(5045,1005,'NO-HOTEL','Nordic Fjord Hotels','Hospitality','energy@fjordhotels.no',2014,'Y',45,'BBB+');

INSERT INTO Invoice (

invoice\_id, customer\_id, invoice\_number, billing\_year,

billing\_month\_number, invoice\_date, due\_date,

currency, status, total\_mwh, total\_amount\_euro,

tax\_amount\_euro, issue\_office

)

VALUES

(6001,5001,'INV-2024-ES-001',2024, 1,'2024-01-10','2024-02-10',

'EUR','Paid', 7000,490000.00,102900.00,'Madrid HQ'),

(6002,5002,'INV-2024-PT-002',2024, 2,'2024-02-12','2024-03-12',

'EUR','Paid', 5200,364000.00, 76440.00,'Lisbon Office'),

(6003,5003,'INV-2024-FR-003',2024, 3,'2024-03-20','2024-04-20',

'EUR','Paid', 6100,427000.00, 89670.00,'Paris HQ'),

(6004,5004,'INV-2024-DE-004',2024, 4,'2024-04-15','2024-05-15',

'EUR','Issued', 4500,315000.00, 66150.00,'Berlin Campus'),

(6005,5005,'INV-2024-NO-005',2024, 5,'2024-05-05','2024-06-05',

'EUR','Paid', 5600,392000.00, 82320.00,'Oslo Office'),

(6006,5006,'INV-2024-IT-006',2024, 6,'2024-06-18','2024-07-18',

'EUR','Paid', 4800,336000.00, 70560.00,'Milan Office'),

(6007,5007,'INV-2024-GR-007',2024, 7,'2024-07-11','2024-08-11',

'EUR','Paid', 3900,273000.00, 57330.00,'Athens Port Office'),

(6008,5008,'INV-2024-NL-008',2024, 8,'2024-08-09','2024-09-09',

'EUR','Pending', 6200,434000.00, 91140.00,'Rotterdam Office'),

(6009,5009,'INV-2023-SE-009',2023, 9,'2023-09-03','2023-10-03',

'EUR','Paid', 3000,210000.00, 44100.00,'Stockholm Utility'),

(6010,5010,'INV-2023-GB-010',2023,10,'2023-10-14','2023-11-14',

'EUR','Paid', 7300,511000.00,107310.00,'London Office'),

(6011,5011,'INV-2022-IE-011',2022,11,'2022-11-06','2022-12-06',

'EUR','Paid', 5200,364000.00, 76440.00,'Dublin Data Hub'),

(6012,5012,'INV-2021-DK-012',2021,12,'2021-12-08','2022-01-08',

'EUR','Issued', 5400,378000.00, 79380.00,'Copenhagen Metro'),

(6013,5013,'INV-2025-PL-013',2025, 1,'2025-01-15','2025-02-15',

'EUR','Pending', 4900,343000.00, 72030.00,'Warsaw Steel Office'),

(6014,5014,'INV-2020-CH-014',2020, 2,'2020-02-10','2020-03-10',

'EUR','Paid', 4600,322000.00, 67620.00,'Zurich HQ'),

(6015,5015,'INV-2025-MA-015',2025, 3,'2025-03-12','2025-04-12',

'EUR','Issued', 4100,287000.00, 60270.00,'Rabat HQ');

(6016,5016,'INV-2024-ES-016',2024, 4,'2024-04-10','2024-05-10',

'EUR','Paid', 5200,364000.00, 76440.00,'Madrid Rail Office'),

(6017,5017,'INV-2024-ES-017',2024, 5,'2024-05-12','2024-06-12',

'EUR','Paid', 4100,287000.00, 60270.00,'Seville Hotel Desk'),

(6018,5018,'INV-2024-ES-018',2024, 6,'2024-06-14','2024-07-14',

'EUR','Pending',4500,315000.00, 66150.00,'Madrid Retail HQ'),

(6019,5019,'INV-2024-PT-019',2024, 7,'2024-07-08','2024-08-08',

'EUR','Paid', 4800,336000.00, 70560.00,'Porto Cloud Office'),

(6020,5020,'INV-2024-PT-020',2024, 3,'2024-03-18','2024-04-18',

'EUR','Paid', 5300,371000.00, 77910.00,'Lisbon Utility HQ'),

(6021,5021,'INV-2024-PT-021',2024, 9,'2024-09-05','2024-10-05',

'EUR','Issued',3900,273000.00, 57330.00,'Porto Hospital Office'),

(6022,5022,'INV-2024-FR-022',2024, 2,'2024-02-11','2024-03-11',

'EUR','Paid', 5600,392000.00, 82320.00,'Marseille Port'),

(6023,5023,'INV-2024-FR-023',2024,10,'2024-10-09','2024-11-09',

'EUR','Pending',4200,294000.00, 61740.00,'Lyon Data Campus'),

(6024,5024,'INV-2024-FR-024',2024,11,'2024-11-13','2024-12-13',

'EUR','Issued',3500,245000.00, 51450.00,'Bordeaux University'),

(6025,5025,'INV-2024-DE-025',2024, 1,'2024-01-16','2024-02-16',

'EUR','Paid', 6000,420000.00, 88200.00,'Ruhr Industrial Office'),

(6026,5026,'INV-2024-DE-026',2024, 4,'2024-04-20','2024-05-20',

'EUR','Paid', 5800,406000.00, 85260.00,'Hamburg Port'),

(6027,5027,'INV-2024-DE-027',2024, 6,'2024-06-07','2024-07-07',

'EUR','Paid', 4400,308000.00, 64680.00,'Munich Hospital Office'),

(6028,5028,'INV-2024-NO-028',2024, 8,'2024-08-10','2024-09-10',

'EUR','Pending',4700,329000.00, 69090.00,'Bergen Utility Branch'),

(6029,5029,'INV-2024-NO-029',2024, 9,'2024-09-12','2024-10-12',

'EUR','Paid', 5100,357000.00, 74970.00,'Oslo Rail Office'),

(6030,5030,'INV-2024-NO-030',2024,10,'2024-10-15','2024-11-15',

'EUR','Paid', 3900,273000.00, 57330.00,'Oslo Retail Office'),

(6031,5031,'INV-2023-ES-031',2023,11,'2023-11-09','2023-12-09',

'EUR','Paid', 3200,224000.00, 47040.00,'Iberia Media Office'),

(6032,5032,'INV-2023-PT-032',2023,12,'2023-12-05','2024-01-05',

'EUR','Paid', 3400,238000.00, 49980.00,'Lisbon Green Bank'),

(6033,5033,'INV-2025-FR-033',2025, 1,'2025-01-10','2025-02-10',

'EUR','Issued',4100,287000.00, 60270.00,'Paris Sustainable Bank'),

(6034,5034,'INV-2025-DE-034',2025, 2,'2025-02-18','2025-03-18',

'EUR','Issued',4300,301000.00, 63210.00,'Berlin Tech Campus'),

(6035,5035,'INV-2025-NO-035',2025, 3,'2025-03-11','2025-04-11',

'EUR','Pending',3600,252000.00, 52920.00,'Oslo AI Campus'),

(6036,5036,'INV-2024-ES-036',2024,12,'2024-12-06','2025-01-06',

'EUR','Issued',3800,266000.00, 55860.00,'Andalucia Health'),

(6037,5037,'INV-2024-PT-037',2024,11,'2024-11-04','2024-12-04',

'EUR','Paid', 3000,210000.00, 44100.00,'Alentejo Agro Office'),

(6038,5038,'INV-2024-FR-038',2024, 3,'2024-03-07','2024-04-07',

'EUR','Paid', 3300,231000.00, 48510.00,'Bretagne Agro Coop'),

(6039,5039,'INV-2024-DE-039',2024, 5,'2024-05-19','2024-06-19',

'EUR','Paid', 4200,294000.00, 61740.00,'Rhine Logistics'),

(6040,5040,'INV-2024-NO-040',2024, 7,'2024-07-16','2024-08-16',

'EUR','Pending',3500,245000.00, 51450.00,'Nordic Logistics'),

(6041,5041,'INV-2022-ES-041',2022, 9,'2022-09-09','2022-10-09',

'EUR','Paid', 2900,203000.00, 42630.00,'Barcelona University'),

(6042,5042,'INV-2022-PT-042',2022,10,'2022-10-12','2022-11-12',

'EUR','Paid', 3100,217000.00, 45570.00,'Lisbon University'),

(6043,5043,'INV-2023-FR-043',2023, 4,'2023-04-03','2023-05-03',

'EUR','Paid', 3600,252000.00, 52920.00,'Nice Metro'),

(6044,5044,'INV-2023-DE-044',2023, 6,'2023-06-14','2023-07-14',

'EUR','Paid', 3800,266000.00, 55860.00,'Frankfurt Malls'),

(6045,5045,'INV-2023-NO-045',2023, 8,'2023-08-21','2023-09-21',

'EUR','Paid', 3400,238000.00, 49980.00,'Nordic Fjord Hotels');

INSERT INTO Invoice\_Line (

invoice\_id, NUMSEQ, plant\_id

)

VALUES

(6001,1,3001),

(6002,1,3002),

(6003,1,3003),

(6004,1,3004),

(6005,1,3005),

(6006,1,3006),

(6007,1,3007),

(6008,1,3008),

(6009,1,3009),

(6010,1,3010),

(6011,1,3011),

(6012,1,3012),

(6013,1,3013),

(6014,1,3014),

(6015,1,3015);

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(6017,1,3017),

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(6020,1,3020),

(6021,1,3021),

(6022,1,3022),

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(6027,1,3027),

(6028,1,3028),

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(6039,1,3039),

(6040,1,3040),

(6041,1,3041),

(6042,1,3042),

(6043,1,3043),

(6044,1,3044),

(6045,1,3045);

INSERT INTO Invoice\_Line\_Detail (

invoice\_id, NUMSEQ, year, month\_number,

energy\_mwh, unit\_price\_euro, line\_amount\_euro,

time\_categorie, loss\_factor\_pct, contract\_type

)

VALUES

(6001,1,2024, 1,7000,70.00,490000.00,'Peak', 2.10,'PPA'),

(6002,1,2024, 2,5200,70.00,364000.00,'Shoulder', 2.20,'PPA'),

(6003,1,2024, 3,6100,70.00,427000.00,'Peak', 2.00,'Spot'),

(6004,1,2024, 4,4500,70.00,315000.00,'Day', 2.30,'PPA'),

(6005,1,2024, 5,5600,70.00,392000.00,'Peak', 2.50,'PPA'),

(6006,1,2024, 6,4800,70.00,336000.00,'Off-peak', 2.40,'PPA'),

(6007,1,2024, 7,3900,70.00,273000.00,'Peak', 2.60,'Spot'),

(6008,1,2024, 8,6200,70.00,434000.00,'Shoulder', 2.70,'Spot'),

(6009,1,2023, 9,3000,70.00,210000.00,'Day', 2.30,'PPA'),

(6010,1,2023,10,7300,70.00,511000.00,'Peak', 2.90,'PPA'),

(6011,1,2022,11,5200,70.00,364000.00,'Off-peak', 2.00,'PPA'),

(6012,1,2021,12,5400,70.00,378000.00,'Shoulder', 2.10,'PPA'),

(6013,1,2025, 1,4900,70.00,343000.00,'Peak', 2.80,'PPA'),

(6014,1,2020, 2,4600,70.00,322000.00,'Day', 2.40,'Transport'),

(6015,1,2025, 3,4100,70.00,287000.00,'Off-peak', 2.20,'PPA');

(6016,1,2024, 4,5200,70.00,364000.00,'Peak', 2.10,'PPA'),

(6017,1,2024, 5,4100,70.00,287000.00,'Shoulder', 2.20,'PPA'),

(6018,1,2024, 6,4500,70.00,315000.00,'Off-peak', 2.40,'Spot'),

(6019,1,2024, 7,4800,70.00,336000.00,'Peak', 2.60,'Spot'),

(6020,1,2024, 3,5300,70.00,371000.00,'Day', 2.30,'PPA'),

(6021,1,2024, 9,3900,70.00,273000.00,'Peak', 2.50,'PPA'),

(6022,1,2024, 2,5600,70.00,392000.00,'Shoulder', 2.70,'PPA'),

(6023,1,2024,10,4200,70.00,294000.00,'Peak', 2.90,'Spot'),

(6024,1,2024,11,3500,70.00,245000.00,'Off-peak', 2.40,'PPA'),

(6025,1,2024, 1,6000,70.00,420000.00,'Peak', 2.80,'PPA'),

(6026,1,2024, 4,5800,70.00,406000.00,'Day', 2.60,'PPA'),

(6027,1,2024, 6,4400,70.00,308000.00,'Off-peak', 2.30,'PPA'),

(6028,1,2024, 8,4700,70.00,329000.00,'Peak', 2.70,'Spot'),

(6029,1,2024, 9,5100,70.00,357000.00,'Shoulder', 2.50,'PPA'),

(6030,1,2024,10,3900,70.00,273000.00,'Off-peak', 2.20,'PPA'),

(6031,1,2023,11,3200,70.00,224000.00,'Peak', 2.30,'PPA'),

(6032,1,2023,12,3400,70.00,238000.00,'Shoulder', 2.40,'PPA'),

(6033,1,2025, 1,4100,70.00,287000.00,'Peak', 2.60,'PPA'),

(6034,1,2025, 2,4300,70.00,301000.00,'Day', 2.50,'PPA'),

(6035,1,2025, 3,3600,70.00,252000.00,'Off-peak', 2.30,'Spot'),

(6036,1,2024,12,3800,70.00,266000.00,'Peak', 2.70,'PPA'),

(6037,1,2024,11,3000,70.00,210000.00,'Day', 2.40,'PPA'),

(6038,1,2024, 3,3300,70.00,231000.00,'Off-peak', 2.50,'PPA'),

(6039,1,2024, 5,4200,70.00,294000.00,'Peak', 2.80,'PPA'),

(6040,1,2024, 7,3500,70.00,245000.00,'Shoulder', 2.60,'Spot'),

(6041,1,2022, 9,2900,70.00,203000.00,'Off-peak', 2.20,'PPA'),

(6042,1,2022,10,3100,70.00,217000.00,'Peak', 2.40,'PPA'),

(6043,1,2023, 4,3600,70.00,252000.00,'Day', 2.30,'PPA'),

(6044,1,2023, 6,3800,70.00,266000.00,'Shoulder', 2.50,'PPA'),

(6045,1,2023, 8,3400,70.00,238000.00,'Off-peak', 2.40,'PPA');

**Model Explanation:**

***Entity 1: Country***

This entity identifies the geographical context in which renewable plants operate and customers are located.  
It also stores climate indicators that help explain why certain regions are better suited for specific renewable asset.

1. **PK: country\_id: Unique identifier for each country.**
2. **Descriptive Attributes:**
   1. country\_name: Official name of the country
   2. iso\_code: Two-letter international code (For example: ES)
   3. region: Sub-regional classification within a continent
   4. continent: Continent where the country is located.
   5. climate\_type: Dominant climate category (Mediterranean, Atlantic coast, Oceanic…)
   6. avg\_sun\_hours\_per\_year: Annual sunlight hours, relevant for solar potential.
   7. avg\_wind\_speed\_ms: Average wind speed, relevant for wind generation

***Entity 2: EnergyType:***

Describes each renewable energy technology family (Solar, Wind, Water, Biomass, Geothermal) and its specific sub-groups’ details:

1. **PK: energy\_type\_id: Unique identifier for each energy technology**
2. Descriptive attributes
   * 1. type\_name: Energy family (Solar, Wind, Water, Biomass, Geothermal)
     2. energy\_type\_detail: More specific subtype (e.g., Solar PV, Offshore Wind, Run-of-River Hydro…)
     3. additional\_source\_description: Short explanation of how the energy is generated
     4. controllable\_indicator: ‘Y’ / ‘N’ - Whether output is adjustable on demand
     5. storage\_friendly\_indicator: ‘Y’ / ‘N’ – Whether production pairs well with storage
     6. co2\_saving\_kg\_permwh: Avoided emissions per MWh
     7. typical\_lifetime\_years: Expected lifetime of energy generating asset

***Entity 3: Plant***

Representing each renewable farm

1. **PK: plant\_id → Unique ID of the plant.**
2. **FKs: country\_id → Country ; energy\_type\_id → EnergyType**
3. Descriptive attributes
   1. Plant\_name: Name of plant
   2. Commissioning\_year: Year the plant started operation.
   3. Capacity\_mw: Generating Capcity (MW)
   4. Maintenance\_level: Required maintenance (Very Low → High)
   5. Land\_area\_hectares: occupied area by the plant in hectare
   6. Latitude: Coordinate decimal degrees
   7. Longitude: Coordinate decimal degrees
   8. Altitude\_m: meters above sea level
   9. Operator\_name: company running the plant

***Entity 4: Plant\_Address***

This entity stores the physical location details of each energy plant.

1. **PK: address\_id → Unique identifier for each address record**
2. **FK: plant\_id (UNIQUE) & country\_id → Identifies the plant and country this address belongs to**
3. Descriptive Attributes:
   1. street\_type: Describes the type of street
   2. name: Actual name of the street used in the plant’s address
   3. number: Represents the building or site number on the street
   4. city: The city or municipality where the plant is located
   5. state: Specifies the state, province - may be optional depending on the country
   6. zipcode: stores the postal code for the plant’s location
   7. country\_id links the address to a specific country in the Country table

***Entity 5: GenerationRecord:***

Records how much energy each plant generated in the year

1. **PK: generation\_id → Unique generation record ID**
2. **FK: plant\_id → References plant that produced the energy**
3. Descriptive attributes
   1. generation\_record\_year: Year of the generation record
   2. Month\_number: Month of generation record → 0 = annual total; 1–12 = specific month
   3. Energy\_mwh: Total energy generated in that year/month
   4. Downtime\_hours: Hours plant was offline
   5. Avg\_temp\_celcius: average temperature generated by plant
   6. Measurement\_basis: Indicates whether data is measured or estimated: “metered”, “modelled”

***Entity 6: CUSTOMER***

Shows information of buyers of green energy: utilities, metros, data centers, etc.

1. **PK: customer\_id Unique customer identifier**
2. **FK: country\_id → Countr**y
3. Descriptive attributes
   1. Customer\_code: internal code for billing
   2. Customer\_name: Name of client: “IberiaGrid Utility”
   3. Sector: Industry sector of customer
   4. Contact\_email: Main contact for communication
   5. Contract\_start\_year: When did customer first start buying energy
   6. Green\_tariff\_flag: ‘Y’ if they demand certified green energy
   7. Billing\_cycle\_days: 30, 45…
   8. Credit\_rating: Risk Assesment: A, B, etc.

***Entity 7: INVOICE (Monthly)***

Represents the monthly invoice issued to a customer

1. **PK: invoice\_id Unique Identifier for invoice**
2. **FK: customer\_id → Customer id that belongs to this invoice**
3. Descriptive attributes:
   1. Invoice\_number: External reference Invoice number: e.g. “INV-2024-ES-001”
   2. Billing\_year: The year energy was billed
   3. Billing\_month\_number: Month Number
   4. Invoice\_date: Date invoice was issued.
   5. Due\_date: Payment due date
   6. Currency: currency code depending on country
   7. Status: Issued /Pending/ Paid
   8. Total\_mwh: total energy on the invoice
   9. Total\_amount\_euro: total invoice value of energy billed
   10. Tax\_amount\_euro: VAT/sales tax amount
   11. Issue\_office: office name issuing the invoice

*(Note: total\_mwh and total\_amount\_euro can be recomputed from line items but are stored for quick billing reports. They still depend only on the invoice key, so 3NF is not violated.)*

***Entity 8: Invoice\_Line (ENERGY SOLD / JUNCTION TABLE):***

This is the junction table resolving the many-to-many relationship between **PLANT** and **INVOICE** - It contains only keys, no descriptive attributes:

1. One invoice can contain energy from several plants.
2. One plant ‘s energy sale can appear on many invoices
3. So Plant and Invoice is M:N, and InvoiceLine is required:
   1. **Composite primary key (invoice\_id, NUMSEQ) where NUMSEQ is the line sequence on that invoice**
   2. **FK: Invoice.invoice\_id & Plant.plant\_id**
4. Descriptive attributes:
   1. invoice\_id(PK,FK): Which invoice this line belongs to.
   2. NUMSEQ (PK): Sequence number of line position in the invoice
   3. plant\_id(FK)

***ENITY 9: Invoice\_line\_detail:***

One-to-one extension of Invoice\_Line containing line-level descriptive data.

1. **Composite Primary Key: (invoice\_id, NUMSEQ) → Same pair as in Invoice\_Line, representing one specific invoice line.**
2. **Foreign Key: (invoice\_id, NUMSEQ) → Invoice\_Line(invoice\_id, NUMSEQ)**
3. Descriptive Attributes
   1. Year: Billing year for this line.
   2. Month\_number: Billing month for this line.
   3. Energy\_mwh: MWh sold on that line item.
   4. Unit\_price\_euro: Price per MWh.
   5. Line\_amount\_euro: energy\_mwh × unit\_price\_euro (pre-tax revenue).
   6. Time\_categorie: Time-of-day band: Peak / Off-peak / Day / Shoulder.
   7. Loss\_factor\_pct: Simple percentage accounting for grid losses.
   8. Contract\_type: PPA / Spot / Transport:
      1. PPA: Long-term Power Purchase Agreement with fixed or structured price.
      2. Spot:Short-term sale at day-ahead or real-time market prices.
      3. Transport: Contract about moving electricity through the grid, not about energy itself.  
         Because all non-key attributes in Invoice\_Line\_Detail depend on (invoice\_id, NUMSEQ) and nothing else, it is in 3NF.

**Relationship types**

1. **Country - Plant → 1:M**  
   1. One country can host many renewable plants.
   2. Each plant is physically located in exactly one country.
2. **Country - Plant\_address → 1:M**
   1. Each address belongs to exactly one country
   2. A country may have zero, one, or many plant addresses.
3. **Plant - Plant\_address → 1:1**
   1. Each address is associated with exactly one plant.
   2. One plant can only have one address.
4. **EnergyType - Plant → 1:M**  
   1. One energy technology (example: Solar PV) can be used by many plants.
   2. Each plant has one dominant technology.
5. **Plant - GenerationRecord → 1:M**
   1. A plant can have multiple annual generation records (different years).
   2. Each generation record belongs to exactly one plant.
6. **Country - Customer → 1:M**  
   1. A country can have many customers.
   2. Each customer is registered in one primary country (billing/legal entity).
7. **Customer - Invoice → 1:M**  
   1. A customer can receive multiple monthly invoices: A client buys energy **every month** (or every billing cycle) → Should receive a **new invoice each period** (Nov, Dec, Jan, etc.).
   2. Each invoice belongs to exactly one customer.
8. **Invoice - Invoice\_Line → 1:M**  
   1. One invoice can contain several line items.
   2. Each line item belongs to exactly one invoice.
9. **Plant-Invoice\_Line → 1:M**  
   1. A plant’s energy sell can reflect on many invoices (and many lines in invoices).
   2. Each invoice line refers to energy coming from one plant.
10. **Plant - Invoice → M:N**
    1. Even though **each invoice line** refers to **one plant**, the **COMBINATION** of all lines across an invoice makes the relationship **many-to-many**.
    2. This many-to-many relationship is resolved through **Invoice\_Line**
       1. One invoice can contain energy from several plants & sources
       2. One plant’s energy sell can appear on many invoices
    3. Consolidated Bill: An invoice may include energy from multiple plants. Therefore, the system supports portfolio billing, not per-plant billing.
    4. **Note: If we tried to make it “1:M” in either direction:** 
       1. **Invoice 1:M Plant (only one plant per invoice) —> Invoice would need a plant\_id, and we lose the ability to bill a customer for a mix of different energy types on one invoice and we can’t send a portfolio invoice for all plants a customer buys from.**
11. **Invoice\_Line - Invoice\_Line\_Detail** → **1:1**
    1. Each line in Invoice\_Line can have at most one matching row in Invoice\_Line\_Detail
    2. Invoice\_Line\_Detail cannot create additional rows per line because it uses the same PK

**What a customer or program can achieve with this model:**

1. **Analyze energy generation performance**
   1. Total MWh per plant, per year.
   2. Compare energy by EnergyType (Solar vs Wind vs Hydro), per country
   3. Study impact of climate (sun hours, wind speed) on energy output.
2. **Helps identify:**
   1. Top locations per energy type
   2. Percentage of energy generated per energy type
   3. Plants with various maintenance levels
   4. Time-series/annual graphs of energy generated per plant/year
3. **Support billing & commercial use cases:**
   1. Track who bought how much energy, when and from which plants.
   2. Separate different contract revenues.
   3. Compute revenue by country, sector, plant, and technology/asset.
   4. Validate that invoice totals match the sum of line items.
4. **Sustainability & risk analysis**
   1. Estimate avoided CO₂ per MWh per energy type.
   2. Rank customers by green\_tariff\_flag or by credit\_rating.
   3. Study long-term asset planning using typical\_lifetime\_years.

**Business Rules & Design Constraint:**

1. **IDs and uniqueness**
   1. Each table has its own ID range to avoid confusing overlaps (Country 1000s, EnergyType 2000s, etc…)
   2. Natural keys have UNIQUE constraints where appropriate.
      1. Each key must uniquely identify exactly one row; values cannot repeat unless they refer to the same entity
   3. No child row can exist without a corresponding parent row (referential integrity)
2. **Years & diversity**
   1. Generation and invoices span multiple years (2020–2025) with about half of the records in 2024, to reflect the “last year” focus while still being realistic.
3. **Normalization Constraints:**
   1. **1NF**
      1. All attributes are atomic.
      2. No repeating groups in any table
   2. **2NF-** No partial dependencies:
      1. In Invoice\_Line and Invoice\_Line\_Detail, all non-key attributes depend on the full composite key (invoice\_id, NUMSEQ).
   3. **3NF -** No transitive dependencies:
      1. Each attribute depends solely on its key.
4. **Junction Table Rules & Constraints**
   1. Invoice\_Line contains only keys; all descriptive attributes are isolated in Invoice\_Line\_Detail. This enforces:
      1. Each invoice can have multiple lines.
      2. Each line has a unique sequence number within that invoice.
      3. Sequence numbers cannot repeat for the same invoice.
5. **Value Meaning Constraints**
   * 1. month\_number = 0 in GenerationRecord indicates an annual record
     2. year must be a valid 4-digit year
6. **General Business Model Rules:**
   1. The model supports international multi-country clean energy billing.
   2. Plants and customers are geographically separate, allowing cross-border energy trade.
   3. Time-based tariffs (Peak, Off-peak, Standard/Shoulder) reflect real energy market pricing.
   4. Generation records allow historical performance tracking (multi-year, multi-plant).
   5. Consolidated Bill: An invoice may include energy from multiple plants. Therefore, the system supports portfolio billing, not per-plant billing.
   6. Note: The CO₂ avoidance calculation compares renewable electricity against a fossil-fuel baseline. In this model, the fossil baseline is represented indirectly through the attribute co2\_saving\_kg\_permwh stored in the EnergyType table. This value reflects emissions that would have occurred if the same electricity had been produced by the local fossil mix (coal, gas, oil). So the fossil control group does not need to be stored in the database and can remain an external assumption used in reporting calculations)

**QUESTION 4: SQL with the answers for each of the four questions shown in the document.Show the SQL statement and include output using your data.**

1) Where are the top 3 relevant locations per energy type?

SELECT

t.type\_name,

t.country\_name,

t.city,

t.total\_energy\_mwh

FROM

(SELECT et.type\_name,

c.country\_name,

pa.city,

SUM(gr.energy\_mwh) AS total\_energy\_mwh,

ROW\_NUMBER()

OVER

(PARTITION BY et.type\_name ORDER BY SUM(gr.energy\_mwh) DESC) AS rn

FROM

GenerationRecord gr

INNER JOIN Plant p ON gr.plant\_id = p.plant\_id

INNER JOIN EnergyType et ON p.energy\_type\_id = et.energy\_type\_id

INNER JOIN Plant\_Address pa ON p.plant\_id = pa.plant\_id

INNER JOIN Country c ON pa.country\_id = c.country\_id

GROUP BY

et.type\_name,

c.country\_name,

pa.city) AS t

WHERE t.rn <= 3

ORDER BY

t.type\_name,

t.total\_energy\_mwh DESC;

A screenshot of a computer

AI-generated content may be incorrect.

2) Percentage of energy generated per each energy type.

SELECT

et.type\_name,

SUM(gr.energy\_mwh) AS total\_energy\_mwh,

ROUND(100.0 \* SUM(gr.energy\_mwh) / (SELECT SUM(energy\_mwh) FROM GenerationRecord), 2) AS pct\_of\_total

FROM

GenerationRecord gr

INNER JOIN Plant p ON gr.plant\_id = p.plant\_id

INNER JOIN EnergyType et ON p.energy\_type\_id = et.energy\_type\_id

GROUP BY

et.type\_name

ORDER BY

pct\_of\_total DESC;

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AI-generated content may be incorrect.

3) Which plant is the one that needs the least human maintenance?

SELECT

p.plant\_name,

p.maintenance\_level,

c.country\_name,

et.type\_name,

pa.street\_type,

pa.name AS street\_name,

pa.number,

pa.city,

pa.state,

pa.zipcode,

gr.energy\_mwh,

gr.downtime\_hours

FROM

Plant p

INNER JOIN GenerationRecord gr ON (p.plant\_id = gr.plant\_id)

INNER JOIN Country c ON (p.country\_id = c.country\_id)

INNER JOIN EnergyType et ON (p.energy\_type\_id = et.energy\_type\_id)

INNER JOIN Plant\_Address pa ON (p.plant\_id = pa.plant\_id)

ORDER BY

CASE p.maintenance\_level

WHEN 'Very Low' THEN 1

WHEN 'Low' THEN 2

WHEN 'Medium' THEN 3

WHEN 'High' THEN 4

END, gr.downtime\_hours ASC

LIMIT 1;

A screenshot of a computer

AI-generated content may be incorrect.

If curious to see for other plants, see results below when we removed “LIMIT 1”:

A screenshot of a computer

AI-generated content may be incorrect.

A table with a list of road names

AI-generated content may be incorrect.

4) Show a graph with the amount of energy generated for the last year.

SELECT

gr.generation\_record\_year,

p.plant\_name,

et.type\_name,

c.country\_name,

gr.energy\_mwh

FROM

GenerationRecord gr

INNER JOIN Plant p ON (gr.plant\_id = p.plant\_id)

INNER JOIN EnergyType et ON (p.energy\_type\_id = et.energy\_type\_id)

INNER JOIN Country c ON (p.country\_id = c.country\_id)

WHERE

gr.generation\_record\_year = 2024 AND gr.month\_number = 0

ORDER BY

gr.energy\_mwh DESC;

A screenshot of a table

AI-generated content may be incorrect.

A graph of energy efficiency

AI-generated content may be incorrect.

**QUESTION 5: Make the 5th question on your own and answer it. Show the SQL statement and include output using your data.**

For all years, by customer sector and energy family (Solar, Wind, Water, Biomass, Geothermal), how much renewable energy was sold (in MWh), and how many tons of CO₂ emissions were avoided based on those sales?

*(Note: The CO₂ avoidance calculation compares renewable electricity against a fossil-fuel baseline. In this model, the fossil baseline is represented indirectly through the attribute co2\_saving\_kg\_permwh stored in the EnergyType table. This value reflects emissions that would have occurred if the same electricity had been produced by the local fossil mix (coal, gas, oil). So the fossil control group does not need to be stored in the database and can remain an external assumption used in reporting calculations)*

SELECT

cu.customer\_name,

c.country\_name,

cu.sector,

et.type\_name AS energy\_family,

ild.year, SUM(ild.energy\_mwh) AS total\_energy\_mwh,

SUM(ild.energy\_mwh \* et.co2\_saving\_kg\_permwh) / 1000 AS total\_co2\_avoided\_tons

FROM

invoice\_line\_detail ild

INNER JOIN invoice\_line il ON (il.invoice\_id = ild.invoice\_id AND il.NUMSEQ = ild.NUMSEQ)

INNERJOIN plant p ON (il.plant\_id = p.plant\_id)

INNER JOIN energytype et ON p.energy\_type\_id = et.energy\_type\_id

INNER JOIN invoice i ON (il.invoice\_id = i.invoice\_id)

INNER JOIN customer cu ON i.customer\_id = cu.customer\_id

INNER JOIN country c ON cu.country\_id = c.country\_id

GROUP BY

cu.customer\_id,

c.country\_name,

cu.sector,

et.type\_name,

ild.year

ORDER BY

total\_co2\_avoided\_tons DESC;

A table of numbers and names

AI-generated content may be incorrect.

A table of numbers with text

AI-generated content may be incorrect.