Table S1. Existing approaches to assessing greenhouse gas emissions from electricity generation

Source	Differentiation of coefficients	Methodological approach and calculation features	Initial data used to calculate grid emission factors
United Nations Framework Convention on Climate Change (UNFCCC), «IFI Technical Working Group», Default Grid Factors Dataset. Ver. 3.1", 2021 [87]	Operating Margine Grid Emission Factor, Combined Margin Grid Emission Factor (Firm energy, Intermittent energy, Energy efficiency, Energy consumption)	Based on the CDM methodology, taking into account electricity production within the country, without interconnections with the energy systems of other countries	IEA data: information on fuel combustion and CO_2 emissions by sector, including gross electricity generation, for 142 countries and territories
International Renewable Energy Agency (IRENA), Energy profile «Russian Federation», 2022 [16]	Depending on the type of fuel	Calculated by dividing power sector emissions by electricity and heat generation	IRENA electricity generation statistics
PNST 646-2022, «Green» standards. «Green» products and «green» technologies. Methodology for assessing the reduction of carbon footprint, 2022 [82]	Regional greenhouse gas emission factors for integrated energy systems and isolated systems	Based on the CDM methodology	Adopted according to research by Lahmeyer International and the European Bank for Reconstruction and Development
Lahmeyer International and the European Bank for Reconstruction and Development, Report «Development of the electricity carbon emission factors for Russia», 2010 [6,15]	Combined Margin, Operating Margin and Build Margin grid emission factors for the Russian energy system and for integrated power systems based on data from 2009 and forecast until 2020	Based on the CDM methodology. Developed for use in determining the baseline scenario for prospective activities within the framework of CDM and JI projects	Data on production and transmission of electricity in the IES, on demand for electricity, data on investment programs
JSC «TSA» and Association NP «Market Council», Greenhouse gas emission factor of the energy system of Russia, 2023 [12]	Grid emission factors for price and non-price zones of the wholesale market	The requirements and recommendations of IPCC, GHG Protocol and ISO 14064-1:2018, IEA, AIB Association of issuing bodies and CDM methods are taken into account. The calculation takes into account only emissions from fuel combustion. Emissions of CO_2, N_2O, CH_4 are taken into account.	Data on the operating parameters of generating facilities published in open sources by the Federal executive authorities of the Russian Federation (data from EMISS, GIS TEK)
Saneev B. et al., «Assessment of the spatial distribution of greenhouse gas emissions from energy facilities in Russia», 2022 [7]	Carbon intensity of electric power supplied by organic fuel sources for thermal power plants and diesel power plants. Data on carbon intensity of heat production at thermal power plants and boiler houses are provided	The assessment was carried out in accordance with IPCC Guidelines	Form of statistical observations of the Federal state statistics service 4-TER «Information on the use of fuel and energy resources»
Ecoinvent Database, 2021 [84]	Emission factors for different types of fuel, grid emission factors with and without taking into account the transmission and distribution of	The carbon footprint of electricity is determined based on average conditions of electricity generation in the Russian Federation. The power plant construction stage is taken into account,	Statistical data, data from scientific publications and reports

Source	Differentiation of coefficients	Methodological approach and calculation features	Initial data used to calculate grid emission factors
	electricity	emissions from renewable energy sources, hydropower and nuclear power plants are not equal to zero	
Climate Transparency Global Partnership, G20 Brown to Green Report 2017, 2017 [88] Report «Climate transparency report: comparing G20 climate action», 2022 [11]	Emission intensity of the power sector (average data for the entire energy system of the Russian Federation, only for CO_2)	The calculations were carried out in accordance with IPCC guidelines	National greenhouse gas inventory data, Enerdata resource data
Climatiq Company, Summary of Emission Factors from Electricity Production, 2022 [89]		Retrieved from the Climate Transparency Report 2022	
Ember Company, Global Electricity Review 2024, 2024 [10]	Carbon intensity of Russia's electricity production	The data aim to include full lifecycle emissions including upstream methane, supply chain and manufacturing emissions, and include all gases, converted into CO_2 eq. over a 100-year timescale	EIA, Russian Power System Operator (SO-UPS), Rosstat, EI, GEM, IRENA
Carbon Footprint Ltd Company, Carbon Footprint Ltd's Greenhouse Gas Emissions Factors for International Grid Electricity (calculated from fuel mix), 2024 [14]	GHG emission factor for electricity production in Russia, emission factor for transmission and distribution of electricity, factor for extraction, purification and transportation of fuel before its use in a power plant	ISO 14064-1:2018 recommendations are taken into account. Solar, nuclear, hydro and wind energy facilities are assumed to have zero greenhouse gas emissions	The composition of the fuel mixture used to generate electricity in the country
Brander M. et al., Technical Paper «Electricity-specific emission factors for grid+ electricity», 2011 [9]	Electricity-specific factors. IEA composite electricity/heat factors	The calculation was made taking into account the generation of electricity and thermal energy	IEA data on fuel used (IEA statistics, 2011), IPCC guidelines data, 2006
Gimadi V. et al., Electronic Bulletin «Carbon Intensity of Electricity in the World and Russia», 2019 [90]	Carbon intensity of electricity	no data	Structure of electricity generation

* CDM – Clean Development Mechanism
JIP – Joint Implementation Projects
UES - unified energy system
IEA – International Energy Agency
IPCC – Intergovernmental Panel on Climate Change
EIA - U.S. Energy Information Administration
EI – Energy Institute
GEM – Global Energy Monitor
EMISS – Unified Interdepartmental Information and Statistical System
GIS TEK – State Information System of the Fuel and Energy Complex