Table S2. Data on the carbon footprint of electricity generated in the Russian Federation

Author / company, name, year	Specifics	Life cycle stages taken into account	Carbon footprint, g CO_2-eq./kWh	Year of calculation	Notes	Source
United Nations Framework Convention on Climate Change (UNFCCC), «IFI Technical Working Group», Default Grid Factors Dataset. Ver. 3.1", 2021	Russia, Operating Margin Grid Emission Factor	Fuel use (combustion)	476 (present situation)	2021	The methodology takes into account electricity generation within the country without taking into account the interconnections of the energy system with the energy systems of other countries	[87]
	Russia, Firm Energy (electricity generation by hydroelectric power plants, geothermal energy)		360			
	Russia, Intermittent Energy (Solar, Wind, Tidal)		432			
	Russia, Energy Efficiency		360			
	Russia, Electricity Consumption		360			
International Renewable Energy Agency (IRENA), Energy profile «Russian Federation», 2022	Russia (electricity from the grid)	Fuel use (combustion), including cogeneration	296	2017	Cogeneration coefficient (generation of electricity and heat)	[16]
			335	2022		
PNST 646-2022, «Green» standards. «Green» products and «green» technologies. Methodology for assessing the reduction of carbon footprint, 2022	IES of the Center	Fuel use (combustion)	621	2022	Compiled on the basis of research data from the European Bank for Reconstruction and Development. The grid emission factors are differentiated by energy systems. A contry-level grid emission factor for the Russian energy system is not provided	[82]
	IES of the East		962			
	IES of North-West		453			
	IES of Siberia		893			
	IES of South		375			
	IES of the Urals		568			
	IES of the Middle Volga		450			
Lahmeyer International and the European Bank for Reconstruction and Development, Report «Dynamics of development of carbon emission factors in electricity production in Russia», 2011	Russia (average)	Fuel use (combustion)	617	2009	The OM, BM and CM have been calculated by weighing each annual carbon emission factor for an electricity system according to the ratio of power generation in the respective electricity system, divided by overall power generation in entire Russia. Developed for use in determining the baseline scenario of prospective activities within the framework of CDM and JI project	[6,15]
			634	2020		
	IES of the Center		617	2009		
			621	2020		
	IES of the East		661	2009		
			962	2020		
	IES of North-West		448	2009		
			453	2020		
	IES of Siberia		1003	2009		
			893	2020		
	IES of the East		376	2009		
			375	2020		
	IES of the Urals		576	2009		

Author / company, name, year	Specifics	Life cycle stages taken into account	Carbon footprint, g CO_2-eq./kWh	Year of calculation	Notes	Source
			568	2020		
	IES of the Middle Volga		356	2009		
			450	2020		
JSC «TSA» and Association NP «Market Council», Greenhouse gas emission factor of the energy system of Russia, 2023	Russia (average)	Fuel use (combustion)	336	2021	Price zones are formed based on the principle of no flow or minimal flow of electricity between individual parts of the energy system. The calculation takes into account only emissions from fuel combustion for electricity generation. Actual grid emission factors are calculated annually based on data on the operation of energy facilities for the past year. Planned grid emission factors are calculated daily based on the volumes of planned hourly electricity production/consumption.	[12]
	First Central Zone (Europe and Urals)		326	2023 (actual values)		
	Second Central Zone (Siberia)		429			
	NCZ of the Arkhangelsk region		582			
	NCZ of the Kaliningrad region		473			
	NCZ of the Komi republic		528			
	NCZ of the Far East		481			
	TITES of the Kamchatka region		511			
	TITES of the Magadan region		57			
	TITES of Sakhalin region		629			
	TITES Chukotka Autonomous Okrug		539			
	First Central Zone (Europe and Urals)		323	2024 (planned values)		
	Second Central Zone (Siberia)		392			
	NCZ of the Arkhangelsk region		554			
	NCZ of the Kaliningrad region		460			
	NCZ of the Komi republic		476			
Saneev B. et al., «Assessment of the spatial distribution of greenhouse gas emissions from energy facilities in Russia », 2022	Russia, TPP	Fuel use (combustion)	605	2018	The calculations used Rosstat data on fuel use and data on carbon dioxide emission factors by fuel type from the national report on the inventory of anthropogenic greenhouse gas emissions [71]	[7]
	Russia, DES		648	2018		
	Central Federal District, TPP		507	2018		
	Central Federal District, DES		356	2018		
	Northwestern Federal District, TPP		535	2018		
	North-West Federal District, DES		741	2018		
	Southern Federal District, TPP		602	2018		
	Southern Federal District		367	2018		
	North Caucasian Federal District, TPP		499	2018		
	North Caucasian Federal District, DES		814	2018		
	Volga Federal District, TPP		443	2018		
	Volga Federal District, DES		631	2018		
	Ural Federal District, TPP		584	2018		
	Ural Federal District, DES		642	2018		

Author / company, name, year	Specifics	Life cycle stages taken into account	Carbon footprint, g CO_2-eq./kWh	Year of calculation	Notes	Source
	Siberian Federal District, TPP		940	2018		
	Siberian Federal District, DES		752	2018		
	Far Eastern Federal District, TPP		922	2018		
	Far Eastern Federal District, DES		692	2018		
Ecoinvent Database, 2021	Russia (sale of electricity from the grid)	Fuel use (combustion)	674	2021	-	[84]
		Fuel use (combustion), electricity transmission and distribution	763	2021	Taking into account the additional carbon footprint from transformation, distribution - 10%	
	Russia (geothermal energy)	Materials production, electricity production	66	2021	Based on data from a station in Switzerland	[91]
	Russia (hard coal)	Station construction, fuel use (combustion), maintenance, cleaning of flue gases from dust	934	2021	The power plant capacity is 100 MW. IEA emission factors were used to calculate the carbon footprint.	[92]
	Russia (natural gas, combined cycle power plant)	Materials production, fuel use (combustion), maintenance	412	2021	400 MW class combined cycle power plant (265 MW gas turbine and 140 MW steam turbine)	
	Russia (natural gas, conventional power plant)	Station construction, fuel use (combustion), maintenance	1541	2021	The power plant capacity is 100 MW. IEA emission factors were used to calculate the carbon footprint.	
	Russia (nuclear power station)	Station construction, fuel use (combustion), maintenance, dismantling	7,0	2021	Nuclear pressure water reactor	

Author / company, name, year	Specifics	Life cycle stages taken into account	Carbon footprint, g CO_2-eq./kWh	Year of calculation	Notes	Source
	Russia (hydroelectric power station)	Materials production, electricity production	4,0	2021	-	[93]
	Russia (fuel oil power plant)	Station construction, fuel use (combustion), flue gas cleaning	1629	2021	The power plant capacity is 500 MW. The fuel used is type S fuel oil	[84]
	Russia (photovoltaic installation, 3 kW on a pitched roof, multilayer, panel)	Materials production, electricity production	94	2021	-	
	Russia (onshore wind turbine, 1-3MW)	Station construction, operation, maintenance	101	2021	-	[95]
	Russia (onshore wind turbine, >3 MW)	Station construction, operation, maintenance	34	2021	-	
	Russia (natural gas, conventional power plant, 100 MW)	Station construction, operation, maintenance	842	2021	-	[95]
Climate Transparency Global Partnership, G20 Brown to Green Report 2017, 2017	Russia (electricity from the grid)	Fuel use (combustion)	390	2017	The grid emission factors is calculated taking into account carbon dioxide emissions and does not take into account emissions of other greenhouse gases	[88]
Climate Transparency Global Partnership, Report «Climate transparency report: comparing G20 climate action», 2022			321.8	2022	-	[11]
Climatiq Company, Summary of Emission Factors from Electricity Production, 2022	Russia (electricity from the grid)	Fuel use (combustion)	321.8	2022	Duplicate data [84]	[89]

Author / company, name, year	Specifics	Life cycle stages taken into account	Carbon footprint, g CO_2-eq./kWh	Year of calculation	Notes	Source
Ember Company, Global Electricity Review 2024, 2024	Russia (electricity from the grid)	no data	441	2023	-	[10]
Carbon Footprint Ltd Company, Carbon Footprint Ltd's Greenhouse Gas Emissions Factors for International Grid Electricity (calculated from fuel mix), 2024	Russia, for the international power grid (based on fuel balance)	Fuel use (combustion)	397	2024	The calculation takes into account the structure of the fuel mixture. Solar, nuclear, hydropower and wind power facilities are taken into account with zero greenhouse gas emissions	[14]
		Electricity transmission and distribution	66.9			
		Fuel use (combustion), electricity transmission and distribution	464			
Brander M. et al., Technical Paper «Electricity-specific emission factors for grid electricity», 2011	Russia (electricity from the grid)	Fuel use (combustion)	513	2011	The composition of the fuel combusted is taken from IEA data (2011)	[9]
		Fuel use (combustion), including cogeneration	325	2011	36% of total emissions are attributed to heat generation; 64% to electricity generation	
Gimadi V. et al., Electronic Bulletin «Carbon Intensity of Electricity in the World and Russia», 2019	Russia taking into account electricity trade with neighboring countries	Fuel use (combustion), electricity transmission and distribution	418	2010	-	[90]
			358	2016		

* IEA – International Energy Agency
TITES – technologically isolated territorial energy systems
NCZ – non-price zone
TPP – thermal power plant
DES – diesel power plant
OM – Operating Margine
BM – Build Margine
CM – Combined Margine