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Criteria for Estimating Greenhouse Gas Emissions from Transport

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Abstract. At the present stage, economic research on climate change and its main problem requires in-depth scientific study and analysis of various factors. An important source of air pollution is the energy sector, especially solid and liquid fuels used for technological purposes in thermal power plants. In Georgia, 1/5 of the total electricity generated is produced in thermal power plants. The article analyses Greenhouse gas emissions in Georgia by sectors and sub-sectors as well the criteria for estimating fuel combustion, such as net calorific value of fuel and carbon content standard indicators. The formula for calculation of CO₂, CH₄ and N₂O emissions from the transport vehicles is developed in this work.

Key words: fuel combustion; greenhouse gases; power engineering; transport.

Introduction

At the present stage, economic research on climate change and its main problem requires in-depth scientific study and analysis of various factors, without which it is

impossible to properly understand the essence of economic events, identify key factors, identify development trends and ways of their further improvement. An important source of air pollution is the energy sector, especially, solid and liquid fuels used for technological purposes in thermal power plants. In Georgia, 1/5 of all generated electricity is produced at thermal power plants (TPP), while the cooling reservoir causes thermal pollution of the river. The products of industrial production in today's world provide many greenhouse gases, such as metals, chemical production and use, cement production and many other. [1]. Traffic jams and exhaust on top of cities are notable. Arguably the most visible source of emissions comes from transport. These are: aviation, rail and road transport. The share of electric and hybrid cars in Georgia is growing, but not enough. Processes such as volatile emissions are important. Before the fuel burns, it already emits emissions into the atmosphere, such as emissions from oil refining products and methane leaks, which are serious and difficult issues to address [2].

Main part

Greenhouse gas emissions in Georgia by sectors and

sub-sectors show that the energy sector, including the transport sub-sector, occupies the first place with 57%, or almost 60%. In the second place are industrial

production processes with 18% and in the third place is agriculture with 17% in 2019 (table 1).

Table 1

Greenhouse gas emissions in Georgia by sectors and sub-sectors

1	Energy (including Transport sub sector)	57
2	Industrial Processes	18
3	Solvents and other products Consumption	4
4	Rural industry	17
5	Land use and forestry	3
6	Waste	1
7	Other	0.0001
	Percent, sum	100

The energy sector considers fuel combustion in the energy industry, transport, manufacturing and building materials, as well as in segments such as commercial, public, household and public facilities, agriculture, fisheries and forestry [3]. In the same sector, volatile

emissions from solid, liquid and gaseous fuels are considered. Analysis show that GHG emissions among energy sector, the largest share comes from the transport subsector 33% in Georgia in 2019 (table 2).

Table 2

Greenhouse gas emissions in the energy sector of Georgia

	Fuel Combustion	
1	Energy Industry (Electricity and Heat Generation)	10
2	Processing Industry and Construction Materials Industry	21
3	Transport	33
4	Other Sectors (trade/ household/rural industry/fishing/forestry)	15,7
	Volatile Emissions from Fuel	
1	Solid Fuel	1,1
2	Oil and Natural Gas	19,2
	Percent, sum	100

Because the contribution of transport to climate change is significant, we examined the quantities of passenger cars, buses, minibuses, agricultural and freight

vehicles (figure 1), and passenger and cargo turnover statistics to determine their impact on the final rate, or greenhouse gas emissions [4].

Figure 1. Transport Network in Georgia

The passenger turnover rate for 2019 includes total data on road, rail, river, sea and air transport [5]. The growth trend of this indicator is mainly due to the increase in passenger traffic, for example, in 2019, almost 80% of passengers traveled by road (using non-ecological fuel), which has a negative impact on climate change. If we analyze the percentage distribution of vehicles in Georgia in 2019, the largest share comes from cars, from which electric cars are only 4-5%. The freight rate for 2019 includes aggregate road, rail, river, sea and air transport data [6]. The downward trend in this indicator is mainly due to the decrease in rail shipments [7]. It should be noted that rail transport accounts for the largest share in terms of freight transport, for example, in 2019, 78% of cargo turnover was accounted by rail transport. One way to reduce greenhouse gases from transport is to use biofuels as fuel [8]. The most common types of bio fuels are biodiesel and bioethanol. Biodiesel creation process takes place in the device, where crops [9], like rape and sunflower are high pressure conditions and will be received combined food, in the inner tank squeezed oil from the reservoir is transferred to the device in the second section, where added oxide, then this mixture goes in generator, where in conditions of high pressure and high temperature is occurred biochemical reaction and about half an hour being taken biodiesel, which can be used in any diesel engine [10].

Bioethanol is made from corn or sugar cane, or from high concentration sugar or starch products such as beet, potato, Manioc. Ethanol is substance, which is received by the fermentation, and it usually interferes with gasoline to increase octane level [11]. Increase the fuel octane level which is necessary to improve the combustion process, until recently used very high toxic substance. Thus, bioethanol as well as a carbon neutral fuel, is considered more environmentally acceptable alternative [12]. Biofuel use in the transport sector must be executed by the methodology approved by the Executive Board of the Clean Development Mechanism [13]. Projects must be performed based on the methodology, approved by Clean Development Mechanism (CDM) Executive Board. For Georgia is used Consolidated Methodology of Baseline Level ACM0017 „Production of Biodiesel for Use as Fuel”[14].

Materials and Research Methods

Each type of fuel has a heat of combustion or calorific value that are represented in special manuals [15], but if this data is not available, standard indicators should be used, from the guideline document - 2006 IPCC Guidelines for National Greenhouse Gas Inventories [16], (table 3).

Table 3

Net Calorific Value (NCV) of Fuel

Fuel Type Description	Net Calorific Value (NCV), (kJ/kg)
Gasoline	44 300
Diesel	43 000
Natural Gas	48 000
Crude oil	42 300
Liquefied natural gas	44 200
Aviation Gasoline	44 300
Kerosene	43 800
Ethan	46 400
Napta	44 500
Bitumen	40 200
Anthracite	26 700
Lignite	11 900
Cox	28 200
Firewood	15 600
Other solid biomass	11 600
Wood charcoal	29 500
Biodiesel	27 000
Other liquid biofuels	27 400
Landfill gas	50 400
Other Biomass Gas	50 400

Each type [17] of fuel has a carbon content data but if this data is not available, should be used standard indicators, from the guideline document - 2006 IPCC

Guidelines for National Greenhouse Gas Inventories [18], (table 4).

Table 4

Carbon Content Data

Fuel Type Description	Carbon, C (Kg/GJ)
Gasoline	18,9
Diesel	20,2
Natural Gas	15,3
Crude oil	20
Liquefied natural gas	17,5
Aviation Gasoline	19,1
Kerosene	19,6
Ethan	18,6
Napta	20
Bitumen	22
Anthracite	26,8
Lignite	27,6
Cox	29,2
Firewood	30,5
Other solid biomass	27,3
Wood charcoal	30,5
Biodiesel	19,3
Other liquid biofuels	21,7
Landfill gas	27,3
Other Biomass Gas	14,9

Conclusion

Results and Their Discussions

To calculate Carbon dioxide (C₂O) emissions consumed by vehicles, needed the country - specific net calorific values are needed (NCV kJ/kg) [19], fuel carbon content (C/Joule) and oxidation coefficient (Oxide Rate,

%), if this data is not available, use standard indicators [20], from the guideline document - 2006 IPCC Guidelines for National Greenhouse Gas Inventories, (table 5) [21].

Table 5

C₂O Emission Coefficient Calculation

Fuel Type Description	Carbon,(kg/GJ)	Oxide Rate, (%)	Emission Coefficient C ₂ O, (kg/TJ)
1	2	3	$4=(2*3*44/12)*1000$
Gasoline	18,9	1	69300
Diesel	20,2	1	74100
Natural Gas	15,3	1	56100
Crude oil	20	1	73300
Liquefied natural gas	17,5	1	64200
Aviation Gasoline	19,1	1	70000
Kerosene	19,6	1	71900
Ethan	18,6	1	61600
Napta	20	1	73300
Bitumen	22	1	80700
Anthracite	26,8	1	98300
Lignite	27,6	1	101000
Cox	29,2	1	107000
Firewood	30,5	1	112000
Other solid biomass	27,3	1	100000
Wood charcoal	30,5	1	112000
Biodiesel	19,3	1	70800
Other liquid biofuels	21,7	1	79600
Landfill gas	27,3	1	100000
Other Biomass Gas	14,9	1	54600

To calculate CH₄ and N₂O emissions using transport there is needed a particular data of consumed fuel and fuel carbon content (C/Joule) [22], if this data is not available, the calculations will be performed at the level

I approach from the guideline document - 2006 IPCC Guidelines for National Greenhouse Gas Inventories [23], (table 6).

Table 6

Calculation of CH₄ and N₂O emissions from the transport

Fuel type description	CH ₄ , kg/TJ	N ₂ O, kg/TJ
Gasoline	33	3,2
Diesel	3,9	3,9
Compressed natural gas	92	3
Liquefied natural gas	62	0,2
Ethan	260	41

CO₂-emissions assessment for road transport is carried out by the following formula [24]:

$$\text{CO}_2 \text{ emission} = \sum \text{Fuel}(a) * \text{Ef}(a)$$

Where - CO₂ emissions (tons); Fuel(a) - used (consumed) Fuel (TJ); Ef(a) - the emission coefficient CO₂ (kg/TJ); a - a type of greenhouse gas [25].

Despite the many positive changes that have taken place in Georgia in recent years, the transport sub-sector still needs to take steps to ensure a gradual transition to European fuel standards, renewal of city transport parks, regulation of second-hand car imports, vehicle inspections and other transport-related measures for climate

change related problem solving [26]. Implementing energy efficiency measures, using renewable energy sources to generate electricity, developing high-tech equipment, introducing fuel standards and tightening regulations, replacing and upgrading old equipment in industrial facilities, technical inspections and renovations of all vehicles By introducing construction norms, reducing product packaging, introducing energy efficient technologies in the processing industry and building materials production, replacing the old natural gas transportation and distribution pipes, etc. It is possible to significantly reduce greenhouse gas emissions, which is undoubtedly a contributing factor in reducing climate change [27].

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საკვანძო სიტყვები: სათბურის გაზები; ელექტროინჟინერია; სათბობის წვა; ტრანსპორტი.

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Критерии оценки выбросов парниковых газов от транспорта

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Аннотация.

На современном этапе экономические исследования изменения климата и его основной проблемы требуют глубокого научного изучения и анализа различных факторов. Важным источником загрязнения воздуха является энергетика, особенно твердое и жидкое топливо, используемое в технологических целях на тепловых электростанциях. В Грузии 1/5 всей вырабатываемой электроэнергии производится на тепловых электростанциях. В статье анализируются выбросы парниковых газов в Грузии по секторам и подсекторам, а также критерии оценки сжигания топлива, такие как низшая теплотворная способность топлива и стандартные показатели содержания углерода. В статье разработана формула для расчета выбросов CO₂, CH₄ и N₂O от транспортных средств.

Ключевые слова: парниковые газы; сжигание топлива; транспорт электроэнергетика.

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