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Carbon-Dioxide Emissions Due to Fossil Fuels Consumption

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Abstract

A majority of Carbon-dioxide including smaller amounts of methane and nitrous are emitted from the consumption of fossil fuels around the world to meet the sustainable development goals and global prosperity. Studies have shown that the increase in greenhouse gases has negative effects on human health, and the environment around us. Emissions from the consumption of fossil fuels in factories and industries either to produce electricity or transport people, goods and services cause the release of CO2 and other pollutants into the atmosphere. The majority of industrial energy is supplied by non-renewable energy resources, which mainly consist of fossil fuels. Currently, fossil fuels are the main source of energy and are concentrated in some regions of the world, therefore direct contamination occurs in areas where they are stored or processed. A majority of electricity consumed by cities and countries across the world is produced from fossil fuels, which accounts for the highest percentage of overall CO2 production in that particular country. People will share the common global environmental problems, either it is local or regional, hence immediate actions are needed to tackle problems at national and regional and global levels. Fortunately, with the advent of new technologies and intervention strategies, it is possible to reduce pollution and reduce the rate of rising global temperature that might result in better economy and ecological systems as well as providing sustainable energy resources. In this research the data on nonrenewable energy sources, fossil fuel reserves in different regions, production and consumption rate of fossils have been identified and reviewed. Additionally, mathematical calculation has been done to find the carbon dioxide emission amounts, both international and national legislations as well as further recommendations have been provided to reduce or prevent emissions.

Keywords: Fossil Fuels, Emissions, Carbon-Dioxide, Oil, Natural Gas, Coal

Abbreviations:

OECD-The Organization for Economic Co-operation and Development. An international organization that works to build better policies for better lives. There are 37 member countries of this organization.
CIS-Commonwealth of Independent States. The Commonwealth of Independent States (CIS) was created in December 1991 by eleven countries from the ex-USSR: Armenia, Azerbaijan, Belarus, Kazakhstan, Kirghizstan, Moldavia, Uzbekistan, Russia, Tajikistan, Turkmenistan, and Ukraine.
Mtoe-Million or mega tons of oil equivalent. The unit quantifies the amount of energy released when burning one mega tone of crude oil.

Btoe-Billion tons of oil equivalent MMBTU-Metric Million British Thermal Unit UNFCCC-United Nations Framework Convention on Climate Change
CCS-Carbon capture and storage technologies
VOCs-Volatile organic compounds. Volatile organic compounds (VOCs) are gases that are given off by many indoor sources
EPA-United States Environmental Protection Agency
GHG emissions-Green House Gas emissions
CCMP-Climate Change Mitigation Policy PAHs-Polycyclic aromatic hydrocarbons 1 kWhr-kilo Watt hour (Energy Unit) 1 GJ-Giga Joule (Energy Unit) Annex I countries-Australia, Austria, Belarus, Belgium, Bulgaria, Canada, Croatia and Cyprus
Annex II countries-Australia, Austria, Belgium, Canada, Denmark, European Community, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Japan, Luxembourg, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom and United States of America.
MEP-Ministry of Environmental Protection

Introduction

There are mainly two types of energy resources, renewable and nonrenewable resources.

Nonrenewable energy resources include coal, oil, natural gas and nuclear energy. Since the world's need for energy mainly depends on these fossil fuels resources, energy supply is one of the major problems. Renewable and nonrenewable energy resources used by society for different purposes on a daily basis. While renewable energy resources is replaced, nonrenewable resources cannot be replaced or their replacement rate is less than their consumption rate that cannot be considered as sustainable energy resource [1].

Fossil fuels created as result of decaying process of animals and plants' remnants during millions of years. Together with heat and pressure, remnants are buried and decaying under layers and sediment rocks. Under high pressure and temperature, plant and animal remains transformed into crude oil (petroleum), coal and natural gas. It is estimated that currently, extracted fossil fuels, are produced by plants and animals that lived in a time called Carboniferous Period around 300 to 360 million years ago. Real source of energy comes from the sun: energy gathered in the tissue of plants through the process of photosynthesis, then, animals consume those plants that transfer the energy into their own bodies. When the fossil fuels burnt, this trapped energy releases [2].

Crude Oil: Gasoline and diesel are mostly produced fuels from crude oil that used for vehicles and for the plastics manufacturing. Crude oil is transferring to upside through permeable layers and gathered in porous rocks in layers called traps. After exploration and investigation, oil reservoirs are found and petroleum is produced through wells [3].

Natural gas: it produced most often together with oil and due to sudden pressure drop near surface gas separates from liquid oil. Natural gas is a mixture of several hydrocarbons, however mainly consists of methane (CH4) [4].

Coal: it is a solid fossil fuel that used for heating homes and generating power plants. It formed after burial of plants and animals in swamps. All these fossils' decays under anaerobic (without oxygen) condition over a long period. Coal produced through digging the ground and underground layers [5] Nuclear energy: this is another nonrenewable energy resource, which transferred from radioactive elements, especially uranium that is extracted from mined ore and then refined to fuel [6].

Through analyzing the consumption rate over regions, it has been determined that dominant fuel in Africa, North America and South America is still oil, while in CIS (Commonwealth of Independent States) and the Middle East natural gas is in highest con-

sumption rate [7]. Overall these two fossils constitutes more than a half of energy consumption in these regions. However, in Asia Pacific region coal is the major consumed fuel and in 2018 share of primary energy of coal declined to its lowest point in North America and Europe (Figure 1)

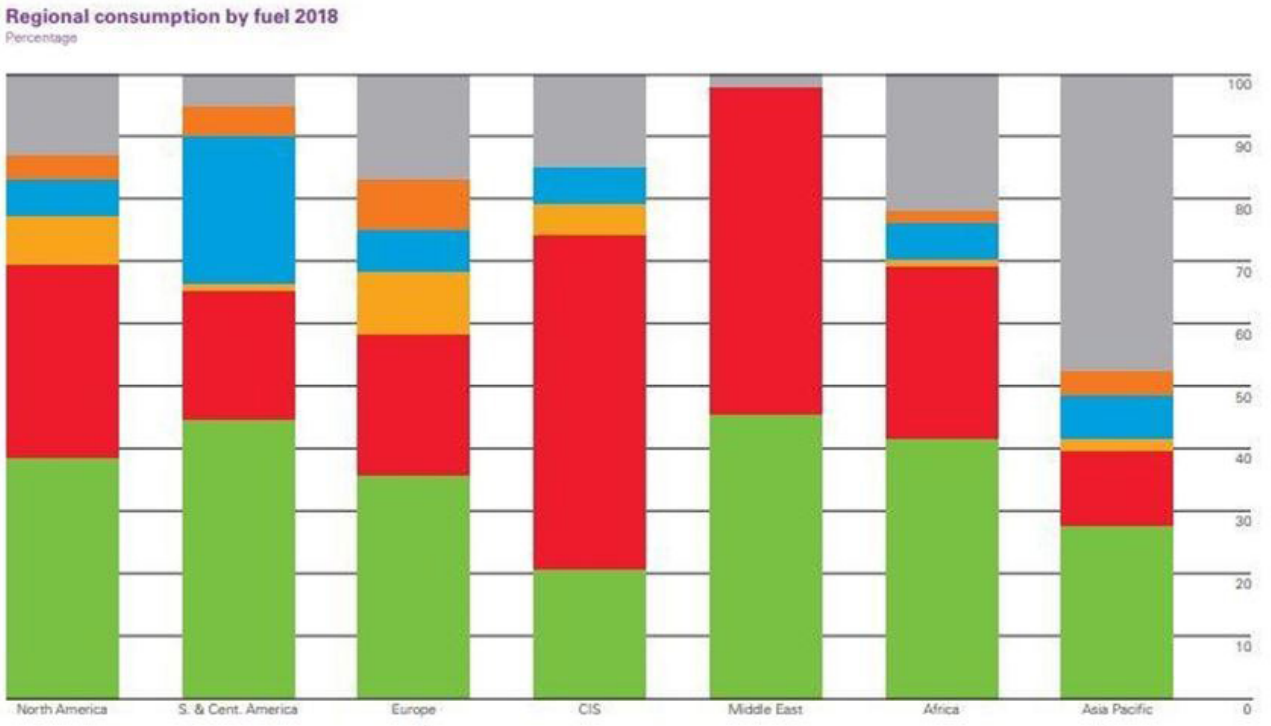


Figure 1: Regional Consumption by fuel (BP Statistical Review of World Energy 2019)

Based on consumption rates of fossils over regions, oil consumed mostly in Asia Pacific and North America. Overall these two regions accounts for nearly 60% of global consumption. Global coal consumption is the highest rate in Asia Pacific. However, nearly 66% of nuclear consumption over the world is mainly concentrated in North America and Europe [8] Energy consumption in Asia Pacific and Southern and Central America is based on hydro energy resources, nearly 60%. Almost 90% of renewables of the entire world used in Asia Pacific, Europe and North America (Figure 2). Since the most of the demand for energy supplied by consuming fossil fuels, carbon dioxide releases alongside with other pollutants. Furthermore, due to greenhouse gas emissions global warming has become the one of the urgent issues in the international level. Due to SO2 (Sulphur-dioxide) emissions sulfuric acid forms when mixed with moisture in the atmosphere, that causes acid rains, which in its turn causes corrosion of metal facilities [9] The aim of this research is to identify fossil fuels proven reserves in different regions, production and consumption rates of fossil fuels and carbon-dioxide emission amount due to fossils consumptions. Furthermore, international laws and legislations are analyzed to determine what targets are set and if they are reached.

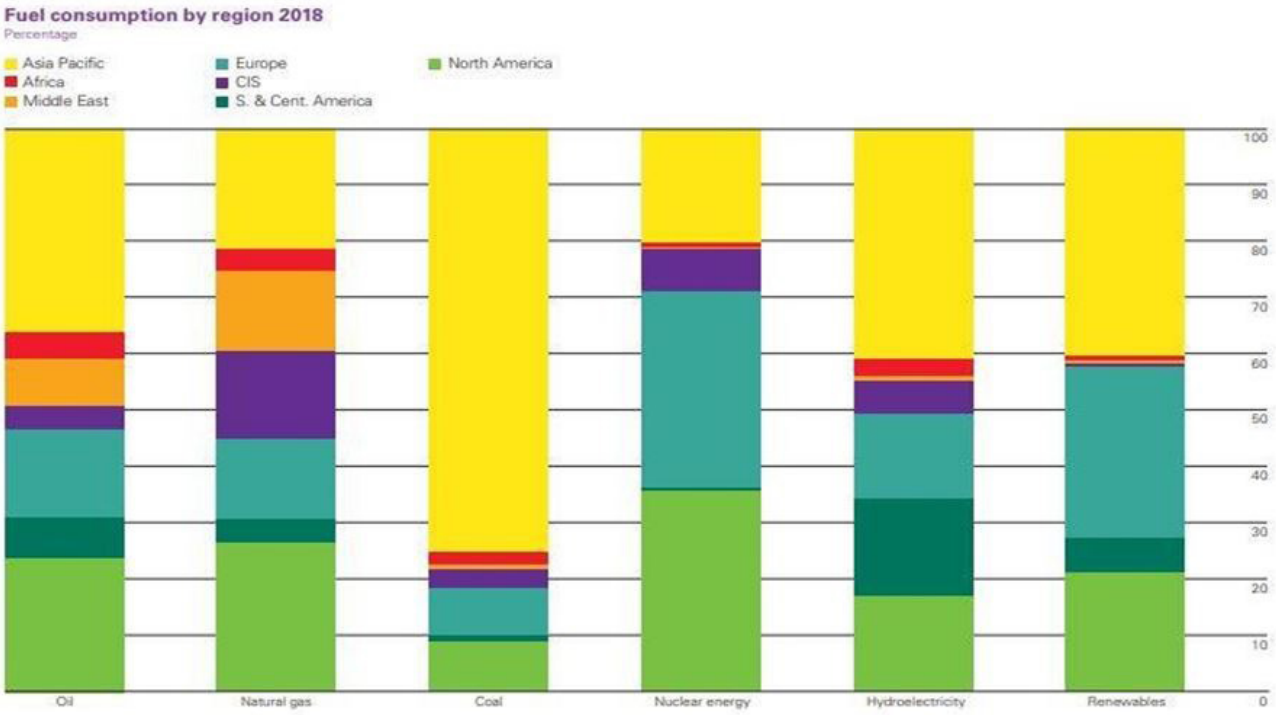


Figure 2: Fuel consumption by region. (BP Statistical Review of World Energy 2019)

Considering all researches in the field of fossil fuels emissions, gaps identified in-depth literature review on emissions due to fossil fuel consumption. Following the existing studies, this research aims to bridge the gap in knowledge. It improves the studies of fossil fuels emissions in local and global perspectives and tries to find alternative solutions. The research aims to provide literature support for carbon emission study using statistical data of consumed energy and about proven reserves of fossil fuels provided by energy companies in different years to ensure that researchers and professionals have deep understanding of investigations and future plans to reduce emissions. The novelty and objectives of this study includes: (i) determine the produced carbon-dioxide amount due to consumption of fossil fuels over the years, (ii) analyzing of International Laws adopted for future targets to reduce of carbon- dioxide emissions, (iii) Possible achievements in reduction of energy consumption and emissions amount.

Materials and Methods

All required data were gathered from a variety of sources such as scientific articles, journals, magazines, newspapers, annual reports of global energy companies, as well as watching some relevant videos related to research topic. Quantitative and qualitative study methods were used to analyze all gathered data. In order to calculate emissions quantitative study was used and for general calculation mean values were selected. To analyze the theoretical information and provide solutions qualitative study method was chosen. Using some mathematical equations, amount of emissions was calculated and included into the tables. All negative aspects of carbon-dioxide emissions were analyzed using statistical approach, quantitative and qualitative data.

Results

Results of Quantitative Data

After obtaining all the data from annual reports of energy companies all the required consumption amounts have been included in the tables below in order to make calculation easier. To calculate the amount of released carbon-dioxide for different regions for each type of fossil fuels the data was obtained from different annual statistical reports expressed in the same energy unit as Mtoe (Million tons of oil equivalent). This helped to accept all consumed fossils to accept as oil and using the same thermal units and conversion factors for calculation:

Types of Energy Resource	Pounds of CO_2 emitted per million British thermal units (BTU) ofenergy for various fuels
Oil	161.3

Table 1: Pounds of CO2 emitted per million British thermal units (BTU) of energy for various fuels [4]

Primary energy: consumption by fuel*

	2017							2018						
Million tonnes oil equivalent	Oil	Natural gas	Coal	Nuclear energy	Hydro-electricity	Renew-ables	Total	Oil	Natural gas	Coal	Nuclear energy	Hydro-electricity	Renew-ables	Total
Canada	108.8	94.3	18.6	22.7	89.7	9.5	343.7	110.0	99.5	14.4	22.6	87.6	10.3	344.4
Mexico	85.8	74.3	15.2	2.5	7.2	4.3	189.3	82.8	77.0	11.9	3.1	7.3	4.8	186.9
US	902.0	635.8	331.3	191.7	67.2	94.5	2222.5	919.7	702.6	317.0	192.2	65.3	103.8	2300.6
Total North America	1096.6	804.4	365.1	216.9	164.1	108.4	2755.5	1112.5	879.1	343.3	217.9	160.3	118.8	2832.0
Argentina	32.0	41.5	1.1	1.4	9.4	0.7	86.1	30.1	41.9	1.2	1.6	9.4	0.9	85.1
Brazil	136.1	32.4	16.6	3.6	83.9	21.4	293.9	135.9	30.9	15.9	3.5	87.7	23.6	297.6
Chile	17.7	4.8	7.7	–	4.8	3.3	38.3	18.1	5.5	7.7	–	5.2	3.5	40.1
Colombia	16.5	10.5	5.2	–	13.0	0.5	45.5	16.6	11.2	5.9	–	12.8	0.5	46.9
Ecuador	11.3	0.7	–	–	4.5	0.1	16.7	12.2	0.6	–	–	4.7	0.1	17.6
Peru	12.0	5.8	0.6	–	6.6	0.4	25.4	12.4	6.1	0.9	–	7.0	0.7	27.0
Trinidad & Tobago	2.1	13.1	–	–	–	†	15.2	2.1	13.2	–	–	–	†	15.3
Venezuela	22.1	33.4	0.1	–	18.0	†	73.6	19.5	28.7	0.1	–	16.3	†	64.6
Other S. & Cent. America	67.4	6.2	3.5	–	22.8	5.2	105.1	68.3	6.8	4.3	–	22.3	6.1	107.8
Total S. & Cent. America	317.2	148.4	34.8	4.9	163.0	31.5	699.8	315.3	144.8	36.0	5.1	165.5	35.4	702.0
Austria	13.1	7.8	3.1	–	8.7	2.8	35.5	13.4	7.5	2.9	–	8.5	2.8	35.0
Belgium	33.7	14.1	3.1	9.6	0.1	3.5	64.1	34.1	14.5	3.3	6.4	0.1	3.8	62.2
Czech Republic	10.4	7.2	15.6	6.4	0.4	1.8	41.8	10.6	6.9	15.7	6.8	0.4	1.7	42.1
Finland	10.3	1.6	4.0	5.1	3.3	3.8	28.1	10.7	1.8	4.3	5.2	3.0	4.3	29.3
France	79.1	38.5	9.3	90.1	11.1	9.4	237.5	78.9	36.7	8.4	93.5	14.5	10.6	242.6
Germany	119.0	77.2	71.5	17.3	4.6	44.4	333.9	113.2	75.9	66.4	17.2	3.8	47.3	323.9
Greece	16.0	4.1	4.8	–	0.9	2.2	28.0	16.0	4.1	4.7	–	1.3	2.4	28.3
Hungary	8.3	8.5	2.2	3.6	†	0.7	23.5	8.8	8.3	2.2	3.6	0.1	0.8	23.7
Italy	62.0	61.5	9.6	–	7.8	15.3	156.3	60.8	59.5	8.9	–	10.4	14.9	154.5
Netherlands	39.6	31.0	9.1	0.8	†	3.9	84.5	40.9	30.7	8.2	0.8	†	4.2	84.8
Norway	10.1	3.9	0.8	–	32.1	0.7	47.6	10.4	3.9	0.8	–	31.3	0.9	47.4
Poland	31.7	16.5	49.8	–	0.6	4.9	103.4	32.8	17.0	50.5	–	0.4	4.4	105.2
Portugal	12.0	5.5	3.2	–	1.3	3.8	25.8	11.5	5.0	2.7	–	2.8	3.9	26.0
Romania	10.3	9.6	5.4	2.6	3.3	2.2	33.4	10.2	9.3	5.3	2.6	4.0	2.0	33.4
Spain	65.0	27.3	13.4	13.1	4.2	15.7	138.8	66.6	27.1	11.1	12.6	8.0	16.0	141.4
Sweden	15.4	0.7	2.0	14.9	14.7	6.8	54.4	14.8	0.7	2.0	15.5	14.0	6.6	53.6
Switzerland	10.9	2.7	0.1	4.6	7.7	0.8	26.9	10.5	2.6	0.1	5.8	7.9	0.9	27.8
Turkey	49.2	44.3	39.5	–	13.2	6.6	152.7	48.6	40.7	42.3	–	13.5	8.5	153.5
Ukraine	9.9	26.0	25.7	19.4	2.0	0.4	83.4	9.6	26.3	26.2	19.1	2.2	0.6	84.0
United Kingdom	78.0	67.8	9.1	15.9	1.3	21.1	193.2	77.0	67.8	7.6	14.7	1.2	23.9	192.3
Other Europe	62.5	26.1	34.1	8.4	14.9	11.4	157.3	62.4	25.9	33.6	8.3	17.9	11.7	159.8
Total Europe	746.2	481.9	315.5	211.8	132.3	162.3	2050.0	742.0	472.0	307.1	212.1	145.3	172.2	2050.7
Azerbaijan	4.7	9.1	†	–	0.4	†	14.3	4.6	9.3	†	–	0.4	†	14.4
Belarus	6.7	15.7	0.8	–	0.1	0.1	23.4	6.8	16.6	1.0	–	0.1	0.1	24.6
Kazakhstan	15.0	13.7	36.4	–	2.5	0.1	67.6	16.4	16.7	40.8	–	2.3	0.1	76.4
Russian Federation	151.5	370.7	83.9	46.0	41.9	0.3	694.3	152.3	390.8	88.0	46.3	43.0	0.3	720.7
Turkmenistan	6.9	21.8	–	–	–	†	28.7	7.1	24.4	–	–	–	†	31.5
Uzbekistan	2.7	37.1	3.5	–	1.7	–	45.0	2.6	36.6	3.1	–	1.6	–	43.9
Other CIS	3.6	4.3	1.8	0.6	7.7	†	18.0	3.7	4.9	2.0	0.5	8.0	†	19.0
Total CIS	191.1	472.3	126.4	46.6	54.3	0.5	891.2	193.5	499.4	134.9	46.7	55.4	0.6	930.5
Iran	84.5	180.5	1.4	1.6	3.9	0.1	272.0	86.2	193.9	1.5	1.6	2.4	0.1	285.7
Iraq	35.6	11.0	–	–	0.5	†	47.1	38.4	14.7	–	–	0.7	†	53.7
Israel	11.7	8.5	5.0	–	†	0.4	25.6	11.5	9.0	4.7	–	†	0.5	25.6
Kuwait	20.4	18.1	0.2	–	–	†	38.7	20.0	18.7	0.2	–	–	†	39.0
Oman	9.2	20.0	0.1	–	–	†	29.3	9.2	21.4	0.1	–	–	†	30.7
Qatar	11.8	37.0	–	–	–	†	48.9	12.2	36.0	–	–	–	†	48.3
Saudi Arabia	168.8	93.9	0.1	–	–	†	262.8	162.6	96.4	0.1	–	–	†	259.2
United Arab Emirates	43.8	64.0	1.0	–	–	0.1	109.0	45.1	65.8	1.1	–	–	0.2	112.2
Other Middle East	26.6	20.1	0.4	–	0.3	0.5	48.0	26.8	19.5	0.4	–	0.3	0.8	47.9
Total Middle East	412.5	453.2	8.2	1.6	4.7	1.3	881.4	412.1	475.6	7.9	1.6	3.4	1.7	902.3
Algeria	19.4	33.4	0.2	–	†	0.1	53.1	19.6	36.7	0.2	–	†	0.1	56.7
Egypt	39.2	48.1	1.6	–	3.0	0.6	92.6	36.7	51.2	2.8	–	3.1	0.8	94.5
Morocco	13.5	1.0	4.5	–	0.3	0.8	20.0	13.2	0.9	5.4	–	0.4	1.1	21.0
South Africa	27.5	3.8	84.3	3.6	0.2	2.4	121.8	26.3	3.7	86.0	2.5	0.2	2.8	121.5
Other Africa	92.4	34.7	7.0	–	24.7	2.2	161.0	95.5	36.4	7.0	–	26.4	2.4	167.8
Total Africa	192.1	121.0	97.6	3.6	28.2	6.1	448.6	191.3	129.0	101.4	2.5	30.1	7.2	461.5
Australia	51.1	35.5	45.1	–	3.1	5.8	140.5	53.3	35.6	44.3	–	3.9	7.2	144.3
Bangladesh	7.9	22.9	1.9	–	0.2	0.1	33.0	9.0	24.4	2.1	–	0.2	0.1	35.8
China	610.7	206.7	1890.4	56.1	263.6	111.4	3139.0	641.2	243.3	1906.7	66.6	272.1	143.5	3273.5
China Hong Kong SAR	21.9	2.7	6.3	–	–	†	30.9	22.2	2.6	6.3	–	–	†	31.1
India	227.1	46.2	415.9	8.5	30.7	21.7	750.1	239.1	49.9	452.2	8.8	31.6	27.5	809.2
Indonesia	79.3	33.1	57.2	–	4.2	3.0	176.9	83.4	33.5	61.6	–	3.7	3.3	185.5
Japan	187.8	100.6	119.9	6.6	17.9	22.4	455.2	182.4	99.5	117.5	11.1	18.3	25.4	454.1
Malaysia	36.0	35.9	19.3	–	5.2	0.3	96.7	36.9	35.5	21.1	–	5.5	0.3	99.3
New Zealand	8.5	4.3	1.2	–	5.7	2.4	22.2	8.4	3.7	1.3	–	6.0	2.4	21.7
Pakistan	29.2	35.0	7.1	1.9	6.9	0.9	81.0	24.3	37.5	11.6	2.2	8.1	1.2	85.0
Philippines	21.7	3.2	15.5	–	2.2	3.1	45.7	22.0	3.5	16.3	–	2.1	3.2	47.0
Singapore	74.8	10.6	0.9	–	–	0.2	86.5	75.8	10.6	0.9	–	–	0.3	87.6
South Korea	130.0	42.8	86.2	33.6	0.6	4.0	297.1	128.9	48.1	88.2	30.2	0.7	5.0	301.0
Sri Lanka	5.4	–	1.4	–	0.9	0.1	7.8	5.3	–	1.2	–	1.4	0.1	8.1
Taiwan	50.1	20.0	39.4	5.1	1.2	1.2	117.0	50.0	20.3	39.3	6.3	1.0	1.5	118.4
Thailand	64.4	43.1	18.3	–	1.1	3.4	130.2	65.8	42.9	18.5	–	1.7	4.0	133.0
Vietnam	23.6	8.2	27.9	–	16.0	0.1	75.8	24.9	8.3	34.3	–	18.3	0.1	85.8
Other Asia Pacific	21.9	9.8	16.9	–	13.6	0.2	62.4	22.5	10.3	18.0	–	14.2	0.3	65.4
Total Asia Pacific	1651.3	660.6	2770.8	111.7	373.2	180.2	5748.0	1695.4	709.6	2841.3	125.3	388.9	225.4	5985.8
Total World	**4607.0**	**3141.9**	**3718.4**	**597.1**	**919.9**	**490.2**	**13474.6**	**4662.1**	**3309.4**	**3772.1**	**611.3**	**948.8**	**561.3**	**13864.9**
of which: OECD	2196.5	1435.2	892.9	443.4	314.6	304.3	5586.9	2204.8	1505.2	861.3	446.1	321.3	330.4	**5669.0**
Non-OECD	2410.5	1706.7	2825.6	153.7	605.3	185.9	7887.7	2457.3	1804.2	2910.8	165.2	627.5	230.8	**8195.9**
European Union	649.5	400.4	234.2	187.8	67.4	152.4	1691.8	646.8	394.2	222.4	187.2	78.0	159.6	**1688.2**

*In this review, primary energy comprises commercially-traded fuels, including modern renewables used to generate electricity.
†Less than 0.05.

Figure 3: Primary Energy Consumption 2017 -2018: Consumption by fuel (BP Statistical Review of World Energy 2019)

Regions (Figure 3)	Total world's **coal** consumption, 2018	Total world's **oil** consumption, 2018	Total world's **gas** consumption, 2018
	%	%	%
Asia Pacific	75.3	36.4	21.4
North America	9.1	23.8	26.6
Europe	8.1	15.9	14.3
CIS	3.6	4.2	15.1
Africa	2.7	4.1	3.8
South and Central America	1.0	6.8	4.4
Middle East	0.2	8.8	14.4
Total World %	100	100	100
Total World Consumption (Mtoe)	3772.1	4662.1	3309.4

Table 2: Percentage of consumption of fossils in different regions in 2018 (BP Statistical review of worldenergy)

Furthermore, overall global consumption amount for each type of fossil fuels have also been providedthat helps to find consumptions for each fossil in different regions through calculation with percentageexpression.

Example Calculation for Carbon emission for Coal in Asia Pacific Region:

In case 161.3 Pound of Oil burns 1 BTU heat releases

1Mtoe=39652608.749183MMBTU,
1Pound = 0.00045 m^3 (Conversion)
Calculation the amount of produced CO_2:

1. Consumed Coal in Asia in 2018 = $\frac{3772.1\times 75.3}{100}\ Mtoe = 2840.1 Mtoe$

2. Then it is needed to calculate how much energy is released as a result of combustion process.In case 1 million tons of oil burning, 39652608.749183 British Thermal Unit heat is released. So to calculate released heat amount:

$$2840.1 Mtoe \times \frac{39652608.749183 MMBTU}{Mtoe} = 1.1\times 10^{11} MMBTU$$

3. As a result of combustion Produced Volume of CO_2 can be calculated in pounds consideringthat 161.3 Pounds oil releases 1MMBTU heat. So Volume of Carbon-dioxide is found in pounds:

$$1.1\times 10^{11} MMBTU \times 161.3 \frac{Pounds}{MMBTU} = 1.7\times 10^{13} Pounds$$

4. Finally, it is expressed in cubic meters:

Covert to cubic meters $= 1.7\times 10^{13} Pounds \times \frac{0.00045 m^3}{Pounds} = 7.9\times 10^{9} m^3 = 7.9 bcm$

Regions (Figure 4)	CO_2, bcm	CO_2, bcm	CO_2, bcm	CO_2, bcm
	Coal	**Oil**	**Gas**	**Total**
Asia Pacific	7.9	4.8	2	14.7
North America	0.1	3.2	2.5	5.8
Europe	0.9	2.1	1.4	4.4
CIS	0.4	0.6	1.4	2.4
Africa	0.4	0.5	0.4	1.3
South and Central America	0.2	0.9	0.4	1.5
Middle East	0.5	1.2	1.4	3.1
Total World	10.5	13.4	9.5	33.2

Table 3: Total Emissions in different regions due to coal, oil and gas consumptions in 2018

Coal: Consumption*

Million tonnes oil equivalent	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	Growth rate per annum 2018	Growth rate per annum 2007-17	Share 2018
Canada	29.4	23.5	24.8	22.2	21.1	20.8	19.6	19.9	18.7	18.6	**14.4**	-22.5%	-4.8%	0.4%
Mexico	10.1	10.3	12.7	14.7	12.8	12.7	12.7	12.7	12.4	15.2	**11.9**	-21.7%	3.0%	0.3%
US	535.9	471.4	498.8	470.6	416.0	431.8	430.9	372.2	340.6	331.3	**317.0**	-4.3%	-4.9%	8.4%
Total North America	575.5	505.2	536.3	507.5	449.9	465.4	463.2	404.8	371.7	365.1	**343.3**	-6.0%	-4.6%	9.1%
Argentina	1.5	0.8	1.2	1.3	1.2	1.3	1.4	1.4	1.0	1.1	**1.2**	13.0%	-1.4%	•
Brazil	13.8	11.1	14.5	15.4	15.3	16.5	17.5	17.6	15.9	16.6	**15.9**	-4.0%	2.0%	0.4%
Chile	4.4	4.0	4.5	5.8	6.7	7.5	7.6	7.3	7.4	7.7	**7.7**	-0.4%	6.6%	0.2%
Colombia	4.4	4.1	4.8	3.9	4.7	5.0	5.3	5.0	6.3	5.2	**5.9**	13.4%	4.4%	0.2%
Ecuador	–	–	–	–	–	–	–	–	–	–	**–**	–	–	–
Peru	0.9	0.8	0.8	0.8	0.9	0.9	0.9	0.8	1.0	0.6	**0.9**	61.8%	-5.6%	•
Trinidad & Tobago	–	–	–	–	–	–	–	–	–	–	**–**	–	–	–
Venezuela	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.1	**0.1**	-9.9%	-2.1%	•
Other S. & Cent. America	2.5	2.2	2.4	2.8	2.8	3.2	3.5	3.6	3.8	3.5	**4.3**	22.0%	3.1%	0.1%
Total S. & Cent. America	27.7	23.3	28.3	30.2	31.7	34.6	36.4	35.8	35.5	34.8	**36.0**	3.7%	2.9%	1.0%
Austria	3.8	2.9	3.4	3.5	3.2	3.3	3.0	3.2	3.0	3.1	**2.9**	-8.4%	-2.1%	0.1%
Belgium	4.6	3.0	3.7	3.5	3.3	3.4	3.3	3.4	3.2	3.1	**3.3**	4.9%	-3.9%	0.1%
Czech Republic	19.7	18.2	18.8	18.5	17.7	16.9	16.4	16.3	16.4	15.6	**15.7**	1.0%	-2.8%	0.4%
Finland	5.3	5.4	6.8	5.5	4.5	5.0	4.5	3.8	4.4	4.0	**4.3**	6.7%	-5.4%	0.1%
France	12.1	10.8	11.5	9.8	11.1	11.6	8.6	8.4	8.2	9.3	**8.4**	-9.6%	-3.2%	0.2%
Germany	80.1	71.7	77.1	78.3	80.5	82.8	79.6	78.7	76.5	71.5	**66.4**	-7.2%	-1.9%	1.8%
Greece	8.3	8.4	7.9	7.9	8.1	7.0	6.7	5.6	4.4	4.8	**4.7**	-2.8%	-6.0%	0.1%
Hungary	3.0	2.6	2.7	2.7	2.6	2.3	2.3	2.3	2.2	2.2	**2.2**	-2.4%	-3.3%	0.1%
Italy	15.8	12.4	13.7	15.3	15.7	13.5	13.2	12.3	11.0	9.6	**8.9**	-7.7%	-5.1%	0.2%
Netherlands	8.0	7.5	7.5	7.4	8.2	8.2	9.1	11.0	10.2	9.1	**8.2**	-10.5%	0.8%	0.2%
Norway	0.7	0.6	0.8	0.8	0.8	0.8	0.9	0.8	0.8	0.8	**0.8**	3.3%	1.8%	•
Poland	55.2	51.8	55.1	55.0	51.2	53.4	49.4	48.7	49.5	49.8	**50.5**	1.5%	-1.2%	1.3%
Portugal	2.5	2.9	1.6	2.2	2.9	2.6	2.7	3.3	2.8	3.2	**2.7**	-16.1%	1.2%	0.1%
Romania	9.4	7.5	7.0	8.2	7.6	5.9	5.8	6.0	5.4	5.4	**5.3**	-1.2%	-5.8%	0.1%
Spain	13.5	9.4	6.9	12.8	15.5	11.4	11.6	13.7	10.5	13.4	**11.1**	-17.3%	-3.9%	0.3%
Sweden	2.8	2.0	2.8	2.5	2.1	2.2	2.0	2.0	2.0	2.0	**2.0**	-0.3%	-3.5%	0.1%
Switzerland	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	**0.1**	–	-4.5%	•
Turkey	29.6	30.9	31.4	33.9	36.5	31.6	36.1	34.7	38.5	39.5	**42.3**	7.2%	3.0%	1.1%
Ukraine	41.8	35.9	38.3	41.5	42.5	41.6	35.6	27.3	32.5	25.7	**26.2**	2.0%	-4.3%	0.7%
United Kingdom	35.6	29.8	30.9	31.4	39.0	37.0	29.8	23.1	11.1	9.1	**7.6**	-16.6%	-13.4%	0.2%
Other Europe	39.1	36.8	38.3	40.9	37.0	37.1	33.8	34.3	34.3	34.1	**33.6**	-1.5%	-1.4%	0.9%
Total Europe	391.2	350.4	366.3	381.8	390.2	377.6	354.5	339.2	326.8	315.5	**307.1**	-2.7%	-2.6%	8.1%
Azerbaijan	†	†	†	†	†	†	†	†	†	†	**†**	–	-13.0%	•
Belarus	0.6	0.6	0.6	0.8	0.8	0.8	0.8	0.7	0.8	0.8	**1.0**	13.7%	1.9%	•
Kazakhstan	33.8	30.9	33.4	36.3	37.9	37.5	37.0	34.2	33.9	36.4	**40.8**	12.2%	1.6%	1.1%
Russian Federation	100.7	92.2	90.5	94.0	98.4	90.5	87.6	92.1	89.3	83.9	**88.0**	4.9%	-1.1%	2.3%
Turkmenistan	–	–	–	–	–	–	–	–	–	–	**–**	–	–	–
Uzbekistan	1.0	1.0	0.9	1.1	1.2	1.1	1.2	1.1	2.7	3.5	**3.1**	-11.1%	13.5%	0.1%
Other CIS	1.1	0.9	0.9	1.0	1.4	1.4	1.7	1.8	1.6	1.8	**2.0**	10.6%	8.4%	0.1%
Total CIS	137.2	125.6	126.4	133.2	139.6	131.4	128.3	130.0	128.3	126.4	**134.9**	6.7%	-0.1%	3.6%
Iran	1.2	1.4	1.3	1.4	1.1	1.4	1.6	1.6	1.5	1.4	**1.5**	4.3%	-0.9%	•
Iraq	–	–	–	–	–	–	–	–	–	–	**–**	–	–	–
Israel	7.9	7.7	7.7	7.9	8.8	7.1	6.6	6.5	5.5	5.0	**4.7**	-6.5%	-4.6%	0.1%
Kuwait	†	–	†	†	–	0.3	0.2	0.2	0.2	0.2	**0.2**	–	81.9%	•
Oman	†	†	†	†	†	0.1	0.1	0.1	0.1	0.1	**0.1**	–	35.8%	•
Qatar	–	–	–	–	–	–	–	–	–	–	**–**	–	–	–
Saudi Arabia	0.1	†	0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.1	**0.1**	–	6.5%	•
United Arab Emirates	0.3	0.3	0.7	0.4	1.4	1.8	2.0	1.7	1.8	1.0	**1.1**	4.8%	22.2%	•
Other Middle East	0.2	0.2	0.3	0.4	0.5	0.5	0.6	0.4	0.4	0.4	**0.4**	•	11.2%	•
Total Middle East	9.7	9.6	10.1	10.3	11.9	11.2	11.2	10.5	9.7	8.2	**7.9**	-2.7%	-1.9%	0.2%
Algeria	0.8	0.5	0.3	0.3	0.3	0.2	0.2	0.1	†	0.2	**0.2**	–	-13.3%	•
Egypt	0.7	0.6	0.5	0.4	0.4	0.4	0.4	1.1	1.7	1.6	**2.8**	68.7%	7.9%	0.1%
Morocco	3.7	2.7	2.8	3.0	3.0	3.0	4.0	4.4	4.3	4.5	**5.4**	22.4%	3.3%	0.1%
South Africa	93.3	93.8	92.8	90.5	88.3	88.4	89.5	85.2	86.9	84.3	**86.0**	2.0%	0.1%	2.3%
Other Africa	3.0	3.3	3.7	4.2	3.9	5.3	7.8	6.8	6.2	7.0	**7.0**	0.2%	6.9%	0.2%
Total Africa	101.4	101.0	100.1	98.4	96.0	97.2	101.9	97.7	99.1	97.6	**101.4**	3.9%	0.6%	2.7%
Australia	58.2	56.3	52.2	50.9	47.8	45.4	45.0	46.5	46.5	45.1	**44.3**	-1.8%	-2.1%	1.2%
Bangladesh	0.6	0.8	0.8	0.7	0.9	1.0	0.9	2.3	1.7	1.9	**2.1**	12.1%	11.9%	0.1%
China	1609.3	1685.8	1748.9	1903.9	1927.8	1969.1	1954.5	1914.0	1889.1	1890.4	**1906.7**	0.9%	1.8%	50.5%
China Hong Kong SAR	6.9	7.2	6.2	7.4	7.3	7.8	8.1	6.7	6.7	6.3	**6.3**	–	-1.7%	0.2%
India	259.3	280.8	290.4	304.6	330.0	352.8	387.5	395.3	400.4	415.9	**452.2**	8.7%	5.7%	12.0%
Indonesia	31.5	33.2	39.5	46.9	53.0	57.0	45.1	51.2	53.4	57.2	**61.6**	7.7%	4.7%	1.6%
Japan	120.3	101.6	115.7	109.6	115.8	121.2	119.1	119.3	118.8	119.9	**117.5**	-2.1%	0.2%	3.1%
Malaysia	9.8	10.6	14.8	14.8	15.9	15.1	15.4	17.4	18.9	19.3	**21.1**	9.4%	8.1%	0.6%
New Zealand	2.1	1.6	1.4	1.4	1.7	1.6	1.4	1.4	1.2	1.2	**1.3**	1.3%	-3.0%	•
Pakistan	6.0	4.9	4.6	4.0	4.0	3.2	4.7	4.7	5.3	7.1	**11.6**	63.3%	2.7%	0.3%
Philippines	6.4	6.1	7.0	7.7	8.1	10.0	10.6	11.6	13.1	15.5	**16.3**	5.2%	11.1%	0.4%
Singapore	†	†	†	†	†	0.3	0.4	0.4	0.4	0.9	**0.9**	1.6%	60.1%	•
South Korea	66.1	68.6	77.1	83.7	80.6	81.5	84.4	85.4	81.5	86.2	**88.2**	2.4%	3.7%	2.3%
Sri Lanka	0.1	0.1	0.1	0.3	0.5	0.5	0.9	1.2	1.3	1.4	**1.2**	-14.3%	41.5%	•
Taiwan	37.0	35.2	37.6	38.9	38.0	38.6	39.0	37.8	38.6	39.4	**39.3**	-0.3%	0.2%	1.0%
Thailand	15.0	15.0	15.4	15.7	16.5	16.2	17.9	17.5	17.7	18.3	**18.5**	1.0%	2.8%	0.5%
Vietnam	11.7	11.2	14.6	17.3	16.1	17.2	20.7	26.1	28.1	27.9	**34.3**	22.9%	16.3%	0.9%
Other Asia Pacific	20.5	16.6	16.2	13.2	13.9	11.4	12.9	12.2	16.1	16.9	**18.0**	7.0%	-1.0%	0.5%
Total Asia Pacific	2260.8	2335.5	2442.6	2621.1	2677.8	2749.7	2768.6	2751.0	2738.9	2770.8	**2841.3**	2.5%	2.3%	75.3%
Total World	**3503.4**	**3450.6**	**3610.1**	**3782.5**	**3797.2**	**3867.0**	**3864.2**	**3769.0**	**3710.0**	**3718.4**	**3772.1**	**1.4%**	**0.7%**	**100.0%**
of which: OECD	1150.8	1029.9	1092.9	1072.8	1028.2	1037.1	1020.1	954.9	900.0	892.9	**861.3**	-3.5%	-2.7%	22.8%
Non-OECD	2352.6	2420.8	2517.1	2709.8	2769.0	2829.9	2844.1	2814.0	2810.1	2825.6	**2910.8**	3.0%	2.2%	77.2%
European Union	303.7	267.7	280.4	288.2	294.6	287.6	268.6	261.4	239.7	234.2	**222.4**	-5.1%	-3.3%	5.9%

*Commercial solid fuels only, i.e. bituminous coal and anthracite (hard coal), lignite and brown (sub-bituminous) coal, and other commercial solid fuels. Excludes coal converted to liquid or gaseous fuels, but includes coal consumed in transformation processes.
†Less than 0.05.
•Less than 0.05%.
Note: Differences between these world consumption figures and the world production statistics are accounted for by stock changes, and unavoidable disparities in the definition, measurement or conversion of coal supply and demand data.

Figure 4: Coal Consumption over the world (BP Statistical Review of World Energy 2019)

As it is seen Asia Pacific region accounts nearly 45% of global emissions that is more than average accepted by UN WHO that increases health related problems in this region such as cancer, heart attackand poor eyesight.

In order to compare carbon emissions in 2001 and 2018 the same calculation is applied to determine the volume of carbon-dioxide emission in 2001. Amount of fossil consumptions for all regions have been provided in the Table 4 with percentage expression. Furthermore, overall consumption has beenindicated as well that makes easier to calculate consumption for all regions separately The same calculation carried out for the year 2001 and all results of calculation provided in the Table

Regions (Figure 3)	Total world's **coal** consumption, 2001	Total world's **oil** consumption, 2001	Total world's **gas** consumption, 2001
	%	%	%
Asia Pacific	45.3	27.7	12.7
North America	26.2	30.4	30.0
Europe	15.3	21.7	19.5
CIS	8.0	4.8	22.8
Africa	3.9	3.3	2.5
South and Central America	1.0	6.2	4.0
Middle East	0.4	5.9	8.4
Total World %	100%	100%	100%
Total World Consumption (Mtoe)	2255.1	3510.6	2164.3

Table 4: Percentage of consumption of fossils in different regions in 2001 (BP Statistical Review 2002)

Regions (Figure 4)	CO_2, bcm	CO_2, bcm	CO_2, bcm	CO_2, bcm
	Coal	**Oil**	**Gas**	**Total**
Asia Pacific	3	2.8	0.8	6.6
North America	1.5	3.1	1.9	6.5
Europe	1.1	2.1	1.2	4.4
CIS	0.4	0.5	1.5	2.4
Africa	0.3	0.3	0.2	0.8
South and Central America	0.1	0.6	0.2	0.9
Middle East	0.1	0.7	0.4	1.2
Total World	6.5	10.1	6.2	22.8

Table 5: Total Emissions in different regions due to coal, oil and gas consumptions in 2001

5. It is seen clearly from the table that Asia Pacific region was the leader in terms of emissions amountin 2001 as well.

For comparison emission amount in 1993 and in 2018 are selected and included in Table 6. It is observable that emission amount nearly increased by 50% compared to 1993. Based on Kyoto Protocolbetween 2008 and 2012 emission level should be 5% less than compared to 1990. However, after calculation over years it is found that emission has increased even nearly 50%, which will increase average global temperature rise over 2^0C which must be 1.5^0C based on agreement. Due to increase inGHGs emissions ozone layer will be thinning faster than before that will enable sun's ultraviolet wavesto radiate the people. In its turn, several diseases will appear related high temperature and radiation, which requires deeper scientific and medical research. Furthermore, due to global increase in emissionsacid rain will increase, as well so it may cause soil destruction, hence food scarcity and starvation of many people. Since the CO_2 (44g/mol) density is more than air (29g/mol) density as the amount of carbon-dioxide increases in the atmosphere heat released from the sun is captured by carbon emissionin the atmosphere and causes global temperature rise. As a result of global temperature rise natural disasters such as floods, wildfires and ice melting will take place. All these issues will affect global ecological balance of nature in terms of animals, plants and drinkable water resources scarcity. Considering all these future potential problems urgent steps should be taken to reduce emission levelboth in national level and global level through adopting and implementation of laws.

In addition to emissions, fossil fuels have many negative effects, such as water, soil air contamination. Despite all these facts fossils will still be the main energy resources during 21st century, because technology for producing fossil fuels are much cheaper than alternative energy resources. However, it is possible to reduce emissions through using cleaner technology or replacing coal with gas.

Types of Energy Resources	CO_2 (bcm), 1993	CO_2 (bcm), 2018 Fig. 3
Coal	6.3	10.5
Natural gas	5.3	9.5
Oil	9.1	13.4
Total	**20.7**	**33.4**

Table 6: Amount of CO_2 released in the world in 1993 and 2018

All consumed energies are expressed in Mtoe, so, during calculation of carbon-dioxide emissions in different regions and different years the 1Btu is accepted as the amount of heat released during combustion of 161.3 pounds of oil. In case 1 million tons of oil burning, 39652608.749183 British Thermal Unit heat is released. After determining the released heat amount (MMBTU) it is used to calculate the volume (Pound) of carbon dioxide. Then conversion factor is used to express volumes in cubic meters. Calculations were carried out by the author to determine in which region and which typeof fossil fuel is consumed more as well as to compare emission amount in different years.

Results of Qualitative Data

According to annual energy reports provided by BP (Statistical Review in 2018) the highest percentage (75.3%) of overall coal consumption (3772.1Mtoe) was consumed in Asia Pacific region. After doing calculation, the volume of carbon emission was found by Asia Pacific in 2018. So, the mostamount of carbon-dioxide (7.9 bcm) out of total 10.5bcm was released by Asia Pacific region due to coal combustion. However, the least was in North America (0.1 bcm). Furthermore, Asia Pacific regionreleases the most carbon emission as a result of oil combustion, as well (4.8 bcm out of total 13.4 bcm),but the least volume of emission released by Africa region only 0.5bcm through oil combustion. However, North America region consumes more gas (26.6%) than other regions so it releases more emission due to gas combustion 2.5 bcm. While, in 2018 Europe, CIS and Middle East almost producedthe same volume of emission 1.4 bcm. For comparing emissions by coal (10.5 bcm), oil (13.4 bcm) andgas (9.5 bcm) it is seen that overall most emission is due to oil combustion as an energy source. Considering the overall emission volume, Asia Pacific region releases more emission 14.7 bcm out of 33.2 bcm of total world emission in 2018, which can be mainly due to economic and population growth.Since the population and economy grow, the demand for energy is growing as well. Hence, the amountof released carbon emissions as well.

Through reviewing annual report in 2002 it is observable that overall energy consumption was low 2164.3Mtoe, hence the emission was low. In 2001, again the most amount of coal was consumed by Asia Pacific region 45.3% of 2255.1Mtoe of overall coal consumption in the world. While, the North America oil consumption was the highest that accounted for 30.4% of overall world oil consumption that was 3510.6Mtoe in that year. In 2001 the least fossil consumption, hence the least emission was released by Africa, Middle East and South and Central America. Overall in 2001 emission volume was 22.8 bcm. In 2001 the most carbon released by Asia Pacific 6.6 bcm. While among the fossil fuels oil accounted for the highest volume of emission 10.1 bcm out of 22.8 bcm, while the least emission wasproduced by gas consumption 6.2 bcm [10].

After analyzing the annual energy reports, it is seen clearly that between 2001 and 2018 coal consumption in Asia Pacific region increased from 45.3% to 75.3%. While, North America decreased coal consumption considerably over these years, according to annual reports consumption rate declined from 26.2% in 2001 to 9.1% in 2018 [11].

Comparing the consumption of oil in North America, it declined from 30.4% in 2001 to 23.8% in 2018. In addition, gas consumption decreased from 30% to 26.6% between 2001 and 2018 in North America.In the context of overall economic growth in Europe oil consumption percentage decreased however, considering emission volume it remained almost the same between 2001 and 2018. In terms of gas consumption rate in Europe the percentage decreased in 2018 compared to 2001 statistics. However,again the overall emission volume remained the same which can be considered as a decline in consumption despite population growth [12].

Considering economic growth overall in Europe region the emission due to coal consumption decreased as well in overall context, however, volume of carbon-dioxide emission due to coal combustion almost remained the same. Africa, South and Central America and Middle East regions released the least amount of emissions compared to other regions [13].

In the Table 15 given above emissions amount due to coal, oil and gas consumption has been provided in 1993 and 2018. For comparison, the overall emission amount increased from 20.7 bcm to 33.4 bcm.Over these years oil has been major energy resource hence the largest emissions due to oil consumption. Over this time frame, it is clearly seen that overall carbon emission as well as for each type of fossil fuel emission amount increased by 50% between 1993 and 2018 [14].

Overall, through comparison among different years, demand for energy increases annually as the population size grow. So the more population means the more energy demand then, the more energyconsumption leads to the more carbon emission. In order to reduce contamination some urgent stepsshould be taken immediately by International Organizations, Governments and societies [15].

Discussions

It could be argued that emission is global issue since carbon emissions and other gas mixtures releasedinto atmosphere spread alongside the world and affect ecology globally. However, the amounts of emissions due to fossil fuel consumption are not the same in different regions of the world dependingon many factors. After searching and analyzing all data the below major points were found:

● Emissions can be both regional and global depending on its spreading means. In addition to emissions due to fossil fuel consumption, there are other contamination types due to fossil fuels extraction such as heavy metals spread via atmosphere as a dust and via water through sweeping into rivers, which requires mainly experimental scientific analysis.

● Coal are the major fossil fuel foe electricity generation in some countries, especially China and India in Asia Pacific region and in Germany in Europe region. It is found that over the last 20 years consumption rate of coal almost increased by 50% hence, emissions increased by that amount dueto fossil. China accounts for more than half of global coal consumption, hence more than half of carbon-dioxide emissions.

● Among all fossils, oil is the most consumed energy resource in terms of usage areal from chemistryindustry until burning for transportation. It is found that over the last 30 years oil consumption hasbeen almost 50% greater than both coal and gas consumption. North America was the leader for oilconsuming, however, Asia Pacific region surpassed it and became world leader.

In terms of gas consumption over the 20 years period North America's leadership replaced by Asia Pacific region. Some countries such as the USA replaced coal by gas for electricity generation since gasproduces nearly 50% less carbon-dioxide than coal.

Carbon-dioxide emission is just one form of emissions due to fossil fuels consumption. Emission in itselfis an extensive subject in terms of many possible ways. Only in fossil fuels context emissions due to carbon-dioxide is considered as the objective of research. Furthermore, it was not possible to calculateaccurate numbers due to decimals as well as other gases in the emissions' content. To simplify the calculation only carbon-dioxide emission is selected as emission. Moreover, due to limited time and accessibility to data and no availability of experiments all calculations for carbon emissions were carriedout mathematically through equations. The data collection method was limited to only annual statistical energy reviews provided by energy companies, articles, magazines and individually to someprofessors. The study in emissions is a broad research field and intensive research considering differentaspects will provide considerable results. However, due to lack of experimentation, time and access toreal industry detailed study was not possible.

Conclusion

It is known that the potential of renewable energy sources is huge. Examples of these sources are the solar energy, the planet's internal energy, geothermal waters, wind power, rise and fall of seas, rivers,biogas, hydrogen and biomass. The importance of these energies has increased in recent years as people's living conditions have improved and energy demand has risen considerably. There are three main types of regenerative energy: - Solar energy, - planetary (gravitational) energy, - geothermal energy.

The results of different scientific investigations are not encouraging. Even in the scenario with the leastchange in nature, the minimum value of temperature rise by the end of the 21st century is 1.4^0C. Currently the actual temperature rise is 0.6^0C. In the future, this increase will be from 2 to 6^0C and morerise can be possible. In almost all scenarios, the results of intensive use of natural fuels allow us to predict that the use of renewable energy sources will accelerate. In this case, the use of non-CO_2 fuelsis expected to increase by 4-25 times. Towards the end of the twenty first century, the transition to zero carbon energy is expected, based on the use of renewable energy sources. One additional way toreduce carbon emissions is to use fuels that produce less CO_2 when burned. Table below shows the amount of CO_2 emitted during the combustion of different fuels, 1 kWhr and 1 GJ of thermal energy. [16]

Fossil fuel	kg CO_2/kW×hr	kg CO_2/GJ
Coal	0,34	94,6
Diesel fuel	0,27	74,1
Oil	0,26	73,3
Kerosene	0,26	71,5
Gasoline	0,25	69,3
Natural gas (CH_4)	0,2	56,1

Table 7: The amount of CO_2 emitted for combustion of different fuels

As can be seen from the table, the fuel that burns with the least amount of carbon dioxide is natural gas. Therefore, it is preferred to use natural gas as a fuel to reduce the amount of carbon dioxide released into the atmosphere during the combustion process. The use of natural gas as a fuel is more efficient, especially in large cities and other large regions with high population density. At the same time, the environment is less polluted, the atmosphere become relatively clean and the amount of carbon dioxide emitted is sharply reduced. The protection of the Earth's atmosphere from pollution and greenhouse gases has been raised to the international level, and it has been decided to unite anddirect the efforts of countries in this area. This issue is reflected in the 1997 Protocol to the United Nations Framework Convention on Climate Change, adopted in Kyoto, Japan. This document is called the "Kyoto Protocol" and its signing covered the period from 16.03.1998 to 15.03.1999. Based on this Protocol all countries must report annual statistics of energy usage and their emissions amount.

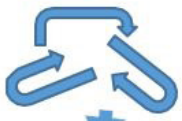
In order to reduce energy consumption, hence carbon-dioxide emission 5 R principles should be appliedin all fields of industry which will also help for sustainable development as well as bring ecological and advantages.

5 R principles to reduce carbon emissions are given below

1.  **Refuse** non-renewable energy resources and use alternative energyresources

2.  **Reduce** energy consumption and change transportation to electrical means or bikes

3.  **Reuse** paper and plastics that will reduce cutting trees and energyconsumption

4.  **Recycle** all the utilized things to reduce energy consumption toproduce again

5.  **Root** use of all food and things where it is produced to reducetransportation

For this purpose, the achievements of modern science and technology should be used, low- energy and high-efficiency equipment and technological processes should be applied, low-carbon fuelsshould be used, and renewable energy sources should be widely used. Only through the joint efforts ofall countries it is possible to eliminate the huge amount of greenhouse gasses and mitigate its impact.All regions have their own potential for alternative energy resources depending on their geographical location. For example, currently the largest area of solar panels are owned by China then Japan, Turkeyand Greece. However, solar panels can be most effective in deserts in Africa and Middle East where nosoil is used for agriculture, so absolutely empty spaces for energy generation with the maximum efficiency. In future, some countries in Asia Pacific region such as China and Japan have the potential for wave energy of seas as well as increase the number of wind turbines and solar panels that may helpto reduce coal consumption in this region considerably. It is commonly known that there is temperaturedifference between the top sea and bottom layers of seas and oceans. Using this temperature difference with the help of special pumps, it is possible to generate electricity with the help of special technology.

In order to reduce energy consumption and use resources efficiently "Smart City" is considered as an ideal model for living infrastructure. Considering all advantages of "Smart City" infrastructure reducingenergy consumption, hence carbon-dioxide emission is also a matter of several fields to operate all together such as civil engineering and information technology, agriculture and land use, overall using all resources in a sustainable way. The "Smart City" model brings the benefits below all of them that leads to less energy consumption and less emissions:

● Better transport services: improvement efficiency throughout the city through in such a designthat all people use the better and shorter distances to reach their daily destination points. Thelocation and route is chosen and designed in such a way that there is less need for transportationfor travelling. In terms of road construction special ways constructed for bikes that even withoutusing cars it is possible to reach destination with bike faster.

● Efficient public services: reduction of involuntary waste of water and electricity with smart technology using natural resources available is possible using solar panels, for example, that uses solar energy to light the streets during the night and it uses the energy that collected during the day. Furthermore, when there is no person near it, either energy or water usage stops.

● Reduction of the environmental footprint: Energy-efficient buildings, air quality sensors and renewable energy sources are providing cities with new tools to reduce their ecological impact.

● Construction infrastructure in more economical way: more densely populated city center and urban area around it to decrease land use and increase forest areas. Fewer public buildings (school, hospital, bank etc.) will meet overall demand, hence less energy consumption

"Smart City" model has been applied in many parts of the world such as in Japan, USA and China. However, the number of these cities are not enough in the world. They are mainly constructed in developed countries, but in developing countries as well smart cities will be constructed in near futurewhich will help to reduce energy consumption, hence carbon-dioxide emission considerably as well asproviding sustainable development.

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