Cumulative CO2 Emissions per Cumulative GDP 1990-2020

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Version 1.1.1, 30 October 2022
DOI:10.5281/zenodo.7264417
all versions DOI:10.5281/zenodo.7264416

Abstract

This work analyzes cumulative CO2 emissions per cumulative GDP (CCp$$) in the period 1990-2020. The dataset includes 192 countries, 99.1% of the population of the world, 99.4% GDP of the world and 99.2% of the global cumulative CO2 emissions without international transport.
The cumulative GDP of the countries included in this work is 2,564 MM$GDP, 99.4% of the world's cumulative GDP of 2,579 MM$GDP.
The CCp$$ of the countries included in this work is 0.0003331 tCO2/$GDP, 99.7% of the world average 0.0003340 tCO2/$GDP.

42 countries have CCp$$ above the world average with 555,796 Mega-tons of cumulative CO2 emissions in the period 1990-2020, compared to 298,338 MtCO2 (54%) of the 150 countries below the world average CCp$$. The cumulative CO2 emissions of those 42 countries above the world average increased global warming by 0.125°C.

Keywords: Climate Change, Global Warming, CO2 emissions, CO2 per GDP, cumulative CO2, cumulative GDP, cumulative CO2 per cumulative GDP

Glossary

Ave	average
CCO2	cumulative CO2 emissions according to publication [1] [2], CO2 emissions produced from fossil fuels and cement production only – land use change is not included, tCO2
CO2	emissions of Carbon Dioxide, CO2
CO2→GW	correlation between cumulative CO2 emissions and global warming = 0.000745°C/GtCO2 [4]
CCp$$	cumulative CO2 emissions per cumulative GDP in the period 1990-2020, tCO2/$GDP (ton CO_2 per $2017)
CCp$$W	World average CCp$$, tCO2/$GDP
Cp$	CO2 emissions per GDP, tCO2/y,$ (ton CO_2 per year, per $2017)
GDP	Gross Domestic Product, constant international $(2017)
Global Warming	global surface temperature change over land+ocean above 1850-1900 baseline (°C)
GtCO2	Giga-ton of CO_2, 10^9 ton, 10^9 ton, 1,000,000,000 ton of CO2
M$	Million $
M$/y	Million $ per year
MM$	10^{12} $, 10^12 $, 1,000,000,000,000 $
MtCO2	Mega-ton CO_2 = 10^6 ton, 10^6 ton, 1,000,000 ton CO2
OWID	Our World in Data – Internet site [1] [2]
Ref	reference
tCO2	ton CO_2
WB	World Bank

Sources of Data

The datasets are from the following sources:

- OWID [1] [2] CO2 emissions produced from fossil fuels and cement production only – land use change is not included
- World Bank (WB) [3] GDP, PPP (constant 2017 international $)

GDP Data

WB publication [3] includes GDP data for 191 countries for the year 2020 and 160 countries for the year 1990.
Part of the missing GDP data for 1990+ in the World Bank dataset [3] was calculated using OWID [1] [2] and conversion factors between the datasets for each year based on conversion factors between the datasets for the USA.
In cases of missing data in both sources for years 1990+, the average annual change was applied, based on the existing data for other years. In the case of the negative average annual change, the missing data for years 1990+ were completed proportionally to the word changes.
Data for one country (Taiwan) are based on OWID [1] [2]. Missing data for the years 2019-2020 were completed proportionally to the word changes.

Dataset

Table 1 - Dataset [1] [2] [3]

	CO2 emissions	GDP
Source of data	OWID	World Bank
Reference	[1] [2]	[3]
Countries	192	192
From year	1990	1990
To year	2020	2020
CO2 from fossil fuels	Yes	
CO2 from cement production	Yes	
CO2 from other sources	No	
Other GHG	No	
Land use change	No	
Units	Mt CO2/y	Constant International $ 2017
Resolution	1 kt CO2/y	1 Constant International $ 2017

Table 2 - Cumulative CO2 emissions 1990-2020 dataset [1] [2] [MtCO2]

		1990-2020
countries		192
dataset countries' cumulative CO2	MtCO2	854,134
world cumulative CO2 without international transport	MtCO2	861,262
dataset/world		99.17%
International transport	MtCO2	27,658
Global world CO2 emissions including international transport	MtCO2	888,920

Table 3 - GDP dataset [3] [M$GDP/y]

		1990	2020
countries		192	192
dataset countries GDP	M$GDP/y	50,994,261	125,514,935
world GDP	M$GDP/y	51,241,011	126,318,951
dataset/world	M$GDP/y	99.52%	99.36%

Table 4 - Dataset and the world

		Dataset	World	Dataset/World
Dataset countries		192		
Cumulative CO2 1990-2020	tCO2	854,134	861,262	99.17%
Cumulative GDP 1990-2020	M$GDP	2,564,126,249	2,578,715,163	99.43%
CCp$$	tCO2/$GDP	0.00033311	0.00033399	99.74%

Correlation between Cumulative CO2 Emissions and Global Warming

The correlation between cumulative CO2 emissions and global warming was analyzed in the publication "*Global Warming and Cumulative CO2*" [4].

Formula 1 - Correlation between Cumulative CO2 Emissions and Global Warming [4] [°C/GtCO2]

CO2→GW = 0.000745°C/GtCO2

Formula for Cumulative CO2 Emissions per Cumulative GDP

Formula 2 - Cumulative CO2 emissions per cumulative GDP

$$CCp\$\$ = \sum_{i=y1}^{yn} CO2_i \div \sum_{i=y1}^{yn} GDP_i$$

CCp$$	Cumulative CO2 emissions per cumulative GDP, tCO2/$GDP
i	year between y1 and yn
y1	start year = 1991
yn	end year = 2020
$CO2_i$	CO2 emissions in year i according to publication [1] [2], tCO2/y
GDP_i	Gross Domestic Product, constant international $(2017) according to publication [3], $GDP/y

Cumulative Global CO2 Emissions

Total global CO2 emissions per year are from 1750 [1] [2]. This is also the first year of calculations of the cumulative CO2 emissions of the world, which means that for this parameter the baseline is 1749.
However, international transport CO2 emissions are from 1950 and the first year of the cumulative CO2 emissions is 1950 [1] [2], which means that for this parameter the baseline is 1949.

The dataset was converted to the 1875 baseline in the publication [9].

Table 5 - Global cumulative CO2 emissions and international transport [9] [tCO2 above 1875 baseline]

		1990	2020
Global cumulative CO2 emissions including international transport	tCO2	792,689,057,443	1,681,608,597,211
International transport cumulative CO2 emissions	tCO2	16,042,804,984	43,700,803,946
Global cumulative CO2 emissions without international transport	tCO2	776,646,252,459	1,637,907,793,265

International transport cumulative CO2 emissions are not related to the specific country, therefore, the comparison between the countries' CO2 emissions and the world is to the global cumulative CO2 emissions without international transport.

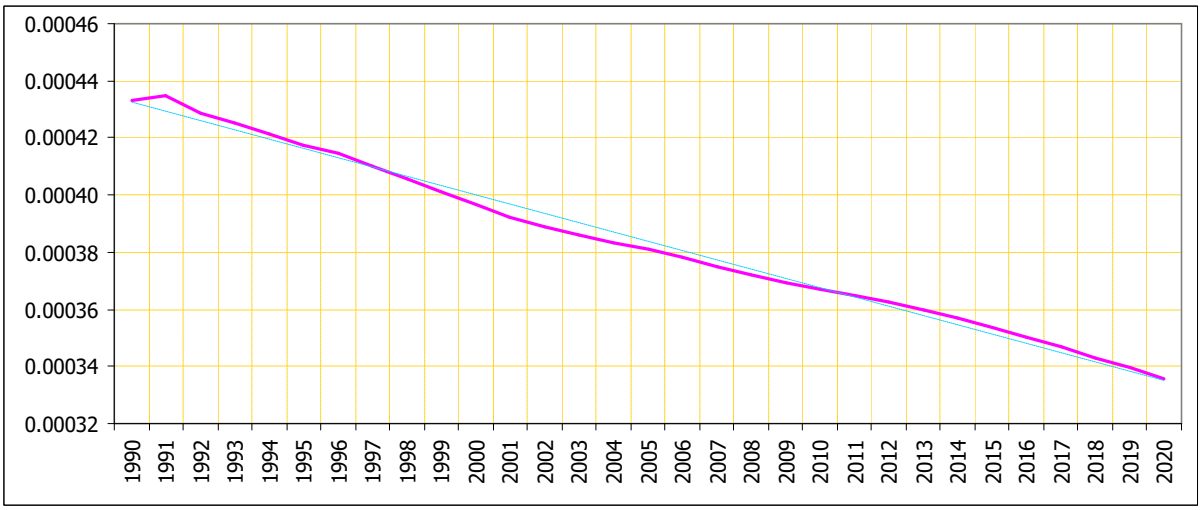
World Data

Table 6 - World data 1990-2020 [1] [2] [3] [5] [6]

Cumulative CO2 1990-2020 without international transport	MtCO2	861,262
Cumulative GDP 1990-2020	M$GDP	2,578,715,163
Cumulative CO2 per Cumulative GDP (CCp$$W)	tCO2/$GDP	0.0003340

The world average cumulative CO2 per cumulative GDP (CCp$$W) in the period 1990-2020 is 0.0003340 tCO2/$GDP.

Chart 1 - Cumulative CO2 emission per cumulative GDP 1990-2020, world average (CCp$$) [tCO2 per $GDP]



Countries Above and Below the World Average CCp$$

Table 7 - Below and above the world average CCp$$ in 2020 (CCp$$W)

		<CCp$$W	>CCp$$W
Countries		150	42
to world		78%	22%
Cumulative CO2 1990-2020	MtCO2	298,338	555,796
to world		35%	65%
Cumulative GDP 1990-2020	M$GDP	1,403,919,567	1,160,206,681
to world		54%	45%
Group average CCp$$	tCO2/$GDP	0.0002125	0.0004790
to world		64%	143%

42 countries above CCp$$W produced less GDP than 150 below CCp$$W, having more than twice CCp$$.

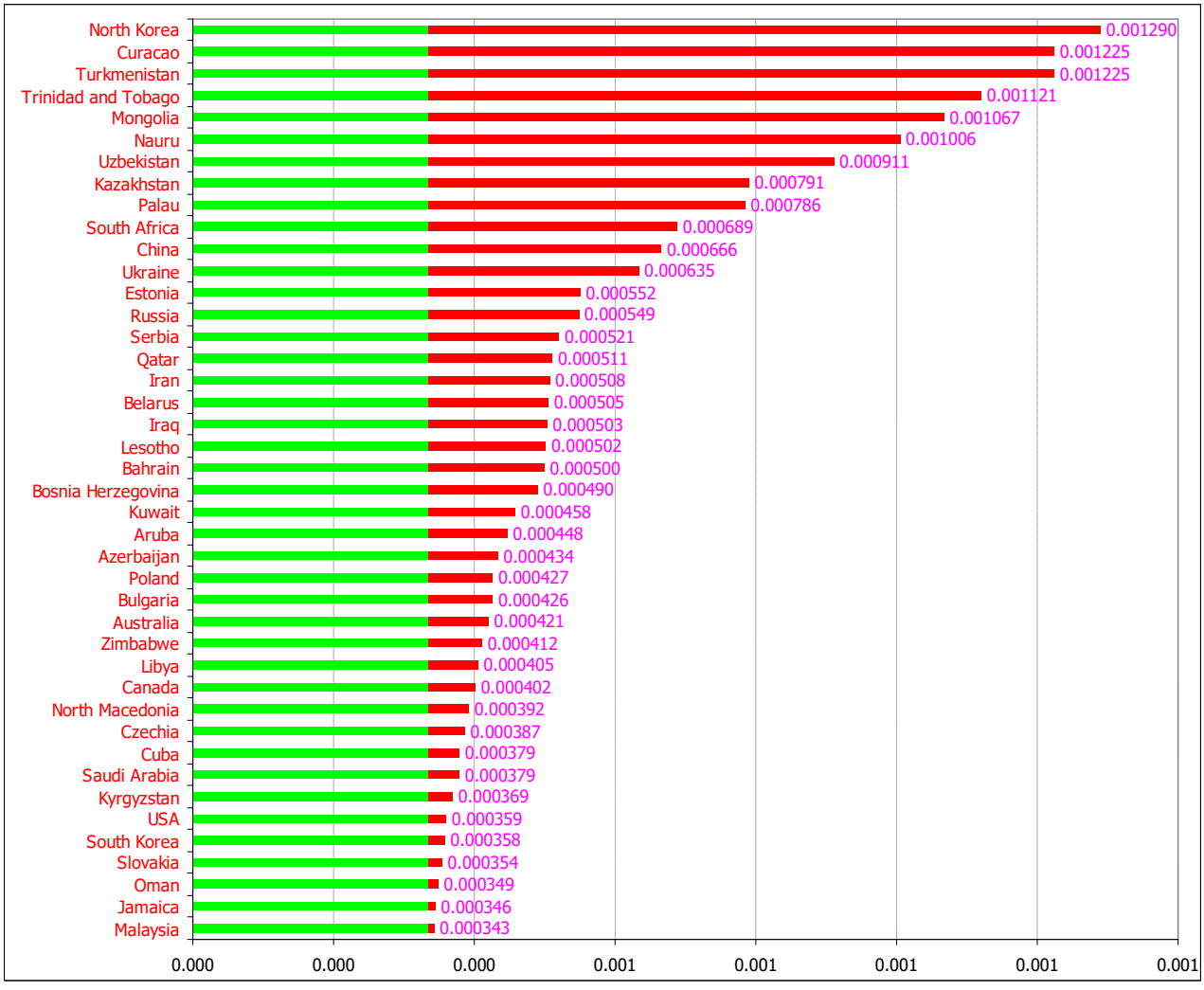
Cumulative CO2 Emissions above the CCp$$W

Table 8 - Cumulative CO2 emissions above the CCp$$W

Countries above CCp$$W		42
Group cumulative GDP 1990-2020	M$GDP	1,160,206,681
Cumulative CO2 according to CCp$$W	MtCO2	387,496
Actual cumulative CO2 emissions	MtCO2	555,796
ΔCO2 emissions above CCp$$W	MtCO2	168,300
CO2→GW [4]	°C/GtCO2	0.000745443
Global Warming caused by ΔCO2	°C	0.125

Cumulative CO2 Emissions per Cumulative GDP 1990-2020

Chart 2 - Cumulative CO2 emission per cumulative GDP (CCp$$) [part 1/4]: 42 countries with CCp$$ above the world average [tCO2 per $GDP]



The green range is the world average CCp$$W = 0.0003340 tCO2/$GDP

Chart 3 - Cumulative CO2 emission per cumulative GDP (CCp$$) [part 2/4 [tCO2 per $GDP]

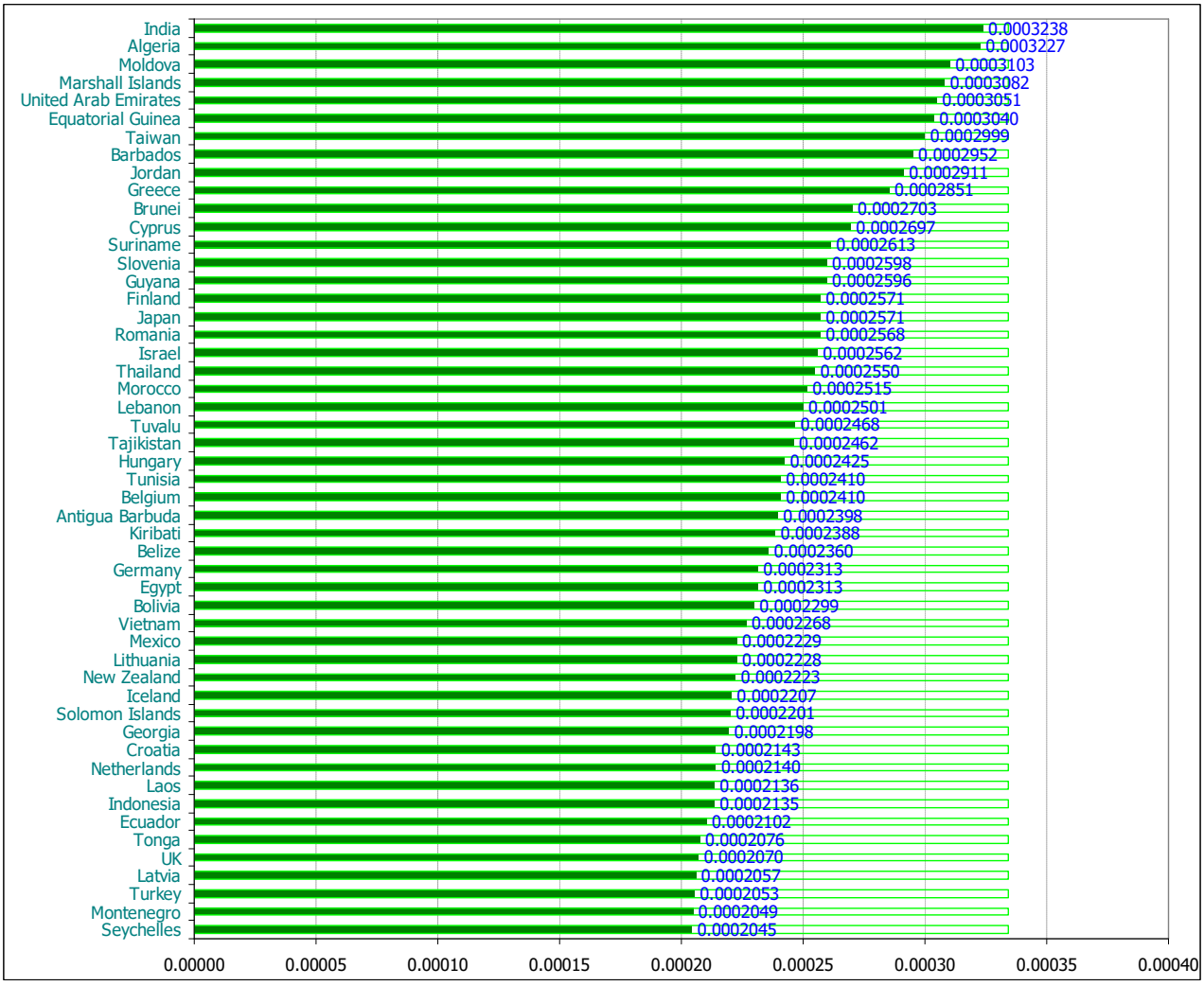


Chart 4 - Cumulative CO2 emission per cumulative GDP (CCp$$) [part 3/4 [tCO2 per $GDP]

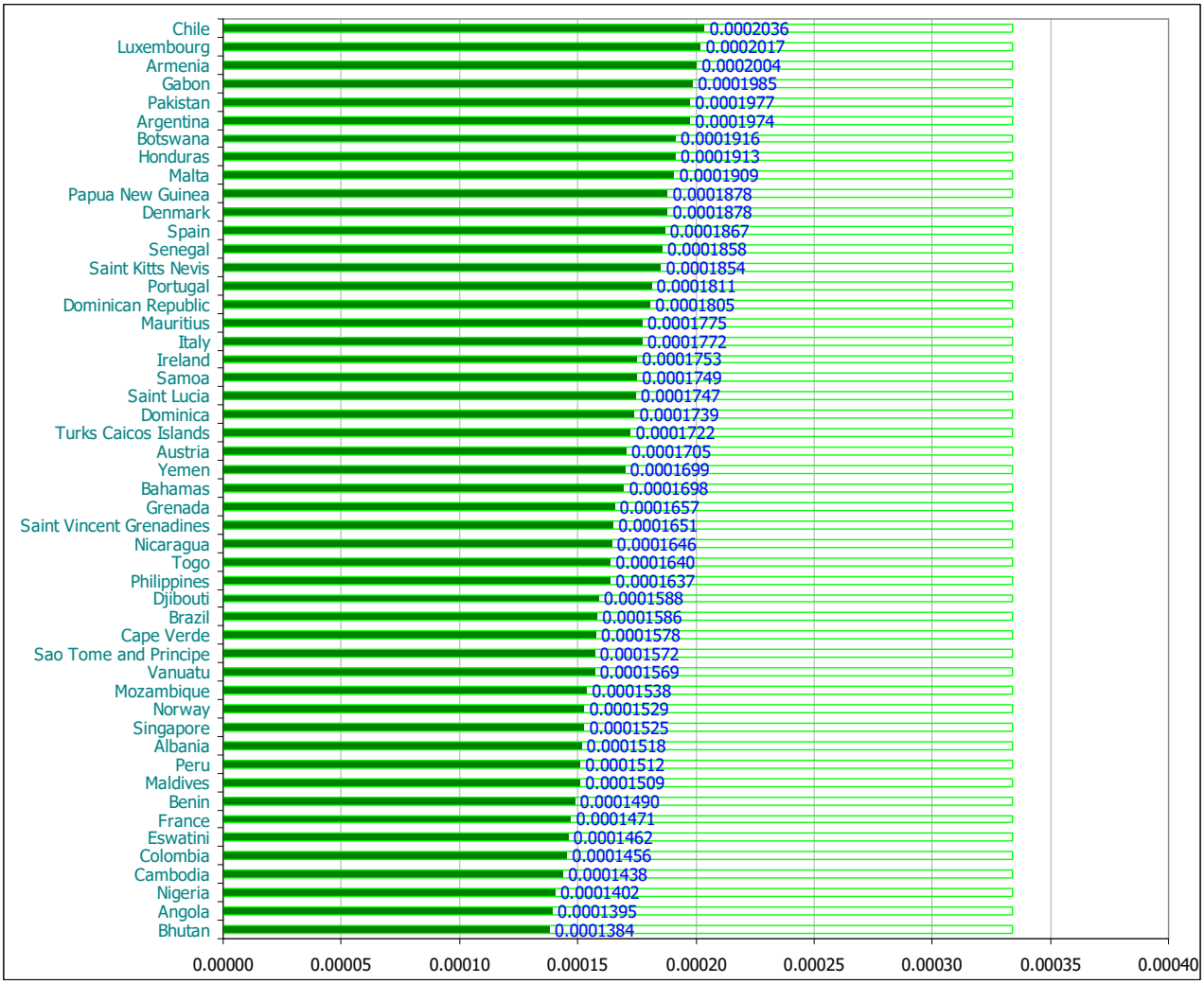
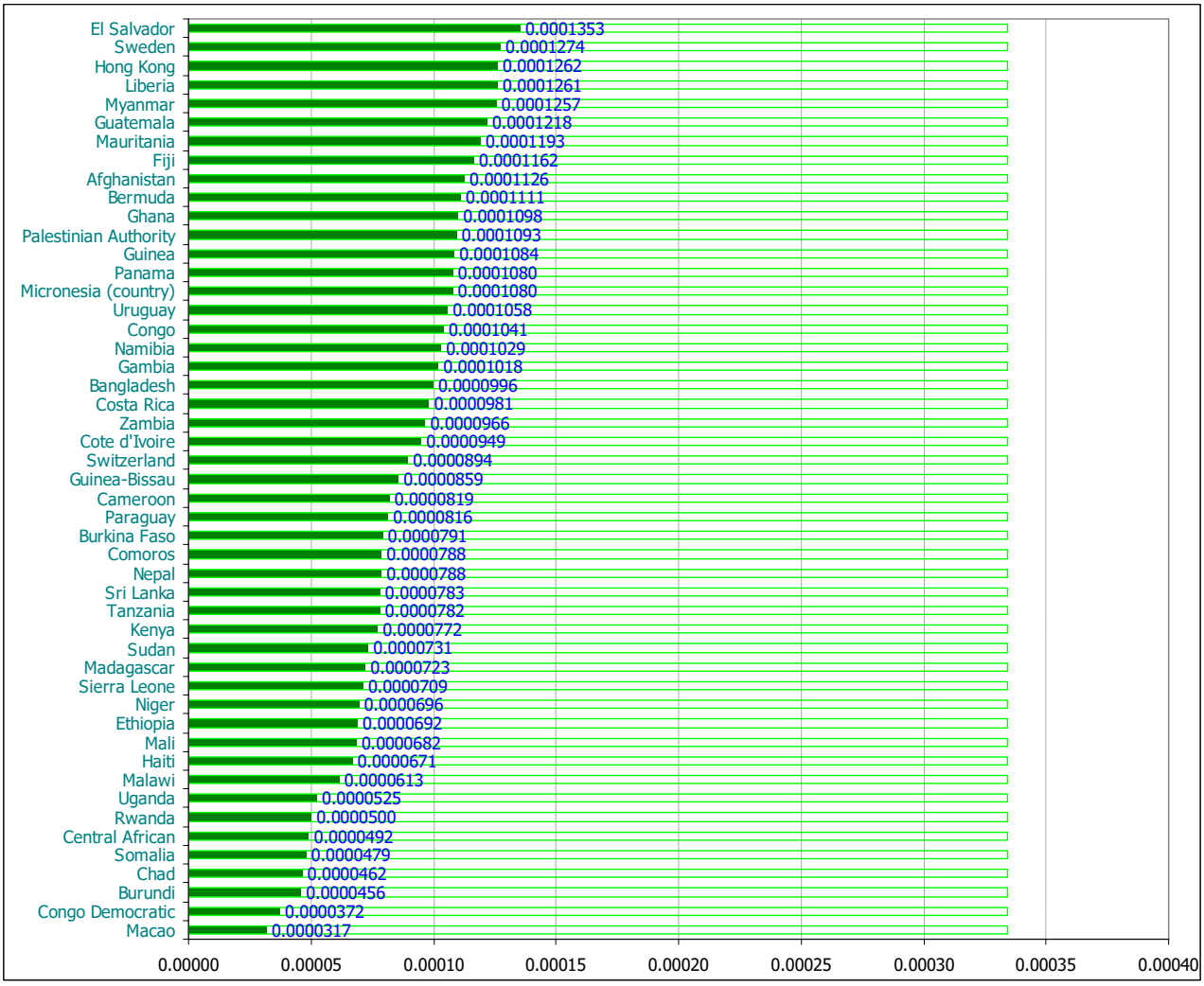


Chart 5 - Cumulative CO2 emission per cumulative GDP (CCp$$) [part 4/4 [tCO2 per $GDP]



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