Bitcoin and Global Climate Change: Emissions beyond borders

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Glossary

PoW	Proof of work
SDG	Sustainable Development Goals
MRIO	Multi-Regional Input-Output modeling
GWP	Global Warming Potential
GHG	Greenhouse gas
$I_{i,me}$	Impact of electricity generation in country i per M. Euro
$PIS_{k,i}$	Percentage of impact of energy source k in electricity generation in country i
$IS_{k,i}$	Impact of energy source k in electricity generation in country i
FEG_i	Footprint of electricity generation in country i per Kg/ kWh
CEG_i	Cost generation of 1 kWh in country i in Euro .
$GWP100_{e,i}$	GWP100 of electricity generation e in country i en Kg CO2-eqv per kWh
$ID_{i,k}$	Industrial designation or common name of Species k in country i
$GWP100_{i,k}$	Global warming potentials species k in country i
NMM_t	Average number of mining machine used per year t
$NMM_{t,k}$	Average number of mining machine used per machine type k per year t.
AH_t	Average of hashrate per year t.
MPr_k	Percentage of using machine type k
MSl_k	The service life of a machine k
H_k	Hashrate per machine type k
CMM_t	Cost of mining machines per year
$MPri_k$	Prices of mining machine type k
$CFME_t$	Carbon footprint of mining equipment per year t.
$CFME$	Footprint of mining equipment per million euro
$AECTr_{i,t}$	Annual electricity consumption per transaction in country i in year t.
$EC_{i,t}$	Annual electricity consumption for Bitcoin mining country i in year t
$Tr_{i,t}$	Total annual number transaction in country i in year t.
$ANTr_{i,t}$	Average number of transactions mined in country i in year t
$MPr_{i,t}$	Mining percentage in country i in year t
$AFECBMTr_{i,t}$	Annual carbon footprint from electricity gene consumption ration of the Bitcoin-mining in country i in year t per transaction per kWh.
$AFECBM_{i,t}$	Annual carbon footprint from electricity consumption of the Bitcoin-mining in country i in year t per kWh

Supplementary Methods

1. Introduction and Background

All 193 member states of the United Nations (UN) have adopted the Sustainable Development Goals[1] in 2015 as the organizing framework for global cooperation development from 2015 to 2030. The goals were defined considering unsatisfactory world economy and considerable progress in know-how and modern technologies. Furthermore, the world is currently experiencing environmental threats such as loss of biodiversity and global warming and increasing social and economic inequalities. Thus, the member states of the UN adopted the Sustainable Development Goals to fight the global challenges that the world is facing, such as environmental threats and increasing inequalities and social exclusion[1]. To do so, six significant transformations are needed to change the way industries and technologies are used namely (1) education, gender and inequality; (2) health, well-being and demography; (3) energy decarburization and sustainable industry; (4) sustainable food, land, water and oceans; (5) sustainable cities and communities; and (6) digital revolution for sustainable development.

One fundamental transformation should be achieved is to harness in a positive way the digital revolution. Our lives are being transformed by using emerging technologies such as internet, social media, artificial intelligence, robotics, cryptocurrencies, virtual reality, augmented reality and cloud computing.

However, these new technologies really challenge us and the idea of a transformation to a digital world that is a productive, secure, sustainable and protects our human rights does not defeat them through surveillance and loss of property, is the sixth of these great transformations. In addition, this transformation must be in line with the United Nations Sustainable Development Goals, especially goal 13 on climate action since the planet is undergoing three mega environmental crises at the moment: human-induced climate change, the massive destruction of biological diversity and the weakening of the functioning of the ecosystems, and mega-pollution in forms of air and water pollution.

Furthermore, the digital revolution includes cryptocurrencies, as one of the most promising emerging technologies. Comparable to national currencies such as the US dollar, a cryptocurrency represents a medium of exchange. However, it is digital and employs encryption techniques to control the creation of monetary units and verification of fund transfers. Cryptocurrencies have gained the attention of financial, banking, and governmental institutions. To illustrate, Mark Carney, the Bank of England Governor, said in a speech to the Inaugural Scottish Economics Conference on the future of money in March 2018[2] "bringing crypto-assets onto a level regulatory playing field could also catalyze private innovation to create a more resilient, effective payments system." Therefore, politicians and financial experts have recognized the importance and advantages of cryptocurrencies like Bitcoin the best-known cryptocurrency and the one for which Blockchain technology was invented. Owing to the growing interest, the price of Bitcoin has reached 60,000 USD[3]. According to JPMorgan[4], it is estimated that a value of 1 Bitcoin will reach 146,000 USD. In conclusion, cryptocurrencies and

Blockchain are very likely to transform the financial world fundamentally. Cryptocurrency and Blockchain applications in this ecosystem are ever-evolving technologies aiming to meet users' needs.

Bitcoin is an electronic, virtual, decentralized currency based on Blockchain technology which was established in 2009 and was created by Satoshi Nakamoto[5] (pseudonym). The Bitcoin ecosystem consists of users that establish communication online through the Bitcoin protocol, which is an open-source software application. Users employ this protocol for storing and purchasing Bitcoins. Furthermore, Bitcoins can be exchanged for other currencies and used to buy and sell goods. Bitcoins are issued on the network and the transactions occur via Bitcoin mining. Its exchange rate is characterized by high fluctuations. In January 2021, there were 18.3 million Bitcoins in circulation with a total value of roughly 730 billion US dollars[6], although the exchange rate of Bitcoins has shown very large fluctuations.

The purpose of using Blockchain in the Bitcoin platform was to bypass a central authority and instead use a trusted peer-to-peer network pseudo-anonymously to ensure the use of digital money to purchase services and goods in a secure way. Blockchain is a public ledger that involves a record of publicly announced transactions. Most importantly, all involved participants can access those transactions, which implies that the identical Blockchain copy is accessible by all of them. Blockchain functions by dividing individual transactions into published and time-stamped blocks, which cannot be reversed or modified. Any potential modification is prevented because the hash of the previous blocks is included in all upcoming blocks.

It is critical to highlight that Bitcoin and Blockchain are not supervised or controlled by any particular body, such as a governing body, centralized body, or bank. Bitcoin transactions are conducted by the mining community, which comprises individual users with mining hardware and computing power. The miners are necessary to validate, verify, and record transactions in the public Blockchain. The mining operation focuses on solving complex mathematical puzzles respecting the proof of work process. The proof of work (PoW) has a double function. First, It serves for validating a transaction. Second, miners need proof of work for earning a reward. Accordingly, there is a completion among the minors for mining a specific transaction, considering the reward is given to the user who is the first to resolve the puzzle. The number of computer calculations required for recording and verifying transactions is enormous. Moreover, the puzzles are exceptionally complex, and their complexity is gradually increasing owing to the increasing value and popularity of Bitcoins. Consequently, the demand for high-powered computer processing and electricity is also on the rise.

2. Methodology
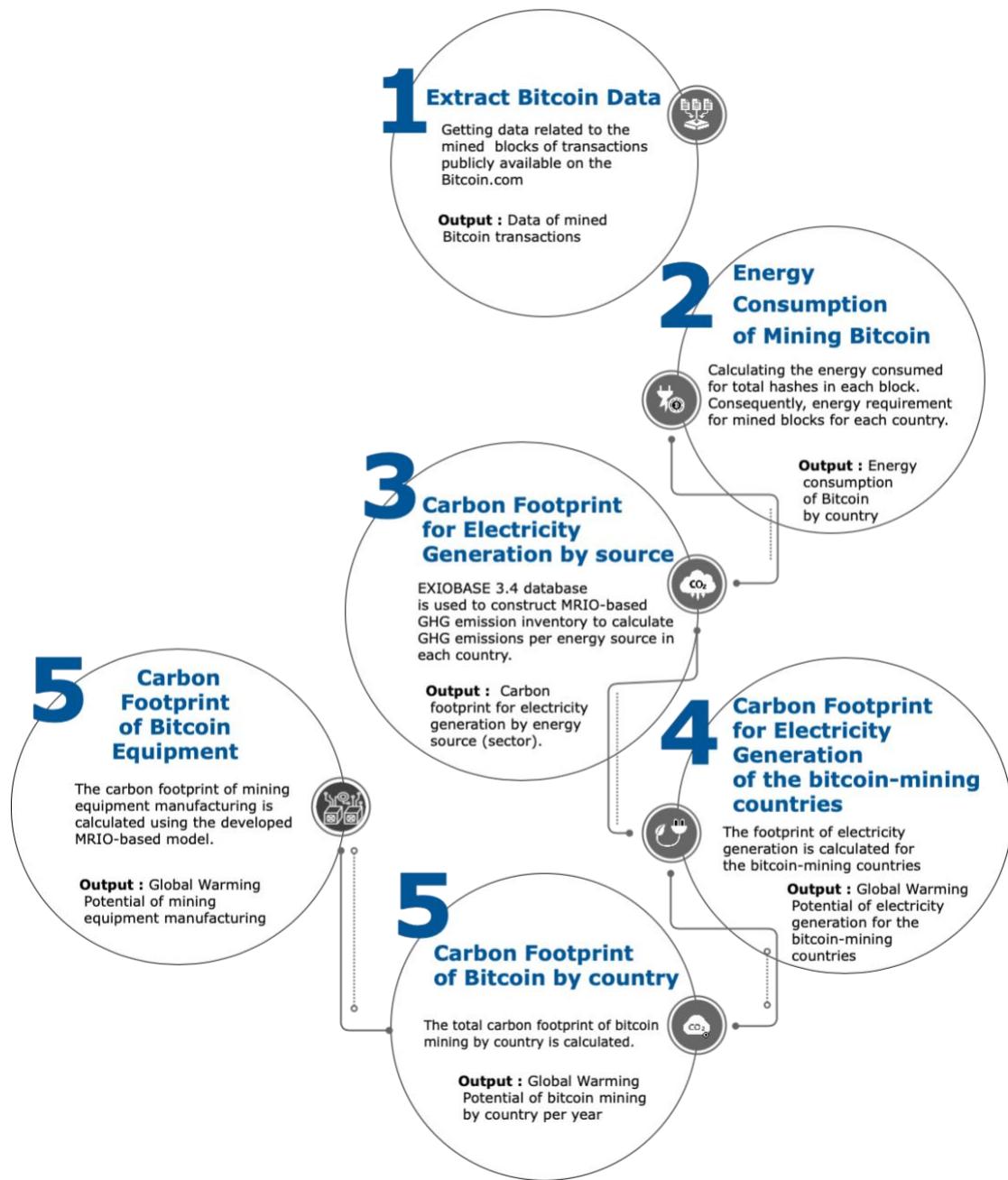
Figure 1: Methodology to estimate the carbon footprint of Bitcoin

To estimate the carbon footprint of Bitcoin, there are six main strategic steps to be followed as shown in Figure 1. The first step is to extract all the data related to the mined Bitcoin transaction publicly available on the Bitcoin website. Next, the energy consumed per total hashes in each transaction is calculated. As a result, the output of the second step is the energy consumption of Bitcoin per country per year. In the third step, the global EXIOBASE 3.4 database is used to develop a MRIO-based carbon footprint analysis and to calculate the carbon footprint of electricity generation. In the fourth step, the footprint of carbon dioxide equivalent to electricity generation calculated in the previous step is used to calculate the footprint of electricity generation by country. Next, carbon footprint of mining equipment manufacturing is calculated using the developed MRIO-based model. Finally, the two main source of carbon emissions are merged and analyzed per country, per transaction for the last 6 years. The function unit of the analysis is per transaction as, arguably, the service provided by the Bitcoin use case. While the utility of Bitcoin can also be considered as "an asset which holds value (such as gold)", the functional unit, in such case, would be significantly fluctuating (e.g. per $ value holding or per gram gold equivalent). Hence, per transaction would provide more a meaningful analysis from carbon footprint estimation perspective. However, we also provide estimations on annual basis per country, per transaction, and per country.

3. Estimation of the energy consumption of Bitcoin

The first step is to extract Bitcoin transaction data from "Bitcoin.com" (please see 3.1. to access the data). Next, we estimated the energy consumption stemming from Bitcoin mining, which is explained in detail in Section 3.2.

3.1. Extract Bitcoin Data

To access the energy consumption data by country please see the related Folder: Document\Chaptre-1\N1-Extract-Data

3.1.1. Method

The "proof-of-work" (PoW) process is used for mining Bitcoins and verifying related transactions on the network. PoW implies that through solving hard math problems, computing power has been used to mine Bitcoin in each block. The computing power requires energy consumption. Thus, for calculating this consumption, it is necessary to access data about the blocks publicly available on the Bitcoin website[7]. To perform the calculation, we proposed a script aimed at downloading all the blocks mined in a given year.

3.1.2. Results

Figure 2 shows the downloaded data of all blocks mined in a given year. The purpose of extracting data is to obtain information regarding the degree of difficulty of mining a Bitcoin block. In terms of the technical aspect, it refers to detecting a hash below a particular target. The degree of difficulty refers to the computing power need to mine the same number of blocks. The more difficult the problem, the more computing power is needed; however, the difficulty increases the security of the network against attacks. In addition, the data regarding the mining pool shows the country in which the mining process takes part.

height	version	mrkl_root	timestam	bits	nonce	hash	prev_blo	next_blo	size	pool_diffi	difficulty	tx_count	reward_b	reward_f	created_	confirmat	is_orpha	curr_max	is_sw_bl	stripped_	weight	Mining_p
556459	5E+08	3351928:	2E+09	4E+08	2E+09	0000000	0000000	0000000	728024	8E+12	6E+12	946	1E+09	5E+06	2E+09	64753	FALSE	2E+09	TRUE	629612	3E+06	BitFury
556460	5E+08	6642612:	2E+09	4E+08	2E+09	0000000	0000000	0000000	1E+06	2E+13	6E+12	3492	1E+09	2E+07	2E+09	64752	FALSE	2E+09	TRUE	923263	4E+06	AntPool
556461	5E+08	dc702d1	2E+09	4E+08	2E+09	0000000	0000000	0000000	991069	3E+13	6E+12	1608	1E+09	2E+06	2E+09	64751	FALSE	2E+09	TRUE	882179	4E+06	SlushPo
556462	5E+08	794f4fed	2E+09	4E+08	3E+09	0000000	0000000	0000000	1E+06	1E+13	6E+12	1883	1E+09	2E+07	2E+09	64750	FALSE	2E+09	TRUE	966697	4E+06	BTC.com
556463	5E+08	f761c7fb:	2E+09	4E+08	7E+07	0000000	0000000	0000000	740677	2E+14	6E+12	1560	1E+09	4E+06	2E+09	64749	FALSE	2E+09	TRUE	634798	3E+06	WAYI.CN
556464	5E+08	35e31e3	2E+09	4E+08	4E+08	0000000	0000000	0000000	688149	8E+13	6E+12	1573	1E+09	5E+06	2E+09	64748	FALSE	2E+09	TRUE	579571	2E+06	AntPool
556465	1E+09	00955d3	2E+09	4E+08	5E+08	0000000	0000000	0000000	358678	7E+12	6E+12	676	1E+09	3E+06	2E+09	64747	FALSE	2E+09	TRUE	303493	1E+06	Huobi.po
556466	5E+08	c068a78	2E+09	4E+08	1E+09	0000000	0000000	0000000	536247	3E+13	6E+12	1084	1E+09	1E+07	2E+09	64746	FALSE	2E+09	TRUE	453115	2E+06	AntPool
556467	5E+08	8128ef7e	2E+09	4E+08	2E+09	0000000	0000000	0000000	202433	6E+12	6E+12	379	1E+09	4E+06	2E+09	64745	FALSE	2E+09	TRUE	181386	746591	SlushPo
556468	5E+08	0ee1277	2E+09	4E+08	3E+09	0000000	0000000	0000000	1E+06	7E+12	6E+12	2547	1E+09	8E+06	2E+09	64744	FALSE	2E+09	TRUE	960067	4E+06	ViaBTC
556469	5E+08	93421b1!	2E+09	4E+08	2E+08	0000000	0000000	0000000	690467	1E+13	6E+12	1384	1E+09	5E+06	2E+09	64743	FALSE	2E+09	TRUE	600388	2E+06	BitFury
556470	5E+08	fe557c7	2E+09	4E+08	4E+08	0000000	0000000	0000000	848405	3E+13	6E+12	1527	1E+09	2E+07	2E+09	64742	FALSE	2E+09	TRUE	717917	3E+06	F2Pool
556471	5E+08	e33205d	2E+09	4E+08	2E+09	0000000	0000000	0000000	1E+06	2E+13	6E+12	3040	1E+09	2E+07	2E+09	64741	FALSE	2E+09	TRUE	928370	4E+06	Poolin
556472	5E+08	c8742be	2E+09	4E+08	2E+09	0000000	0000000	0000000	1E+06	6E+12	6E+12	3005	1E+09	7E+06	2E+09	64740	FALSE	2E+09	TRUE	959428	4E+06	AntPool
556473	5E+08	8197d4d:	2E+09	4E+08	1E+09	0000000	0000000	0000000	1E+06	6E+12	6E+12	3321	1E+09	2E+07	2E+09	64739	FALSE	2E+09	TRUE	920464	4E+06	Huobi.po
556474	5E+08	53a0d4e	2E+09	4E+08	2E+09	0000000	0000000	0000000	1E+06	2E+14	6E+12	1762	1E+09	3E+06	2E+09	64738	FALSE	2E+09	TRUE	979140	4E+06	SlushPo
556475	5E+08	f97787c	2E+09	4E+08	3E+07	0000000	0000000	0000000	611994	4E+13	6E+12	1212	1E+09	5E+06	2E+09	64737	FALSE	2E+09	TRUE	480726	2E+06	F2Pool
556476	5E+08	7b09233	2E+09	4E+08	2E+09	0000000	0000000	0000000	877186	6E+12	6E+12	1843	1E+09	8E+06	2E+09	64736	FALSE	2E+09	TRUE	756626	3E+06	BTC.com
556477	5E+08	9e52e81	2E+09	4E+08	3E+09	0000000	0000000	0000000	294313	2E+14	6E+12	630	1E+09	2E+06	2E+09	64735	FALSE	2E+09	TRUE	248827	1E+06	ViaBTC
556478	5E+08	9e67d58	2E+09	4E+08	4E+08	0000000	0000000	0000000	1E+06	2E+13	6E+12	2186	1E+09	7E+06	2E+09	64734	FALSE	2E+09	TRUE	921130	4E+06	BTC.com
556479	5E+08	8f8a499f	2E+09	4E+08	3E+08	0000000	0000000	0000000	1E+06	2E+13	6E+12	2094	1E+09	9E+06	2E+09	64733	FALSE	2E+09	TRUE	929719	4E+06	Huobi.po
556480	5E+08	9c68f20	2E+09	4E+08	2E+09	0000000	0000000	0000000	141952	1E+14	6E+12	317	1E+09	845556	2E+09	64732	FALSE	2E+09	TRUE	115443	488281	Poolin
556481	5E+08	f352520!	2E+09	4E+08	4E+08	0000000	0000000	0000000	642204	1E+14	6E+12	1301	1E+09	4E+06	2E+09	64731	FALSE	2E+09	TRUE	542324	2E+06	Poolin
556482	5E+08	22fed60	2E+09	4E+08	2E+07	0000000	0000000	0000000	1E+06	1E+13	6E+12	2725	1E+09	1E+07	2E+09	64730	FALSE	2E+09	TRUE	949810	4E+06	BTC.com
556483	5E+08	11c01c9(	2E+09	4E+08	9E+08	0000000	0000000	0000000	911937	7E+12	6E+12	1287	1E+09	6E+06	2E+09	64729	FALSE	2E+09	TRUE	789661	3E+06	F2Pool
556484	5E+08	947489e	2E+09	4E+08	3E+09	0000000	0000000	0000000	894476	2E+13	6E+12	1952	1E+09	1E+07	2E+09	64728	FALSE	2E+09	TRUE	751724	3E+06	DPOOL
556485	5E+08	e58eeb1	2E+09	4E+08	4E+08	0000000	0000000	0000000	361987	4E+13	6E+12	862	1E+09	3E+06	2E+09	64727	FALSE	2E+09	TRUE	312041	1E+06	ViaBTC
556486	5E+08	ab32c83	2E+09	4E+08	4E+08	0000000	0000000	0000000	1E+06	3E+13	6E+12	2800	1E+09	2E+07	2E+09	64726	FALSE	2E+09	TRUE	916609	4E+06	BTC.TOP
556487	5E+08	7583f09	2E+09	4E+08	2E+09	0000000	0000000	0000000	1E+06	2E+13	6E+12	2125	1E+09	4E+06	2E+09	64725	FALSE	2E+09	TRUE	970223	4E+06	Poolin
556488	5E+08	62f2a50	2E+09	4E+08	2E+09	0000000	0000000	0000000	402337	8E+12	6E+12	653	1E+09	2E+06	2E+09	64724	FALSE	2E+09	TRUE	330503	1E+06	ViaBTC
556489	5E+08	b5d338b	2E+09	4E+08	7E+08	0000000	0000000	0000000	907564	6E+12	6E+12	1870	1E+09	7E+06	2E+09	64723	FALSE	2E+09	TRUE	765479	3E+06	DPOOL
556490	5E+08	720e56a	2E+09	4E+08	4E+08	0000000	0000000	0000000	763862	4E+13	6E+12	1723	1E+09	6E+06	2E+09	64722	FALSE	2E+09	TRUE	645507	3E+06	unknown
556491	5E+08	2d088f14	2E+09	4E+08	2E+09	0000000	0000000	0000000	366121	2E+13	6E+12	748	1E+09	2E+06	2E+09	64721	FALSE	2E+09	TRUE	291021	1E+06	Huobi.po
556492	5E+08	5fd9d99	2E+09	4E+08	2E+09	0000000	0000000	0000000	1E+06	3E+15	6E+12	2330	1E+09	1E+07	2E+09	64720	FALSE	2E+09	TRUE	952794	4E+06	Poolin

Figure 2: Screenshot of the data extracted from Bitcoin.com

3.2.   Energy consumption of Bitcoin

To access the energy consumption data by country please see the related Folder: Document\Chaptre-1\N2-EnergyConsumptionOfCountries

3.2.1.   Method

This section shows the steps required for estimating the energy consumption needed to mine Bitcoin.

Step 1: Load Data:

To perform analysis, three sources of data were used.
- _Source One:_ We used the following load databases that include all blocks per year. Those data were used to conduct calculations shown previously.

- _Source Two:_ We followed Bendiksen et al.[8,9] to adopt the equipment types used in the analysis, as those authors noted that approximately 80% of miners used Antminer S9 for modeling, followed by 7.6.% and 6.7% of miners who used Avalon 841 and Ebang E 10, respectively. The remaining 5.8% used other machines for modeling. Those three types of mining hardware are shown in Table 1 along with the metrics required for calculating the energy consumption.

Table 1. List of Bitcoin processing hardware and their electricity consumption

Mining Hardware	Hash Rate (Ghash/s)	Consumption (GWh)	Energy Efficiency (Mhash/J)	References
AntMiner S9	14,000	1.38E-06	10.448	10
Avalon821	11,000	1.2E-06	9.167	10 , 11, 12
Ebit E10	18,000	1.62E-06	11.111	10 , 11, 12

Table 1 shows the hash rate (Ghash/s), Consumption, (GWh), Energy Efficiency (Mhash/J), and references for AntMiner S9, Avalon 821, and Ebit E10. It can be seen that the lowest hash rate is for Avalon 821 (11 000 Ghash/s) and the highest rate for Ebit E10 (18 000 Ghash/s).

- *Source Three:* we use the list of companies doing mining and the CO_2 emissions of electricity generation in their claimed countries proposed by Mora et al[10]. Table 2 shows the list of companies engaged in mining Bitcoin and claiming blocks, the place where they are located, and the amount of CO2e emitted in those places. It can be seen that the majority of the companies are located either in China or in the US, depending on their server location. However, a significant number of companies also operate globally. This Table shows the values of CO_2 emissions of electricity generation in the countries where mining takes place, although it does not show where the actual Bitcoin computing occurs.

Table 2. List of companies doing mining Bitcoin

Mining pool	Known Server Location	CO_2 -eqv. /GWh(Tons)	Carbon/GWh(Tons)	Mining pool website
1Hash	China	661.73	180.4554	http://www.1hash.com/
AntPool	China	661.73	180.4554	https://antpool.com
BATPOOL	China	661.73	180.4554	https://www.batpool.com/
BCMonster	U.S., China	580.04	158.1783	http://www.bcmonster.com/
BitClub Network	U.S.	498.34	135.8986	https://bitclubnetwork.com
Bitcoin.com	Global	573.86	156.493	https://pool.Bitcoin.com
Bitfury	Georgia, Finland, Iceland	132.6	36.16035	http://www.bitfury.org/
BitMinter	U.S., E.U.	414.46	113.0243	https://bitminter.com
BTC.com	China	661.73	180.4554	https://pool.btc.com
BTC.TOP	China	661.73	180.4554	http://btc.top/
BTCC	China	661.73	180.4554	https://pool.btcc.com/
BW Pool	China	661.73	180.4554	https://www.bw.com
Canoe Pool	U.S.	498.34	135.8986	https://www.canoepool.com
ConnectBTC	China	661.73	180.4554	https://www.connectbtc.com/#
DiscusFish / F2Pool	U.S., China	580.04	158.1783	http://www.f2pool.com
Eligius	U.S.	498.34	135.8986	http://eligius.st
EXX & BW	China	661.73	180.4554	https://xbtc.exx.com/
GBMiners	India	706.44	192.6479	http://52.66.51.105/
GoGreenLight	Sweden	60.32	16.44941	http://www.gogreenlight.se/
HaoBTC	China	661.73	180.4554	https://haobtc.com/
Kano CKPool	Global	573.86	156.493	http://www.kano.is
MMPool	Global	573.86	156.493	http://mmpool.org
NA	Global	573.86	156.493	ForBlocksWithNoCompany
NiceHashSolo	Global	573.86	156.493	https://solo.nicehash.com/
P2Pool.org	Global	573.86	156.493	http://p2pool.org
Slush	Global	573.86	156.493	https://mining.Bitcoin.cz
Solo CKPool	Global	573.86	156.493	http://solo.ckpool.org
Telco 214	U.S.	498.34	135.8986	http:///www.telco214.com/
ViaBTC	China	661.73	180.4554	http://www.viabtc.com/

Step 2: Energy consumption of Bitcoin:

After loading the data, we first converted the unit so all the data are in the same metrics level. After that, we merged all the information and then calculated the energy consumed per total hashes in each block. Consequently, we estimated carbon emissions from the given block in tons of Carbon. Finally, we displayed the result per country based on the server location as illustrated in Figure 3.

```python
for i in range(iterations):
    efficiencies = processors_df.sample(n=merged_df.shape[0]  ,replace=True).reset_index()
    #pd.DataFrame(efficiencies).to_csv("C:/Users/LENOVO/Desktop/Datasource/efficienciesTest1.csv")
    simulation_df = pd.concat([merged_df, efficiencies],axis=1)

    # Energy consumed
    simulation_df["TotalGwhInBlock"] = (simulation_df["Hashes"] / simulation_df["HashesPerJ"]) * (2.78 * (10 ** -13))
    simulation_df["TotalTwhInBlock"] = simulation_df["TotalGwhInBlock"] / 1000
    # Carbon-dioxide gas emitted
    simulation_df["CarboninGtnForBlock"] = simulation_df["TotalGwhInBlock"] * simulation_df["TonsOfCarbonPerGWh"] / (10 ** 9)
    # Energy consumed per total hashes in each block
    simulation_df["EnergyPerHashes"] = simulation_df["TotalGwhInBlock"] * (10**9) / simulation_df["Hashes"]

    total_carbon_emissions = simulation_df["CarboninGtnForBlock"].sum()
    emissions.append(total_carbon_emissions)
    total_energy_consumptions = simulation_df["TotalTwhInBlock"].sum()
    energy_consumptions.append(total_energy_consumptions)

    grouped_df = simulation_df.groupby(["Known_Server_Location"])
    #pd.DataFrame(grouped_df).to_csv("C:/Users/LENOVO/Desktop/Datasource/groupedTest2.csv")
    grouped_df = grouped_df.sum()

    #pd.DataFrame(grouped_df).to_csv("C:/Users/LENOVO/Desktop/Datasource/groupedTest2.csv")
    emissions_energy_per_country.append(grouped_df[["CarboninGtnForBlock","TotalTwhInBlock", "EnergyPerHashes"]].reset_index(drop=False))
```

Figure 3: Screenshot of the source code that energy consumption of Bitcoin

3.2.2.   Results

In Table 3, the energy consumption used for Bitcoin mining is provided as well as the percentage of mean energy per country. The mean and standard deviation of the energy consumption for 1,000 iterations in 2020 were 55.575156623000346 TWh/yr +/- 0.026148636138702892. Moreover, Table 3 is in line with Table 2, demonstrating that the vast majority of consumed energy occurred in China, followed by the US. More precisely, China consumed 42.207 TWh, which comprises more than 75% of the total energy consumed. The next biggest consumer is the US with 8.954320183 TWh/yr, which is approximately 16.1% of total consumption. Comparably, unknown servers consumed 3.958248079 TWh/yr, which is almost 7%.

Table 3. Energy consumption by country for 2020

Years	Energy consumption TWh	Percentage Consumption (%)
China	42.20706448	75.945
Finland	0.151841293	0.273
Georgia	0.151841293	0.273
Unknow Servers	3.958248079	7.122
Iceland	0.151841293	0.273
U.S.	8.954320183	16.112
Total	55.57515662	100

The total global annual consumption of energy is shown in Table 4, confirming the results of Köhler, Susanne, and Massimo Pizzol[9] (31,29 TWh/yr) and of Alex de Vries[13] (22−67 TWh/yr). It shows a constantly increasing trend from 2015 when the total energy consumption was 0.152 TWh. However, a striking increase has occurred starting from 2018. To illustrate, the total consumption in 2017 was 4.97 TWh, and it dramatically increased to 22.462 TWh in 2018, 38.907 TWh in 2019, and 55.57 TWh in 2020. It is expected that this trend will continue in the upcoming years.

Table 4. Global annual energy consumption of Bitcoin

Years	Energy consumption TWh
2015	0.15209092427180862
2016	1.2281897287226884
2017	4.976362706069375
2018	22.46275130593014
2019	38.90745271604894
2020	55.575156623000346

4. Estimation of the Carbon Footprint of Bitcoin

Related Folder: Document\Chaptre-2\ N1-MRIO-LCSAModel

4.1. Carbon Footprint for Electricity Generation by sector

4.1.1. Method

The calculation of a carbon footprint occurring from electricity generation by Bitcoin-mining countries is estimated using EXIOBASE 3.4[14]. Electricity can be generated using nuclear power, wind, gas petrol, and coal, but also other resources. Thus, It is important to determine which resource a particular country uses in order to estimate its carbon emissions from electricity generation as each source has different emission intensity per kWh of electricity generation. The global EXIOBASE 3.4 database[14] was selected because it comprises numerous social, economic, environmental, and sustainability factors related to electricity generation by source, encompassing the supply-chain of the electricity genearion by source, by country, and by industrial sector. It provides a time series of symmetric multinational input-output tables encompassing 43 countries, 5 rest of the world regions, and 163 industries, covering approximately the entire global economy. These tables are based on raw data obtained from Eurostat, Comtrade, UN System of National Accounts, and national agencies[15]. Stadler et al. [15] provide a comprehensive discussion on methodological aspects of MRIO. The MRIO model is constructed as by using Leontief's inverse formula to show inputs and outputs:

Equation 1: Leontief's inverse formula

$$X = (I-A)^{-1} * y$$

Where, an output vector, x, represents a function of I, A, and y; y denotes the column vector of the total demand (in M. Euro), A denotes the input/output coefficient matrix (in M. Euro/M. Euro), I denotes the identity matrix, and x denotes the column vector of total output (in M. Euro). The term $(I-A)^{-1}$ is the Leontief inverse, where L represents the total requirements matrix. In the direct

requirement matrix of A, each element represents the total inputs necessary to fabricate one output unit per sector.

This relationship, socioeconomic factors (e.g., value-added tax, income, employment rate, and tax), and sector-specific environmental satellite factors (e.g., resource use, carbon emissions, water consumption, energy use) were analysed in a global MRIO model to access impacts related to an output unit of a given sector and indirect impacts of the global supply chains of the industry. We used the total requirement matrix to perform this analysis. In Equation (2), a B represents a vector of social, economic, and environmental impacts created per industry per economic output unit (M. Euro):

Equation 2: Environmental, economic and social impacts per industry per economic output unit (M. Euro)

$$B = E * (diag(x)) - 1$$

Here, the totals are denoted with x (in M. Euro) and E represents the satellite accounts. Thus, B represents the matrix of intensities per M. Euro. With diagonal, I shows that it is necessary to diagonalize the vector x. We multiplied B of Equation (1) by L and y to obtain Equation (3) as follows:

Equation 3: Quantification of the direct and indirect social, economic and environmental impacts sectors

$$r = BLy$$

In this Equation, we multiplied by B (intensity matrix per unit of output) to calculate the r vector. Subsequently, we multiplied the r factor by y (the total output of each sector (final output vector)). After that, we used the r vector to quantify both direct and indirect environmental, economic, and social impacts per sector. Finally, we calculate the carbon footprint impacts of the regional and international supply chains. A powerful Python programming language was used to carry out all matrix operations of big matrix data and sectorial multipliers for ten energy sources are listed in Table 5.

Table 5. Electricity production by source

Source	Unit
Electricity by coal	TJ
Electricity by gas	TJ
Electricity by nuclear	TJ
Electricity by hydro	TJ
Electricity by wind	TJ
Electricity by petroleum and other oil derivatives	TJ
Electricity by biomass and waste	TJ
Electricity by solar photovoltaic	TJ
Electricity by solar thermal	TJ
Electricity by tide, wave and ocean	TJ
Electricity by Geothermal	TJ

4.1.2. Results

Figure 4 shows a screenshot of the part generated file. Figure 4 displays the GHG emissions per Million Euro output of each electricity sector provided in Table 5 for each mining country. Figure 4 shows an example output of this step.

For all result of this step please see;

Related Folder: Document\Chaptre-2\N1-MRIO-LCSAModel

Abreviation	Sector	CO2 - combustion - air(air-kg)	CH4 - combustion - air(air-kg)	N2O - combustion - air(air-kg)
CN	Electricity by coal	24118847.76	255.7464318	841.3677882
CN	Other Bituminous (	262125.0284	4.337452792	8.155646963
CN	Basic iron and steel	81923.84043	12.45610171	0.477637363
CN	Steam and hot wate	24828.79037	0.495026713	0.839828438
CN	Other non-metallic	11248.44819	0.248067262	0.162817433
CN	Coke Oven Coke	10052.67771	1.659153646	0.249724094
CN	Rubber and plastic	9672.216859	1.008277706	0.01398232
CN	Air transport servic	7025.701142	0.161808632	0.273299967
CN	Chemicals nec	5966.967248	0.644660034	0.07700643
CN	Coking Coal	5480.276696	0.090683597	0.170510997
RU	Other Bituminous (	5399.188529	0.074845764	0.08306013
CN	Other business serv	5211.830486	0.851275328	0.048797387
CN	Supporting and aux	5151.508507	0.598559199	0.086737968
CN	Sea and coastal wat	4886.710154	0.444831238	0.017808327
CN	Crude petroleum ar	4851.92831	1.374437205	0.025146993
ID	Sub-Bituminous Co	4345.455751	0.045461989	0.067515718
CN	Inland water transp	3813.756388	0.356606836	0.070066695
CN	Electricity by gas	3557.976173	1.944614425	0.006345521
CN	Railway transportat	3538.292057	0.202735213	0.068570079

Figure 4: Screenshot of the part generated file that contains greenhouse gas emissions caused by electricity generation in China (The table involves all the global supply-chain sectors involved electricity generation in China)

4.2. Carbon Footprint for Electricity Generation of the Bitcoin-mining countries

4.2.1. Method:

The purpose of this part was to estimate the footprint by calculating the Global Warming Potential (GWP). It measures how much energy the emissions of 1 ton of a gas will absorb over a given period, relative to the emissions of 1 ton of carbon dioxide (CO_2).

In China, 65% of electricity generation in 2019 came from coal[16,17], as shown in Table 6. All the other sources of power account for considerably lower amounts of total electricity generation. The electricity from hydroelectric power plants accounts for 17%. However, it is important to note that China has gradually increased the amount of electricity from renewable resources, such as wind power (5.4%), solar power (3%), and biomass (1.4%). The total Chinese renewable capacity in 2020 was 850 GW.

We multiplied the impact of each source by the percentage to calculate the impact of electricity generation using the following Equation (4):

Equation 4: Impact of electricity generation in country I per M. Euro

$$I_{i,me} = \sum_{k=0}^{n} (PIS_{k,i} \times IS_{k,i})$$

Where $I_{i,me}$ is impact of electricity generation in country i per M. Euro. $PIS_{k,i}$ is the percentage of impact of energy source k in electricity generation in country i. $IS_{k,i}$ is the impact of energy source k in electricity generation in country i.

In the case of China, the carbon footprint of electricity generation is calculated by following Equation (5)

Equation 5: Impact of electricity generation in China per M. Euro

$$I_{China,me} = 0{,}646 \text{ X } IS_{Coal,China} + 0{,}033 \text{ X } IS_{N.Gas,China} + 0{,}046 \text{ X } IS_{Nuclear,China} + 0{,}171 \text{ X } IS_{Hydro,China} + 0{,}054 \text{ X } IS_{Wind,China} + 0{,}03 \text{ X } IS_{Solar,China} + 0{,}014 \text{ X } IS_{Biomass,China} \cdot$$

Table 6: Electricity Generation by the energy source in China

Source of electricity	Electricity generation (%)
Coal	64.6%
Hydro	16.90%
Wind	5.40%
Nuclear	4.60%
Natural gas	3.30%
Solar	3%
Biomass	1.40%
Pumped storage hydro	0.40%
Other thermal	0.30%

Next, we multiplied the carbon footprint of electricity generation per M. Euro by the cost of electricity generation to calculate the footprint by equivalent carbon dioxide using the EXIOBASES's MRIO model through the following Equation (6):

Equation 6: Footprint of electricity generation in Country I per Kg/ kWh

$$FEG_i = I_{i,me} \times CEG_i \times 10^{-6}$$

Where FEG_i is footprint of electricity generation in country i per $Kg/\ kWh$ $I_{i,me}$ is the impact of electricity generation in country i per M. Euro. CEG_i is the cost generation of 1 kWh in country i in Euro .

Producer prices of electricity ($2015 constant dollar) are shown in Table 7; we deducted tax and profit margin values from 2015. The prices are collected from multiple sources[18,19]

Table 7: Costs of generating electricity by countries in Euro

Country	India	China	USA	Finland	Sweden	Iceland	Georgia
Price in Euro	0.02	0.05	0.075	0.144	0.128	0.088	0.04

Global Warming Potentials (GWP) can be calculated by multiplying the impact metric in columns 6, 7, and 8, which show the combustion of CO_2, CH_4, and N_2O in air, respectively, with the Global Warming Potentials presented by the UN Climate Change[20] and illustrated in Table 8.

Table 8: Global Warming Potentials (IPCC Second Assessment Report)

Industrial designation	Chemical formula	GWP values for X-year time horizon		
		20 years	100 years	500 years
Carbon dioxide	CO_2	1	1	1
Methane	CH_4	56	21	6.5
Nitrous oxide	N_2O	280	310	170

GWP values of electricity generation in China for the 100-year period is calculated following the Equation (7):

Equation 7: Global Warming Potentials of electricity generation in country I per

$$GWP100_{e,i} = \sum_{k=0}^{n} ID_{i,k} \times GWP100_{i,k}$$

Where $GWP100_{e,i}$ is GWP100 of electricity generation e in country i en Kg CO2-eqv per kWh. $ID_{i,k}$ is Industrial designation or common name of Species k in country i. $GWP100_{i,k}$ is global warming potentials species k in country i.

The GWP$_{100}$ for the other countries such as the U.S, India, Iceland, Finland, Sweden, and Georgia is calculated using the same methodology using the information:

a) USA

In the U.S, electricity is primarily generated by fossil fuels. In 2019, natural gas accounted for approximately 38% of electricity generation in the U.S[21]. Electricity is generated from natural gas using gas turbines and steam turbines. Natural gas is followed by coal as the energy source, accounting for one-quarter of electricity generation as illustrated in Table 9. The majority of coal-fired power plants operate on steam turbines, whereas a minority first convert coal to gas to be further used in gas turbines. The third-largest energy source, nuclear energy, operating on the principle of nuclear fission, also employs steam turbines to generate electricity. Different renewable resources generate approximately 17% of electricity in the US. 7.3% of electricity is generated via wind power, followed by hydropower (7.3%) and solar power (1.8%). Moreover, the electricity generation in the US also uses petroleum as a source (1%). More precisely, petroleum coke and residual fuel oil generate electricity via steam turbines, whereas in the case of diesel fuel oil, electricity is generated using diesel-engine generators. In addition, it is also possible to burn distillates and residual fuel oil in gas turbines.

Table 9: Electricity Generation by the energy source in USA

Source of electricity	Electricity generation (%)
Natural gas	38.4%
Coal	23.5%

Nuclear	19.7%
Wind power	7.3%
Hydro	6.6%
Solar	1.8%
Biomass	1.4%
Petroleum	0.5%
Geothermal	0.4%
Other	0.4%

a) India

India is both the third global largest producer and consumer of electricity. In November 2020, the capacity of the Indian national electric grid was 374.2 GW[22]. Table 10 shows that electricity generated from coal accounts for more than one half of Indian total electricity production. However, India also generates a significant amount of electricity from renewable resources. 12.2% of electricity generation is conducted by large hydro power plants, followed by wind power (10.2%), solar power (9.7%), gas (6.7%), and biomass (2.8%).

Table 10: Electricity Generation by the energy source in India

Source of electricity	Electricity generation (%)
Coal	53.4%
Large Hydro	12.2%
Wind Power	10.2%
Solar	9.7%
Gas	6.7%
Biomass	2.8%
Nuclear	1.8%
Lignite	1.7%
Small Hydro	1.3%
Diesel	0.1%

b) Georgia

A total primary energy supply (TPES) in Georgia was 4.793 Mtoe in 2016[23], whereas electricity generation was 11.5 TWh. Remarkably, natural gas is the main energy source of electricity generation in Georgia accounting for 43%, which is followed by oil (26%), hydropower (16%), and Biofuels (9%). The electricity from Coal plants accounts for 6% as shown in Table 11.

Table 11: Electricity Generation by the energy source in Georgia

Source of electricity	Electricity generation (%)
Natural gas	43%
Oil	26%
Hydroelectric	16%
Biofuels and waste	9%
Coal	6%

c) Iceland

Iceland[24] is a unique country in the world as it uses a variety of renewable resources to meet all its needs for electricity (99.99%), considering that only 0.01% of its total energy generation comes from fossil fuels. The most important energy source is hydropower (71.03%), followed by geothermal sources (28.91%). In addition, Iceland also invests in wind power (0.04%) as illustrated in Table 12.

Table 12: Electricity Generation by the energy source in Iceland

Source of electricity	Electricity generation (%)
Hydro power	71.03%
Geothermal	28.91%
Wind Power	0.04%
Fossil fuels	0.01%

d) Sweden

Sweden is among the countries that are leaders in a low-carbon economy[25]. Among 30 members of the International Energy Agency (IEA), it had the second-lowest CO_2 emissions per capita and per GDP in 2017. Sweden is a signatory to the Energy Agreement and Climate Framework and its deadline for becoming a net-zero carbon economy in 2045. Its primary resources of electricity generation are nuclear power and hydropower. In 2019, hydropower accounted for 39.3% (65 TWh) of electricity generation, which is comparable to nuclear power with 39.1% (TWh). Moreover, wind power contributed with 12.1% (19.9 TWh) as shown in Table 13.

Table 13: Electricity Generation by the energy source in Sweden

Source of electricity	Electricity generation (%)
Hydro power	39.3%
Nuclear	39.1%
Wind Power	12.1%
Other	9.5%

e) Finland

The Finnish electricity sector depends on cogeneration and import from Sweden (23.3%), forest industry black liquor and wood consumption, and nuclear power. In 2019, electricity generation[26] from two power plants at the shores of the Baltic sea accounted for 26.6% of the total production. In addition, electricity generation from hydropower accounted for 14.3%, followed by wood (13%) and wind power (7%) as illustrated in Table 14.

Table 14: Electricity Generation by the energy source in Finland

Source of electricity	Electricity generation (%)
Nuclear	26.60%
Imports	23.30%
Hydro	14.30%
Wood	13.00%
Wind Power	7%
Coal	4.90%

Gas	4.50%
Peat	3.30%
Other	2.70%
Oil	0.30%
Solar	0.20%

4.2.2. Results

Table 15 shows total GWP100 per kWh of electricity generation in each Bitcoin mining country. This estimation includes the entire global supply-chain of electricity generation sectors in the associated countries thus providing a comprehensive estimate.

Table 15: GWP kWh of Electricity generation sector for Bitcoin-mining countries

Countries	GWP100 (gram CO_2-eqv per kWh)
China	822.1
USA	653.135
India	882.203
Finland	379.934
Georgia	83.129
Iceland	17.353

4.3. Carbon Footprint of Bitcoin Equipment

4.3.1. Method

To estimate the carbon footprint indicators caused by the production of mining equipment per Million Euro Market, MRIO process for "Office machinery and computers (30)" in China was selected. Because, all the machines are produced in China. Thus, in order to estimate the average cost of the Mining Equipment production each year, we calculated the average Hashrate used in the Bitcoin network to determine the number of equipment used.

i. Mining Equipment specification:
According to Bendiksen et al.[8,9], 79.9% of miners used Antminer S9 for modeling, followed by 7.6.% and 6.7% of miners who used Avalon 841 and Ebang E 10, respectively. The remaining 5.8% used other machines for modeling, as shown in Table :
- **Antminer S9** : Different versions and batches of Antminer S9s are available. However, it is not possible to know the exact distribution of these batches and versions. Therefore, the specifications of the only version currently available for sale were taken. They are of the Antminer S9i, which has four different batches. Assuming that all batches are on the market with an equal share, this leads to specifications of 13.75 TH/sec, 1321.25 W, and 4.2 kg.17
- **Avalon 841** : The specifications of the Avalon 841 are 14 TH/sec, 1290W, and 5.2kg.18
- **Ebang E10**: The specifications for the Ebang E10 miner are 18 TH/sec, 1650W, and 9.8kg.19
- Other machines: To obtain the same numbers for the remaining machines, a distribution had to be determined, which is shown in Table 16.

Table 16: Distribution of other mining equipment in this study

Machine	Share	Hashrate [TH/s]	Price ($)
Total	100.000%		
Bitfily	0.578%	24.5	400
Bitfury Tardis	0.578%	80	2000
Antminer S15	11.561%	28	1700
Avalon 921	43.353%	20	290
GMO Mining B2/B3	9.249%	24	2000
DragonMint T1	14.451%	16	2729
Innosilicon T2 Turbo	5.780%	24	1300
MicroBT's Whatsminer M10	14.451%	33	2300

Thus, we determined following specifications of other machines:
- The hash rate is 23.26 TH/s.
- The electricity consumption is 1836.6 W.
- The average cost is $1323. The average cost multiplied by 0.8 to estimate an average producer price in $2015 dollar. Assuming that 20% of the sale price is for profit and taxes.

ii.   Average hash rate in the Bitcoin platform per year

We calculated the average hash rate in the Bitcoin platform per year, as shown in the Table 17.

Table 17: Average hash rate in the Bitcoin platform per year

Year	Average hash rate TH/s
2015	405341
2016	1,532,974
2017	6,306,453
2018	36,403,242
2019	67,023,852
2020	119,864,038

i.   Number of mining machine per year

The number of equipment used for Bitcoin mining per years can be calculated following Equation (8):

Equation 8: Number of mining machine used per year

$$NMM_t = \sum_{k=0}^{n} NMM_{k,t} = \sum_{k=0}^{n} (AH_t \times MPr_k)/(MSl_k \times H_k)$$

Where, NMM_t is the average number of mining machine used per year t. $NMM_{t,k}$ is the average number of mining machine used per machine type k per year t. AH_t is average of hashrate per year t. MPr_k is the percentage of using machine type k. MSl_k is the service life of a machine k. H_k is the hashrate per machine type k.

The amount of equipment that is produced and hence needs to be disposed of is approximated using machine lifetime. According to Digiconomist[27]. Bitcoin mining equipment has an average lifetime of 1.5 years.

Par example for 2020 the estimated number of mining machine is
NMM_t = (119,864,038 X 0.79)/ (1.5 X 14) + (119,864,038 X 0.076) / (1.5 X 11) + (119,864,038 X 0.067) / (1.5 X 18) + (119,864,038 X 0.058) / (1.5 X 23.26)
NMM_t= 8414011 machines.

ii.   Cost of mining machine per year

The cost of the machine used for Bitcoin mining is calculated following Equation (9):

Equation 9: Cost of machine used for Bitcoin mining per year.

Cost of mining machine per year = $\sum_{k=0}^{n} NumberOfMachineUsed * Price\ Of\ Machine * 0.8$

$$CMM_t = \sum_{k=0}^{n} NMM_{t,k} \times MPri_k \times 0.8$$

Where, CMM_t is the cost of mining machines per year t. $NMM_{t,k}$ is the average number of mining machine used per machine type k per year t. MPr_k is the prices of mining machine type k.

iii.   Carbon footprint of mining equipment

The carbon footprint of mining equipment is calculated following the Equation (10):

Equation 10: Carbon Footprint of Mining Equipment per Year

$$CFME_t = CMM_t \times CFME$$

Where $CFME_t$ is the carbon footprint of mining equipment per year t. CMM_t is the cost of mining machines per year t. $CFME$ is the footprint of mining equipment per million euro.

4.3.2. Results

Table 18: Carbon Footprint of Mining Equipment

Years	Carbon Footprint of Mining Equipment Per Transaction (gCO$_2$-eqv.)	Total Carbon Footprint of Mining Equipment (Mt gCO$_2$-eqv.) Per year
2015	0.50	0.022885524
2016	1.09	0.089343288
2017	3.11	0.321840044
2018	23.84	1.947067268
2019	30.50	3.661283543
2020	53.36	6.006096182

4.4. Carbon Footprint of Bitcoin energy consumption by country

4.4.1. Method

a) Average electricity consumption per transaction

For estimating carbon footprint of a Bitcoin-mining in each the countries, It is required to calculate the average energy consumption per transaction. To do this, we followed Equation (11), where the total energy used in Bitcoin mining a given year is divided by the number of transactions in the same year.

Equation 11: Average energy consumption per transaction

$$AECTr_{i,t} = \frac{EC_{i,t}}{Tr_{i,t}}$$

Where, $AECTr_{i,t}$ is annual electricity consumption per transaction in country i in year t. $EC_{i,t}$ is the total annual electricity consumption for Bitcoin mining country i in year t. $Tr_{i,t}$ is total annual number transaction in country i in year t.

Table 19 shows the number of transactions mined per year; there were 120,034,648 transactions mined in 2019.

Table 19: The number of transactions mined per year

Years	Number of Transaction mined

2015	45,343,445
2016	81,967,153
2017	103,593,217
2018	81,685,231
2019	120,034,648
2020	112,552,302

As an example, we calculate the average energy consumption per transaction for 2019
Based on Table 4, the energy consumption consumed by the miners in 2019 is 38.90745272 (TWh).

Accordingly, we calculated the average energy consumption per transaction for 2019 as follows:
$AECTr_{total,2019}$= 120034648 / 38.90745272
$AECTr_{total,2019}$= 3.24135E-07 (TWH) per transaction
$AECTr_{total,2019}$= 324.14 (kWh) per transaction

b) Average number of transactions mined in the mining countries:

We used Equation (12) to calculate the average number of transactions mined per country.
Accordingly, the total number of the transactions mined in a given year was multiplied by the percentage of energy consumed for mining Bitcoin:

Equation 12: Average number of transactions mined per country

$$ANTr_{i,t} = Tr_{i,t} \times MPr_{i,t}$$

Where, $ANTr_{i,t}$ is average number of transactions mined in country i in year t. $Tr_{i,t}$ is total annual number transaction mined in country i in year t. $MPr_{i,t}$ is the mining percentage in country i in year t.
For example, we calculated the average number of transactions mined in 2019 in China as follows:
$ANTr_{China,2019}$= 120,034,648 *0.72 = 85533777.22 Transaction

c) Annual Carbon footprint of Bitcoin energy consumption per country per transaction:

We used Equation (13) to calculate annual carbon footprint of Bitcoin energy consumption for mining per country per transaction. Accordingly, the total number of the transactions mined in a given year was multiplied by the percentage of energy consumed for mining Bitcoin:

Equation 13: Annual carbon footprint of Bitcoin electricity consumption per country per transaction

$$AFECBMTr_{i,t} = AECTr_{i,t} \times GWP100_{e,i}$$

Where $AFECBMTr_{i,t}$ is annual carbon footprint from electricity gene consumption ration of the Bitcoin-mining in country i in year t per transaction per kWh. $AECTr_{i,t}$ is annual electricity

consumption per transaction in country i in year t. $GWP100_{e,i}$ is GWP100 of electricity generation e in country i.

As an example, the annual carbon footprint of Bitcoin energy consumption per transaction mined in China for 2019:
$AFECBMTr_{China,2019}$ = 324.1351839 *0.813166656 = 263.5759237 (kWh) per transaction

d) Annual Footprint of electricity needed for mining Bitcoin per Country:

Equation (14) is used to estimate the annual footprint of energy electricity needed for mining Bitcoin per country.

Equation 14: Annual Footprint of Energy Electricity needed for mining Bitcoin per Country per kWh

$$AFECBM_{i,t} = AFECBMTr_{i,t} \times Tr_{i,t}$$

Where $AFEBM_{i,t}$ annual carbon footprint from electricity consumption of the Bitcoin-mining in country i in year t per kWh. $AFEGBMTr_{i,t}$ is annual carbon footprint from electricity generation of the Bitcoin-mining in country i in year t per transaction. $Tr_{i,t}$ is total annual number transaction in country i in year t

For example, we calculated the average number of transactions mined in China in 2019 as follows:

$AFECBM_{China,2019}$= 85533777.22 * 263.5759237
= 22544644334.45 kWh

e) Annual for unknown servers
The results presented in Section 1.1 indicate that approximately 11 % of the transactions are mined via servers in unknown locations. Therefore, for calculating the footprint impact of mining for these transactions, it is necessary to compile electricity generation of the most important Bitcoin-mining countries and calculate the percentage of electricity generation per country.
Table 20 shows the list of countries by electricity production. The electricity production of China is 7.503,400 GWh, which accounts for 27.142% of global production, which is followed by the US (15.921%), India (5.638), and Russia (4.045%).

Table 20: List of countries by electricity production

	Electricity production (GWh)	Percentage	Date of information
Total	27385428	100.000%	
China	7503400	27.399%	2019 [27]
United States	4401300	16.072%	2019 [27]
India	1558700	5.692%	2019 [27]
Russia	1118100	4.083%	2019 [27]

Japan	1036300	3.784%	2019 [27]
Canada	954400	3.485%	2018 [28]
South Korea	794300	2.900%	2018 [28]
Brazil	688000	2.512%	2018 [28]
Germany	648700	2.369%	2018 [28]
France	574200	2.097%	2018 [28]
Saudi Arabia	383800	1.401%	2018 [28]
UK	333900	1.219%	2018 [28]
Mexico	332100	1.213%	2018 [28]
Iran	310800	1.135%	2018 [28]
Turkey (see: Electricity sector in Turkey)	302500	1.105%	2018 [28]
Italy	290600	1.061%	2018 [28]
Spain	275000	1.004%	2018 [28]
Taiwan	273600	0.999%	2018 [28]
Indonesia	267300	0.976%	2018 [28]
Australia	261400	0.955%	2018 [28]
South Africa	256000	0.935%	2018 [28]
Vietnam	212900	0.777%	2018 [28]
Egypt	200000	0.730%	2018 [28]
Thailand	177600	0.649%	2018 [28]
Poland	170100	0.621%	2018 [28]
Malaysia	168400	0.615%	2018 [28]
Sweden	163500	0.597%	2018 [28]
Ukraine	159400	0.582%	2018 [28]
Norway	147000	0.537%	2018 [28]
Argentina	146600	0.535%	2018 [28]
Pakistan	140600	0.513%	2018 [28]
UAE	136900	0.500%	2018 [28]
Netherlands	117500	0.429%	2018 [28]
Kazakhstan	107100	0.391%	2018 [28]
Iraq	103300	0.377%	2018 [28]
Philippines	99800	0.364%	2018 [28]
Venezuela	99200	0.362%	2018 [28]
Czech Republic	88000	0.321%	2018 [28]
Chile	80200	0.293%	2018 [28]
Bangladesh	79100	0.289%	2018 [28]
Colombia	77400	0.283%	2018 [28]
Algeria	76400	0.279%	2018 [28]
Belgium	74600	0.272%	2018 [28]
Kuwait	74200	0.271%	2018 [28]
Switzerland	69800	0.255%	2018 [28]
Finland	69600	0.254%	2018 [28]

Country	Value	Percent	Year
Israel	69600	0.254%	2018 [28]
Austria	68200	0.249%	2018 [28]
Romania	65200	0.238%	2018 [28]
Paraguay	63700	0.233%	2016 [29]
Uzbekistan	62400	0.228%	2018 [28]
Portugal	59900	0.219%	2018 [28]
Peru	58817	0.215%	2018 [30]
Greece	54200	0.198%	2018 [28]
Singapore	52900	0.193%	2018 [28]
Bulgaria	45300	0.165%	2017 [31]
New Zealand	44300	0.162%	2018 [28]
Qatar	39500	0.144%	2018 [28]
Serbia	38821	0.142%	2017 [32]
Belarus	38800	0.142%	2018 [28]
Oman	37300	0.136%	2018 [28]
Hong Kong	36700	0.134%	2018 [28]
Syria	35892	0.131%	2018 [21]
Libya	35450	0.129%	2015 [33]
Morocco	34400	0.126%	2018 [28]
Denmark	33716	0.123%	2017 [34]
Hungary	32000	0.117%	2018 [28]
Ireland	30400	0.111%	2016 [29]
Ecuador	29400	0.107%	2018 [28]
Nigeria	28000	0.102%	2018 [35]
Slovakia	27500	0.100%	2018 [22]
Azerbaijan	25200	0.092%	2018 [28]
Turkmenistan	24200	0.088%	2018 [28]
North Korea	20992	0.077%	2018 [28]
Puerto Rico	20015	0.073%	2018 [28]
Iceland	18550	0.068%	2018 [35]
Cuba	16745	0.061%	2018 [28]
Mozambique	16661	0.061%	2018 [28]
Slovenia	16500	0.060%	2018 [22]
Kyrgyzstan	16035	0.059%	2018 [28]
Sri Lanka	15500	0.057%	2018 [28]
Lebanon	15423	0.056%	2018 [28]
Ethiopia	15192	0.055%	2020 [3]
Tajikistan	14956	0.055%	2018 [28]
Tunisia	14762	0.054%	2012 [36]
Bosnia and Herzegovina	14472	0.053%	2017 [37]
Dominican Republic	14367	0.052%	2015 [8]
Bahrain	13086	0.048%	2018 [28]

Jordan	12998	0.047%	2018 [28]
Croatia	12820	0.047%	2016 [35]
Laos	12242	0.045%	2018 [28]
Estonia	12176	0.044%	2016 [35]
Georgia	11574	0.042%	2016 [35]
Zambia	11338	0.041%	2015 [8]
Ghana	10906	0.040%	2018 [28]
Trinidad and Tobago	10300	0.038%	2018 [28]
Uruguay	10161	0.037%	2018 [28]
Costa Rica	9888	0.036%	2018 [28]
Côte d'Ivoire	9796	0.036%	2017 [38]
Kenya	9258	0.034%	2015 [39]
Sudan (both Sudan and South Sudan)	8917	0.033%	2018 [28]
Guatemala	8361	0.031%	2018 [28]
Congo, Democratic Republic of the	7802	0.028%	2018 [28]
Armenia	7763	0.028%	2017 [40]
Panama	7642	0.028%	2018 [28]
Zimbabwe	7297	0.027%	2018 [28]
Burma	7144	0.026%	2018 [28]
Bhutan	6976	0.025%	2018 [28]
Bolivia	6835	0.025%	2018 [28]
Honduras	6712	0.025%	2018 [28]
Latvia	6425	0.023%	2016 [35]
El Salvador	5992	0.022%	2018 [28]
Kosovo	5906	0.022%	2017 [41]
Cameroon	5857	0.021%	2018 [28]
Yemen	5834	0.021%	2018 [28]
Mongolia	5802	0.021%	2016 [42]
North Macedonia	5629	0.021%	2016 [35]
Angola	5512	0.020%	2018 [28]
Moldova	5456	0.020%	2018 [28]
Tanzania	5115	0.019%	2018 [28]
Cyprus	4887	0.018%	2016 [35]
Jamaica	4745	0.017%	2018 [28]
Albania	4525	0.017%	2017 [43]
Lithuania	4266	0.016%	2016 [35]
Senegal	3921	0.014%	2017 [44]
Nicaragua	3522	0.013%	2018 [28]
Brunei	3500	0.013%	2018 [28]
Botswana	3449	0.013%	2015 [37]

Papua New Guinea	3325	0.012%	2018 [28]
Nepal	3279	0.012%	2018 [28]
Montenegro	3141	0.011%	2016 [35]
Reunion	2841	0.010%	2018 [28]
Mauritius	2627	0.010%	2018 [28]
Uganda	2493	0.009%	2018 [28]
New Caledonia	2430	0.009%	2018 [28]
Malta	2250	0.008%	2016 [45]
Luxembourg	2196	0.008%	2016 [35]
Bahamas	2190	0.008%	2018 [28]
Malawi	2069	0.008%	2018 [28]
Guam	1734	0.006%	2018 [28]
Gabon	1702	0.006%	2018 [28]
Martinique	1702	0.006%	2018 [28]
Guadeloupe	1650	0.006%	2018 [28]
Suriname	1600	0.006%	2018 [28]
Namibia	1585	0.006%	2018 [28]
Madagascar	1340	0.005%	2018 [28]
Netherlands Antilles	1287	0.005%	2018 [28]
Congo, Republic of the	1255	0.005%	2018 [28]
Barbados	1002	0.004%	2018 [28]
U.S. Virgin Islands	996	0.004%	2018 [28]
Cambodia	991	0.004%	2018 [28]
Aruba	980	0.004%	2018 [28]
Guinea	950	0.003%	2018 [28]
Mauritania	930	0.003%	2018 [28]
French Guiana	885	0.003%	2018 [28]
Fiji	836	0.003%	2018 [28]
Afghanistan	833	0.003%	2018 [28]
Macau	833	0.003%	2018 [28]
French Polynesia	825	0.003%	2018 [28]
Guyana	725	0.003%	2018 [28]
Lesotho	700	0.003%	2018 [28]
Bermuda	674	0.002%	2018 [28]
Haiti	652	0.002%	2018 [28]
Cayman Islands	594	0.002%	2018 [28]
Burkina Faso	579	0.002%	2018 [28]
Greenland	538	0.002%	2016 [46]
Palestine	535	0.002%	2018 [28]
Rwanda	525	0.002%	2016 [46]
Mali	520	0.002%	2018 [28]
Equatorial Guinea	500	0.002%	2016 [46]

Niger	495	0.002%	2016 [46]
Belize	452	0.002%	2018 [28]
Eritrea	416	0.002%	2016 [46]
Djibouti	406	0.001%	2016 [46]
Maldives	402	0.001%	2016 [46]
Eswatini	381	0.001%	2016 [46]
Saint Lucia	369	0.001%	2016 [46]
Somalia	339	0.001%	2016 [46]
Benin	335	0.001%	2016 [46]
Antigua and Barbuda	331	0.001%	2016 [46]
Faroe Islands	306	0.001%	2016 [46]
Gambia	304	0.001%	2016 [46]
Burundi	304	0.001%	2016 [46]
Liberia	300	0.001%	2016 [46]
Sierra Leone	300	0.001%	2016 [46]
Gibraltar	239	0.001%	2016 [46]
Turks and Caicos Islands	235	0.001%	2016 [46]
Togo	233	0.001%	2016 [46]
Chad	224	0.001%	2016 [46]
Saint Kitts and Nevis	208	0.001%	2016 [46]
Grenada	202	0.001%	2016 [46]
Central African Republic	171	0.001%	2016 [46]
American Samoa	169	0.001%	2016 [46]
Saint Vincent and the Grenadines	157	0.001%	2016 [46]
Samoa	132	0.000%	2016 [46]
Dominica	111	0.000%	2016 [46]
Solomon Islands	103	0.000%	2016 [46]
Sao Tome and Principe	66	0.000%	2016 [46]
Tonga	52	0.000%	2016 [46]
Saint Pierre and Miquelon	46	0.000%	2016 [46]
Comoros	42	0.000%	2016 [46]
Guinea-Bissau	39	0.000%	2016 [46]
Kiribati	29	0.000%	2016 [46]
Montserrat	24	0.000%	2016 [46]
Falkland Islands	19	0.000%	2016 [46]
Saint Helena	7	0.000%	2016 [46]
Niue	3	0.000%	2016 [46]

The Global Energy and CO_2 Status Report [48] states the average carbon emission of electricity produced in 2018 was 475 gCO2/kWh, which represents an increase of 10% from 2010. In terms of intensity, this contributed to the significantly lower global CO_2 emission. Without this improvement, global CO_2 emissions would have been 11% higher than current power sector emissions.

To estimate the emission of electricity generated, we divided the average carbon emission of electricity by the percentage of electricity production. Hence, the emission of electricity generated is multiplied by the emission of electricity generated to calculate the annual Carbon emission per transaction. Furthermore, we multiplied the annual carbon emission per transaction by the number of transactions to calculate the annual carbon emission distribution.

4.4.2. Results

a) Total Carbon footprint of Bitcoin mining energy consumption

Table 21: GWP of Bitcoin mining energy consumption per transaction by country by year

Countries	GWP per transaction per year (kgCO₂-eqv.)					
	2015	2016	2017	2018	2019	2020
China	5.005	12.318	39.492	226.071	266.472	405.930
U.S.	3.976	9.787	31.375	179.607	211.704	322.500
Unknown server	2.892	7.117	22.818	130.621	153.964	234.542
Finland	2.313	5.693	18.251	104.479	123.150	187.601
Georgia	0.506	1.246	3.993	22.860	26.945	41.047
Iceland	0.106	0.260	0.834	4.772	5.625	8.569
India	0.000	13.219	42.379	242.598	0.000	0.000
Sweden	0.000	0.259	0.831	0.000	0.000	0.000
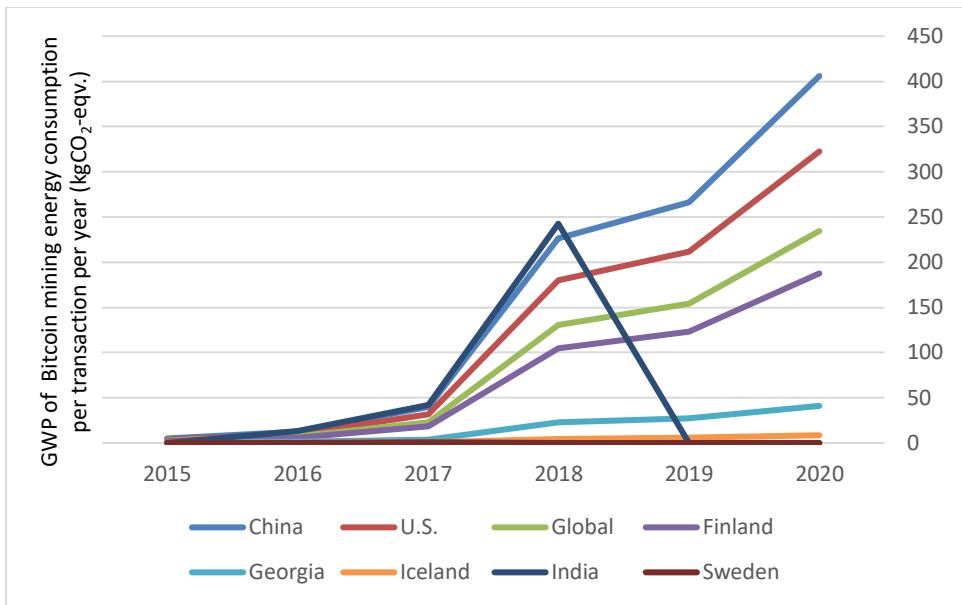
Figure 5: GWP of Bitcoin mining energy consumption per transaction by country by year (kgCO₂-eqv.)

Table 22: Total annual GWP of Bitcoin mining energy consumption by country by country by year

Countries	Total GWP per year (MtCO₂-eqv.)					
	2015	2016	2017	2018	2019	2020
China	0.13561	0.64899	2.94105	12.97205	22.79232	34.69843
U.S.	0.03512	0.12270	0.30717	1.37899	2.92891	5.84839
Unknown server	0.00880	0.05170	0.24183	1.85170	2.20334	1.88017
Finland	0.00476	0.01526	0.03581	0.07724	0.26006	0.05769
Georgia	0.00104	0.00334	0.00783	0.01690	0.05690	0.01262
Iceland	0.00022	0.00070	0.00164	0.00353	0.01188	0.00263
India	0.00000	0.01373	0.11098	0.05530	0.00000	0.00000
Sweden	0.00000	0.00008	0.00017	0.00000	0.00000	0.00000
Total	0.1855	0.8427	3.5353	16.3004	28.2534	42.4999
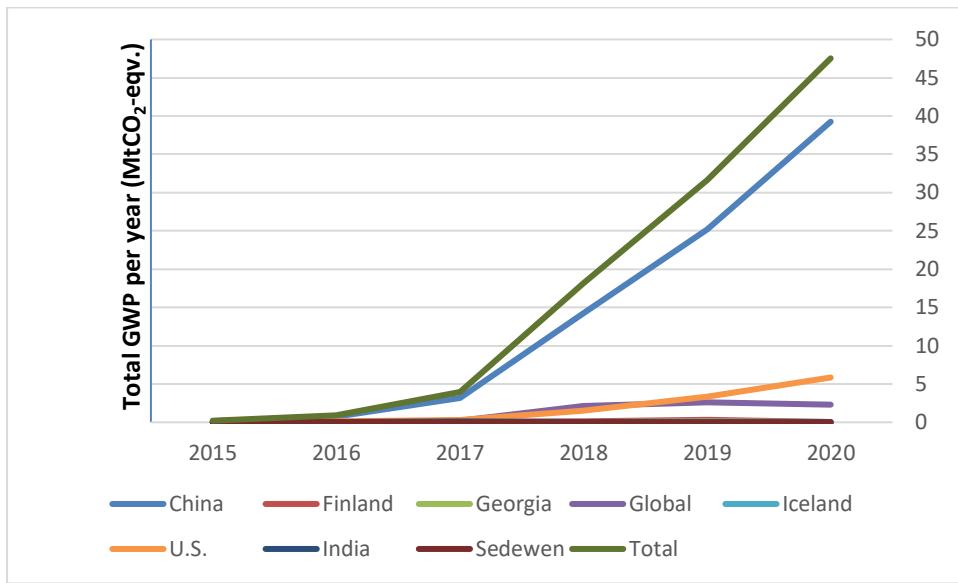
Figure 6: Total annual GWP of Bitcoin mining energy consumption by country by country by year (MtCO₂-eqv.)

b) China

Table 23: Carbon Footprint Distribution of Bitcoin mining energy consumption in China per transaction by country

Order	Country Code	P.A.D.* (%)	GWP per transaction per year (kgCO₂-eqv.)					
			2020	2019	2018	2017	2016	2015
1	CN	99.391%	403.456760	264.848098	224.693283	39.251060	12.243238	4.974400
2	WA	0.093%	0.378787	0.248654	0.210954	0.036851	0.011495	0.004670
3	US	0.092%	0.371707	0.244006	0.207011	0.036162	0.011280	0.004583
4	RU	0.077%	0.314406	0.206391	0.175099	0.030588	0.009541	0.003876
5	WM	0.042%	0.171322	0.112464	0.095413	0.016667	0.005199	0.002112
6	JP	0.037%	0.149740	0.098297	0.083393	0.014568	0.004544	0.001846
7	KR	0.037%	0.149300	0.098008	0.083148	0.014525	0.004531	0.001841
8	ID	0.035%	0.141601	0.092954	0.078861	0.013776	0.004297	0.001746
9	DE	0.031%	0.125893	0.082642	0.070113	0.012248	0.003820	0.001552
10	WL	0.025%	0.101351	0.066532	0.056445	0.009860	0.003076	0.001250

Table 24: Carbon Footprint Distribution of Bitcoin mining energy consumption in China per transaction by sector in Supply Chain

Order	Country Code	Sector	P.A.D.* (%)	GWP per transaction per year (kgCO₂-eqv.)					
				2020	2019	2018	2017	2016	2015
1	CN	Electricity by coal	95.260%	386.689357	253.841181	215.355175	37.619811	11.734417	4.767667
2	CN	Electricity by gas	1.861%	7.552507	4.957823	4.206145	0.7347600	0.229187	0.093118
3	CN	Other Bituminous Coal	1.039%	4.218519	2.769235	2.349379	0.4104066	0.128015	0.052012
4	CN	Basic iron and steel and of ferro-alloys and first products thereof	0.386%	1.567937	1.029268	0.873216	0.1525397	0.047580	0.019332

			P.A.D. (%)	2020	2019	2018	2017	2016	2015
5	CN	Steam and hot water supply services	0.119%	0.482845	0.316962	0.268906	0.0469745	0.014652	0.005953
6	CN	Other non-metallic mineral products	0.058%	0.236244	0.155082	0.131569	0.0229834	0.007169	0.002913
7	CN	Rubber and plastic products (25)	0.046%	0.185159	0.121547	0.103119	0.018013	0.005619	0.002283
8	CN	Coke Oven Coke	0.042%	0.171680	0.112699	0.095612	0.016702	0.005210	0.002117
9	CN	Air transport services (62)	0.039%	0.158272	0.103897	0.088145	0.015397	0.004803	0.001951
10	WA	Natural gas and services related to natural gas extraction, excluding surveying	0.032%	0.129924	0.085288	0.072357	0.0126399	0.003943	0.001602
11	CN	Chemicals nec	0.030%	0.122509	0.080421	0.068228	0.0119185	0.003718	0.001510
12	CN	Supporting and auxiliary transport services; travel agency services (63)	0.029%	0.118832	0.078007	0.066180	0.0115607	0.003606	0.001465
13	US	Air transport services (62)	0.028%	0.114479	0.075149	0.063755	0.011137	0.003474	0.001411
14	CN	Sea and coastal water transportation services	0.028%	0.112173	0.073636	0.062471	0.010912	0.003404	0.001383
15	CN	Other business services (74)	0.027%	0.109266	0.071727	0.060852	0.0106301	0.003316	0.001347
16	CN	Electricity by hydro	0.026%	0.107285	0.070427	0.059749	0.010437	0.003256	0.001323
17	CN	Crude petroleum and services related to crude oil extraction, excluding surveying	0.025%	0.101896	0.066889	0.056748	0.009913	0.003092	0.001256
18	CN	Coking Coal	0.023%	0.094611	0.062107	0.052691	0.009204	0.002871	0.001167
19	RU	Other Bituminous Coal	0.022%	0.088975	0.058408	0.049552	0.008656	0.002700	0.001097
20	CN	Inland water transportation services	0.022%	0.088228	0.057917	0.049136	0.008583	0.002677	0.001088

Table 25: Total Annual Carbon Footprint Distribution of Bitcoin mining energy consumption in China by country

Order	Country Code	P.A.D. * (%)	Total GWP per year (MtCO$_2$-eqv.)					
			2020	2019	2018	2017	2016	2015
1	CN	99.391%	34.487	22.653	12.893	2.923	6.450×10^{-1}	1.348×10^{-1}

2	WA	0.093%	$3.238\ 10^{-2}$	$2.127\ 10^{-2}$	$1.210\ 10^{-2}$	$2.744\ 10^{-3}$	$6.056\ 10^{-4}$	$1.265\ 10^{-4}$
3	US	0.092%	$3.177\ 10^{-2}$	$2.087\ 10^{-2}$	$1.188\ 10^{-2}$	$2.693\ 10^{-3}$	$5.943\ 10^{-4}$	$1.242\ 10^{-4}$
4	RU	0.077%	$2.688\ 10^{-2}$	$1.765\ 10^{-2}$	$1.005\ 10^{-2}$	$2.278\ 10^{-3}$	$5.027\ 10^{-4}$	$1.050\ 10^{-4}$
5	WM	0.042%	$1.464\ 10^{-2}$	$9.619\ 10^{-3}$	$5.475\ 10^{-3}$	$1.241\ 10^{-3}$	$2.739\ 10^{-4}$	$5.723\ 10^{-5}$
6	JP	0.037%	$1.280\ 10^{-2}$	$8.408\ 10^{-3}$	$4.785\ 10^{-3}$	$1.085\ 10^{-3}$	$2.394\ 10^{-4}$	$5.002\ 10^{-5}$
7	KR	0.037%	$1.276\ 10^{-2}$	$8.383\ 10^{-3}$	$4.771\ 10^{-3}$	$1.082\ 10^{-3}$	$2.387\ 10^{-4}$	$4.988\ 10^{-5}$
8	ID	0.035%	$1.210\ 10^{-2}$	$7.951\ 10^{-3}$	$4.525\ 10^{-3}$	$1.026\ 10^{-3}$	$2.264\ 10^{-4}$	$4.730\ 10^{-5}$
9	DE	0.031%	$1.076\ 10^{-2}$	$7.069\ 10^{-3}$	$4.023\ 10^{-3}$	$9.121\ 10^{-4}$	$2.013\ 10^{-4}$	$4.206\ 10^{-5}$
10	WL	0.025%	$8.663\ 10^{-3}$	$5.691\ 10^{-3}$	$3.239\ 10^{-3}$	$7.343\ 10^{-4}$	$1.620\ 10^{-4}$	$3.386\ 10^{-5}$

Table 26: Total Annual Carbon Footprint Distribution of Bitcoin mining energy consumption in China by sector

Order	Country Code	Sector	P.A.D.* (%)	Total GWP per year (MtCO$_2$-eqv.)					
				2020	2019	2018	2017	2016	2015
1	CN	Electricity by coal	95.260%	33 .054	21 .712	12 .357	2 .802	$6.182\ 10^{-1}$	$1.292\ 10^{-1}$
2	CN	Electricity by gas	1.861%	$6.456\ 10^{-1}$	$4.241\ 10^{-1}$	$2.414\ 10^{-1}$	$5.472\ 10^{-2}$	$1.207\ 10^{-2}$	$2.523\ 10^{-3}$
3	CN	Other Bituminous Coal	1.039%	$3.606\ 10^{-1}$	$2.369\ 10^{-1}$	$1.348\ 10^{-1}$	$3.056\ 10^{-2}$	$6.744\ 10^{-3}$	$1.409\ 10^{-3}$
4	CN	Basic iron and steel and of ferro-alloys and first products thereof	0.386%	$1.340\ 10^{-1}$	$8.804\ 10^{-2}$	$5.011\ 10^{-2}$	$1.136\ 10^{-2}$	$2.507\ 10^{-3}$	$5.238\ 10^{-4}$
5	CN	Steam and hot water supply services	0.119%	$4.127\ 10^{-2}$	$2.711\ 10^{-2}$	$1.543\ 10^{-2}$	$3.498\ 10^{-3}$	$7.720\ 10^{-4}$	$1.613\ 10^{-4}$
6	CN	Other non-metallic mineral products	0.058%	$2.019\ 10^{-2}$	$1.326\ 10^{-2}$	$7.550\ 10^{-3}$	$1.712\ 10^{-3}$	$3.777\ 10^{-4}$	$7.892\ 10^{-5}$
7	CN	Rubber and plastic products (25)	0.046%	$1.583\ 10^{-2}$	$1.040\ 10^{-2}$	$5.917\ 10^{-3}$	$1.342\ 10^{-3}$	$2.960\ 10^{-4}$	$6.186\ 10^{-5}$
8	CN	Coke Oven Coke	0.042%	$1.468\ 10^{-2}$	$9.640\ 10^{-3}$	$5.486\ 10^{-3}$	$1.244\ 10^{-3}$	$2.745\ 10^{-4}$	$5.735\ 10^{-5}$

9	CN	Air transport services (62)	0.039%	$1.353\ 10^{-2}$	$8.887\ 10^{-3}$	$5.058\ 10^{-3}$	$1.147\ 10^{-3}$	$2.530\ 10^{-4}$	$5.287\ 10^{-5}$
10	WA	Natural gas and services related to natural gas extraction, excluding surveying	0.032%	$1.111\ 10^{-2}$	$7.295\ 10^{-3}$	$4.152\ 10^{-3}$	$9.413\ 10^{-4}$	$2.077\ 10^{-4}$	$4.340\ 10^{-5}$
11	CN	Chemicals nec	0.030%	$1.047\ 10^{-2}$	$6.879\ 10^{-3}$	$3.915\ 10^{-3}$	$8.876\ 10^{-4}$	$1.959\ 10^{-4}$	$4.093\ 10^{-5}$
12	CN	Supporting and auxiliary transport services; travel agency services (63)	0.029%	$1.016\ 10^{-2}$	$6.672\ 10^{-3}$	$3.797\ 10^{-3}$	$8.610\ 10^{-4}$	$1.900\ 10^{-4}$	$3.970\ 10^{-5}$
13	US	Air transport services (62)	0.028%	$9.786\ 10^{-3}$	$6.428\ 10^{-3}$	$3.658\ 10^{-3}$	$8.294\ 10^{-4}$	$1.830\ 10^{-4}$	$3.824\ 10^{-5}$
14	CN	Sea and coastal water transportation services	0.028%	$9.588\ 10^{-3}$	$6.298\ 10^{-3}$	$3.585\ 10^{-3}$	$8.127\ 10^{-4}$	$1.793\ 10^{-4}$	$3.747\ 10^{-5}$
15	CN	Other business services (74)	0.027%	$9.340\ 10^{-3}$	$6.135\ 10^{-3}$	$3.492\ 10^{-3}$	$7.917\ 10^{-4}$	$1.747\ 10^{-4}$	$3.650\ 10^{-5}$
16	CN	Electricity by hydro	0.026%	$9.171\ 10^{-3}$	$6.024\ 10^{-3}$	$3.428\ 10^{-3}$	$7.773\ 10^{-4}$	$1.715\ 10^{-4}$	$3.584\ 10^{-5}$
17	CN	Crude petroleum and services related to crude oil extraction, excluding surveying	0.025%	$8.710\ 10^{-3}$	$5.721\ 10^{-3}$	$3.256\ 10^{-3}$	$7.383\ 10^{-4}$	$1.629\ 10^{-4}$	$3.404\ 10^{-5}$
18	CN	Coking Coal	0.023%	$8.087\ 10^{-3}$	$5.312\ 10^{-3}$	$3.023\ 10^{-3}$	$6.855\ 10^{-4}$	$1.513\ 10^{-4}$	$3.161\ 10^{-5}$
19	RU	Other Bituminous Coal	0.022%	$7.606\ 10^{-3}$	$4.996\ 10^{-3}$	$2.843\ 10^{-3}$	$6.446\ 10^{-4}$	$1.423\ 10^{-4}$	$2.972\ 10^{-5}$
20	CN	Inland water transportation services	0.022%	$7.542\ 10^{-3}$	$4.954\ 10^{-3}$	$2.819\ 10^{-3}$	$6.392\ 10^{-4}$	$1.411\ 10^{-4}$	$2.947\ 10^{-5}$

c) Finland

Table 27: Carbon Footprint Distribution of Bitcoin mining energy consumption in Finland per transaction by country

Order	Country Code	P.A.D.* (%)	GWP per transaction per year (kgCO2-eqv.)					
			2020	2019	2018	2017	2016	2015
1	FI	51.471%	96.559885	63.386475	53.776166	9.394012	2.930192	1.190530
2	RU	45.311%	85.003120	55.800068	47.339968	8.269691	2.579492	1.048042
3	SE	0.593%	1.112213	0.730109	0.619414	0.108204	0.033751	0.013713
4	WA	0.330%	0.619010	0.406347	0.344739	0.060222	0.018784	0.007632
5	WM	0.266%	0.499096	0.327630	0.277957	0.048555	0.015145	0.006154
6	CN	0.254%	0.476906	0.313064	0.265599	0.046397	0.014472	0.005880
7	DE	0.192%	0.359942	0.236283	0.200459	0.035018	0.010923	0.004438
8	US	0.185%	0.346721	0.227604	0.193096	0.033731	0.010522	0.004275
9	IN	0.135%	0.253339	0.166304	0.141090	0.024647	0.007688	0.003124
10	PL	0.110%	0.207134	0.135972	0.115357	0.020151	0.006286	0.002554

Table 28: Carbon Footprint Distribution of Bitcoin mining energy consumption in Finland per transaction by sector in Supply Chain

Order	Country Code	Sector	P.A.D.* (%)	GWP per transaction per year (kgCO2-eqv.)					
				2020	2019	2018	2017	2016	2015
1	FI	Electricity by coal	41.402%	77.669877	50.986180	43.255936	7.5562620	2.356958	0.957627

2	RU	Natural gas and services related to natural gas extraction. excluding surveying	39.494%	74.091745	48.637325	41.263201	7.2081566	2.248377	0.913511
3	RU	Other Bituminous Coal	3.825%	7.176369	4.710908	3.996666	0.698166	0.217773	0.088481
4	FI	Electricity by biomass and waste	3.003%	5.633945	3.698388	3.137659	0.5481090	0.170967	0.069463
5	FI	Natural Gas Liquids	1.419%	2.661855	1.747368	1.482442	0.2589636	0.080776	0.032819
6	FI	Electricity by nuclear	1.183%	2.218764	1.456501	1.235675	0.2158566	0.067330	0.027356
7	FI	Electricity by gas	0.848%	1.591157	1.044511	0.886148	0.1547987	0.048285	0.019618
8	FI	Electricity by hydro	0.821%	1.539449	1.010567	0.857350	0.1497682	0.046716	0.018981
9	RU	Heavy Fuel Oil	0.383%	0.717964	0.471305	0.399849	0.0698484	0.021787	0.008852
10	RU	Steam and hot water supply services	0.370%	0.693650	0.455345	0.386308	0.0674830	0.021049	0.008552
11	FI	Electricity by petroleum and other oil derivatives	0.355%	0.666181	0.437313	0.371010	0.0648107	0.020216	0.008214
12	RU	Transportation services via pipelines	0.332%	0.622810	0.408842	0.346856	0.0605912	0.018900	0.007679
13	FI	Steam and hot water supply services	0.315%	0.591575	0.388338	0.329460	0.0575524	0.017952	0.007294
14	FI	Distribution services of gaseous fuels through mains	0.263%	0.494062	0.324326	0.275153	0.0480657	0.014993	0.006092
15	FI	Wholesale trade and commission trade services. except of motor vehicles and motorcycles (51)	0.233%	0.437961	0.287498	0.243910	0.0426078	0.013290	0.005400
16	FI	Electricity by wind	0.139%	0.260495	0.171001	0.145075	0.0253427	0.007905	0.003212
17	RU	Crude petroleum and services related to crude oil extraction. excluding surveying	0.134%	0.251462	0.165071	0.140044	0.0244639	0.007631	0.003100
18	FI	Air transport services (62)	0.132%	0.246906	0.162081	0.137507	0.0240207	0.007493	0.003044
19	FI	Motor Gasoline	0.129%	0.242020	0.158873	0.134786	0.0235453	0.007344	0.002984
20	SE	Electricity by hydro	0.124%	0.232214	0.152436	0.129325	0.0225913	0.007047	0.002863

Table 29: Total Annual Carbon Footprint Distribution of Bitcoin mining energy consumption in Finland by country

Order	Country Code	P.A.D.* (%)	Total GWP per year (MtCO$_2$-eqv.)					
			2020	2019	2018	2017	2016	2015
1	FI	51.471%	2.969×10^{-2}	1.339×10^{-1}	3.976×10^{-2}	1.843×10^{-2}	7.856×10^{-3}	2.450×10^{-3}
2	RU	45.311%	2.614×10^{-2}	1.178×10^{-1}	3.500×10^{-2}	1.622×10^{-2}	6.916×10^{-3}	2.157×10^{-3}
3	SE	0.593%	3.420×10^{-4}	1.542×10^{-3}	4.579×10^{-4}	2.123×10^{-4}	9.049×10^{-5}	2.822×10^{-5}
4	WA	0.330%	1.904×10^{-4}	8.581×10^{-4}	2.549×10^{-4}	1.182×10^{-4}	5.036×10^{-5}	1.571×10^{-5}
5	WM	0.266%	1.535×10^{-4}	6.919×10^{-4}	2.055×10^{-4}	9.526×10^{-5}	4.061×10^{-5}	1.267×10^{-5}
6	CN	0.254%	1.467×10^{-4}	6.611×10^{-4}	1.964×10^{-4}	9.103×10^{-5}	3.880×10^{-5}	1.210×10^{-5}
7	DE	0.192%	1.107×10^{-4}	4.990×10^{-4}	1.482×10^{-4}	6.870×10^{-5}	2.929×10^{-5}	9.134×10^{-6}
8	US	0.185%	1.066×10^{-4}	4.806×10^{-4}	1.428×10^{-4}	6.618×10^{-5}	2.821×10^{-5}	8.799×10^{-6}
9	IN	0.135%	7.790×10^{-5}	3.512×10^{-4}	1.043×10^{-4}	4.836×10^{-5}	2.061×10^{-5}	6.429×10^{-6}
10	PL	0.110%	6.370×10^{-5}	2.871×10^{-4}	8.528×10^{-5}	3.954×10^{-5}	1.685×10^{-5}	5.256×10^{-6}

Table 30: Total Annual Carbon Footprint Distribution of Bitcoin mining energy consumption in Finland by sector

Order	Country Code	Sector	P.A.D.* (%)	Total GWP per year (MtCO$_2$-eqv.)					
				2020	2019	2018	2017	2016	2015

1	FI	Electricity by coal	41.402%	$2.388\ 10^{-2}$	$1.077\ 10^{-1}$	$3.198\ 10^{-2}$	$1.482\ 10^{-2}$	$6.319\ 10^{-3}$	$1.971\ 10^{-3}$
2	RU	Natural gas and services related to natural gas extraction, excluding surveying	39.494%	$2.278\ 10^{-2}$	$1.027\ 10^{-1}$	$3.051\ 10^{-2}$	$1.414\ 10^{-2}$	$6.028\ 10^{-3}$	$1.880\ 10^{-3}$
3	RU	Other Bituminous Coal	3.825%	$2.207\ 10^{-3}$	$9.948\ 10^{-3}$	$2.955\ 10^{-3}$	$1.370\ 10^{-3}$	$5.839\ 10^{-4}$	$1.821\ 10^{-4}$
4	FI	Electricity by biomass and waste	3.003%	$1.733\ 10^{-3}$	$7.810\ 10^{-3}$	$2.320\ 10^{-3}$	$1.075\ 10^{-3}$	$4.584\ 10^{-4}$	$1.430\ 10^{-4}$
5	FI	Natural Gas Liquids	1.419%	$8.186\ 10^{-4}$	$3.690\ 10^{-3}$	$1.096\ 10^{-3}$	$5.081\ 10^{-4}$	$2.166\ 10^{-4}$	$6.755\ 10^{-5}$
6	FI	Electricity by nuclear	1.183%	$6.823\ 10^{-4}$	$3.076\ 10^{-3}$	$9.135\ 10^{-4}$	$4.235\ 10^{-4}$	$1.805\ 10^{-4}$	$5.631\ 10^{-5}$
7	FI	Electricity by gas	0.848%	$4.893\ 10^{-4}$	$2.206\ 10^{-3}$	$6.551\ 10^{-4}$	$3.037\ 10^{-4}$	$1.295\ 10^{-4}$	$4.038\ 10^{-5}$
8	FI	Electricity by hydro	0.821%	$4.734\ 10^{-4}$	$2.134\ 10^{-3}$	$6.338\ 10^{-4}$	$2.938\ 10^{-4}$	$1.253\ 10^{-4}$	$3.907\ 10^{-5}$
9	RU	Heavy Fuel Oil	0.383%	$2.208\ 10^{-4}$	$9.953\ 10^{-4}$	$2.956\ 10^{-4}$	$1.370\ 10^{-4}$	$5.841\ 10^{-5}$	$1.822\ 10^{-5}$
10	RU	Steam and hot water supply services	0.370%	$2.133\ 10^{-4}$	$9.616\ 10^{-4}$	$2.856\ 10^{-4}$	$1.324\ 10^{-4}$	$5.644\ 10^{-5}$	$1.760\ 10^{-5}$
11	FI	Electricity by petroleum and other oil derivatives	0.355%	$2.049\ 10^{-4}$	$9.235\ 10^{-4}$	$2.743\ 10^{-4}$	$1.272\ 10^{-4}$	$5.420\ 10^{-5}$	$1.691\ 10^{-5}$
12	RU	Transportation services via pipelines	0.332%	$1.915\ 10^{-4}$	$8.634\ 10^{-4}$	$2.564\ 10^{-4}$	$1.189\ 10^{-4}$	$5.067\ 10^{-5}$	$1.581\ 10^{-5}$
13	FI	Steam and hot water supply services	0.315%	$1.819\ 10^{-4}$	$8.201\ 10^{-4}$	$2.436\ 10^{-4}$	$1.129\ 10^{-4}$	$4.813\ 10^{-5}$	$1.501\ 10^{-5}$
14	FI	Distribution services of gaseous fuels through mains	0.263%	$1.519\ 10^{-4}$	$6.849\ 10^{-4}$	$2.034\ 10^{-4}$	$9.430\ 10^{-5}$	$4.020\ 10^{-5}$	$1.254\ 10^{-5}$
15	FI	Wholesale trade and commission trade services, except of motor vehicles and motorcycles (51)	0.233%	$1.347\ 10^{-4}$	$6.071\ 10^{-4}$	$1.803\ 10^{-4}$	$8.359\ 10^{-5}$	$3.563\ 10^{-5}$	$1.111\ 10^{-5}$
16	FI	Electricity by wind	0.139%	$8.011\ 10^{-5}$	$3.611\ 10^{-4}$	$1.073\ 10^{-4}$	$4.972\ 10^{-5}$	$2.119\ 10^{-5}$	$6.611\ 10^{-6}$
17	RU	Crude petroleum and services related to crude oil extraction, excluding surveying	0.134%	$7.733\ 10^{-5}$	$3.486\ 10^{-4}$	$1.035\ 10^{-4}$	$4.800\ 10^{-5}$	$2.046\ 10^{-5}$	$6.381\ 10^{-6}$

18	FI	Air transport services (62)	0.132%	$7.593 \ 10^{-5}$	$3.423 \ 10^{-4}$	$1.017 \ 10^{-4}$	$4.713 \ 10^{-5}$	$2.009 \ 10^{-5}$	$6.266 \ 10^{-6}$
19	FI	Motor Gasoline	0.129%	$7.442 \ 10^{-5}$	$3.355 \ 10^{-4}$	$9.964 \ 10^{-5}$	$4.619 \ 10^{-5}$	$1.969 \ 10^{-5}$	$6.142 \ 10^{-6}$
20	SE	Electricity by hydro	0.124%	$7.141 \ 10^{-5}$	$3.219 \ 10^{-4}$	$9.561 \ 10^{-5}$	$4.432 \ 10^{-5}$	$1.889 \ 10^{-5}$	$5.893 \ 10^{-6}$

d) Georgia

Carbon Footprint Distribution of Bitcoin mining energy consumption in Georgia per transaction by country

Order	Country Code	P.A.D.* (%)	GWP per transaction per year (kgCO2-eqv.)					
			2020	**2019**	**2018**	**2017**	**2016**	**2015**
1	WE	96.061%	39.430061	25.883757	21.959404	3.836029	1.196539	0.000058
2	RU	1.110%	0.455531	0.299032	0.253695	0.044317	0.013823	0.000162
3	CN	0.484%	0.198660	0.130410	0.110638	0.019327	0.006029	0.000203
4	WM	0.316%	0.129813	0.085215	0.072295	0.012629	0.003939	0.000008
5	WA	0.316%	0.129551	0.085044	0.072150	0.012604	0.003931	0.000123
6	US	0.250%	0.102471	0.067267	0.057068	0.009969	0.003110	0.000633
7	DE	0.127%	0.052076	0.034185	0.029002	0.005066	0.001580	0.000075
8	IT	0.095%	0.038936	0.025559	0.021684	0.003788	0.001182	0.000042
9	IN	0.094%	0.038500	0.025273	0.021442	0.003746	0.001168	0.000394
10	ES	0.079%	0.032314	0.021213	0.017997	0.003144	0.000981	0.000068

Table 31: Carbon Footprint Distribution of Bitcoin mining energy consumption in Georgia per transaction by sector in Supply Chain

Order	Country Code	Sector	P.A.D.* (%)	Total GWP per year (MtCO$_2$-eqv.)					
				2020	2019	2018	2017	2016	2015
1	WE	Electricity by gas	78.292%	32.136439	21.095878	17.897437	3.1264547	0.975208	0.39622464
2	WE	Distribution services of gaseous fuels through mains	4.973%	2.041423	1.340086	1.136910	0.1986036	0.061949	0.02516962
3	WE	Electricity by coal	3.926%	1.611373	1.057782	0.897407	0.1567655	0.048898	0.01986735
4	WE	Steam and hot water supply services	3.283%	1.347747	0.884725	0.750588	0.1311181	0.040899	0.01661698
5	WE	Electricity by hydro	2.047%	0.840123	0.551496	0.467881	0.0817329	0.025494	0.01035825
6	WE	Construction work (45)	0.587%	0.240873	0.158121	0.134147	0.0234338	0.007310	0.00296984
7	WE	Wholesale trade and commission trade services, except of motor vehicles and motorcycles (51)	0.277%	0.113725	0.074655	0.063336	0.0110639	0.003451	0.00140217
8	WE	Retail trade services, except of motor vehicles and motorcycles; repair services of personal and household goods (52)	0.227%	0.093323	0.061262	0.051974	0.0090791	0.002832	0.00115063
9	RU	Heavy Fuel Oil	0.218%	0.089420	0.058700	0.049800	0.0086994	0.002714	0.0011025
10	CN	Electricity by coal	0.216%	0.088545	0.058125	0.049313	0.0086142	0.002687	0.00109171
11	RU	Steam and hot water supply services	0.204%	0.083777	0.054995	0.046657	0.0081503	0.002542	0.00103292
12	WE	Cement, lime and plaster	0.204%	0.083622	0.054893	0.046571	0.008135	0.002538	0.00103101
13	WE	Poultry	0.135%	0.055252	0.036270	0.030771	0.0053752	0.001677	0.00068122
14	WE	Other business services (74)	0.132%	0.054104	0.035516	0.030132	0.0052636	0.001642	0.00066707
15	WE	Blast Furnace Gas	0.129%	0.053125	0.034874	0.029587	0.0051684	0.001612	0.00065501
16	WE	Coke oven gas	0.124%	0.050871	0.033394	0.028331	0.004949	0.001544	0.00062722

17	RU	Transportation services via pipelines	0.115%	0.047102	0.030920	0.026232	0.0045824	0.001429	0.00058074
18	RU	Gas/Diesel Oil	0.095%	0.039151	0.025701	0.021804	0.0038088	0.001188	0.00048271
19	WE	Natural Gas Liquids	0.086%	0.035260	0.023146	0.019637	0.0034303	0.001070	0.00043474
20	RU	Basic iron and steel and of ferro-alloys and first products thereof	0.084%	0.034500	0.022648	0.019214	0.0033564	0.001047	0.00042537

Table 32: Total Annual Carbon Footprint Distribution of Bitcoin mining energy consumption in Georgia by country

Order	Country Code	P.A.D.* (%)	Total GWP per year (MtCO$_2$-eqv.)					
			2020	2019	2018	2017	2016	2015
1	WE	96.061%	1.213×10^{-2}	5.466×10^{-2}	1.623×10^{-2}	7.526×10^{-3}	3.208×10^{-3}	1.001×10^{-3}
2	RU	1.110%	1.401×10^{-4}	6.315×10^{-4}	1.876×10^{-4}	8.695×10^{-5}	3.706×10^{-5}	1.156×10^{-5}
3	CN	0.484%	6.109×10^{-5}	2.754×10^{-4}	8.179×10^{-5}	3.792×10^{-5}	1.616×10^{-5}	5.041×10^{-6}
4	WM	0.316%	3.992×10^{-5}	1.800×10^{-4}	5.345×10^{-5}	2.478×10^{-5}	1.056×10^{-5}	3.294×10^{-6}
5	WA	0.316%	3.984×10^{-5}	1.796×10^{-4}	5.334×10^{-5}	2.473×10^{-5}	1.054×10^{-5}	3.288×10^{-6}
6	US	0.250%	3.151×10^{-5}	1.421×10^{-4}	4.219×10^{-5}	1.956×10^{-5}	8.337×10^{-6}	2.600×10^{-6}
7	DE	0.127%	1.601×10^{-5}	7.219×10^{-5}	2.144×10^{-5}	9.940×10^{-6}	4.237×10^{-6}	1.322×10^{-6}
8	IT	0.095%	1.197×10^{-5}	5.398×10^{-5}	1.603×10^{-5}	7.432×10^{-6}	3.168×10^{-6}	9.881×10^{-7}
9	IN	0.094%	1.184×10^{-5}	5.337×10^{-5}	1.585×10^{-5}	7.349×10^{-6}	3.132×10^{-6}	9.770×10^{-7}
10	ES	0.079%	9.937×10^{-6}	4.480×10^{-5}	1.330×10^{-5}	6.168×10^{-6}	2.629×10^{-6}	8.200×10^{-7}

Table 33: Total Annual Carbon Footprint Distribution of Bitcoin mining energy consumption in Georgia by sector

Order	Country Code	Sector	P.A.D.* (%)	Total GWP per year (MtCO$_2$-eqv.)					
				2020	**2019**	**2018**	**2017**	**2016**	**2015**
1	WE	Electricity by gas	78.292%	$9.882\ 10^{-3}$	$4.455\ 10^{-2}$	$1.323\ 10^{-2}$	$6.134\ 10^{-3}$	$2.615\ 10^{-3}$	$8.155\ 10^{-4}$
2	WE	Distribution services of gaseous fuels through mains	4.973%	$6.278\ 10^{-4}$	$2.830\ 10^{-3}$	$8.405\ 10^{-4}$	$3.896\ 10^{-4}$	$1.661\ 10^{-4}$	$5.181\ 10^{-5}$
3	WE	Electricity by coal	3.926%	$4.955\ 10^{-4}$	$2.234\ 10^{-3}$	$6.634\ 10^{-4}$	$3.076\ 10^{-4}$	$1.311\ 10^{-4}$	$4.089\ 10^{-5}$
4	WE	Steam and hot water supply services	3.283%	$4.144\ 10^{-4}$	$1.868\ 10^{-3}$	$5.549\ 10^{-4}$	$2.572\ 10^{-4}$	$1.097\ 10^{-4}$	$3.420\ 10^{-5}$
5	WE	Electricity by hydro	2.047%	$2.583\ 10^{-4}$	$1.165\ 10^{-3}$	$3.459\ 10^{-4}$	$1.604\ 10^{-4}$	$6.835\ 10^{-5}$	$2.132\ 10^{-5}$
6	WE	Construction work (45)	0.587%	$7.407\ 10^{-5}$	$3.339\ 10^{-4}$	$9.917\ 10^{-5}$	$4.598\ 10^{-5}$	$1.960\ 10^{-5}$	$6.113\ 10^{-6}$
7	WE	Wholesale trade and commission trade services, except of motor vehicles and motorcycles (51)	0.277%	$3.497\ 10^{-5}$	$1.577\ 10^{-4}$	$4.682\ 10^{-5}$	$2.171\ 10^{-5}$	$9.253\ 10^{-6}$	$2.886\ 10^{-6}$
8	WE	Retail trade services, except of motor vehicles and motorcycles; repair services of personal and household goods (52)	0.227%	$2.870\ 10^{-5}$	$1.294\ 10^{-4}$	$3.842\ 10^{-5}$	$1.781\ 10^{-5}$	$7.593\ 10^{-6}$	$2.368\ 10^{-6}$
9	RU	Heavy Fuel Oil	0.218%	$2.750\ 10^{-5}$	$1.240\ 10^{-4}$	$3.682\ 10^{-5}$	$1.707\ 10^{-5}$	$7.275\ 10^{-6}$	$2.269\ 10^{-6}$
10	CN	Electricity by coal	0.216%	$2.723\ 10^{-5}$	$1.227\ 10^{-4}$	$3.646\ 10^{-5}$	$1.690\ 10^{-5}$	$7.204\ 10^{-6}$	$2.247\ 10^{-6}$
11	RU	Steam and hot water supply services	0.204%	$2.576\ 10^{-5}$	$1.161\ 10^{-4}$	$3.449\ 10^{-5}$	$1.599\ 10^{-5}$	$6.816\ 10^{-6}$	$2.126\ 10^{-6}$
12	WE	Cement, lime and plaster	0.204%	$2.571\ 10^{-5}$	$1.159\ 10^{-4}$	$3.443\ 10^{-5}$	$1.596\ 10^{-5}$	$6.804\ 10^{-6}$	$2.122\ 10^{-6}$
13	WE	Poultry	0.135%	$1.699\ 10^{-5}$	$7.659\ 10^{-5}$	$2.275\ 10^{-5}$	$1.055\ 10^{-5}$	$4.495\ 10^{-6}$	$1.402\ 10^{-6}$
14	WE	Other business services (74)	0.132%	$1.664\ 10^{-5}$	$7.500\ 10^{-5}$	$2.228\ 10^{-5}$	$1.033\ 10^{-5}$	$4.402\ 10^{-6}$	$1.373\ 10^{-6}$

15	WE	Blast Furnace Gas	0.129%	$1.634 \ 10^{-5}$	$7.365 \ 10^{-5}$	$2.187 \ 10^{-5}$	$1.014 \ 10^{-5}$	$4.322 \ 10^{-6}$	$1.348 \ 10^{-6}$
16	WE	Coke oven gas	0.124%	$1.564 \ 10^{-5}$	$7.052 \ 10^{-5}$	$2.094 \ 10^{-5}$	$9.710 \ 10^{-6}$	$4.139 \ 10^{-6}$	$1.291 \ 10^{-6}$
17	RU	Transportation services via pipelines	0.115%	$1.448 \ 10^{-5}$	$6.530 \ 10^{-5}$	$1.939 \ 10^{-5}$	$8.990 \ 10^{-6}$	$3.832 \ 10^{-6}$	$1.195 \ 10^{-6}$
18	RU	Gas/Diesel Oil	0.095%	$1.204 \ 10^{-5}$	$5.427 \ 10^{-5}$	$1.612 \ 10^{-5}$	$7.473 \ 10^{-6}$	$3.185 \ 10^{-6}$	$9.935 \ 10^{-7}$
19	WE	Natural Gas Liquids	0.086%	$1.084 \ 10^{-5}$	$4.888 \ 10^{-5}$	$1.452 \ 10^{-5}$	$6.730 \ 10^{-6}$	$2.869 \ 10^{-6}$	$8.948 \ 10^{-7}$
20	RU	Basic iron and steel and of ferro-alloys and first products thereof	0.084%	$1.061 \ 10^{-5}$	$4.783 \ 10^{-5}$	$1.420 \ 10^{-5}$	$6.585 \ 10^{-6}$	$2.807 \ 10^{-6}$	$8.755 \ 10^{-7}$

e) Iceland

Table 34: Carbon Footprint Distribution of Bitcoin mining energy consumption in Iceland per transaction by country

Order	Country Code	P.A.D.* (%)	GWP per transaction per year (kgCO2-eqv.)					
			2020	2019	2018	2017	2016	2015
1	WE	66.470%	5.695668	3.738906	3.172034	0.554114	0.172840	0.070224
2	RU	8.125%	0.696177	0.457003	0.387715	0.067729	0.021126	0.008583
3	CN	4.289%	0.367536	0.241268	0.204688	0.035756	0.011153	0.004532
4	WA	3.298%	0.282615	0.185522	0.157394	0.027495	0.008576	0.003484
5	WM	3.082%	0.264066	0.173345	0.147064	0.025690	0.008013	0.003256
6	US	1.778%	0.152377	0.100027	0.084862	0.014824	0.004624	0.001879
7	DE	1.129%	0.096708	0.063483	0.053858	0.009408	0.002935	0.001192
8	IN	0.932%	0.079884	0.052440	0.044489	0.007772	0.002424	0.000985
9	IT	0.707%	0.060572	0.039762	0.033734	0.005893	0.001838	0.000747
10	KR	0.628%	0.053840	0.035343	0.029985	0.005238	0.001634	0.000664

Table 35: Carbon Footprint Distribution of Bitcoin mining energy consumption in Iceland per transaction by sector in Supply Chain

Order	Country Code	Sector	P.A.D.* (%)	GWP per transaction per year (kgCO2-eqv.)					
				2020	2019	2018	2017	2016	2015
1	WE	Electricity by hydro	18.903%	1.619751	1.063281	0.902072	0.1575805	0.049153	0.01997064
2	WE	Electricity by coal	13.525%	1.158887	0.760748	0.645408	0.1127444	0.035167	0.01428843
3	WE	Distribution services of gaseous fuels through mains	7.880%	0.675220	0.443246	0.376044	0.0656900	0.020490	0.00832509
4	WE	Steam and hot water supply services	6.853%	0.587227	0.385483	0.327039	0.0571294	0.017820	0.00724018
5	WE	Construction work (45)	3.202%	0.274407	0.180134	0.152823	0.026696	0.008327	0.00338329
6	CN	Electricity by coal	1.909%	0.163556	0.107366	0.091088	0.0159118	0.004963	0.00201656
7	RU	Steam and hot water supply services	1.519%	0.130129	0.085423	0.072471	0.0126598	0.003949	0.00160441
8	RU	Heavy Fuel Oil	1.383%	0.118500	0.077789	0.065995	0.0115284	0.003596	0.00146103
9	WE	Wholesale trade and commission trade services, except of motor vehicles and motorcycles (51)	1.284%	0.109989	0.072202	0.061255	0.0107005	0.003338	0.00135611
10	WE	Retail trade services, except of motor vehicles and motorcycles; repair services of personal and household goods (52)	1.167%	0.100010	0.065651	0.055698	0.0097296	0.003035	0.00123307
11	WE	Cement, lime and plaster	1.093%	0.093659	0.061482	0.052161	0.0091118	0.002842	0.00115477
12	WE	Poultry	0.876%	0.075091	0.049294	0.041820	0.0073054	0.002279	0.00092584
13	WE	Electricity by solar thermal	0.873%	0.074785	0.049092	0.041649	0.0072755	0.002269	0.00092205
14	WE	Electricity by gas	0.843%	0.072272	0.047443	0.040250	0.0070311	0.002193	0.00089107
15	RU	Transportation services via pipelines	0.684%	0.058586	0.038459	0.032628	0.0056996	0.001778	0.00072233

16	CN	Basic iron and steel and of ferro-alloys and first products thereof	0.647%	0.055473	0.036415	0.030894	0.0053967	0.001683	0.00068395
17	WE	Other business services (74)	0.592%	0.050731	0.033302	0.028253	0.0049354	0.001539	0.00062549
18	US	Electricity by coal	0.561%	0.048112	0.031583	0.026795	0.0046807	0.001460	0.0005932
19	RU	Gas/Diesel Oil	0.532%	0.045592	0.029928	0.025391	0.0044354	0.001384	0.00056212
20	WE	Pigs	0.524%	0.044881	0.029462	0.024995	0.0043663	0.001362	0.00055336

Table 36: Total Annual Carbon Footprint Distribution of Bitcoin mining energy consumption in Iceland by country

Order	Country Code	P.A.D.* (%)	Total GWP per year (MtCO$_2$-eqv.)					
			2020	**2019**	**2018**	**2017**	**2016**	**2015**
1	WE	66.470%	1.751×10^{-3}	7.896×10^{-3}	2.345×10^{-3}	1.087×10^{-3}	4.634×10^{-4}	1.445×10^{-4}
2	RU	8.125%	2.141×10^{-4}	9.651×10^{-4}	2.866×10^{-4}	1.329×10^{-4}	5.664×10^{-5}	1.767×10^{-5}
3	CN	4.289%	1.130×10^{-4}	5.095×10^{-4}	1.513×10^{-4}	7.015×10^{-5}	2.990×10^{-5}	9.327×10^{-6}
4	WA	3.298%	8.691×10^{-5}	3.918×10^{-4}	1.164×10^{-4}	5.394×10^{-5}	2.299×10^{-5}	7.172×10^{-6}
5	WM	3.082%	8.120×10^{-5}	3.661×10^{-4}	1.087×10^{-4}	5.040×10^{-5}	2.148×10^{-5}	6.701×10^{-6}
6	US	1.778%	4.686×10^{-5}	2.112×10^{-4}	6.274×10^{-5}	2.908×10^{-5}	1.240×10^{-5}	3.867×10^{-6}
7	DE	1.129%	2.974×10^{-5}	1.341×10^{-4}	3.982×10^{-5}	1.846×10^{-5}	7.868×10^{-6}	2.454×10^{-6}
8	IN	0.932%	2.457×10^{-5}	1.107×10^{-4}	3.289×10^{-5}	1.525×10^{-5}	6.499×10^{-6}	2.027×10^{-6}
9	IT	0.707%	1.863×10^{-5}	8.397×10^{-5}	2.494×10^{-5}	1.156×10^{-5}	4.928×10^{-6}	1.537×10^{-6}
10	KR	0.628%	1.656×10^{-5}	7.464×10^{-5}	2.217×10^{-5}	1.028×10^{-5}	4.380×10^{-6}	1.366×10^{-6}

Table 37: Total Annual Carbon Footprint Distribution of Bitcoin mining energy consumption in Iceland by sector

Order	Country Code	Sector	P.A.D.* (%)	Total GWP per year (MtCO$_2$-eqv.)					
				2020	**2019**	**2018**	**2017**	**2016**	**2015**
1	WE	Electricity by hydro	18.903%	4.981×10^{-4}	2.245×10^{-3}	6.669×10^{-4}	3.092×10^{-4}	1.318×10^{-4}	4.110×10^{-5}
2	WE	Electricity by coal	13.525%	3.564×10^{-4}	1.607×10^{-3}	4.771×10^{-4}	2.212×10^{-4}	9.429×10^{-5}	2.941×10^{-5}
3	WE	Distribution services of gaseous fuels through mains	7.880%	2.076×10^{-4}	9.360×10^{-4}	2.780×10^{-4}	1.289×10^{-4}	5.494×10^{-5}	1.714×10^{-5}
4	WE	Steam and hot water supply services	6.853%	1.806×10^{-4}	8.140×10^{-4}	2.418×10^{-4}	1.121×10^{-4}	4.778×10^{-5}	1.490×10^{-5}
5	WE	Construction work (45)	3.202%	8.438×10^{-5}	3.804×10^{-4}	1.130×10^{-4}	5.238×10^{-5}	2.233×10^{-5}	6.964×10^{-6}
6	CN	Electricity by coal	1.909%	5.030×10^{-5}	2.267×10^{-4}	6.734×10^{-5}	3.122×10^{-5}	1.331×10^{-5}	4.151×10^{-6}
7	RU	Steam and hot water supply services	1.519%	4.002×10^{-5}	1.804×10^{-4}	5.358×10^{-5}	2.484×10^{-5}	1.059×10^{-5}	3.302×10^{-6}
8	RU	Heavy Fuel Oil	1.383%	3.644×10^{-5}	1.643×10^{-4}	4.879×10^{-5}	2.262×10^{-5}	9.641×10^{-6}	3.007×10^{-6}
9	WE	Wholesale trade and commission trade services, except of motor vehicles and motorcycles (51)	1.284%	3.382×10^{-5}	1.525×10^{-4}	4.528×10^{-5}	2.099×10^{-5}	8.949×10^{-6}	2.791×10^{-6}
10	WE	Retail trade services, except of motor vehicles and motorcycles; repair services of personal and household goods (52)	1.167%	3.075×10^{-5}	1.386×10^{-4}	4.118×10^{-5}	1.909×10^{-5}	8.137×10^{-6}	2.538×10^{-6}
11	WE	Cement, lime and plaster	1.093%	2.880×10^{-5}	1.298×10^{-4}	3.856×10^{-5}	1.788×10^{-5}	7.620×10^{-6}	2.377×10^{-6}
12	WE	Poultry	0.876%	2.309×10^{-5}	1.041×10^{-4}	3.092×10^{-5}	1.433×10^{-5}	6.110×10^{-6}	1.906×10^{-6}
13	WE	Electricity by solar thermal	0.873%	2.300×10^{-5}	1.037×10^{-4}	3.079×10^{-5}	1.427×10^{-5}	6.085×10^{-6}	1.898×10^{-6}

14	WE	Electricity by gas	0.843%	$2.222 \ 10^{-5}$	$1.002 \ 10^{-4}$	$2.976 \ 10^{-5}$	$1.379 \ 10^{-5}$	$5.880 \ 10^{-6}$	$1.834 \ 10^{-6}$
15	RU	Transportation services via pipelines	0.684%	$1.802 \ 10^{-5}$	$8.122 \ 10^{-5}$	$2.412 \ 10^{-5}$	$1.118 \ 10^{-5}$	$4.767 \ 10^{-6}$	$1.487 \ 10^{-6}$
16	CN	Basic iron and steel and of ferro-alloys and first products thereof	0.647%	$1.706 \ 10^{-5}$	$7.690 \ 10^{-5}$	$2.284 \ 10^{-5}$	$1.059 \ 10^{-5}$	$4.513 \ 10^{-6}$	$1.408 \ 10^{-6}$
17	WE	Other business services (74)	0.592%	$1.560 \ 10^{-5}$	$7.033 \ 10^{-5}$	$2.089 \ 10^{-5}$	$9.683 \ 10^{-6}$	$4.128 \ 10^{-6}$	$1.287 \ 10^{-6}$
18	US	Electricity by coal	0.561%	$1.480 \ 10^{-5}$	$6.670 \ 10^{-5}$	$1.981 \ 10^{-5}$	$9.183 \ 10^{-6}$	$3.914 \ 10^{-6}$	$1.221 \ 10^{-6}$
19	RU	Gas/Diesel Oil	0.532%	$1.402 \ 10^{-5}$	$6.320 \ 10^{-5}$	$1.877 \ 10^{-5}$	$8.702 \ 10^{-6}$	$3.709 \ 10^{-6}$	$1.157 \ 10^{-6}$
20	WE	Pigs	0.524%	$1.380 \ 10^{-5}$	$6.222 \ 10^{-5}$	$1.848 \ 10^{-5}$	$8.567 \ 10^{-6}$	$3.652 \ 10^{-6}$	$1.139 \ 10^{-6}$

Table 38: Carbon Footprint Distribution of Bitcoin mining energy consumption in USA per transaction by country

Order	Total GWP per year (MtCO$_2$-eqv.)																	
	2020			2019			2018			2017			2016			2015		
	C.C.	P.A.D.* (%)	GWP	C.C.	P.A.D.* (%)	GWP	C.C.	P.A.D.* (%)	GWP	C.C.	P.A.D.* (%)	GWP	C.C.	P.A.D.* (%)	GWP	C.C.	P.A.D.* (%)	GWP
1	US	85.76%	322.310	US	88.25%	211.507	US	88.85%	179.425	US	91.07%	31.334	US	91.14%	9.774	US	89.78%	3.972
2	CN	12.85%	48.307	CN	10.57%	25.340	CN	10.02%	20.227	CN	7.99%	2.750	CN	7.92%	$8.49 \cdot 10^{-1}$	CN	9.17%	$4.06 \cdot 10^{-1}$
3	JP	0.21%	0.781	JP	0.17%	$4.11 \cdot 10^{-1}$	JP	0.16%	$3.28 \cdot 10^{-1}$	JP	0.13%	$4.47 \cdot 10^{-2}$	JP	0.13%	$1.38 \cdot 10^{-2}$	JP	0.15%	$6.59 \cdot 10^{-3}$
4	WA	0.20%	0.747	WA	0.17%	$3.95 \cdot 10^{-1}$	WA	0.16%	$3.16 \cdot 10^{-1}$	WA	0.13%	$4.35 \cdot 10^{-2}$	WA	0.13%	$1.34 \cdot 10^{-2}$	WA	0.14%	$6.37 \cdot 10^{-3}$
5	KR	0.16%	0.602	KR	0.13%	$3.17 \cdot 10^{-1}$	KR	0.13%	$2.53 \cdot 10^{-1}$	KR	0.10%	$3.45 \cdot 10^{-2}$	KR	0.10%	$1.07 \cdot 10^{-2}$	KR	0.12%	$5.08 \cdot 10^{-3}$
6	WM	0.15%	0.575	WM	0.13%	$3.06 \cdot 10^{-1}$	WM	0.12%	$2.45 \cdot 10^{-1}$	WM	0.10%	$3.4 \cdot 10^{-2}$	WM	0.10%	$1.05 \cdot 10^{-2}$	WM	0.11%	$4.95 \cdot 10^{-3}$
7	RU	0.10%	0.386	RU	0.09%	$2.18 \cdot 10^{-1}$	RU	0.09%	$1.78 \cdot 10^{-1}$	RU	0.08%	$2.69 \cdot 10^{-2}$	RU	0.08%	$8.33 \cdot 10^{-3}$	RU	0.08%	$3.72 \cdot 10^{-3}$
8	DE	0.10%	0.376	DE	0.08%	$1.99 \cdot 10^{-1}$	DE	0.08%	$1.59 \cdot 10^{-1}$	WL	0.07%	$2.28 \cdot 10^{-2}$	WL	0.07%	$7.08 \cdot 10^{-3}$	DE	0.07%	$3.21 \cdot 10^{-3}$
9	WL	0.08%	0.281	WL	0.07%	$1.7 \cdot 10^{-1}$	WL	0.07%	$1.41 \cdot 10^{-1}$	DE	0.06%	$2.2 \cdot 10^{-2}$	DE	0.06%	$6.79 \cdot 10^{-3}$	WL	0.07%	$3.02 \cdot 10^{-3}$
10	IN	0.05%	0.177	IN	0.04%	$9.43 \cdot 10^{-2}$	IN	0.04%	$7.57 \cdot 10^{-2}$	IN	0.03%	$1.06 \cdot 10^{-2}$	IN	0.03%	$3.27 \cdot 10^{-3}$	IN	0.04%	$1.53 \cdot 10^{-3}$

Table 39: Carbon Footprint Distribution of Bitcoin mining energy consumption in USA per transaction by sector in Supply Chain

Order	Country Code	Sector	P.A.D.* (%)	GWP per transaction per year (kgCO2-eqv.)					
				2020	2019	2018	2017	2016	2015
1	US	Electricity by coal	56.791%	183.149687	120.228116	101.999789	17.818066	5.557833	2.258135
2	US	Electricity by gas	41.142%	132.681598	87.098476	73.893083	12.90818	4.026336	1.635891
3	US	Electricity by petroleum and other oil derivatives	0.659%	2.125696	1.395407	1.183843	0.2068024	0.064506	0.026209
4	US	Electricity by biomass and waste	0.604%	1.947295	1.278296	1.084488	0.1894462	0.059092	0.024009
5	US	Other Bituminous Coal	0.232%	0.749653	0.492108	0.417497	0.0729314	0.022749	0.009243
6	US	Transportation services via pipelines	0.102%	0.330010	0.216634	0.183789	0.0321056	0.010014	0.004069
7	US	Retail trade services, except of motor vehicles and motorcycles; repair services of personal and household goods (52)	0.086%	0.276179	0.181297	0.153810	0.0268686	0.008381	0.003405
8	US	Sub-Bituminous Coal	0.029%	0.093179	0.061167	0.051893	0.0090651	0.002828	0.001149
9	US	Electricity by nuclear	0.019%	0.061936	0.040658	0.034494	0.0060255	0.001880	0.000764
10	US	Retail trade services of motor fuel	0.018%	0.059098	0.038794	0.032913	0.0057494	0.001793	0.000729
11	US	Air transport services (62)	0.017%	0.055055	0.036141	0.030661	0.0053561	0.001671	0.000679
12	RU	Heavy Fuel Oil	0.015%	0.049414	0.032437	0.027519	0.0048072	0.001499	0.000609
13	US	Railway transportation services	0.013%	0.043451	0.028524	0.024199	0.0042272	0.001319	0.000536
14	CN	Electricity by coal	0.013%	0.041566	0.027286	0.023149	0.0040437	0.001261	0.000512
15	WL	Heavy Fuel Oil	0.011%	0.035360	0.023212	0.019693	0.0034400	0.001073	0.000436

16	WL	Crude petroleum and services related to crude oil extraction, excluding surveying	0.011%	0.034211	0.022458	0.019053	0.0033282	0.001038	0.000422
17	MX	Heavy Fuel Oil	0.010%	0.030998	0.020349	0.017263	0.0030157	0.000941	0.000382
18	RU	Steam and hot water supply services	0.009%	0.028765	0.018882	0.016020	0.0027984	0.000873	0.000355
19	WL	Petroleum Coke	0.009%	0.027482	0.018040	0.015305	0.0026736	0.000834	0.000339
20	US	Steam and hot water supply services	0.008%	0.027049	0.017756	0.015064	0.0026314	0.000821	0.000333

Table 40: Total Annual Carbon Footprint Distribution of Bitcoin mining energy consumption in USA by country

Order	Country Code	P.A.D.* (%)	Total GWP per year (MtCO$_2$-eqv.)					
			2020	**2019**	**2018**	**2017**	**2016**	**2015**
1	US	99.770%	5.835	2.922	1.376	3.065×10^{-1}	1.224×10^{-1}	3.503×10^{-2}
2	WL	0.052%	3.045×10^{-3}	1.525×10^{-3}	7.179×10^{-4}	1.599×10^{-4}	6.388×10^{-5}	1.828×10^{-5}
3	RU	0.038%	2.213×10^{-3}	1.108×10^{-3}	5.217×10^{-4}	1.162×10^{-4}	4.642×10^{-5}	1.329×10^{-5}
4	CN	0.027%	1.590×10^{-3}	7.961×10^{-4}	3.748×10^{-4}	8.349×10^{-5}	3.335×10^{-5}	9.544×10^{-6}
5	MX	0.022%	1.287×10^{-3}	6.443×10^{-4}	3.033×10^{-4}	6.757×10^{-5}	2.699×10^{-5}	7.725×10^{-6}
6	CA	0.022%	1.258×10^{-3}	6.299×10^{-4}	2.966×10^{-4}	6.606×10^{-5}	2.639×10^{-5}	7.552×10^{-6}
7	WM	0.010%	5.714×10^{-4}	2.862×10^{-4}	1.347×10^{-4}	3.001×10^{-5}	1.199×10^{-5}	3.431×10^{-6}
8	WA	0.008%	4.733×10^{-4}	2.370×10^{-4}	1.116×10^{-4}	2.486×10^{-5}	9.929×10^{-6}	2.842×10^{-6}
9	WF	0.005%	2.999×10^{-4}	1.502×10^{-4}	7.072×10^{-5}	1.575×10^{-5}	6.293×10^{-6}	1.801×10^{-6}
10	GB	0.004%	2.536×10^{-4}	1.270×10^{-4}	5.980×10^{-5}	1.332×10^{-5}	5.321×10^{-6}	1.523×10^{-6}

Table 41: Total Annual Carbon Footprint Distribution of Bitcoin mining energy consumption in USA by sector

Order	Country Code	Sector	P.A.D.* (%)	Total GWP per year (MtCO$_2$-eqv.)					
				2020	**2019**	**2018**	**2017**	**2016**	**2015**
1	US	Electricity by coal	56.791%	3.321	1.663	$7.831\ 10^{-1}$	1.327	$6.968\ 10^{-2}$	$1.994\ 10^{-2}$
2	US	Electricity by gas	41.142%	2.406	1.205	$5.673\ 10^{-1}$	$9.613\ 10^{-1}$	$5.048\ 10^{-2}$	$1.445\ 10^{-2}$
3	US	Electricity by petroleum and other oil derivatives	0.659%	$3.855\ 10^{-2}$	$1.931\ 10^{-2}$	$9.089\ 10^{-3}$	$1.540\ 10^{-2}$	$8.088\ 10^{-4}$	$2.315\ 10^{-4}$
4	US	Electricity by biomass and waste	0.604%	$3.531\ 10^{-2}$	$1.769\ 10^{-2}$	$8.326\ 10^{-3}$	$1.411\ 10^{-2}$	$7.409\ 10^{-4}$	$2.120\ 10^{-4}$
5	US	Other Bituminous Coal	0.232%	$1.359\ 10^{-2}$	$6.808\ 10^{-3}$	$3.205\ 10^{-3}$	$5.431\ 10^{-3}$	$2.852\ 10^{-4}$	$8.163\ 10^{-5}$
6	US	Transportation services via pipelines	0.102%	$5.985\ 10^{-3}$	$2.997\ 10^{-3}$	$1.411\ 10^{-3}$	$2.391\ 10^{-3}$	$1.256\ 10^{-4}$	$3.593\ 10^{-5}$
7	US	Retail trade services, except of motor vehicles and motorcycles; repair services of personal and household goods (52)	0.086%	$5.008\ 10^{-3}$	$2.508\ 10^{-3}$	$1.181\ 10^{-3}$	$2.001\ 10^{-3}$	$1.051\ 10^{-4}$	$3.007\ 10^{-5}$
8	US	Sub-Bituminous Coal	0.029%	$1.690\ 10^{-3}$	$8.462\ 10^{-4}$	$3.984\ 10^{-4}$	$6.751\ 10^{-4}$	$3.545\ 10^{-5}$	$1.015\ 10^{-5}$
9	US	Electricity by nuclear	0.019%	$1.123\ 10^{-3}$	$5.625\ 10^{-4}$	$2.648\ 10^{-4}$	$4.487\ 10^{-4}$	$2.357\ 10^{-5}$	$6.744\ 10^{-6}$
10	US	Retail trade services of motor fuel	0.018%	$1.072\ 10^{-3}$	$5.367\ ^{10-4}$	$2.527\ 10^{-4}$	$4.282\ 10^{-4}$	$2.249\ 10^{-5}$	$6.435\ 10^{-6}$
11	US	Air transport services (62)	0.017%	$9.984\ 10^{-4}$	$5.000\ 10^{-4}$	$2.354\ 10^{-4}$	$3.989\ 10^{-4}$	$2.095\ 10^{-5}$	$5.995\ 10^{-6}$
12	RU	Heavy Fuel Oil	0.015%	$8.961\ 10^{-4}$	$4.488\ 10^{-4}$	$2.113\ 10^{-4}$	$3.580\ 10^{-4}$	$1.880\ 10^{-5}$	$5.380\ 10^{-6}$
13	US	Railway transportation services	0.013%	$7.880\ 10^{-4}$	$3.946\ 10^{-4}$	$1.858\ 10^{-4}$	$3.148\ 10^{-4}$	$1.653\ 10^{-5}$	$4.731\ 10^{-6}$
14	CN	Electricity by coal	0.013%	$7.538\ 10^{-4}$	$3.775\ 10^{-4}$	$1.777\ 10^{-4}$	$3.012\ 10^{-4}$	$1.581\ 10^{-5}$	$4.526\ 10^{-6}$
15	WL	Heavy Fuel Oil	0.011%	$6.412\ 10^{-4}$	$3.211\ 10^{-4}$	$1.512\ 10^{-4}$	$2.562\ 10^{-4}$	$1.345\ 10^{-5}$	$3.850\ 10^{-6}$

16	WL	Crude petroleum and services related to crude oil extraction, excluding surveying	0.011%	$6.204\ 10^{-4}$	$3.107\ 10^{-4}$	$1.463\ 10^{-4}$	$2.479\ 10^{-4}$	$1.302\ 10^{-5}$	$3.725\ 10^{-6}$
17	MX	Heavy Fuel Oil	0.010%	$5.621\ 10^{-4}$	$2.815\ 10^{-4}$	$1.325\ 10^{-4}$	$2.246\ 10^{-4}$	$1.179\ 10^{-5}$	$3.375\ 10^{-6}$
18	RU	Steam and hot water supply services	0.009%	$5.216\ 10^{-4}$	$2.612\ 10^{-4}$	$1.230\ 10^{-4}$	$2.084\ 10^{-4}$	$1.094\ 10^{-5}$	$3.132\ 10^{-6}$
19	WL	Petroleum Coke	0.009%	$4.984\ 10^{-4}$	$2.496\ 10^{-4}$	$1.175\ 10^{-4}$	$1.991\ 10^{-4}$	$1.046\ 10^{-5}$	$2.992\ 10^{-6}$
20	US	Steam and hot water supply services	0.008%	$4.905\ 10^{-4}$	$2.457\ 10^{-4}$	$1.157\ 10^{-4}$	$1.960\ 10^{-4}$	$1.029\ 10^{-5}$	$2.945\ 10^{-6}$

g) India

Table 42: Carbon Footprint Distribution of Bitcoin mining energy consumption in India per transaction by country

Order	Country Code	P.A.D.* (%)	GWP per transaction per year (kgCO2-eqv.)		
			2018	**2017**	**2016**
1	IN	99.739%	13.184345	42.268191	241.964893
2	CN	0.073%	0.009612	0.030816	0.176407
3	ID	0.061%	0.008095	0.025952	0.148564
4	US	0.020%	0.002684	0.008605	0.049259
5	WM	0.018%	0.002415	0.007741	0.044312
6	WA	0.014%	0.001793	0.005749	0.032910
7	AU	0.012%	0.001584	0.005080	0.029078
8	RU	0.011%	0.001395	0.004472	0.025603
9	ZA	0.010%	0.001262	0.004045	0.023154
10	KR	0.009%	0.001162	0.003726	0.021329

Table 43: Carbon Footprint Distribution of Bitcoin mining energy consumption in India per transaction by sector in Supply Chain

Order	Country Code	Sector	P.A.D* (%)	GWP per transaction per year (kgCO2-eqv.)		
				2018	2017	2016
1	IN	Electricity by coal	94.832%	230.061748	40.1888626	12.535759
2	IN	Electricity by gas	3.627%	8.799549	1.5371693	0.479476
3	IN	Electricity by biomass and waste	0.539%	1.308463	0.2285719	0.071296
4	IN	Other Bituminous Coal	0.460%	1.116126	0.1949730	0.060816
5	IN	Coking Coal	0.069%	0.167356	0.0292349	0.009119
6	ID	Sub-Bituminous Coal	0.054%	0.130555	0.0228062	0.007114
7	IN	Electricity by petroleum and other oil derivatives	0.042%	0.101649	0.0177567	0.005539
8	CN	Electricity by coal	0.038%	0.091587	0.0159991	0.004990
9	IN	Other land transportation services	0.029%	0.069684	0.0121729	0.003797
10	IN	Basic iron and steel and of ferro-alloys and first products thereof	0.016%	0.039732	0.0069406	0.002165
11	IN	Railway transportation services	0.016%	0.038604	0.0067436	0.002103
12	IN	Electricity by hydro	0.011%	0.027326	0.0047734	0.001489
13	IN	Furniture; other manufactured goods n.e.c. (36)	0.011%	0.027019	0.0047198	0.001472
14	CN	Basic iron and steel and of ferro-alloys and first products thereof	0.010%	0.025426	0.0044415	0.001385
15	IN	Rubber and plastic products (25)	0.008%	0.020047	0.0035020	0.001092
16	US	Other Bituminous Coal	0.007%	0.017379	0.0030358	0.000947

17	IN	Supporting and auxiliary transport services; travel agency services (63)	0.007%	0.016729	0.0029222	0.000912
18	IN	Gas/Diesel Oil	0.007%	0.016005	0.0027958	0.000872
19	AU	Coking Coal	0.007%	0.015866	0.0027715	0.000864
20	ID	Other Bituminous Coal	0.006%	0.015102	0.0026382	0.000823

Table 44: Total Annual Carbon Footprint Distribution of Bitcoin mining energy consumption in India by country

Order	Country Code	P.A.D.* (%)	Total GWP per year (MtCO$_2$-eqv.)		
			2018	2017	2016
1	IN	99.739%	1.370×10^{-2}	1.107×10^{-1}	5.515×10^{-2}
2	CN	0.073%	9.985×10^{-6}	8.070×10^{-5}	4.021×10^{-5}
3	ID	0.061%	8.409×10^{-6}	6.796×10^{-5}	3.386×10^{-5}
4	US	0.020%	2.788×10^{-6}	2.253×10^{-5}	1.123×10^{-5}
5	WM	0.018%	2.508×10^{-6}	2.027×10^{-5}	1.010×10^{-5}
6	WA	0.014%	1.863×10^{-6}	1.505×10^{-5}	7.502×10^{-6}
7	AU	0.012%	1.646×10^{-6}	1.330×10^{-5}	6.628×10^{-6}
8	RU	0.011%	1.449×10^{-6}	1.171×10^{-5}	5.836×10^{-6}
9	ZA	0.010%	1.311×10^{-6}	1.059×10^{-5}	5.278×10^{-6}
10	KR	0.009%	1.207×10^{-6}	9.757×10^{-6}	4.862×10^{-6}

Table 45: Total Annual Carbon Footprint Distribution of Bitcoin mining energy consumption in India by sector

Order	Country Code	Sector	P.A.D.*	Total GWP per year (MtCO$_2$-eqv.)		
				2018	**2017**	**2016**
1	IN	Electricity by coal	94.832%	$5.244 \cdot 10^{-2}$	$1.052 \cdot 10^{-1}$	$1.302 \cdot 10^{-2}$
2	IN	Electricity by gas	3.627%	$2.006 \cdot 10^{-3}$	$4.025 \cdot 10^{-3}$	$4.981 \cdot 10^{-4}$
3	IN	Electricity by biomass and waste	0.539%	$2.983 \cdot 10^{-4}$	$5.986 \cdot 10^{-4}$	$7.407 \cdot 10^{-5}$
4	IN	Other Bituminous Coal	0.460%	$2.544 \cdot 10^{-4}$	$5.106 \cdot 10^{-4}$	$6.318 \cdot 10^{-5}$
5	IN	Coking Coal	0.069%	$3.815 \cdot 10^{-5}$	$7.656 \cdot 10^{-5}$	$9.473 \cdot 10^{-6}$
6	ID	Sub-Bituminous Coal	0.054%	$2.976 \cdot 10^{-5}$	$5.972 \cdot 10^{-5}$	$7.390 \cdot 10^{-6}$
7	IN	Electricity by petroleum and other oil derivatives	0.042%	$2.317 \cdot 10^{-5}$	$4.650 \cdot 10^{-5}$	$5.754 \cdot 10^{-6}$
8	CN	Electricity by coal	0.038%	$2.088 \cdot 10^{-5}$	$4.190 \cdot 10^{-5}$	$5.184 \cdot 10^{-6}$
9	IN	Other land transportation services	0.029%	$1.588 \cdot 10^{-5}$	$3.188 \cdot 10^{-5}$	$3.944 \cdot 10^{-6}$
10	IN	Basic iron and steel and of ferro-alloys and first products thereof	0.016%	$9.057 \cdot 10^{-6}$	$1.818 \cdot 10^{-5}$	$2.249 \cdot 10^{-6}$
11	IN	Railway transportation services	0.016%	$8.799 \cdot 10^{-6}$	$1.766 \cdot 10^{-5}$	$2.185 \cdot 10^{-6}$
12	IN	Electricity by hydro	0.011%	$6.229 \cdot 10^{-6}$	$1.250 \cdot 10^{-5}$	$1.547 \cdot 10^{-6}$
13	IN	Furniture; other manufactured goods n.e.c. (36)	0.011%	$6.159 \cdot 10^{-6}$	$1.236 \cdot 10^{-5}$	$1.529 \cdot 10^{-6}$
14	CN	Basic iron and steel and of ferro-alloys and first products thereof	0.010%	$5.796 \cdot 10^{-6}$	$1.163 \cdot 10^{-5}$	$1.439 \cdot 10^{-6}$
15	IN	Rubber and plastic products (25)	0.008%	$4.570 \cdot 10^{-6}$	$9.171 \cdot 10^{-6}$	$1.135 \cdot 10^{-6}$

16	US	Other Bituminous Coal	0.007%	3.961 10^{-6}	7.950 10^{-6}	9.837 10^{-7}
17	IN	Supporting and auxiliary transport services; travel agency services (63)	0.007%	3.813 10^{-6}	7.653 10^{-6}	9.469 10^{-7}
18	IN	Gas/Diesel Oil	0.007%	3.648 10^{-6}	7.321 10^{-6}	9.060 10^{-7}
19	AU	Coking Coal	0.007%	3.616 10^{-6}	7.258 10^{-6}	8.981 10^{-7}
20	ID	Other Bituminous Coal	0.006%	3.443 10^{-6}	6.909 10^{-6}	8.549 10^{-7}

h) Sweden

Table 46: Carbon Footprint Distribution of Bitcoin mining energy consumption in Sweden per transaction by country

Order	Country Code	P.A.D.* (%)	GWP per transaction per year (kgCO2-eqv.)	
			2017	2016
1	SE	45%	0.376321457	0.117382643
2	RU	6%	0.052933418	0.016511056
3	WM	6%	0.048119902	0.015009618
4	CN	5%	0.04158796	0.012972167
5	WA	5%	0.04106802	0.012809986
6	DE	3%	0.027536192	0.008589122
7	US	3%	0.023165755	0.00722589
8	FI	2%	0.014892919	0.004645417
9	NL	2%	0.013234116	0.004128001
10	GB	2%	0.013154834	0.004103272

Table 47: Carbon Footprint Distribution of Bitcoin mining energy consumption in Sweden per transaction by sector in Supply Chain

Order	Country Code	Sector	P.A.D.* (%)	Total GWP per year (MtCO$_2$-eqv.)	
				2017	2016
1	SE	Electricity by hydro	10.594%	0.3763214	0.027459
2	SE	Electricity by nuclear	10.406%	0.0529334	0.026973
3	SE	Electricity by solar thermal	7.328%	0.0481199	0.018994
4	SE	Wholesale trade and commission trade services, except of motor vehicles and motorcycles (51)	2.058%	0.041587	0.005334
5	CN	Electricity by coal	2.045%	0.041068	0.005300
6	SE	Sea and coastal water transportation services	2.038%	0.0275361	0.005282
7	RU	Heavy Fuel Oil	1.444%	0.0231657	0.003742
8	WA	Sea and coastal water transportation services	1.292%	0.0148929	0.003349
9	SE	Retail trade services, except of motor vehicles and motorcycles; repair services of personal and household goods (52)	1.158%	0.0132341	0.003001
10	SE	Supporting and auxiliary transport services; travel agency services (63)	1.104%	0.0131548	0.002861
11	SE	Other land transportation services	1.083%	0.0124654	0.002808
12	RU	Steam and hot water supply services	1.046%	0.0118584	0.002710
13	WM	Sea and coastal water transportation services	1.006%	0.0112138	0.002608
14	SE	Pulp	0.977%	0.0110292	0.002533
15	SE	Electricity by wind	0.892%	0.0094867	0.002312

16	LV	Products of forestry, logging and related services (02)	0.849%	0.0094850	0.002200
17	SE	Products of forestry, logging and related services (02)	0.795%	0.0091078	0.002062
18	CN	Basic iron and steel and of ferro-alloys and first products thereof	0.750%	0.0079432	0.001944
19	WM	Rubber and plastic products (25)	0.709%	0.0075450	0.001836
20	DE	Sea and coastal water transportation services	0.688%	0.0067209	0.001783

Table 48: Total Annual Carbon Footprint Distribution of Bitcoin mining energy consumption in Sweden by country

Order	Country Code	P.A.D.* (%)	Total GWP per year (MtCO$_2$-eqv.)	
			2017	2016
1	SE	45%	7.822×10^{-5}	3.820×10^{-5}
2	RU	6%	1.100×10^{-5}	5.374×10^{-6}
3	WM	6%	1.000×10^{-5}	4.885×10^{-6}
4	CN	5%	8.644×10^{-6}	4.222×10^{-6}
5	WA	5%	8.536×10^{-6}	4.169×10^{-6}
6	DE	3%	5.723×10^{-6}	2.795×10^{-6}
7	US	3%	4.815×10^{-6}	2.352×10^{-6}
8	FI	2%	3.095×10^{-6}	1.512×10^{-6}
9	NL	2%	2.751×10^{-6}	1.344×10^{-6}
10	GB	2%	2.734×10^{-6}	1.335×10^{-6}

Table 49: Total Annual Carbon Footprint Distribution of Bitcoin mining energy consumption in Sweden by sector

Order	Country Code	Sector	P.A.D.*	Total GWP per year (MtCO$_2$-eqv.)

				2017	2016
1	SE	Electricity by hydro	10.594%	9.413×10^{-5}	8.937×10^{-6}
2	SE	Electricity by nuclear	10.406%	1.324×10^{-5}	8.779×10^{-6}
3	SE	Electricity by solar thermal	7.328%	1.204×10^{-5}	6.182×10^{-6}
4	SE	Wholesale trade and commission trade services, except of motor vehicles and motorcycles (51)	2.058%	1.040×10^{-5}	1.736×10^{-6}
5	CN	Electricity by coal	2.045%	1.027×10^{-5}	1.725×10^{-6}
6	SE	Sea and coastal water transportation services	2.038%	6.888×10^{-6}	1.719×10^{-6}
7	RU	Heavy Fuel Oil	1.444%	5.794×10^{-6}	1.218×10^{-6}
8	WA	Sea and coastal water transportation services	1.292%	3.725×10^{-6}	1.090×10^{-6}
9	SE	Retail trade services, except of motor vehicles and motorcycles; repair services of personal and household goods (52)	1.158%	3.310×10^{-6}	9.767×10^{-7}
10	SE	Supporting and auxiliary transport services; travel agency services (63)	1.104%	3.290×10^{-6}	9.313×10^{-7}
11	SE	Other land transportation services	1.083%	3.118×10^{-6}	9.140×10^{-7}
12	RU	Steam and hot water supply services	1.046%	2.966×10^{-6}	8.821×10^{-7}
13	WM	Sea and coastal water transportation services	1.006%	2.805×10^{-6}	8.489×10^{-7}
14	SE	Pulp	0.977%	2.759×10^{-6}	8.243×10^{-7}
15	SE	Electricity by wind	0.892%	2.373×10^{-6}	7.526×10^{-7}
16	LV	Products of forestry, logging and related services (02)	0.849%	2.372×10^{-6}	7.161×10^{-7}
17	SE	Products of forestry, logging and related services (02)	0.795%	2.278×10^{-6}	6.710×10^{-7}
18	CN	Basic iron and steel and of ferro-alloys and first products thereof	0.750%	1.987×10^{-6}	6.326×10^{-7}

19	WM	Rubber and plastic products (25)	0.709%	$1.887 \ 10^{-6}$	$5.977 \ 10^{-7}$
20	DE	Sea and coastal water transportation services	0.688%	$1.681 \ 10^{-6}$	$5.802 \ 10^{-7}$

4.5.   Carbon Footprint of Bitcoin Mining by country

4.5.1.   Method

   After calculating the carbon footprint of equipment (section 4.3) needed for mining Bitcoin and analyzing the carbon footprint of electricity needed for mining Bitcoin by country (section 4.4). In this section we will analyze the total carbon footprint of Bitcoin mining. Furthermore, the GWP per transaction per year and Total Annual Carbon Footprint Distribution of Bitcoin mining was calculated using the same methodology described in the previous section.

4.5.2.   Results

i)   Total Carbon footprint of Bitcoin Mining

Table 50: GWP of Bitcoin Mining per transaction by country by year in kgCO2-eqv.

Countries	GWP per transaction per year (kgCO$_2$-eqv.)					
	2015	2016	2017	2018	2019	2020
China	5.453	13.255	42.541	248.396	294.443	459.279
U.S.	4.424	10.723	34.408	201.932	239.676	375.849
Unknown server	3.340	8.054	25.635	152.946	181.936	287.888
Finland	2.761	6.630	21.301	126.804	151.134	240.949
Georgia	0.954	2.182	7.043	45.185	54.929	94.395
Iceland	0.553	1.197	3.883	27.097	33.608	53.348
India	0.000	14.156	45.429	264.924	0.000	0.000
Sweden	0.000	1.196	3.881	0.000	0.000	0.000
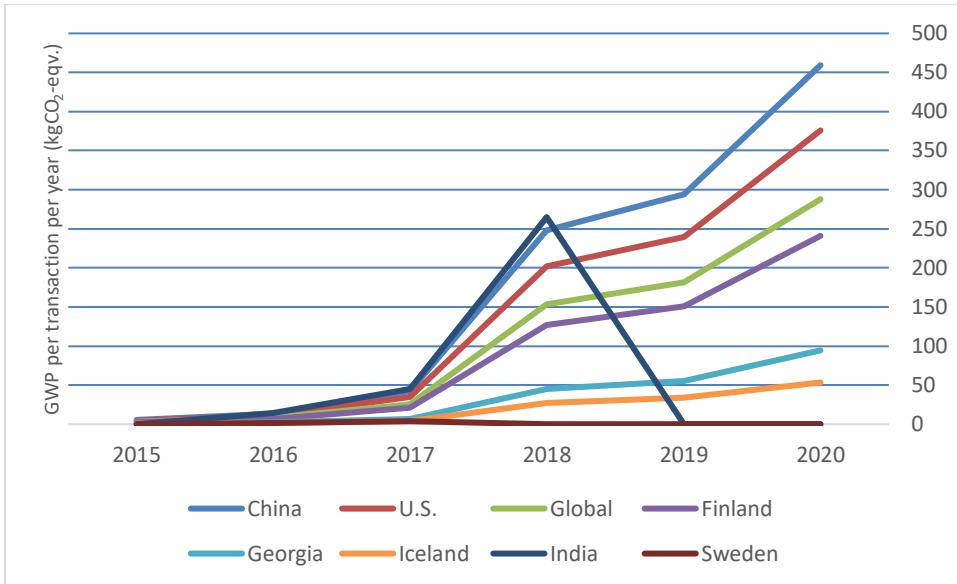
Figure 7: GWP of Bitcoin Mining per transaction by country by year in kgCO2-eqv

Table 51: Total Annual GHG emission of Bitcoin mining per by country by country by year

Countries	Total GWP per year (MtCO$_2$-eqv.)					
	2015	2016	2017	2018	2019	2020
China	0.1477	0.6983	3.1682	14.2531	25.1848	39.2586
U.S.	0.0391	0.1344	0.3369	1.5504	3.3159	5.8484
Unknown server	0.0102	0.0585	0.2418	2.1682	2.6036	2.3078
Finland	0.0057	0.0178	0.0418	0.0937	0.3192	0.0741
Georgia	0.0020	0.0059	0.0138	0.0334	0.1160	0.0290
Iceland	0.0011	0.0032	0.0076	0.0200	0.0710	0.0164
India	0.0000	0.0147	0.1190	0.0604	0.0000	0.0000
Sweden	0.0000	0.0004	0.0008	0.0000	0.0000	0.0000
Total	0.2058	0.9332	3.9299	18.1792	31.6105	47.5343
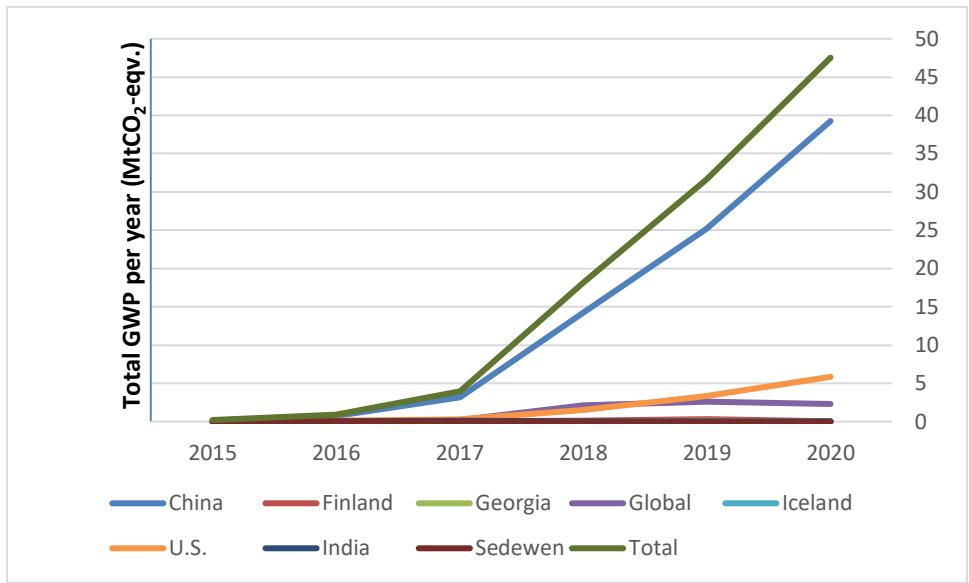
Figure 8: Total Gas emissions emission by country by year

a) China

Table 52: Abbreviation of sectors

Sector	Abbreviation
Electricity by coal	Elec. Coal
Electricity by gas	Elec. Gas
Basic iron and steel and of ferro-alloys and first products thereof	Iron and Steel
Other Bituminous Coal	Bituminous Coal
Steam and hot water supply services	Steam-Hot W. Sply.
Rubber and plastic products (25)	Rubber and plastic
Office machinery and computers (30)	O. Machinery and Computers
Chemicals nec	Chemicals nec
Air transport services (62)	Air transport services
Other non-metallic mineral products	Other mineral products
Supporting and auxiliary transport services; travel agency services (63)	Supporting transport
Coke Oven Coke	Coke Oven
Chemicals nec	Chemicals nec
Inland water transportation services	Inland transportation
Sea and coastal water transportation services	Sea transportation
Other business services (74)	Other business services
Railway transportation services	Railway transportation
Paper and paper products	paper products
Other land transportation services	land transportation
Crude petroleum and services related to crude oil extraction, excluding surveying	Crude petroleum
Electricity by petroleum and other oil derivatives	Elec. Petroleum
Wholesale trade and commission trade services, except of motor vehicles and motorcycles (51)	Wholesale trade
Retail trade services. except of motor vehicles and motorcycles; repair services of personal and household goods (52)	Retail trade
Bottles for treatment, Recycling of bottles by direct reuse	Bottles for treatment
Distribution services of gaseous fuels through mains	Dist. of gaseous fuels
Re-processing of ash into clinker Natural gas and services related to natural gas extraction. excluding surveying	Re-processing of ash
Natural gas and services related to natural gas extraction. excluding surveying abbreviation	Natural Gas Services

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Table 53: Carbon Footprint Distribution of Bitcoin mining in China per transaction by country

	GWP per transaction per year (kgCO$_2$-eqv.)																
Order	2020			2019			2018			2017			2016			2015		
	C.C.	P.A.D.* (%)	GWP	C.C.	P.A.D.* (%)	GWP	C.C.	P.A.D.* (%)	GWP	C.C.	P.A.D.* (%)	GWP	C.C.	P.A.D.* (%)	GWP	C.C.	P.A.D.* (%)	GWP
1	CN	98.35%	451.676	CN	98.54%	290.130	CN	98.58%	244.872	CN	98.75%	42.007	CN	90.38%	8.58×10^{-1}	CN	98.65%	5.379
2	WA	0.24%	1.100	WA	0.21%	0.627	WA	0.21%	0.513	WA	0.18%	7.81×10^{-2}	JP	1.45%	1.74×10^{-1}	WA	0.20%	1.07×10^{-2}
3	JP	0.20%	0.923	US	0.18%	0.533	US	0.18%	0.437	US	0.16%	6.76×10^{-2}	WA	1.35%	2.58×10^{-2}	US	0.17%	9.20×10^{-3}
4	US	0.20%	0.922	JP	0.17%	0.504	JP	0.16%	0.407	JP	0.14%	5.88×10^{-2}	KR	1.12%	2.12×10^{-2}	JP	0.15%	8.33×10^{-3}
5	KR	0.16%	0.745	KR	0.14%	0.410	KR	0.13%	0.332	KR	0.11%	4.86×10^{-2}	US	1.03%	1.76×10^{-2}	KR	0.13%	6.84×10^{-3}
6	WM	0.16%	0.715	WM	0.14%	0.398	WM	0.13%	0.323	WM	0.11%	4.78×10^{-2}	WM	1.02%	1.44×10^{-2}	WM	0.12%	6.68×10^{-3}
7	RU	0.13%	0.578	RU	0.12%	0.345	RU	0.12%	0.285	RU	0.11%	4.57×10^{-2}	DE	0.68%	1.43×10^{-2}	RU	0.11%	6.09×10^{-3}
8	DE	0.11%	0.489	DE	0.09%	0.273	DE	0.09%	0.222	DE	0.08%	3.30×10^{-2}	RU	0.49%	1.21×10^{-2}	DE	0.08%	4.60×10^{-3}
9	ID	0.06%	0.272	ID	0.06%	0.162	ID	0.05%	0.134	ID	0.05%	2.13×10^{-2}	IN	0.31%	9.31×10^{-3}	ID	0.05%	2.84×10^{-3}
10	IN	0.05%	0.229	IN	0.04%	0.129	IN	0.04%	0.105	WL	0.04%	1.63×10^{-2}	ID	0.25%	5.31×10^{-3}	WL	0.04%	2.20×10^{-3}

Table 54: Carbon Footprint Distribution of Bitcoin mining in China per transaction by sector in Supply Chain

	GWP per transaction per year (kgCO$_2$-eqv.)																							
O.	2020				2019				2018				2017				2016				2015			
	C.C.	Sector	P.A.D.* (%)	GWP	C.C.	Sector	P.A.D.* (%)	GWP	C.C.	Sector	P.A.D.* (%)	GWP	C.C.	Sector	P.A.D.* (%)	GWP	C.C.	Sector	P.A.D.* (%)	GWP	C.C.	Sector	P.A.D.* (%)	GWP
1	CN	Elec. Coal	90.19%	414.226	CN	Elec. Coal	91.10%	268.279	CN	Elec. Coal	91.34%	226.879	CN	Elec. Coal	92.13%	39.194	CN	Elec. Coal	92.18%	12.218	CN	Elec. Coal	91.68%	4.999
2	CN	Elec. Gas	1.73%	7.931	CN	Elec. Gas	1.75%	5.156	CN	Elec. Gas	1.76%	4.365	CN	Elec. Gas	1.78%	7.56×10^{-1}	CN	Elec. Gas	1.78%	2.36×10^{-1}	CN	Elec. Gas	1.77%	9.6×10^{-2}
3	CN	Iron and Steel	1.68%	7.712	CN	Iron and Steel	1.44%	4.251	CN	Iron and Steel	1.39%	3.444	CN	Iron and Steel	1.18%	5.04×10^{-1}	CN	Iron and Steel	1.17%	1.55×10^{-1}	CN	Iron and Steel	1.30%	7.1×10^{-2}
4	CN	Bituminous Coal	1.07%	4.899	CN	Bituminous Coal	1.06%	3.126	CN	Bituminous Coal	1.06%	2.634	CN	Bituminous Coal	1.06%	4.49×10^{-1}	CN	Bituminous Coal	1.06%	1.4×10^{-1}	CN	Bituminous Coal	1.06%	5.8×10^{-2}
5	CN	Steam-Hot W. Sply.	0.67%	3.072	CN	Steam-Hot W. Sply.	0.57%	1.674	CN	Steam-Hot W. Sply.	0.54%	1.352	CN	Steam-Hot W. Sply.	0.46%	1.95×10^{-1}	CN	Steam-Hot W. Sply.	0.45%	6×10^{-2}	CN	Steam-Hot W. Sply.	0.51%	2.8×10^{-2}
6	CN	Rubber and plastic	0.37%	1.684	CN	Rubber and plastic	0.31%	0.907	CN	Rubber and plastic	0.29%	0.73	CN	Rubber and plastic	0.24%	1.04×10^{-1}	CN	Rubber and plastic	0.24%	3.2×10^{-2}	CN	Rubber and plastic	0.27%	1.5×10^{-2}
7	CN	O. machinery and computers	0.34%	1.543	CN	O. machinery and computers	0.28%	0.81	CN	O. machinery and computers	0.26%	0.647	CN	O. machinery and computers	0.21%	8.9×10^{-2}	CN	O. machinery and computers	0.21%	2.7×10^{-2}	CN	O. machinery and computers	0.24%	1.3×10^{-2}
8	CN	Chemicals nec	0.26%	1.207	CN	Chemicals nec	0.22%	0.649	CN	Chemicals nec	0.21%	0.522	CN	Chemicals nec	0.17%	7.4×10^{-2}	CN	Chemicals nec	0.17%	2.3×10^{-2}	CN	Chemicals nec	0.20%	1.1×10^{-2}
9	CN	Air transport services	0.19%	0.858	CN	Other mineral products	0.16%	0.478	CN	Other mineral products	0.16%	0.389	CN	Other mineral products	0.14%	5.8×10^{-2}	CN	Other mineral products	0.14%	1.8×10^{-2}	CN	Other mineral products	0.15%	8×10^{-3}
10	CN	Other mineral products	0.19%	0.851	CN	Air transport services	0.16%	0.471	CN	Air transport services	0.15%	0.381	CN	Air transport services	0.13%	5.5×10^{-2}	CN	Air transport services	0.13%	1.7×10^{-2}	CN	Air transport services	0.14%	8×10^{-3}
11	CN	Supporting transport	0.12%	0.552	CN	Supporting transport	0.10%	0.305	CN	Supporting transport	0.10%	0.247	CN	Supporting transport	0.09%	3.6×10^{-2}	CN	Supporting transport	0.09%	1.1×10^{-2}	CN	Supporting transport	0.09%	5×10^{-3}
12	CN	Coke Oven	0.10%	0.444	CN	Coke Oven	0.09%	0.255	CN	Coke Oven	0.08%	0.209	CN	Coke Oven	0.08%	3.2×10^{-2}	CN	Coke Oven	0.08%	1×10^{-2}	CN	Coke Oven	0.08%	4×10^{-3}
13	CN	Inland transportation	0.09%	0.428	CN	Inland transportation	0.08%	0.236	CN	Inland transportation	0.08%	0.191	CN	Inland transportation	0.07%	2.8×10^{-2}	CN	Inland transportation	0.07%	9×10^{-3}	CN	Inland transportation	0.07%	4×10^{-3}

Order	C.C.	Sector	P.A.D.* (%)	GWP	C.C.	Sector	P.A.D.* (%)	GWP	C.C.	Sector	P.A.D.* (%)	GWP	C.C.	Sector	P.A.D.* (%)	GWP	C.C.	Sector	P.A.D.* (%)	GWP	C.C.	Sector	P.A.D.* (%)	GWP
14	CN	Sea transportation	0.09%	0.407	CN	Sea transportation	0.08%	0.228	CN	Sea transportation	0.08%	0.186	CN	Sea transportation	0.07%	$2.8\ 10^{-2}$	CN	Sea transportation	0.07%	$9\ 10^{-3}$	CN	Sea transportation	0.07%	$4\ 10^{-3}$
15	CN	Other business services	0.07%	0.341	CN	Other business services	0.07%	0.193	CN	Other business services	0.06%	0.158	CN	Other business services	0.06%	$2.4\ 10^{-2}$	CN	Other business services	0.06%	$7\ 10^{-3}$	CN	Other business services	0.06%	$3\ 10^{-3}$
16	CN	Railway transportation	0.07%	0.323	CN	Railway transportation	0.06%	0.18	CN	Railway transportation	0.06%	0.146	CN	Railway transportation	0.05%	$2.2\ 10^{-2}$	CN	Railway transportation	0.05%	$7\ 10^{-3}$	CN	Railway transportation	0.06%	$3\ 10^{-3}$
17	DE	Sea transportation	0.07%	0.314	DE	Sea transportation	0.06%	0.173	DE	Sea transportation	0.06%	0.14	DE	Sea transportation	0.05%	$2.1\ 10^{-2}$	DE	Sea transportation	0.05%	$6\ 10^{-3}$	DE	Sea transportation	0.05%	$3\ 10^{-3}$
18	CN	Paper products	0.07%	0.306	CN	Paper products	0.06%	0.167	CN	Paper products	0.05%	0.135	CN	Crude petroleum	0.05%	$2\ 10^{-2}$	CN	Crude petroleum	0.05%	$6\ 10^{-3}$	CN	Paper products	0.05%	$3\ 10^{-3}$
19	CN	Land transportation	0.06%	0.284	CN	Crude petroleum	0.05%	0.158	CN	Crude petroleum	0.05%	0.13	CN	Paper products	0.05%	$2\ 10^{-2}$	CN	Paper products	0.05%	$6\ 10^{-3}$	CN	Crude petroleum	0.05%	$3\ 10^{-3}$
20	CN	Crude petroleum	0.06%	0.276	CN	Land transportation	0.05%	0.157	CN	Land transportation	0.05%	0.127	CN	Land transportation	0.04%	$1.9\ 10^{-2}$	CN	Land transportation	0.04%	$6\ 10^{-3}$	CN	Land transportation	0.05%	$3\ 10^{-3}$

Table 55: Total Annual Carbon Footprint Distribution of Bitcoin mining in China by country

	Total GWP per year (MtCO₂-eqv.)																	
Order	2020			2019			2018			2017			2016			2015		
	C.C.	P.A.D.* (%)	GWP	C.C.	P.A.D.* (%)	GWP	C.C.	P.A.D.* (%)	GWP	C.C.	P.A.D.* (%)	GWP	C.C.	P.A.D.* (%)	GWP	C.C.	P.A.D.* (%)	GWP
1	CN	98.35%	38.609	CN	98.54%	24.816	CN	98.58%	0.892	CN	98.75%	3.128	CN	90.38%	$2.31\ 10^{-2}$	CN	98.651%	$1.46\ 10^{-1}$
2	WA	0.24%	0.094	WA	0.21%	0.054	US	0.21%	0.332	WA	0.18%	$5.81\ 10^{-3}$	JP	1.45%	$1.73\ 10^{-3}$	WA	0.197%	$2.9\ 10^{-4}$
3	JP	0.20%	0.079	US	0.18%	0.046	IN	0.18%	0.144	US	0.16%	$5.04\ 10^{-3}$	WA	1.35%	$1.38\ 10^{-3}$	US	0.169%	$2.49\ 10^{-4}$
4	US	0.20%	0.079	JP	0.17%	0.043	RU	0.16%	0.063	JP	0.14%	$4.38\ 10^{-3}$	KR	1.12%	$1.31\ 10^{-3}$	JP	0.153%	$2.26\ 10^{-4}$
5	KR	0.16%	0.064	KR	0.14%	0.035	JP	0.13%	0.063	KR	0.11%	$3.62\ 10^{-3}$	US	1.03%	$9.24\ 10^{-3}$	KR	0.125%	$1.85\ 10^{-4}$
6	WM	0.16%	0.061	WM	0.14%	0.034	CA	0.13%	0.053	WM	0.11%	$3.56\ 10^{-3}$	WM	1.02%	$1.35\ 10^{-3}$	WM	0.122%	$1.81\ 10^{-4}$
7	RU	0.13%	0.049	RU	0.12%	0.029	WA	0.12%	0.050	RU	0.11%	$3.4\ 10^{-3}$	DE	0.68%	$1.05\ 10^{-3}$	RU	0.112%	$1.65\ 10^{-4}$
8	DE	0.11%	0.042	DE	0.09%	0.023	WM	0.09%	0.049	DE	0.08%	$2.46\ 10^{-3}$	RU	0.49%	$1.76\ 10^{-3}$	DE	0.084%	$1.25\ 10^{-4}$
9	ID	0.06%	0.023	ID	0.06%	0.014	KR	0.05%	0.048	ID	0.05%	$1.58\ 10^{-3}$	IN	0.31%	$4.0\ 10^{-3}$	ID	0.052%	$7.7\ 10^{-5}$
10	IN	0.05%	0.020	IN	0.04%	0.011	WL	0.04%	0.047	WL	0.04%	$1.22\ 10^{-3}$	ID	0.25%	$4.32\ 10^{-4}$	WL	0.040%	$5.96\ 10^{-5}$

Table 56: Total Annual Carbon Footprint Distribution of Bitcoin mining in China by sector

	Total GWP per year (MtCO₂-eqv.)																						
O.	2020				2019				2018				2017				2016				2015			
	C.C.	Sector	P.A.D.* (%)	GWP	C.C.	Sector	P.A.D.* (%)	GWP	C.C.	Sector	P.A.D.* (%)	GWP	C.C.	Sector	P.A.D.* (%)	GWP	C.C.	Sector	P.A.D.* (%)	GWP	C.C.	Sector	P.A.D.* (%)	GWP
1	CN	Elec. Coal	90.19%	35.408	CN	Elec. Coal	91.11%	22.947	CN	Elec. Coal	91.34%	13.018	CN	Elec. Coal	92.13%	2.919	CN	Elec. Coal	92.18%	$6.44\ 10^{-1}$	CN	Elec. Coal	91.68%	$1.35\ 10^{-1}$
2	CN	Elec. Gas	1.73%	$6.78\ 10^{-1}$	CN	Elec. Gas	1.75%	$4.41\ 10^{-1}$	CN	Elec. Gas	1.76%	$2.50\ 10^{-1}$	CN	Elec. Gas	1.78%	$5.63\ 10^{-2}$	CN	Elec. Gas	1.78%	$1.24\ 10^{-2}$	CN	Elec. Gas	1.77%	$2.61\ 10^{-3}$
3	CN	Iron and Steel	1.68%	$6.59\ 10^{-1}$	CN	Iron and Steel	1.44%	$3.64\ 10^{-1}$	CN	Iron and Steel	1.39%	$1.98\ 10^{-1}$	CN	Iron and Steel	1.18%	$3.75\ 10^{-2}$	CN	Iron and Steel	1.17%	$8.19\ 10^{-3}$	CN	Iron and Steel	1.30%	$1.92\ 10^{-3}$
4	CN	Bituminous Coal	1.07%	$4.19\ 10^{-1}$	CN	Bituminous Coal	1.06%	$2.67\ 10^{-1}$	CN	Bituminous Coal	1.06%	$1.51\ 10^{-1}$	CN	Bituminous Coal	1.06%	$3.35\ 10^{-2}$	CN	Bituminous Coal	1.06%	$7.37\ 10^{-3}$	CN	Bituminous Coal	1.06%	$1.56\ 10^{-3}$
5	CN	Steam-Hot W. Sply.	0.67%	$2.63\ 10^{-1}$	CN	Steam-Hot W. Sply.	0.57%	$1.43\ 10^{-1}$	CN	Steam-Hot W. Sply.	0.54%	$7.76\ 10^{-2}$	CN	Steam-Hot W. Sply.	0.46%	$1.45\ 10^{-2}$	CN	Steam-Hot W. Sply.	0.45%	$3.17\ 10^{-3}$	CN	Steam-Hot W. Sply.	0.51%	$7.50\ 10^{-4}$

Order	C.C.	P.A.D. (%)	GWP	C.C.	P.A.D. (%)	GWP	C.C.	P.A.D. (%)	GWP	C.C.	P.A.D. (%)	GWP	C.C.	P.A.D. (%)	GWP	C.C.	P.A.D. (%)	GWP
6	CN	Rubber and plastic	0.37%	1.44×10^{-1} / CN Rubber and plastic	0.31%	7.76×10^{-2} / CN Rubber and plastic	0.29%	4.19×10^{-2} / CN Rubber and plastic	0.24%	7.72×10^{-3} / CN Rubber and plastic	0.24%	1.68×10^{-3} / CN Rubber and plastic	0.27%	4.03×10^{-4}			

(continued table, rows 6–20)

#	C.C.	Sector	P.A.D.	GWP	C.C.	Sector	P.A.D.	GWP	C.C.	Sector	P.A.D.	GWP	C.C.	Sector	P.A.D.	GWP	C.C.	Sector	P.A.D.	GWP	C.C.	Sector	P.A.D.	GWP
6	CN	Rubber and plastic	0.37%	1.44×10^{-1}	CN	Rubber and plastic	0.31%	7.76×10^{-2}	CN	Rubber and plastic	0.29%	4.19×10^{-2}	CN	Rubber and plastic	0.24%	7.72×10^{-3}	CN	Rubber and plastic	0.24%	1.68×10^{-3}	CN	Rubber and plastic	0.27%	4.03×10^{-4}
7	CN	O. Machinery and Computers	0.34%	1.32×10^{-1}	CN	O. Machinery and Computers	0.28%	6.93×10^{-2}	CN	O. Machinery and Computers	0.26%	3.71×10^{-2}	CN	O. Machinery and Computers	0.21%	6.60×10^{-3}	CN	O. Machinery and Computers	0.21%	1.44×10^{-3}	CN	O. Machinery and Computers	0.24%	3.52×10^{-4}
8	CN	Chemicals nec	0.26%	1.03×10^{-1}	CN	Chemicals nec	0.22%	5.55×10^{-2}	CN	Chemicals nec	0.21%	3.00×10^{-2}	CN	Chemicals nec	0.17%	5.50×10^{-3}	CN	Chemicals nec	0.17%	1.20×10^{-3}	CN	Chemicals nec	0.20%	2.88×10^{-4}
9	CN	Air transport services	0.19%	7.34×10^{-2}	CN	Other mineral products	0.16%	4.08×10^{-2}	CN	Other mineral products	0.16%	2.23×10^{-2}	CN	Other mineral products	0.14%	4.33×10^{-3}	CN	Other mineral products	0.14%	9.47×10^{-4}	CN	Other mineral products	0.15%	2.19×10^{-4}
10	CN	Other mineral products	0.19%	7.28×10^{-2}	CN	Air transport services	0.16%	4.03×10^{-2}	CN	Air transport services	0.15%	2.19×10^{-2}	CN	Air transport services	0.13%	4.13×10^{-3}	CN	Air transport services	0.13%	9.01×10^{-4}	CN	Air transport services	0.14%	2.12×10^{-4}
11	CN	Supporting transport	0.12%	4.72×10^{-2}	CN	Supporting transport	0.10%	2.61×10^{-2}	CN	Supporting transport	0.10%	1.42×10^{-2}	CN	Supporting transport	0.09%	2.70×10^{-3}	CN	Supporting transport	0.09%	5.91×10^{-4}	CN	Supporting transport	0.09%	1.38×10^{-4}
12	CN	Coke Oven	0.10%	3.79×10^{-2}	CN	Coke Oven	0.09%	2.18×10^{-2}	CN	Coke Oven	0.08%	1.20×10^{-2}	CN	Coke Oven	0.08%	2.40×10^{-3}	CN	Coke Oven	0.08%	5.26×10^{-4}	CN	Coke Oven	0.08%	1.19×10^{-4}
13	CN	Inland transportation	0.09%	3.65×10^{-2}	CN	Inland transportation	0.08%	2.02×10^{-2}	CN	Inland transportation	0.08%	1.10×10^{-2}	CN	Inland transportation	0.07%	2.08×10^{-3}	CN	Inland transportation	0.07%	4.55×10^{-4}	CN	Inland transportation	0.07%	1.07×10^{-4}
14	CN	Sea transportation	0.09%	3.47×10^{-2}	CN	Sea transportation	0.08%	1.95×10^{-2}	CN	Sea transportation	0.08%	1.07×10^{-2}	CN	Sea transportation	0.07%	2.07×10^{-3}	CN	Sea transportation	0.07%	4.52×10^{-4}	CN	Sea transportation	0.07%	1.04×10^{-4}
15	CN	Other business services	0.07%	2.91×10^{-2}	CN	Other business services	0.07%	1.65×10^{-2}	CN	Other business services	0.06%	9.06×10^{-3}	CN	Other business services	0.06%	1.78×10^{-3}	CN	Other business services	0.06%	3.89×10^{-4}	CN	Other business services	0.06%	8.92×10^{-5}
16	CN	Railway transportation	0.07%	2.76×10^{-2}	CN	Railway transportation	0.06%	1.54×10^{-2}	CN	Railway transportation	0.06%	8.39×10^{-3}	CN	Railway transportation	0.05%	1.61×10^{-3}	CN	Railway transportation	0.05%	3.52×10^{-4}	CN	Railway transportation	0.06%	8.20×10^{-5}
17	DE	Sea transportation	0.07%	2.68×10^{-2}	DE	Sea transportation	0.06%	1.48×10^{-2}	DE	Sea transportation	0.06%	8.06×10^{-3}	DE	Sea transportation	0.05%	1.53×10^{-3}	DE	Sea transportation	0.05%	3.34×10^{-4}	DE	Sea transportation	0.05%	7.84×10^{-5}
18	CN	Paper products	0.07%	2.61×10^{-2}	CN	Paper products	0.06%	1.43×10^{-2}	CN	Paper products	0.05%	7.76×10^{-3}	CN	Crude petroleum	0.05%	1.48×10^{-3}	CN	Crude petroleum	0.05%	3.24×10^{-4}	CN	Paper products	0.05%	7.51×10^{-5}
19	CN	Land transportation	0.06%	2.42×10^{-2}	CN	Crude petroleum	0.05%	1.35×10^{-2}	CN	Crude petroleum	0.05%	7.43×10^{-3}	CN	Paper products	0.05%	1.46×10^{-3}	CN	Paper products	0.05%	3.18×10^{-4}	CN	Crude petroleum	0.05%	7.36×10^{-5}
20	CN	Crude petroleum	0.06%	2.36×10^{-2}	CN	Land transportation	0.05%	1.34×10^{-2}	CN	Land transportation	0.05%	7.30×10^{-3}	CN	Land transportation	0.04%	1.39×10^{-3}	CN	Land transportation	0.04%	3.04×10^{-4}	CN	Land transportation	0.05%	7.11×10^{-5}

b) Finland

Table 57: Carbon Footprint Distribution of Bitcoin mining in Finland per transaction by country

	GWP per transaction per year (kgCO2-eqv.)																	
Order	**2020**			**2019**			**2018**			**2017**			**2016**			**2015**		
	C.C.	P.A.D.* (%)	GWP	C.C.	P.A.D.* (%)	GWP	C.C.	P.A.D.* (%)	GWP	C.C.	P.A.D.* (%)	GWP	C.C.	P.A.D.* (%)	GWP	C.C.	P.A.D.* (%)	GWP
1	FI	40.08%	96.568	FI	41.94%	63.391	FI	42.41%	53.780	FI	44.10%	9.394	FI	44.20%	2.930	FI	43.13%	1.191
2	RU	35.39%	85.267	RU	37.01%	55.938	RU	37.42%	47.450	RU	38.89%	8.285	RU	38.98%	2.584	RU	38.04%	1.050
3	CN	20.21%	48.695	CN	16.94%	25.606	CN	16.12%	20.444	CN	13.16%	2.803	CN	12.99%	0.861	CN	14.87%	4.11×10^{-1}
4	WA	0.56%	1.340	WA	0.52%	0.784	WA	0.51%	0.646	SE	0.51%	0.109	SE	0.51%	0.034	SE	0.50%	1.38×10^{-2}
5	SE	0.47%	1.124	SE	0.49%	0.736	SE	0.49%	0.624	WA	0.48%	0.101	WA	0.47%	0.031	WA	0.50%	1.37×10^{-2}
6	WM	0.43%	1.043	WM	0.41%	0.613	WM	0.40%	0.506	WM	0.37%	0.080	WM	0.37%	0.025	WM	0.39%	1.07×10^{-2}
7	US	0.37%	0.897	US	0.34%	0.516	US	0.33%	0.423	US	0.31%	0.065	US	0.30%	0.020	US	0.32%	8.89×10^{-3}
8	JP	0.35%	0.847	JP	0.30%	0.454	JP	0.29%	0.365	DE	0.26%	0.056	DE	0.26%	0.017	DE	0.27%	7.48×10^{-3}

9	DE	0.30%	0.723	DE	0.28%	0.427	DE	0.28%	0.352	JP	0.24%	0.051	JP	0.24%	0.016	JP	0.27%	$7.41\ 10^{-3}$
10	KR	0.28%	0.668	KR	0.24%	0.360	KR	0.23%	0.289	KR	0.19%	0.041	KR	0.19%	0.013	KR	0.21%	$5.89\ 10^{-3}$

Table 58: Carbon Footprint Distribution of Bitcoin mining in Finland per transaction by sector in Supply Chain

O.	GWP per transaction per year (kgCO$_2$-eqv.)																							
	2020				2019				2018				2017				2016				2015			
	C.C.	Sector	P.A.D.* (%)	GWP	C.C.	Sector	P.A.D.* (%)	GWP	C.C.	Sector	P.A.D.* (%)	GWP	C.C.	Sector	P.A.D.* (%)	GWP	C.C.	Sector	P.A.D.* (%)	GWP	C.C.	Sector	P.A.D.* (%)	GWP
1	FI	Elec. Coal	32.24%	77.670	FI	Elec. Coal	33.74%	50.986	FI	Elec. Coal	34.11%	43.256	FI	Elec. Coal	35.47%	7.556	FI	Elec. Coal	35.55%	2.357	FI	Elec. Coal	34.69%	$9.58\ 10^{-1}$
2	RU	Natural Gas Services	30.75%	74.097	RU	Natural Gas Services	32.18%	48.640	RU	Natural Gas Services	32.54%	41.265	RU	Natural Gas Services	33.84%	7.208	RU	Natural Gas Services	33.91%	2.248	RU	Natural Gas Services	33.09%	$9.14\ 10^{-1}$
3	CN	Elec. Coal	11.51%	27.734	CN	Elec. Coal	9.64%	14.574	CN	Elec. Coal	9.18%	11.634	CN	Elec. Coal	7.48%	1.593	CN	Elec. Coal	7.39%	$4.90\ 10^{-1}$	CN	Elec. Coal	8.46%	$2.34\ 10^{-1}$
4	RU	Bituminous Coal	2.99%	7.209	RU	Bituminous Coal	3.13%	4.728	RU	Bituminous Coal	3.16%	4.010	RU	Bituminous Coal	3.29%	$7.00\ 10^{-1}$	RU	Bituminous Coal	3.29%	$2.18\ 10^{-1}$	RU	Bituminous Coal	3.22%	$8.88\ 10^{-2}$
5	CN	Iron and Steel	2.58%	6.222	FI	Electricity by biomass and waste	2.45%	3.698	FI	Electricity by biomass and waste	2.47%	3.138	FI	Electricity by biomass and waste	2.57%	$5.48\ 10^{-1}$	FI	Electricity by biomass and waste	2.58%	$1.71\ 10^{-1}$	FI	Electricity by biomass and waste	2.52%	$6.95\ 10^{-2}$
6	FI	Electricity by biomass and waste	2.34%	5.634	CN	Iron and Steel	2.17%	3.274	CN	Iron and Steel	2.06%	2.614	CN	Iron and Steel	1.68%	$3.59\ 10^{-1}$	CN	Iron and Steel	1.66%	$1.10\ 10^{-1}$	CN	Iron and Steel	1.90%	$5.25\ 10^{-2}$
7	FI	Natural Gas Liquids	1.11%	2.662	FI	Natural Gas Liquids	1.16%	1.747	FI	Natural Gas Liquids	1.17%	1.483	FI	Natural Gas Liquids	1.22%	$2.59\ 10^{-1}$	FI	Natural Gas Liquids	1.22%	$8.08\ 10^{-2}$	FI	Natural Gas Liquids	1.19%	$3.28\ 10^{-2}$
8	CN	Steam-Hot W. Sply.	1.08%	2.609	FI	Electricity by nuclear	0.96%	1.457	FI	Electricity by nuclear	0.97%	1.236	FI	Electricity by nuclear	1.01%	$2.16\ 10^{-1}$	FI	Electricity by nuclear	1.02%	$6.73\ 10^{-2}$	FI	Electricity by nuclear	0.99%	$2.74\ 10^{-2}$
9	FI	Electricity by nuclear	0.92%	2.219	CN	Steam-Hot W. Sply.	0.91%	1.371	CN	Steam-Hot W. Sply.	0.86%	1.095	FI	Elec. Gas	0.73%	$1.55\ 10^{-1}$	FI	Elec. Gas	0.73%	$4.83\ 10^{-2}$	CN	Steam-Hot W. Sply.	0.80%	$2.20\ 10^{-2}$
10	FI	Elec. Gas	0.66%	1.591	FI	Elec. Gas	0.69%	1.045	FI	Elec. Gas	0.70%	0.886	CN	Steam-Hot W. Sply.	0.70%	$1.50\ 10^{-1}$	FI	Electricity by hydro	0.71%	$4.67\ 10^{-2}$	FI	Elec. Gas	0.71%	$1.96\ 10^{-2}$
11	FI	Electricity by hydro	0.64%	1.539	FI	Electricity by hydro	0.67%	1.011	FI	Electricity by hydro	0.68%	0.857	FI	Electricity by hydro	0.70%	$1.50\ 10^{-1}$	CN	Steam-Hot W. Sply.	0.70%	$4.61\ 10^{-2}$	FI	Electricity by hydro	0.69%	$1.90\ 10^{-2}$
12	CN	O. Machinery and Computers	0.64%	1.531	CN	O. Machinery and Computers	0.53%	0.803	CN	O. Machinery and Computers	0.51%	0.641	CN	O. Machinery and Computers	0.41%	$8.76\ 10^{-2}$	CN	O. Machinery and Computers	0.41%	$2.69\ 10^{-2}$	CN	O. Machinery and Computers	0.47%	$1.29\ 10^{-2}$
13	CN	Rubber and plastic	0.63%	1.515	CN	Rubber and plastic	0.53%	0.797	CN	Rubber and plastic	0.50%	0.636	CN	Rubber and plastic	0.41%	$8.72\ 10^{-2}$	CN	Rubber and plastic	0.40%	$2.68\ 10^{-2}$	CN	Rubber and plastic	0.46%	$1.28\ 10^{-2}$
14	CN	Chemicals nec	0.46%	1.096	CN	Chemicals nec	0.38%	0.576	CN	Chemicals nec	0.36%	0.460	RU	Heavy Fuel Oil	0.33%	$7.10\ 10^{-2}$	RU	Heavy Fuel Oil	0.33%	$2.21\ 10^{-2}$	CN	Chemicals nec	0.34%	$9.25\ 10^{-3}$
15	RU	Heavy Fuel Oil	0.31%	0.738	RU	Heavy Fuel Oil	0.32%	0.482	RU	Heavy Fuel Oil	0.32%	0.408	RU	Steam-Hot W. Sply.	0.33%	$6.92\ 10^{-2}$	RU	Steam-Hot W. Sply.	0.33%	$2.16\ 10^{-2}$	RU	Heavy Fuel Oil	0.33%	$9.02\ 10^{-3}$
16	RU	Steam-Hot W. Sply.	0.30%	0.724	RU	Steam-Hot W. Sply.	0.31%	0.472	RU	Steam-Hot W. Sply.	0.32%	0.399	FI	Elec. Petroleum	0.30%	$6.48\ 10^{-2}$	FI	Elec. Petroleum	0.31%	$2.02\ 10^{-2}$	RU	Steam-Hot W. Sply.	0.32%	$8.81\ 10^{-3}$
17	CN	Air transport services	0.30%	0.710	FI	Elec. Petroleum	0.29%	0.437	FI	Elec. Petroleum	0.29%	0.371	CN	Chemicals nec	0.30%	$6.31\ 10^{-2}$	RU	Transportation services via pipelines	0.29%	$1.95\ 10^{-2}$	FI	Elec. Petroleum	0.30%	$8.21\ 10^{-3}$

18	CN	Bituminous Coal	0.29%	0.688	RU	Transportation services via pipelines	0.28%	0.426	RU	Transportation services via pipelines	0.28%	0.360	RU	Transportation services via pipelines	0.29%	$6.25\ 10^{-2}$	CN	Chemicals nec	0.29%	$1.94\ 10^{-2}$	RU	Transportation services via pipelines	0.29%	$7.95\ 10^{-3}$
19	FI	Elec. Petroleum	0.28%	0.666	FI	Steam-Hot W. Sply.	0.26%	0.388	FI	Steam-Hot W. Sply.	0.26%	0.330	FI	Steam-Hot W. Sply.	0.27%	$5.76\ 10^{-2}$	FI	Steam-Hot W. Sply.	0.27%	$1.80\ 10^{-2}$	FI	Steam-Hot W. Sply.	0.26%	$7.30\ 10^{-3}$
20	RU	Transportation services via pipelines	0.27%	0.655	CN	Air transport services	0.25%	0.374	CN	Air transport services	0.24%	0.298	FI	Dist. of gaseous fuels	0.23%	$4.81\ 10^{-2}$	FI	Dist. of gaseous fuels	0.23%	$1.50\ 10^{-2}$	FI	Dist. of gaseous fuels	0.22%	$6.09\ 10^{-3}$

Table 59: Total Annual Carbon Footprint Distribution of Bitcoin mining in Finland by country

| | Total GWP per year (MtCO$_2$-eqv.) | | | | | | | | | | | | | | | | | |
| Order | 2020 | | | 2019 | | | 2018 | | | 2017 | | | 2016 | | | 2015 | | |
	C.C.	P.A.D.* (%)	GWP	C.C.	P.A.D.* (%)	GWP	C.C.	P.A.D.* (%)	GWP	C.C.	P.A.D.* (%)	GWP	C.C.	P.A.D.* (%)	GWP	C.C.	P.A.D.* (%)	GWP
1	FI	40.08%	$2.97\ 10^{-2}$	FI	41.94%	$1.34\ 10^{-1}$	FI	42.41%	$3.98\ 10^{-2}$	FI	44.10%	3.12841	FI	44.20%	$7.86\ 10^{-3}$	FI	43.13%	$2.45\ 10^{-3}$
2	RU	35.39%	$2.62\ 10^{-2}$	RU	37.01%	$1.18\ 10^{-1}$	RU	37.42%	$3.51\ 10^{-2}$	RU	38.89%	$5.81\ 10^{-3}$	RU	38.98%	$6.93\ 10^{-3}$	RU	38.04%	$2.16\ 10^{-3}$
3	CN	20.21%	$1.5\ 10^{-2}$	CN	16.94%	$5.41\ 10^{-2}$	CN	16.12%	$1.51\ 10^{-2}$	CN	13.16%	$5.04\ 10^{-3}$	CN	12.99%	$2.31\ 10^{-3}$	CN	14.87%	$8.45\ 10^{-4}$
4	WA	0.56%	$4.12\ 10^{-4}$	WA	0.52%	$1.66\ 10^{-3}$	WA	0.51%	$4.78\ 10^{-4}$	SE	0.51%	$4.38\ 10^{-3}$	SE	0.51%	$9.1\ 10^{-5}$	SE	0.50%	$2.84\ 10^{-5}$
5	SE	0.47%	$3.46\ 10^{-4}$	SE	0.49%	$1.55\ 10^{-3}$	SE	0.49%	$4.62\ 10^{-4}$	WA	0.48%	$3.62\ 10^{-3}$	WA	0.47%	$8.43\ 10^{-5}$	WA	0.50%	$2.82\ 10^{-5}$
6	WM	0.43%	$3.21\ 10^{-4}$	WM	0.41%	$1.29\ 10^{-3}$	WM	0.40%	$3.74\ 10^{-4}$	WM	0.37%	$3.56\ 10^{-3}$	WM	0.37%	$6.62\ 10^{-5}$	WM	0.39%	$2.21\ 10^{-5}$
7	US	0.37%	$2.76\ 10^{-4}$	US	0.34%	$1.09\ 10^{-3}$	US	0.33%	$3.13\ 10^{-4}$	US	0.31%	$3.4\ 10^{-3}$	US	0.30%	$5.41\ 10^{-5}$	US	0.32%	$1.83\ 10^{-5}$
8	JP	0.35%	$2.61\ 10^{-4}$	JP	0.30%	$9.6\ 10^{-4}$	JP	0.29%	$2.7\ 10^{-4}$	DE	0.26%	$2.46\ 10^{-3}$	DE	0.26%	$4.64\ 10^{-5}$	DE	0.27%	$1.54\ 10^{-5}$
9	DE	0.30%	$2.22\ 10^{-4}$	DE	0.28%	$9.01\ 10^{-4}$	DE	0.28%	$2.6\ 10^{-4}$	JP	0.24%	$1.58\ 10^{-3}$	JP	0.24%	$4.25\ 10^{-5}$	JP	0.27%	$1.52\ 10^{-5}$
10	KR	0.28%	$2.05\ 10^{-4}$	KR	0.24%	$7.6\ 10^{-4}$	KR	0.23%	$2.14\ 10^{-4}$	KR	0.19%	$1.22\ 10^{-3}$	KR	0.19%	$3.39\ 10^{-5}$	KR	0.21%	$1.21\ 10^{-5}$

Table 60: Total Annual Carbon Footprint Distribution of Bitcoin mining in Finland by sector

| | GWP per transaction per year (kgCO$_2$-eqv.) | | | | | | | | | | | | | | | | | |
| O. | 2020 | | | 2019 | | | 2018 | | | 2017 | | | 2016 | | | 2015 | | |
	C.C.	Sector	P.A.D.* (%)	GWP	C.C.	Sector	P.A.D.* (%)	GWP	C.C.	Sector	P.A.D.* (%)	GWP	C.C.	Sector	P.A.D.* (%)	GWP	C.C.	Sector	P.A.D.* (%)	GWP	C.C.	Sector	P.A.D.* (%)	GWP
1	FI	Elec. Coal	32.24%	$2.39\ 10^{-2}$	FI	Elec. Coal	33.74%	$1.08\ 10^{-1}$	FI	Elec. Coal	34.11%	$3.20\ 10^{-2}$	FI	Elec. Coal	35.47%	$1.48\ 10^{-2}$	FI	Elec. Coal	35.55%	$6.32\ 10^{-3}$	FI	Elec. Coal	34.69%	$1.97\ 10^{-3}$
2	RU	Natural Gas Services	30.75%	$2.28\ 10^{-2}$	RU	Natural Gas Services	32.18%	$1.03\ 10^{-1}$	RU	Natural Gas Services	32.54%	$3.05\ 10^{-2}$	RU	Natural Gas Services	33.84%	$1.41\ 10^{-2}$	RU	Natural Gas Services	33.91%	$6.03\ 10^{-3}$	RU	Natural Gas Services	33.09%	$1.88\ 10^{-3}$
3	CN	Elec. Coal	11.51%	$8.53\ 10^{-3}$	CN	Elec. Coal	9.64%	$3.08\ 10^{-2}$	CN	Elec. Coal	9.18%	$8.60\ 10^{-3}$	CN	Elec. Coal	7.48%	$3.13\ 10^{-3}$	CN	Elec. Coal	7.39%	$1.31\ 10^{-3}$	CN	Elec. Coal	8.46%	$4.81\ 10^{-4}$
4	RU	Bituminous Coal	2.99%	$2.22\ 10^{-3}$	RU	Bituminous Coal	3.13%	$9.98\ 10^{-3}$	RU	Bituminous Coal	3.16%	$2.96\ 10^{-3}$	RU	Bituminous Coal	3.29%	$1.37\ 10^{-3}$	RU	Bituminous Coal	3.29%	$5.85\ 10^{-4}$	RU	Bituminous Coal	3.22%	$1.83\ 10^{-4}$
5	CN	Iron and Steel	2.58%	$1.91\ 10^{-3}$	FI	Electricity by biomass and waste	2.45%	$7.81\ 10^{-3}$	FI	Electricity by biomass and waste	2.47%	$2.32\ 10^{-3}$	FI	Electricity by biomass and waste	2.57%	$1.08\ 10^{-3}$	FI	Electricity by biomass and waste	2.58%	$4.58\ 10^{-4}$	FI	Electricity by biomass and waste	2.52%	$1.43\ 10^{-4}$
6	FI	Electricity by biomass and waste	2.34%	$1.73\ 10^{-3}$	CN	Iron and Steel	2.17%	$6.91\ 10^{-3}$	CN	Iron and Steel	2.06%	$1.93\ 10^{-3}$	CN	Iron and Steel	1.68%	$7.04\ 10^{-4}$	CN	Iron and Steel	1.66%	$2.96\ 10^{-4}$	CN	Iron and Steel	1.90%	$1.08\ 10^{-4}$

Order	C.C.	Item	P.A.D.* (%)	GWP	C.C.	Item	P.A.D.* (%)	GWP	C.C.	Item	P.A.D.* (%)	GWP	C.C.	Item	P.A.D.* (%)	GWP	C.C.	Item	P.A.D.* (%)	GWP	C.C.	Item	P.A.D.* (%)	GWP
7	FI	Natural Gas Liquids	1.11%	$8.19\ 10^{-4}$	FI	Natural Gas Liquids	1.16%	$3.69\ 10^{-3}$	FI	Natural Gas Liquids	1.17%	$1.10\ 10^{-3}$	FI	Natural Gas Liquids	1.22%	$5.08\ 10^{-4}$	FI	Natural Gas Liquids	1.22%	$2.17\ 10^{-4}$	FI	Natural Gas Liquids	1.19%	$6.76\ 10^{-5}$
8	CN	Steam-Hot W. Sply.	1.08%	$8.02\ 10^{-4}$	FI	Electricity by nuclear	0.96%	$3.08\ 10^{-3}$	FI	Electricity by nuclear	0.97%	$9.14\ 10^{-4}$	FI	Electricity by nuclear	1.01%	$4.23\ 10^{-4}$	FI	Electricity by nuclear	1.02%	$1.81\ 10^{-4}$	FI	Electricity by nuclear	0.99%	$5.63\ 10^{-5}$
9	FI	Electricity by nuclear	0.92%	$6.82\ 10^{-4}$	CN	Steam-Hot W. Sply.	0.91%	$2.90\ 10^{-3}$	CN	Steam-Hot W. Sply.	0.86%	$8.09\ 10^{-4}$	FI	Elec. Gas	0.73%	$3.04\ 10^{-4}$	FI	Elec. Gas	0.73%	$1.29\ 10^{-4}$	CN	Steam-Hot W. Sply.	0.80%	$4.52\ 10^{-5}$
10	FI	Elec. Gas	0.66%	$4.89\ 10^{-4}$	FI	Elec. Gas	0.69%	$2.21\ 10^{-3}$	FI	Elec. Gas	0.70%	$6.55\ 10^{-4}$	CN	Steam-Hot W. Sply.	0.70%	$2.94\ 10^{-4}$	FI	Electricity by hydro	0.71%	$1.25\ 10^{-4}$	FI	Elec. Gas	0.71%	$4.04\ 10^{-5}$
11	FI	Electricity by hydro	0.64%	$4.73\ 10^{-4}$	FI	Electricity by hydro	0.67%	$2.13\ 10^{-3}$	FI	Electricity by hydro	0.68%	$6.34\ 10^{-4}$	FI	Electricity by hydro	0.70%	$2.94\ 10^{-4}$	CN	Steam-Hot W. Sply.	0.70%	$1.24\ 10^{-4}$	FI	Electricity by hydro	0.69%	$3.91\ 10^{-5}$
12	CN	O. Machinery and Computers	0.64%	$4.71\ 10^{-4}$	CN	O. Machinery and Computers	0.53%	$1.70\ 10^{-3}$	CN	O. Machinery and Computers	0.51%	$4.74\ 10^{-4}$	CN	O. Machinery and Computers	0.41%	$1.72\ 10^{-4}$	CN	O. Machinery and Computers	0.41%	$7.21\ 10^{-5}$	CN	O. Machinery and Computers	0.47%	$2.65\ 10^{-5}$
13	CN	Rubber and plastic	0.63%	$4.66\ 10^{-4}$	CN	Rubber and plastic	0.53%	$1.68\ 10^{-3}$	CN	Rubber and plastic	0.50%	$4.70\ 10^{-4}$	CN	Rubber and plastic	0.41%	$1.71\ 10^{-4}$	CN	Rubber and plastic	0.40%	$7.19\ 10^{-5}$	CN	Rubber and plastic	0.46%	$2.63\ 10^{-5}$
14	CN	Chemicals nec	0.46%	$3.37\ 10^{-4}$	CN	Chemicals nec	0.38%	$1.22\ 10^{-3}$	CN	Chemicals nec	0.36%	$3.40\ 10^{-4}$	RU	Heavy Fuel Oil	0.33%	$1.39\ 10^{-4}$	RU	Heavy Fuel Oil	0.33%	$5.94\ 10^{-5}$	CN	Chemicals nec	0.34%	$1.90\ 10^{-5}$
15	RU	Heavy Fuel Oil	0.31%	$2.27\ 10^{-4}$	RU	Heavy Fuel Oil	0.32%	$1.02\ 10^{-3}$	RU	Heavy Fuel Oil	0.32%	$3.02\ 10^{-4}$	RU	Steam-Hot W. Sply.	0.33%	$1.36\ 10^{-4}$	RU	Steam-Hot W. Sply.	0.33%	$5.79\ 10^{-5}$	RU	Heavy Fuel Oil	0.33%	$1.86\ 10^{-5}$
16	RU	Steam-Hot W. Sply.	0.30%	$2.23\ 10^{-4}$	RU	Steam-Hot W. Sply.	0.31%	$9.96\ 10^{-4}$	RU	Steam-Hot W. Sply.	0.32%	$2.95\ 10^{-4}$	FI	Elec. Petroleum	0.30%	$1.27\ 10^{-4}$	FI	Elec. Petroleum	0.31%	$5.42\ 10^{-5}$	RU	Steam-Hot W. Sply.	0.32%	$1.81\ 10^{-5}$
17	CN	Air transport services	0.30%	$2.18\ 10^{-4}$	FI	Elec. Petroleum	0.29%	$9.24\ 10^{-4}$	FI	Elec. Petroleum	0.29%	$2.74\ 10^{-4}$	CN	Chemicals nec	0.30%	$1.24\ 10^{-4}$	RU	Transportation services via pipelines	0.29%	$5.22\ 10^{-5}$	FI	Elec. Petroleum	0.30%	$1.69\ 10^{-5}$
18	CN	Bituminous Coal	0.29%	$2.12\ 10^{-4}$	RU	Transportation services via pipelines	0.28%	$8.99\ 10^{-4}$	RU	Transportation services via pipelines	0.28%	$2.66\ 10^{-4}$	RU	Transportation services via pipelines	0.29%	$1.23\ 10^{-4}$	CN	Chemicals nec	0.29%	$5.20\ 10^{-5}$	RU	Transportation services via pipelines	0.29%	$1.64\ 10^{-5}$
19	FI	Elec. Petroleum	0.28%	$2.05\ 10^{-4}$	FI	Steam-Hot W. Sply.	0.26%	$8.20\ 10^{-4}$	FI	Steam-Hot W. Sply.	0.26%	$2.44\ 10^{-4}$	FI	Steam-Hot W. Sply.	0.27%	$1.13\ 10^{-4}$	FI	Steam-Hot W. Sply.	0.27%	$4.81\ 10^{-5}$	FI	Steam-Hot W. Sply.	0.26%	$1.50\ 10^{-5}$
20	RU	Transportation services via pipelines	0.27%	$2.02\ 10^{-4}$	CN	Air transport services	0.25%	$7.89\ 10^{-4}$	CN	Air transport services	0.24%	$2.21\ 10^{-4}$	FI	Dist. of gaseous fuels	0.23%	$9.43\ 10^{-5}$	FI	Dist. of gaseous fuels	0.23%	$4.02\ 10^{-5}$	FI	Dist. of gaseous fuels	0.22%	$1.25\ 10^{-5}$

c) Georgia

Table 61: Carbon Footprint Distribution of Bitcoin mining in Georgia per transaction by country

Order	Total GWP per year (MtCO₂-eqv.)																	
	2020			**2019**			**2018**			**2017**			**2016**			**2015**		
	C.C.	P.A.D.* (%)	GWP	C.C.	P.A.D.* (%)	GWP	C.C.	P.A.D.* (%)	GWP	C.C.	P.A.D.* (%)	GWP	C.C.	P.A.D.* (%)	GWP	C.C.	P.A.D.* (%)	GWP
1	CN	51.29%	48.417	WE	47.17%	25.911	GE	48.65%	21.981	GE	54.51%	3.839	GE	54.87%	1.197	CN	90.38%	$4.07\ 10^{-1}$
2	GE	41.83%	39.482	CN	46.28%	25.423	CN	44.90%	20.289	CN	39.41%	2.776	CN	39.08%	$8.53\ 10^{-1}$	JP	1.45%	$6.67\ 10^{-3}$
3	WA	0.90%	0.850	WA	0.84%	0.463	WA	0.83%	0.374	RU	0.84%	$5.94\ 10^{-2}$	RU	0.85%	$1.85\ 10^{-2}$	WA	1.35%	$7.65\ 10^{-3}$
4	JP	0.83%	0.788	RU	0.80%	0.437	RU	0.81%	0.364	WA	0.76%	$5.38\ 10^{-2}$	WA	0.76%	$1.66\ 10^{-2}$	KR	1.12%	$5.36\ 10^{-3}$
5	RU	0.76%	0.719	JP	0.76%	0.415	JP	0.73%	0.332	JP	0.65%	$4.56\ 10^{-2}$	JP	0.64%	$1.4\ 10^{-2}$	US	1.03%	$5.88\ 10^{-3}$
6	WM	0.71%	0.674	WM	0.68%	0.371	WM	0.66%	0.300	WM	0.62%	$4.37\ 10^{-2}$	WM	0.62%	$1.35\ 10^{-2}$	WM	1.02%	$6.17\ 10^{-3}$
7	US	0.69%	0.653	US	0.65%	0.356	US	0.64%	0.287	US	0.59%	$4.14\ 10^{-2}$	US	0.59%	$1.28\ 10^{-2}$	DE	0.68%	$3.69\ 10^{-3}$
8	KR	0.66%	0.625	KR	0.60%	0.332	KR	0.59%	0.266	KR	0.52%	$3.69\ 10^{-2}$	KR	0.52%	$1.14\ 10^{-2}$	RU	0.49%	$7.83\ 10^{-3}$
9	DE	0.44%	0.415	DE	0.41%	0.224	DE	0.40%	0.181	DE	0.37%	$2.58\ 10^{-2}$	DE	0.36%	$7.95\ 10^{-3}$	IN	0.31%	$1.85\ 10^{-3}$

| 10 | IN | 0.22% | 0.203 | IN | 0.20% | 0.111 | IN | 0.20% | 0.090 | IN | 0.19% | 1.31×10^{-2} | IN | 0.19% | 4.05×10^{-3} | ID | 0.25% | 1.18×10^{-3} |

Table 62: Carbon Footprint Distribution of Bitcoin mining in Georgia per transaction by sector in Supply Chain

| O. | GWP per transaction per year (kgCO₂-eqv.) | | | | | | | | | | | | | | | | | | | | | | | |
| | 2020 | | | | 2019 | | | | 2018 | | | | 2017 | | | | 2016 | | | | 2015 | | | |
	C.C.	Sector	P.A.D.* (%)	GWP	C.C.	Sector	P.A.D.* (%)	GWP	C.C.	Sector	P.A.D.* (%)	GWP	C.C.	Sector	P.A.D.* (%)	GWP	C.C.	Sector	P.A.D.* (%)	GWP	C.C.	Sector	P.A.D.* (%)	GWP
1	GE	Elec. Gas	34.05%	32.138	GE	Elec. Gas	38.41%	21.096	GE	Elec. Gas	39.61%	17.898	GE	Elec. Gas	44.39%	3.127	GE	Elec. Gas	44.68%	9.75×10^{-1}	GE	Elec. Gas	41.54%	3.96×10^{-1}
2	CN	Elec. Coal	29.27%	27.625	CN	Elec. Coal	26.40%	14.502	CN	Elec. Coal	25.61%	11.573	CN	Elec. Coal	22.47%	1.583	CN	Elec. Coal	22.28%	4.86×10^{-1}	CN	Elec. Coal	24.35%	2.32×10^{-1}
3	CN	Iron and Steel	6.54%	6.178	CN	Iron and Steel	5.91%	3.245	CN	Iron and Steel	5.73%	2.590	CN	Iron and Steel	5.03%	0.354	CN	Iron and Steel	4.99%	1.09×10^{-1}	CN	Iron and Steel	5.45%	5.20×10^{-2}
4	CN	Steam-Hot W. Sply.	2.75%	2.597	CN	Steam-Hot W. Sply.	2.48%	1.363	WE	Dist. of gaseous fuels	2.52%	1.137	WE	Dist. of gaseous fuels	2.82%	0.199	WE	Dist. of gaseous fuels	2.84%	6.20×10^{-2}	WE	Dist. of gaseous fuels	2.64%	2.52×10^{-2}
5	WE	Dist. of gaseous fuels	2.16%	2.042	WE	Dist. of gaseous fuels	2.44%	1.340	CN	Steam-Hot W. Sply.	2.41%	1.088	WE	Elec. Coal	2.24%	0.157	GE	Elec. Coal	2.25%	4.91×10^{-2}	CN	Steam-Hot W. Sply.	2.29%	2.18×10^{-2}
6	GE	Elec. Coal	1.72%	1.623	GE	Elec. Coal	1.94%	1.064	GE	Elec. Coal	2.00%	0.902	CN	Steam-Hot W. Sply	2.11%	0.149	CN	Steam-Hot W. Sply.	2.10%	4.57×10^{-2}	GE	Elec. Coal	2.09%	2.00×10^{-2}
7	CN	O. Machinery and Computers	1.62%	1.531	GE	Steam-Hot W. Sply.	1.62%	0.891	GE	Steam-Hot W. Sply.	1.67%	0.755	GE	Steam-Hot W. Sply	1.87%	0.132	GE	Steam-Hot W. Sply.	1.88%	4.11×10^{-2}	GE	Steam-Hot W. Sply.	1.75%	1.67×10^{-2}
8	CN	Rubber and plastic	1.59%	1.505	CN	O. Machinery and Computers	1.46%	0.803	CN	O. Machinery and Computers	1.42%	0.641	CN	O. Machinery and Computers	1.24%	0.088	CN	O. Machinery and Computers	1.23%	2.69×10^{-2}	CN	O. Machinery and Computers	1.35%	1.29×10^{-2}
9	GE	Steam-Hot W. Sply.	1.44%	1.359	CN	Rubber and plastic	1.44%	0.790	CN	Rubber and plastic	1.40%	0.631	CN	Rubber and plastic	1.23%	0.086	CN	Rubber and plastic	1.22%	2.65×10^{-2}	CN	Rubber and plastic	1.33%	1.27×10^{-2}
10	CN	Chemicals nec	1.16%	1.090	CN	Chemicals nec	1.04%	0.573	GE	Electricity by hydro	1.04%	0.468	GE	Electricity by hydro	1.16%	0.082	GE	Electricity by hydro	1.17%	2.55×10^{-2}	GE	Electricity by hydro	1.09%	1.04×10^{-2}
11	GE	Electricity by hydro	0.89%	0.840	GE	Electricity by hydro	1.00%	0.551	CN	Chemicals nec	1.01%	0.457	CN	Chemicals nec	0.89%	0.063	CN	Chemicals nec	0.88%	1.92×10^{-2}	CN	Chemicals nec	0.96%	9.17×10^{-3}
12	CN	Air transport services	0.75%	0.704	CN	Air transport services	0.67%	0.370	CN	Air transport services	0.65%	0.295	CN	Air transport services	0.57%	0.040	CN	Air transport services	0.57%	1.24×10^{-2}	CN	Air transport services	0.62%	5.93×10^{-3}
13	CN	Bituminous Coal	0.73%	0.684	CN	Bituminous Coal	0.65%	0.359	CN	Bituminous Coal	0.63%	0.287	CN	Bituminous Coal	0.56%	0.039	CN	Bituminous Coal	0.55%	1.21×10^{-2}	CN	Bituminous Coal	0.60%	5.76×10^{-3}
14	CN	Other mineral products	0.66%	0.621	CN	Other mineral products	0.59%	0.327	CN	Other mineral products	0.58%	0.261	CN	Other mineral products	0.51%	0.036	CN	Other mineral products	0.50%	1.10×10^{-2}	CN	Other mineral products	0.55%	5.24×10^{-3}
15	CN	Supporting transport	0.46%	0.434	CN	Supporting transport	0.42%	0.228	CN	Supporting transport	0.40%	0.182	CN	Supporting transport	0.35%	0.025	CN	Supporting transport	0.35%	7.64×10^{-3}	CN	Supporting transport	0.38%	3.65×10^{-3}
16	CN	Elec. Gas	0.40%	0.380	CN	Elec. Gas	0.36%	0.199	CN	Elec. Gas	0.35%	0.159	GE	Construction work (45)	0.33%	0.023	GE	Construction work (45)	0.34%	7.32×10^{-3}	CN	Elec. Gas	0.34%	3.19×10^{-3}
17	CN	Inland transportation	0.36%	0.340	CN	Inland transportation	0.33%	0.179	CN	Inland transportation	0.32%	0.143	CN	Elec. Gas	0.31%	0.022	CN	Elec. Gas	0.31%	6.69×10^{-3}	GE	Construction work (45)	0.31%	2.97×10^{-3}
18	CN	Sea transportation	0.31%	0.296	GE	Construction work (45)	0.29%	0.158	GE	Construction work (45)	0.30%	0.134	CN	Inland transportation	0.28%	0.019	CN	Inland transportation	0.27%	5.99×10^{-3}	CN	Inland transportation	0.30%	2.86×10^{-3}
19	CN	Coke Oven	0.29%	0.273	CN	Sea transportation	0.28%	0.156	CN	Sea transportation	0.27%	0.124	CN	Sea transportation	0.24%	0.017	CN	Sea transportation	0.24%	5.22×10^{-3}	CN	Sea transportation	0.26%	2.49×10^{-3}
20	CN	Paper products	0.27%	0.256	CN	Coke Oven	0.26%	0.143	CN	Coke Oven	0.25%	0.114	CN	Coke Oven	0.22%	0.016	CN	Coke Oven	0.22%	4.81×10^{-3}	CN	Coke Oven	0.24%	2.30×10^{-3}

Table 63: Total Annual Carbon Footprint Distribution of Bitcoin mining in Georgia by country

Total GWP per year (MtCO$_2$-eqv.)

Order	2020 C.C.	2020 P.A.D.* (%)	2020 GWP	2019 C.C.	2019 P.A.D.* (%)	2019 GWP	2018 C.C.	2018 P.A.D.* (%)	2018 GWP	2017 C.C.	2017 P.A.D.* (%)	2017 GWP	2016 C.C.	2016 P.A.D.* (%)	2016 GWP	2015 C.C.	2015 P.A.D.* (%)	2015 GWP
1	CN	51.29%	1.49×10^{-2}	GE	47.17%	5.47×10^{-2}	GE	48.65%	1.63×10^{-2}	GE	54.51%	7.53×10^{-3}	GE	54.87%	3.21×10^{-3}	CN	90.38%	8.38×10^{-4}
2	GE	41.83%	1.21×10^{-2}	CN	46.28%	5.37×10^{-2}	CN	44.90%	1.5×10^{-2}	CN	39.41%	5.45×10^{-3}	CN	39.08%	2.29×10^{-3}	JP	1.45%	1.37×10^{-5}
3	WA	0.90%	2.61×10^{-4}	WA	0.84%	9.78×10^{-4}	WA	0.83%	2.76×10^{-4}	RU	0.84%	1.16×10^{-4}	RU	0.85%	4.95×10^{-5}	WA	1.35%	1.57×10^{-5}
4	JP	0.83%	2.42×10^{-4}	RU	0.80%	9.23×10^{-4}	RU	0.81%	2.69×10^{-4}	WA	0.76%	1.06×10^{-4}	WA	0.76%	4.45×10^{-5}	KR	1.12%	1.1×10^{-5}
5	RU	0.76%	2.21×10^{-4}	JP	0.76%	8.77×10^{-4}	JP	0.73%	2.45×10^{-4}	JP	0.65%	8.95×10^{-5}	JP	0.64%	3.76×10^{-5}	US	1.03%	1.21×10^{-5}
6	WM	0.71%	2.07×10^{-4}	WM	0.68%	7.82×10^{-4}	WM	0.66%	2.22×10^{-4}	WM	0.62%	8.58×10^{-5}	WM	0.62%	3.62×10^{-5}	WM	1.02%	1.27×10^{-5}
7	US	0.69%	2.01×10^{-4}	US	0.65%	7.52×10^{-4}	US	0.64%	2.12×10^{-4}	US	0.59%	8.13×10^{-5}	US	0.59%	3.43×10^{-5}	DE	0.68%	7.59×10^{-6}
8	KR	0.66%	1.92×10^{-4}	KR	0.60%	7.01×10^{-4}	KR	0.59%	1.96×10^{-4}	KR	0.52%	7.24×10^{-5}	KR	0.52%	3.04×10^{-5}	RU	0.49%	1.61×10^{-5}
9	DE	0.44%	1.28×10^{-4}	DE	0.41%	4.74×10^{-4}	DE	0.40%	1.34×10^{-4}	DE	0.37%	5.06×10^{-5}	DE	0.36%	2.13×10^{-5}	IN	0.31%	3.81×10^{-6}
10	IN	0.22%	6.23×10^{-5}	IN	0.20%	2.35×10^{-4}	IN	0.20%	6.66×10^{-5}	IN	0.19%	2.58×10^{-5}	IN	0.19%	1.09×10^{-5}	ID	0.25%	2.43×10^{-6}

Table 64: Total Annual Carbon Footprint Distribution of Bitcoin mining in Georgia by sector

Total GWP per year (MtCO$_2$-eqv.)

O.	2020 C.C.	2020 Sector	2020 P.A.D.* (%)	2020 GWP	2019 C.C.	2019 Sector	2019 P.A.D.* (%)	2019 GWP	2018 C.C.	2018 Sector	2018 P.A.D.* (%)	2018 GWP	2017 C.C.	2017 Sector	2017 P.A.D.* (%)	2017 GWP	2016 C.C.	2016 Sector	2016 P.A.D.* (%)	2016 GWP	2015 C.C.	2015 Sector	2015 P.A.D.* (%)	2015 GWP
1	GE	Elec. Gas	34.05%	9.88×10^{-3}	GE	Elec. Gas	38.41%	4.46×10^{-2}	GE	Elec. Gas	39.61%	1.32×10^{-2}	GE	Elec. Gas	44.39%	6.13×10^{-3}	GE	Elec. Gas	44.68%	2.61×10^{-3}	GE	Elec. Gas	41.54%	8.16×10^{-4}
2	CN	Elec. Coal	29.27%	8.50×10^{-3}	CN	Elec. Coal	26.40%	3.06×10^{-2}	CN	Elec. Coal	25.61%	8.56×10^{-3}	CN	Elec. Coal	22.47%	3.11×10^{-3}	CN	Elec. Coal	22.28%	1.30×10^{-3}	CN	Elec. Coal	24.35%	4.78×10^{-4}
3	CN	Iron and Steel	6.54%	1.90×10^{-3}	CN	Iron and Steel	5.91%	6.85×10^{-3}	CN	Iron and Steel	5.73%	1.91×10^{-3}	CN	Iron and Steel	5.03%	6.95×10^{-4}	CN	Iron and Steel	4.99%	2.92×10^{-4}	CN	Iron and Steel	5.45%	1.07×10^{-4}
4	CN	Steam-Hot W. Sply.	2.75%	7.99×10^{-4}	CN	Steam-Hot W. Sply.	2.48%	2.88×10^{-3}	GE	Dist. of gaseous fuels	2.52%	8.41×10^{-4}	GE	Dist. of gaseous fuels	2.82%	3.90×10^{-4}	GE	Dist. of gaseous fuels	2.84%	1.66×10^{-4}	GE	Dist. of gaseous fuels	2.64%	5.18×10^{-5}
5	GE	Dist. of gaseous fuels	2.16%	6.28×10^{-4}	GE	Dist. of gaseous fuels	2.44%	2.83×10^{-3}	CN	Steam-Hot W. Sply.	2.41%	8.04×10^{-4}	GE	Elec. Coal	2.24%	3.09×10^{-4}	GE	Elec. Coal	2.25%	1.32×10^{-4}	CN	Steam-Hot W. Sply.	2.29%	4.49×10^{-5}
6	GE	Elec. Coal	1.72%	4.99×10^{-4}	GE	Elec. Coal	1.94%	2.25×10^{-3}	GE	Elec. Coal	2.00%	6.67×10^{-4}	CN	Steam-Hot W. Sply	2.11%	2.92×10^{-4}	CN	Steam-Hot W. Sply	2.10%	1.23×10^{-4}	GE	Elec. Coal	2.09%	4.11×10^{-5}
7	CN	O. Machinery and Computers	1.62%	4.71×10^{-4}	GE	Steam-Hot W. Sply.	1.62%	1.88×10^{-3}	GE	Steam-Hot W. Sply.	1.67%	5.58×10^{-4}	GE	Steam-Hot W. Sply	1.87%	2.59×10^{-4}	GE	Steam-Hot W. Sply.	1.88%	1.10×10^{-4}	GE	Steam-Hot W. Sply.	1.75%	3.44×10^{-5}
8	CN	Rubber and plastic	1.59%	4.63×10^{-4}	CN	O. Machinery and Computers	1.46%	1.70×10^{-3}	CN	O. Machinery and Computers	1.42%	4.74×10^{-4}	CN	O. Machinery and Computers	1.24%	1.72×10^{-4}	CN	O. Machinery and Computers	1.23%	7.21×10^{-5}	CN	O. Machinery and Computers	1.35%	2.64×10^{-5}
9	GE	Steam-Hot W. Sply.	1.44%	4.18×10^{-4}	CN	Rubber and plastic	1.44%	1.67×10^{-3}	CN	Rubber and plastic	1.40%	4.66×10^{-4}	CN	Rubber and plastic	1.23%	1.69×10^{-4}	CN	Rubber and plastic	1.22%	7.11×10^{-5}	CN	Rubber and plastic	1.33%	2.61×10^{-5}
10	CN	Chemicals nec	1.16%	3.35×10^{-4}	CN	Chemicals nec	1.04%	1.21×10^{-3}	GE	Electricity by hydro	1.04%	3.46×10^{-4}	GE	Electricity by hydro	1.16%	1.60×10^{-4}	GE	Electricity by hydro	1.17%	6.84×10^{-5}	GE	Electricity by hydro	1.09%	2.13×10^{-5}
11	GE	Electricity by hydro	0.89%	2.58×10^{-4}	GE	Electricity by hydro	1.00%	1.16×10^{-3}	CN	Chemicals nec	1.01%	3.38×10^{-4}	CN	Chemicals nec	0.89%	1.23×10^{-4}	CN	Chemicals nec	0.88%	5.15×10^{-5}	CN	Chemicals nec	0.96%	1.89×10^{-5}

#	C.C.	Sector	P.A.D.	GWP	C.C.	Sector	P.A.D.	GWP	C.C.	Sector	P.A.D.	GWP	C.C.	Sector	P.A.D.	GWP	C.C.	Sector	P.A.D.	GWP	C.C.	Sector	P.A.D.	GWP
12	CN	Air transport services	0.75%	$2.17\ 10^{-4}$	CN	Air transport services	0.67%	$7.82\ 10^{-4}$	CN	Air transport services	0.65%	$2.18\ 10^{-4}$	CN	Air transport services	0.57%	$7.94\ 10^{-5}$	CN	Air transport services	0.57%	$3.33\ 10^{-5}$	CN	Air transport services	0.62%	$1.22\ 10^{-5}$
13	CN	Bituminous Coal	0.73%	$2.10\ 10^{-4}$	CN	Bituminous Coal	0.65%	$7.59\ 10^{-4}$	CN	Bituminous Coal	0.63%	$2.12\ 10^{-4}$	CN	Bituminous Coal	0.56%	$7.70\ 10^{-5}$	CN	Bituminous Coal	0.55%	$3.23\ 10^{-5}$	CN	Bituminous Coal	0.60%	$1.18\ 10^{-5}$
14	CN	Other mineral products	0.66%	$1.91\ 10^{-4}$	CN	Other mineral products	0.59%	$6.89\ 10^{-4}$	CN	Other mineral products	0.58%	$1.93\ 10^{-4}$	CN	Other mineral products	0.51%	$7.01\ 10^{-5}$	CN	Other mineral products	0.50%	$2.94\ 10^{-5}$	CN	Other mineral products	0.55%	$1.08\ 10^{-5}$
15	CN	Supporting transport	0.46%	$1.34\ 10^{-4}$	CN	Supporting transport	0.42%	$4.81\ 10^{-4}$	CN	Supporting transport	0.40%	$1.35\ 10^{-4}$	CN	Supporting transport	0.35%	$4.88\ 10^{-5}$	CN	Supporting transport	0.35%	$2.05\ 10^{-5}$	CN	Supporting transport	0.38%	$7.51\ 10^{-6}$
16	CN	Elec. Gas	0.40%	$1.17\ 10{-4}$	CN	Elec. Gas	0.36%	$4.21\ 10{-4}$	CN	Elec. Gas	0.35%	$1.18\ 10^{-4}$	GE	Construction work (45)	0.33%	$4.60\ 10^{-5}$	GE	Construction work (45)	0.34%	$1.96\ 10{-5}$	CN	Elec. Gas	0.34%	$6.57\ 10{-6}$
17	CN	Inland transportation	0.36%	$1.05\ 10{-4}$	CN	Inland transportation	0.33%	$3.77\ 10{-4}$	CN	Inland transportation	0.32%	$1.05\ 10^{-4}$	CN	Elec. Gas	0.31%	$4.27\ 10^{-5}$	CN	Elec. Gas	0.31%	$1.79\ 10{-5}$	GE	Construction work (45)	0.31%	$6.12\ 10{-6}$
18	CN	Sea transportation	0.31%	$9.11\ 10{-5}$	GE	Construction work (45)	0.29%	$3.34\ 10{-4}$	GE	Construction work (45)	0.30%	$9.93\ 10^{-5}$	CN	Inland transportation	0.28%	$3.82\ 10{-5}$	CN	Inland transportation	0.27%	$1.61\ 10{-5}$	CN	Inland transportation	0.30%	$5.89\ 10{-6}$
19	CN	Coke Oven	0.29%	$8.40\ 10{-5}$	CN	Sea transportation	0.28%	$3.28\ 10{-4}$	CN	Sea transportation	0.27%	$9.18\ 10^{-5}$	CN	Sea transportation	0.24%	$3.33\ 10{-5}$	CN	Sea transportation	0.24%	$1.40\ 10{-5}$	CN	Sea transportation	0.26%	$5.13\ 10{-6}$
20	CN	Paper products	0.27%	$7.87\ 10{-5}$	CN	Coke Oven	0.26%	$3.03\ 10{-4}$	CN	Coke Oven	0.25%	$8.46\ 10^{-5}$	CN	Coke Oven	0.22%	$3.07\ 10{-5}$	CN	Coke Oven	0.22%	$1.29\ 10{-5}$	CN	Coke Oven	0.24%	$4.73\ 10{-6}$

d) Iceland

Table 65: Carbon Footprint Distribution of Bitcoin mining in Iceland per transaction by country

	GWP per transaction per year (kgCO$_2$-eqv.)																	
Order	**2020**			**2019**			**2018**			**2017**			**2016**			**2015**		
	C.C.	P.A.D.* (%)	GWP	C.C.	P.A.D.* (%)	GWP	C.C.	P.A.D.* (%)	GWP	C.C.	P.A.D.* (%)	GWP	C.C.	P.A.D.* (%)	GWP	C.C.	P.A.D.* (%)	GWP
1	CN	78.47%	48.586	CN	75.98%	25.534	CN	75.22%	20.383	CN	71.90%	2.792	CN	71.68%	$8.58\ 10^{-1}$	CN	73.95%	$4.09\ 10^{-1}$
2	IS	9.28%	5.748	IS	11.21%	3.766	IS	11.79%	3.194	IS	14.35%	$5.57\ 10^{-1}$	IS	14.52%	$1.74\ 10^{-1}$	IS	12.77%	$7.07\ 10^{-2}$
3	WA	1.62%	1.003	RU	1.77%	0.595	RU	1.84%	0.498	RU	2.13%	$8.28\ 10^{-2}$	RU	2.15%	$2.58\ 10^{-2}$	RU	1.95%	$1.08\ 10^{-2}$
4	RU	1.55%	0.960	WA	1.68%	0.564	WA	1.69%	0.459	WA	1.77%	$6.87\ 10^{-2}$	WA	1.77%	$2.12\ 10^{-2}$	WA	1.72%	$9.53\ 10^{-3}$
5	WM	1.31%	0.808	WM	1.37%	0.459	WM	1.38%	0.375	WM	1.46%	$5.68\ 10^{-2}$	WM	1.47%	$1.76\ 10^{-2}$	WM	1.41%	$7.82\ 10^{-3}$
6	JP	1.29%	0.800	JP	1.26%	0.423	JP	1.25%	0.339	JP	1.21%	$4.69\ 10^{-2}$	JP	1.20%	$1.44\ 10^{-2}$	JP	1.23%	$6.83\ 10^{-3}$
7	US	1.14%	0.703	US	1.16%	0.389	US	1.16%	0.315	US	1.19%	$4.63\ 10^{-2}$	US	1.19%	$1.43\ 10^{-2}$	US	1.17%	$6.5\ 10^{-3}$
8	KR	1.05%	0.649	KR	1.03%	0.348	KR	1.03%	0.279	KR	1.01%	$3.93\ 10^{-2}$	KR	1.01%	$1.21\ 10^{-2}$	KR	1.02%	$5.66\ 10^{-3}$
9	DE	0.74%	0.459	DE	0.76%	0.254	DE	0.76%	0.206	DE	0.78%	$3.01\ 10^{-2}$	DE	0.78%	$9.31\ 10^{-3}$	DE	0.77%	$4.24\ 10^{-3}$
10	IN	0.39%	0.244	IN	0.41%	0.139	IN	0.42%	0.113	IN	0.44%	$1.72\ 10^{-2}$	IN	0.44%	$5.31\ 10^{-3}$	IN	0.43%	$2.36\ 10^{-3}$

Table 66: Carbon Footprint Distribution of Bitcoin mining in Iceland per transaction by sector in Supply Chain

	GWP per transaction per year (kgCO$_2$-eqv.)																							
O.	**2020**				**2019**				**2018**				**2017**				**2016**				**2015**			
	C.C.	Sector	P.A.D.*	GWP	C.C.	Sector	P.A.D.*	GWP	C.C.	Sector	P.A.D.*	GWP	C.C.	Sector	P.A.D.*	GWP	C.C.	Sector	P.A.D.*	GWP	C.C.	Sector	P.A.D.*	GWP

			(%)				(%)				(%)				(%)				(%)				(%)	
1	CN	Elec. Coal	44.74%	27.7	CN	Elec. Coal	43.30%	14.552	CN	Elec. Coal	42.86%	11.615	CN	Elec. Coal	40.95%	1.59	CN	Elec. Coal	40.82%	4.89×10^{-1}	CN	Elec. Coal	42.13%	2.33×10^{-1}
2	CN	Iron and Steel	10.01%	6.2	CN	Iron and Steel	9.70%	3.259	CN	Iron and Steel	9.60%	2.602	CN	Iron and Steel	9.18%	3.57×10^{-1}	CN	Iron and Steel	9.16%	1.10×10^{-1}	CN	Iron and Steel	9.44%	5.23×10^{-2}
3	CN	Steam-Hot W. Sply.	4.21%	2.605	CN	Steam-Hot W. Sply.	4.07%	1.368	CN	Steam-Hot W. Sply.	4.03%	1.092	IS	Electricity by hydro	4.06%	1.58×10^{-1}	IS	Electricity by hydro	4.11%	4.92×10^{-2}	CN	Steam-Hot W. Sply.	3.96%	2.19×10^{-2}
4	IS	Electricity by hydro	2.62%	1.620	IS	Electricity by hydro	3.16%	1.063	IS	Electricity by hydro	3.33%	9.02×10^{-1}	CN	Steam-Hot W. Sply	3.85%	1.50×10^{-1}	CN	Steam-Hot W. Sply.	3.84%	4.59×10^{-2}	IS	Electricity by hydro	3.61%	2.00×10^{-2}
5	CN	O. Machinery and Computers	2.47%	1.531	CN	O. Machinery and Computers	2.39%	8.03×10^{-1}	IS	Elec. Coal	2.40%	6.50×10^{-1}	IS	Elec. Coal	2.92%	1.13×10^{-1}	IS	Elec. Coal	2.96%	3.54×10^{-2}	IS	Elec. Coal	2.60%	1.44×10^{-2}
6	CN	Rubber and plastic	2.44%	1.512	CN	Rubber and plastic	2.37%	7.95×10^{-1}	CN	O. Machinery and Computers	2.36%	6.41×10^{-1}	CN	O. Machinery and Computers	2.25%	8.75×10^{-2}	CN	O. Machinery and Computers	2.25%	2.69×10^{-2}	CN	O. Machinery and Computers	2.32%	1.29×10^{-2}
7	IS	Elec. Coal	1.89%	1.170	IS	Elec. Coal	2.28%	7.67×10^{-1}	CN	Rubber and plastic	2.34%	6.35×10^{-1}	CN	Rubber and plastic	2.24%	8.70×10^{-2}	CN	Rubber and plastic	2.23%	2.67×10^{-2}	CN	Rubber and plastic	2.30%	1.27×10^{-2}
8	CN	Chemicals nec	1.77%	1.095	CN	Chemicals nec	1.71%	5.75×10^{-1}	CN	Chemicals nec	1.70%	4.59×10^{-1}	IS	Dist. of gaseous fuels	1.69%	6.57×10^{-2}	IS	Dist. of gaseous fuels	1.71%	2.05×10^{-2}	CN	Chemicals nec	1.67%	9.23×10^{-3}
9	CN	Air transport services	1.14%	0.707	IS	Dist. of gaseous fuels	1.32%	4.44×10^{-1}	IS	Dist. of gaseous fuels	1.39%	3.76×10^{-1}	CN	Chemicals nec	1.62%	6.30×10^{-2}	CN	Chemicals nec	1.62%	1.93×10^{-2}	IS	Dist. of gaseous fuels	1.51%	8.33×10^{-3}
10	CN	Bituminous Coal	1.11%	0.687	IS	Steam-Hot W. Sply.	1.17%	3.91×10^{-1}	IS	Steam-Hot W. Sply.	1.23%	3.32×10^{-1}	IS	Steam-Hot W. Sply	1.49%	5.78×10^{-2}	IS	Steam-Hot W. Sply.	1.51%	1.80×10^{-2}	IS	Steam-Hot W. Sply.	1.33%	7.34×10^{-3}
11	IS	Dist. of gaseous fuels	1.09%	0.676	CN	Air transport services	1.11%	3.72×10^{-1}	CN	Air transport services	1.10%	2.97×10^{-1}	CN	Air transport services	1.05%	4.07×10^{-2}	CN	Air transport services	1.05%	1.25×10^{-2}	CN	Air transport services	1.08%	5.96×10^{-3}
12	CN	Other mineral products	1.01%	0.627	CN	Bituminous Coal	1.08%	3.61×10^{-1}	CN	Bituminous Coal	1.06%	2.88×10^{-1}	CN	Bituminous Coal	1.02%	3.95×10^{-2}	CN	Bituminous Coal	1.01%	1.21×10^{-2}	CN	Bituminous Coal	1.05%	5.79×10^{-3}
13	IS	Steam-Hot W. Sply.	0.97%	0.599	CN	Other mineral products	0.98%	3.30×10^{-1}	CN	Other mineral products	0.97%	2.64×10^{-1}	CN	Other mineral products	0.93%	3.63×10^{-2}	CN	Other mineral products	0.93%	1.12×10^{-2}	CN	Other mineral products	0.96%	5.30×10^{-3}
14	CN	Supporting transport	0.70%	0.436	CN	Supporting transport	0.68%	2.29×10^{-1}	CN	Supporting transport	0.67%	1.83×10^{-1}	IS	Construction work (45)	0.69%	2.67×10^{-2}	IS	Construction work (45)	0.70%	8.33×10^{-3}	CN	Supporting transport	0.66%	3.67×10^{-3}
15	CN	Elec. Gas	0.62%	0.381	CN	Elec. Gas	0.60%	2.00×10^{-1}	CN	Elec. Gas	0.59%	1.60×10^{-1}	CN	Supporting transport	0.64%	2.50×10^{-2}	CN	Supporting transport	0.64%	7.68×10^{-3}	IS	Construction work (45)	0.61%	3.39×10^{-3}
16	CN	Inland transportation	0.55%	0.341	IS	Construction work (45)	0.54%	1.80×10^{-1}	IS	Construction work (45)	0.57%	1.53×10^{-1}	CN	Elec. Gas	0.56%	2.19×10^{-2}	CN	Elec. Gas	0.56%	6.72×10^{-3}	CN	Elec. Gas	0.58%	3.21×10^{-3}
17	CN	Sea transportation	0.48%	0.298	CN	Inland transportation	0.53%	1.79×10^{-1}	CN	Inland transportation	0.53%	1.43×10^{-1}	CN	Inland transportation	0.50%	1.96×10^{-2}	CN	Inland transportation	0.50%	6.02×10^{-3}	CN	Inland transportation	0.52%	2.87×10^{-3}
18	IS	Construction work (45)	0.44%	0.275	CN	Sea transportation	0.47%	1.57×10^{-1}	CN	Sea transportation	0.46%	1.25×10^{-1}	CN	Sea transportation	0.44%	1.71×10^{-2}	CN	Sea transportation	0.44%	5.27×10^{-3}	CN	Sea transportation	0.45%	2.51×10^{-3}
19	CN	Coke Oven	0.44%	0.274	CN	Coke Oven	0.43%	1.44×10^{-1}	CN	Coke Oven	0.43%	1.15×10^{-1}	CN	Coke Oven	0.41%	1.58×10^{-2}	CN	Coke Oven	0.40%	4.85×10^{-3}	CN	Coke Oven	0.42%	2.31×10^{-3}
20	CN	Paper products	0.42%	0.257	CN	Paper products	0.40%	1.36×10^{-1}	CN	Paper products	0.40%	1.08×10^{-1}	CN	paper products	0.38%	1.49×10^{-2}	CN	Paper products	0.38%	4.57×10^{-3}	CN	Paper products	0.39%	2.17×10^{-3}

Table 67: Total Annual Carbon Footprint Distribution of Bitcoin mining in Iceland by country

Order	Total GWP per year (MtCO₂-eqv.)					
	2020	**2019**	**2018**	**2017**	**2016**	**2015**

	C.C.	P.A.D.*(%)	GWP	C.C.	P.A.D.*(%)	GWP	C.C.	P.A.D.*(%)	GWP	C.C.	P.A.D.*(%)	GWP	C.C.	P.A.D.*(%)	GWP	C.C.	P.A.D.*(%)	GWP
1	CN	78.47%	$1.49\ 10^{-2}$	CN	75.98%	$5.39\ 10^{-2}$	CN	75.22%	$1.51\ 10^{-2}$	CN	71.90%	$5.48\ 10^{-3}$	CN	71.68%	$2.3\ 10^{-3}$	CN	73.95%	$8.42\ 10^{-4}$
2	IS	9.28%	$1.77\ 10^{-3}$	IS	11.21%	$7.95\ 10^{-3}$	IS	11.79%	$2.36\ 10^{-3}$	IS	14.35%	$1.09\ 10^{-3}$	IS	14.52%	$4.66\ 10^{-4}$	IS	12.77%	$1.45\ 10^{-4}$
3	WA	1.62%	$3.09\ 10^{-4}$	RU	1.77%	$1.26\ 10^{-3}$	RU	1.84%	$3.68\ 10^{-4}$	RU	2.13%	$1.62\ 10^{-4}$	RU	2.15%	$6.9\ 10^{-5}$	RU	1.95%	$2.22\ 10^{-5}$
4	RU	1.55%	$2.95\ 10^{-4}$	WA	1.68%	$1.19\ 10^{-3}$	WA	1.69%	$3.39\ 10^{-4}$	WA	1.77%	$1.35\ 10^{-4}$	WA	1.77%	$5.69\ 10^{-5}$	WA	1.72%	$1.96\ 10^{-5}$
5	WM	1.31%	$2.48\ 10^{-4}$	WM	1.37%	$9.69\ 10^{-4}$	WM	1.38%	$2.77\ 10^{-4}$	WM	1.46%	$1.11\ 10^{-4}$	WM	1.47%	$4.71\ 10^{-5}$	WM	1.41%	$1.61\ 10^{-5}$
6	JP	1.29%	$2.46\ 10^{-4}$	JP	1.26%	$8.94\ 10^{-4}$	JP	1.25%	$2.5\ 10^{-4}$	JP	1.21%	$9.19\ 10^{-5}$	JP	1.20%	$3.86\ 10^{-5}$	JP	1.23%	$1.41\ 10^{-5}$
7	US	1.14%	$2.16\ 10^{-4}$	US	1.16%	$8.21\ 10^{-4}$	US	1.16%	$2.33\ 10^{-4}$	US	1.19%	$9.08\ 10^{-5}$	US	1.19%	$3.83\ 10^{-5}$	US	1.17%	$1.34\ 10^{-5}$
8	KR	1.05%	$2.0\ 10^{-4}$	KR	1.03%	$7.34\ 10^{-4}$	KR	1.03%	$2.06\ 10^{-4}$	KR	1.01%	$7.7\ 10^{-5}$	KR	1.01%	$3.24\ 10^{-5}$	KR	1.02%	$1.17\ 10^{-5}$
9	DE	0.74%	$1.41\ 10^{-4}$	DE	0.76%	$5.36\ 10^{-4}$	DE	0.76%	$1.52\ 10^{-4}$	DE	0.78%	$5.91\ 10^{-5}$	DE	0.78%	$2.49\ 10^{-5}$	DE	0.77%	$8.72\ 10^{-6}$
10	IN	0.39%	$7.5\ 10^{-5}$	IN	0.41%	$2.92\ 10^{-4}$	IN	0.42%	$8.37\ 10^{-5}$	IN	0.44%	$3.36\ 10^{-5}$	IN	0.44%	$1.42\ 10^{-5}$	IN	0.43%	$4.86\ 10^{-6}$

Table 68: Total Annual Carbon Footprint Distribution of Bitcoin mining in Iceland by sector

	Total GWP per year (MtCO$_2$-eqv.)																							
O.	2020				2019				2018				2017				2016				2015			
	C.C.	Sector	P.A.D.*(%)	GWP	C.C.	Sector	P.A.D.*(%)	GWP	C.C.	Sector	P.A.D.*(%)	GWP	C.C.	Sector	P.A.D.*(%)	GWP	C.C.	Sector	P.A.D.*(%)	GWP	C.C.	Sector	P.A.D.*(%)	GWP
1	CN	Elec. Coal	44.74%	$8.52\ 10^{-3}$	CN	Elec. Coal	43.30%	$3.07\ 10^{-2}$	CN	Elec. Coal	42.86%	$8.59\ 10^{-3}$	CN	Elec. Coal	40.95%	$3.12\ 10^{-3}$	CN	Elec. Coal	40.82%	$1.31\ 10^{-3}$	CN	Elec. Coal	42.13%	$4.80\ 10^{-4}$
2	CN	Iron and Steel	10.01%	$1.91\ 10^{-3}$	CN	Iron and Steel	9.70%	$6.88\ 10^{-3}$	CN	Iron and Steel	9.60%	$1.92\ 10^{-3}$	CN	Iron and Steel	9.18%	$7.00\ 10^{-4}$	CN	Iron and Steel	9.16%	$2.94\ 10^{-4}$	CN	Iron and Steel	9.44%	$1.08\ 10^{-4}$
3	CN	Steam-Hot W. Sply.	4.21%	$8.01\ 10^{-4}$	CN	Steam-Hot W. Sply.	4.07%	$2.89\ 10^{-3}$	CN	Steam-Hot W. Sply.	4.03%	$8.07\ 10^{-4}$	IS	Electricity by hydro	4.06%	$3.09\ 10^{-4}$	IS	Electricity by hydro	4.11%	$1.32\ 10^{-4}$	CN	Steam-Hot W. Sply.	3.96%	$4.51\ 10^{-5}$
4	IS	Electricity by hydro	2.62%	$4.98\ 10^{-4}$	IS	Electricity by hydro	3.16%	$2.25\ 10^{-3}$	IS	Electricity by hydro	3.33%	$6.67\ 10^{-4}$	CN	Steam-Hot W. Sply	3.85%	$2.93\ 10^{-4}$	CN	Steam-Hot W. Sply.	3.84%	$1.23\ 10^{-4}$	IS	Electricity by hydro	3.61%	$4.11\ 10^{-5}$
5	CN	O. Machinery and Computers	2.47%	$4.71\ 10^{-4}$	CN	O. Machinery and Computers	2.39%	$1.70\ 10^{-3}$	IS	Elec. Coal	2.40%	$4.81\ 10^{-4}$	IS	Elec. Coal	2.92%	$2.22\ 10^{-4}$	IS	Elec. Coal	2.96%	$9.48\ 10^{-5}$	IS	Elec. Coal	2.60%	$2.96\ 10^{-5}$
6	CN	Rubber and plastic	2.44%	$4.65\ 10^{-4}$	CN	Rubber and plastic	2.37%	$1.68\ 10^{-3}$	CN	O. Machinery and Computers	2.36%	$4.74\ 10^{-4}$	CN	O. Machinery and Computers	2.25%	$1.72\ 10^{-4}$	CN	O. Machinery and Computers	2.25%	$7.21\ 10^{-5}$	CN	O. Machinery and Computers	2.32%	$2.65\ 10^{-5}$
7	IS	Elec. Coal	1.89%	$3.60\ 10^{-4}$	IS	Elec. Coal	2.28%	$1.62\ 10^{-3}$	CN	Rubber and plastic	2.34%	$4.69\ 10^{-4}$	CN	Rubber and plastic	2.24%	$1.71\ 10^{-4}$	CN	Rubber and plastic	2.23%	$7.17\ 10^{-5}$	CN	Rubber and plastic	2.30%	$2.62\ 10^{-5}$
8	CN	Chemicals nec	1.77%	$3.37\ 10^{-4}$	CN	Chemicals nec	1.71%	$1.22\ 10^{-3}$	CN	Chemicals nec	1.70%	$3.40\ 10^{-4}$	IS	Dist. of gaseous fuels	1.69%	$1.29\ 10^{-4}$	IS	Dist. of gaseous fuels	1.71%	$5.50\ 10^{-5}$	CN	Chemicals nec	1.67%	$1.90\ 10^{-5}$
9	CN	Air transport services	1.14%	$2.17\ 10^{-4}$	IS	Dist. of gaseous fuels	1.32%	$9.37\ 10^{-4}$	IS	Dist. of gaseous fuels	1.39%	$2.78\ 10^{-4}$	CN	Chemicals nec	1.62%	$1.24\ 10^{-4}$	CN	Chemicals nec	1.62%	$5.19\ 10^{-5}$	IS	Dist. of gaseous fuels	1.51%	$1.71\ 10^{-5}$
10	CN	Bituminous Coal	1.11%	$2.11\ 10^{-4}$	IS	Steam-Hot W. Sply.	1.17%	$8.27\ 10^{-4}$	IS	Steam-Hot W. Sply.	1.23%	$2.45\ 10^{-4}$	IS	Steam-Hot W. Sply	1.49%	$1.13\ 10^{-4}$	IS	Steam-Hot W. Sply.	1.51%	$4.83\ 10^{-5}$	IS	Steam-Hot W. Sply.	1.33%	$1.51\ 10^{-5}$
11	IS	Dist. of gaseous fuels	1.09%	$2.08\ 10^{-4}$	CN	Air transport services	1.11%	$7.85\ 10^{-4}$	CN	Air transport services	1.10%	$2.20\ 10^{-4}$	CN	Air transport services	1.05%	$7.99\ 10^{-5}$	CN	Air transport services	1.05%	$3.35\ 10^{-5}$	CN	Air transport services	1.08%	$1.23\ 10^{-5}$
12	CN	Other mineral products	1.01%	$1.93\ 10^{-4}$	CN	Bituminous Coal	1.08%	$7.63\ 10^{-4}$	CN	Bituminous Coal	1.06%	$2.13\ 10^{-4}$	CN	Bituminous Coal	1.02%	$7.76\ 10^{-5}$	CN	Bituminous Coal	1.01%	$3.26\ 10^{-5}$	CN	Bituminous Coal	1.05%	$1.19\ 10^{-5}$
13	IS	Steam-Hot W. Sply.	0.97%	$1.84\ 10^{-4}$	CN	Other mineral products	0.98%	$6.97\ 10^{-4}$	CN	Other mineral products	0.97%	$1.95\ 10^{-4}$	CN	Other mineral products	0.93%	$7.12\ 10^{-5}$	CN	Other mineral products	0.93%	$2.99\ 10^{-5}$	CN	Other mineral products	0.96%	$1.09\ 10^{-5}$
14	CN	Supporting transport	0.70%	$1.34\ 10^{-4}$	CN	Supporting transport	0.68%	$4.83\ 10^{-4}$	CN	Supporting transport	0.67%	$1.35\ 10^{-4}$	IS	Construction work (45)	0.69%	$5.24\ 10^{-5}$	IS	Construction work (45)	0.70%	$2.23\ 10^{-5}$	CN	Supporting transport	0.66%	$7.55\ 10^{-6}$

15	CN	Elec. Gas	0.62%	$1.17\ 10^{-4}$	CN	Elec. Gas	0.60%	$4.23\ 10^{-4}$	CN	Elec. Gas	0.59%	$1.18\ 10^{-4}$	CN	Supporting transport	0.64%	$4.91\ 10^{-5}$	CN	Supporting transport	0.64%	$2.06\ 10^{-5}$	IS	Construction work (45)	0.61%	$6.97\ 10^{-6}$
16	CN	Inland transportation	0.55%	$1.05\ 10^{-4}$	IS	Construction work (45)	0.54%	$3.81\ 10^{-4}$	IS	Construction work (45)	0.57%	$1.13\ 10^{-4}$	CN	Elec. Gas	0.56%	$4.29\ 10^{-5}$	CN	Elec. Gas	0.56%	$1.80\ 10^{-5}$	CN	Elec. Gas	0.58%	$6.60\ 10^{-6}$
17	CN	Sea transportation	0.48%	$9.15\ 10^{-5}$	CN	Inland transportation	0.53%	$3.78\ 10^{-4}$	CN	Inland transportation	0.53%	$1.06\ 10^{-4}$	CN	Inland transportation	0.50%	$3.84\ 10^{-5}$	CN	Inland transportation	0.50%	$1.61\ 10^{-5}$	CN	Inland transportation	0.52%	$5.91\ 10^{-6}$
18	IS	Construction work (45)	0.44%	$8.45\ 10^{-5}$	CN	Sea transportation	0.47%	$3.31\ 10^{-4}$	CN	Sea transportation	0.46%	$9.24\ 10^{-5}$	CN	Sea transportation	0.44%	$3.36\ 10^{-5}$	CN	Sea transportation	0.44%	$1.41\ 10^{-5}$	CN	Sea transportation	0.45%	$5.17\ 10^{-6}$
19	CN	Coke Oven	0.44%	$8.43\ 10^{-5}$	CN	Coke Oven	0.43%	$3.04\ 10^{-4}$	CN	Coke Oven	0.43%	$8.51\ 10^{-5}$	CN	Coke Oven	0.41%	$3.09\ 10^{-5}$	CN	Coke Oven	0.40%	$1.30\ 10^{-5}$	CN	Coke Oven	0.42%	$4.76\ 10^{-6}$
20	CN	Paper products	0.42%	$7.92\ 10^{-5}$	CN	Paper products	0.40%	$2.86\ 10^{-4}$	CN	Paper products	0.40%	$8.00\ 10^{-5}$	CN	Paper products	0.38%	$2.91\ 10^{-5}$	CN	Paper products	0.38%	$1.22\ 10^{-5}$	CN	Paper products	0.39%	$4.48\ 10^{-6}$

e) USA

Table 69: Carbon Footprint Distribution of Bitcoin mining in USA per transaction by country

		GWP per transaction per year (kgCO$_2$-eqv.)																	
		2020			**2019**			**2018**			**2017**			**2016**			**2015**		
Order		C.C.	P.A.D.* (%)	GWP	C.C.	P.A.D.* (%)	GWP	C.C.	P.A.D.* (%)	GWP	C.C.	P.A.D.* (%)	GWP	C.C.	P.A.D.* (%)	GWP	C.C.	P.A.D.* (%)	GWP
1		US	85.76%	322.310	US	88.25%	211.507	US	88.85%	179.425	US	91.07%	31.334	US	91.14%	9.774	US	89.78%	3.972
2		CN	12.85%	48.307	CN	10.57%	25.340	CN	10.02%	20.227	CN	7.99%	2.750	CN	7.92%	$8.49\ 10^{-1}$	CN	9.17%	$4.06\ 10^{-1}$
3		JP	0.21%	0.781	JP	0.17%	$4.11\ 10^{-1}$	JP	0.16%	$3.28\ 10^{-1}$	JP	0.13%	$4.47\ 10^{-2}$	JP	0.13%	$1.38\ 10^{-2}$	JP	0.15%	$6.59\ 10^{-3}$
4		WA	0.20%	0.747	WA	0.17%	$3.95\ 10^{-1}$	WA	0.16%	$3.16\ 10^{-1}$	WA	0.13%	$4.35\ 10^{-2}$	WA	0.13%	$1.34\ 10^{-2}$	WA	0.14%	$6.37\ 10^{-3}$
5		KR	0.16%	0.602	KR	0.13%	$3.17\ 10^{-1}$	KR	0.13%	$2.53\ 10^{-1}$	KR	0.10%	$3.45\ 10^{-2}$	KR	0.10%	$1.07\ 10^{-2}$	KR	0.12%	$5.08\ 10^{-3}$
6		WM	0.15%	0.575	WM	0.13%	$3.06\ 10^{-1}$	WM	0.12%	$2.45\ 10^{-1}$	WM	0.10%	$3.4\ 10^{-2}$	WM	0.10%	$1.05\ 10^{-2}$	WM	0.11%	$4.95\ 10^{-3}$
7		RU	0.10%	0.386	RU	0.09%	$2.18\ 10^{-1}$	RU	0.09%	$1.78\ 10^{-1}$	RU	0.08%	$2.69\ 10^{-2}$	RU	0.08%	$8.33\ 10^{-3}$	RU	0.08%	$3.72\ 10^{-3}$
8		DE	0.10%	0.376	DE	0.08%	$1.99\ 10^{-1}$	DE	0.08%	$1.59\ 10^{-1}$	WL	0.07%	$2.28\ 10^{-2}$	WL	0.07%	$7.08\ 10^{-3}$	DE	0.07%	$3.21\ 10^{-3}$
9		WL	0.08%	0.281	WL	0.07%	$1.7\ 10^{-1}$	WL	0.07%	$1.41\ 10^{-1}$	DE	0.06%	$2.2\ 10^{-2}$	DE	0.06%	$6.79\ 10^{-3}$	WL	0.07%	$3.02\ 10^{-3}$
10		IN	0.05%	0.177	IN	0.04%	$9.43\ 10^{-2}$	IN	0.04%	$7.57\ 10^{-2}$	IN	0.03%	$1.06\ 10^{-2}$	IN	0.03%	$3.27\ 10^{-3}$	IN	0.04%	$1.53\ 10^{-3}$

Table 70: Carbon Footprint Distribution of Bitcoin mining in USA per transaction by sector in Supply Chain

		GWP per transaction per year (kgCO$_2$-eqv.)																				
O.		**2020**				**2019**				**2018**				**2017**				**2016**				**2015**
	C.C.	Sector	P.A.D.* (%)	GWP	C.C.	Sector	P.A.D.* (%)	GWP	C.C.	Sector	P.A.D.* (%)	GWP	C.C.	Sector	P.A.D.* (%)	GWP	C.C.	Sector	P.A.D.* (%)	GWP	C.C.	Sector	P.A.D.* (%)	GWP
1	US	Elec. Coal	48.78%	183.320	US	Elec. Coal	50.20%	120.318	US	Elec. Coal	50.55%	102.071	US	Elec. Coal	51.81%	17.828	US	Elec. Coal	51.86%	5.561	US	Elec. Coal	51.07%	2.260
2	US	Elec. Gas	35.31%	132.715	US	Elec. Gas	36.35%	87.116	US	Elec. Gas	36.60%	73.907	US	Elec. Gas	37.52%	12.910	US	Elec. Gas	37.55%	4.027	US	Elec. Gas	36.98%	1.636
3	CN	Elec. Coal	7.34%	27.579	CN	Elec. Coal	6.04%	14.466	CN	Elec. Coal	5.72%	11.547	CN	Elec. Coal	4.56%	1.570	CN	Elec. Coal	4.52%	$4.85\ 10^{-1}$	CN	Elec. Coal	5.24%	$2.32\ 10^{-1}$
4	CN	Iron and Steel	1.64%	6.154	CN	Iron and Steel	1.35%	3.228	CN	Iron and Steel	1.28%	2.577	CN	Iron and Steel	1.02%	$3.50\ 10^{-1}$	CN	Iron and Steel	1.01%	$1.08\ 10^{-1}$	CN	Iron and Steel	1.17%	$5.17\ 10^{-2}$

Order	C.C.	(2020)	P.A.D. (%)	GWP	C.C.	(2019)	P.A.D. (%)	GWP	C.C.	(2018)	P.A.D. (%)	GWP	C.C.	(2017)	P.A.D. (%)	GWP	C.C.	(2016)	P.A.D. (%)	GWP	C.C.	(2015)	P.A.D. (%)	GWP
5	CN	Steam-Hot W. Sply.	0.69%	2.592	US	Elec. Petroleum	0.58%	1.397	US	Elec. Petroleum	0.59%	1.185	US	Elec. Petroleum	0.60%	$2.07\,10^{-1}$	US	Elec. Petroleum	0.60%	$6.45\,10^{-2}$	US	Elec. Petroleum	0.59%	$2.62\,10^{-2}$
6	US	Elec. Petroleum	0.57%	2.128	CN	Steam-Hot W. Sply.	0.57%	1.360	CN	Steam-Hot W. Sply.	0.54%	1.085	US	Electricity by biomass and waste	0.55%	$1.90\,10^{-1}$	US	Electricity by biomass and waste	0.55%	$5.91\,10^{-2}$	US	Electricity by biomass and waste	0.54%	$2.40\,10^{-2}$
7	US	Electricity by biomass and waste	0.52%	1.949	US	Electricity by biomass and waste	0.53%	1.279	US	Electricity by biomass and waste	0.54%	1.085	CN	Steam-Hot W. Sply.	0.43%	$1.48\,10^{-1}$	CN	Steam-Hot W. Sply.	0.43%	$4.56\,10^{-2}$	CN	Steam-Hot W. Sply.	0.49%	$2.18\,10^{-2}$
8	CN	O. Machinery and Computers	0.41%	1.531	CN	O. Machinery and Computers	0.34%	0.803	CN	O. Machinery and Computers	0.32%	0.641	CN	O. Machinery and Computers	0.25%	$8.70\,10^{-2}$	CN	O. Machinery and Computers	0.25%	$2.69\,10^{-2}$	CN	O. Machinery and Computers	0.29%	$1.29\,10^{-2}$
9	CN	Rubber and plastic	0.40%	1.502	CN	Rubber and plastic	0.33%	0.788	CN	Rubber and plastic	0.31%	0.629	CN	Rubber and plastic	0.25%	$8.55\,10^{-2}$	CN	Rubber and plastic	0.25%	$2.64\,10^{-2}$	CN	Rubber and plastic	0.29%	$1.26\,10^{-2}$
10	CN	Chemicals nec	0.29%	1.086	CN	Chemicals nec	0.24%	0.570	CN	Chemicals nec	0.23%	0.455	US	Bituminous Coal	0.21%	$7.38\,10^{-2}$	US	Bituminous Coal	0.22%	$2.30\,10^{-2}$	US	Bituminous Coal	0.21%	$9.37\,10^{-3}$
11	US	Bituminous Coal	0.20%	0.764	US	Bituminous Coal	0.21%	0.500	US	Bituminous Coal	0.21%	0.424	CN	Chemicals nec	0.18%	$6.18\,10^{-2}$	CN	Chemicals nec	0.18%	$1.91\,10^{-2}$	CN	Chemicals nec	0.21%	$9.12\,10^{-3}$
12	CN	Air transport services	0.19%	0.701	CN	Air transport services	0.15%	0.368	CN	Air transport services	0.15%	0.293	CN	Air transport services	0.12%	$3.99\,10^{-2}$	CN	Air transport services	0.12%	$1.23\,10^{-2}$	CN	Air transport services	0.13%	$5.89\,10^{-3}$
13	CN	Bituminous Coal	0.18%	0.683	CN	Bituminous Coal	0.15%	0.358	CN	Bituminous Coal	0.14%	0.286	CN	Bituminous Coal	0.11%	$3.89\,10^{-2}$	CN	Bituminous Coal	0.11%	$1.20\,10^{-2}$	CN	Bituminous Coal	0.13%	$5.74\,10^{-3}$
14	CN	Other mineral products	0.16%	0.616	CN	Other mineral products	0.14%	0.323	CN	Other mineral products	0.13%	0.258	CN	Other mineral products	0.10%	$3.51\,10^{-2}$	CN	Other mineral products	0.10%	$1.08\,10^{-2}$	CN	Other mineral products	0.12%	$5.18\,10^{-3}$
15	CN	Supporting transport	0.12%	0.434	CN	Supporting transport	0.10%	0.227	US	Transportation services via pipelines	0.09%	0.188	US	Transportation services via pipelines	0.10%	$3.26\,10^{-2}$	US	Transportation services via pipelines	0.10%	$1.02\,10^{-2}$	US	Transportation services via pipelines	0.09%	$4.15\,10^{-3}$
16	CN	Elec. Gas	0.10%	0.379	US	Transportation services via pipelines	0.09%	0.222	CN	Supporting transport	0.09%	0.181	US	Retail trade	0.08%	$2.75\,10^{-2}$	US	Retail trade	0.08%	$8.59\,10^{-3}$	CN	Supporting transport	0.08%	$3.64\,10^{-3}$
17	CN	Inland transportation	0.09%	0.340	CN	Elec. Gas	0.08%	0.199	CN	Elec. Gas	0.08%	0.159	CN	Supporting transport	0.07%	$2.47\,10^{-2}$	CN	Supporting transport	0.07%	$7.62\,10^{-3}$	US	Retail trade	0.08%	$3.50\,10^{-3}$
18	US	Transportation services via pipelines	0.09%	0.340	US	Retail trade	0.08%	0.187	US	Retail trade	0.08%	0.159	CN	Elec. Gas	0.06%	$2.16\,10^{-2}$	CN	Elec. Gas	0.06%	$6.67\,10^{-3}$	CN	Elec. Gas	0.07%	$3.19\,10^{-3}$
19	CN	Sea transportation	0.08%	0.295	CN	Inland transportation	0.07%	0.178	CN	Inland transportation	0.07%	0.142	CN	Inland transportation	0.06%	$1.93\,10^{-2}$	CN	Inland transportation	0.06%	$5.97\,10^{-3}$	CN	Inland transportation	0.06%	$2.85\,10^{-3}$
20	US	Retail trade	0.08%	0.288	CN	Sea transportation	0.07%	0.155	CN	Sea transportation	0.06%	0.124	CN	Sea transportation	0.05%	$1.68\,10^{-2}$	CN	Sea transportation	0.05%	$5.19\,10^{-3}$	CN	Sea transportation	0.06%	$2.48\,10^{-3}$

Table 71: Total Annual Carbon Footprint Distribution of Bitcoin mining in USA by country

Order	Total GWP per year (MtCO$_2$-eqv.)																	
	2020			2019			2018			2017			2016			2015		
	C.C.	P.A.D.* (%)	GWP	C.C.	P.A.D.* (%)	GWP	C.C.	P.A.D.* (%)	GWP	C.C.	P.A.D.* (%)	GWP	C.C.	P.A.D.* (%)	GWP	C.C.	P.A.D.* (%)	GWP
1	US	85.76%	5.845	US	88.25%	2.926	US	88.85%	1.378	US	91.07%	$3.07\,10^{-1}$	US	91.14%	$1.23\,10^{-1}$	US	89.78%	$3.51\,10^{-2}$
2	CN	12.85%	$8.76\,10^{-1}$	CN	10.57%	$3.51\,10^{-1}$	CN	10.02%	$1.55\,10^{-1}$	CN	7.99%	$2.69\,10^{-2}$	CN	7.92%	$1.07\,10^{-2}$	CN	9.17%	$3.58\,10^{-3}$
3	JP	0.21%	$1.42\,10^{-2}$	JP	0.17%	$5.68\,10^{-3}$	JP	0.16%	$2.52\,10^{-3}$	JP	0.13%	$4.38\,10^{-4}$	JP	0.13%	$1.73\,10^{-4}$	JP	0.15%	$5.82\,10^{-5}$
4	WA	0.20%	$1.35\,10^{-2}$	WA	0.17%	$5.47\,10^{-3}$	WA	0.16%	$2.43\,10^{-3}$	WA	0.13%	$4.26\,10^{-4}$	WA	0.13%	$1.69\,10^{-4}$	WA	0.14%	$5.63\,10^{-5}$
5	KR	0.16%	$1.09\,10^{-2}$	KR	0.13%	$4.38\,10^{-3}$	KR	0.13%	$1.94\,10^{-3}$	KR	0.10%	$3.38\,10^{-4}$	KR	0.10%	$1.34\,10^{-4}$	KR	0.12%	$4.49\,10^{-5}$
6	WM	0.15%	$1.04\,10^{-2}$	WM	0.13%	$4.23\,10^{-3}$	WM	0.12%	$1.88\,10^{-3}$	WM	0.10%	$3.33\,10^{-4}$	WM	0.10%	$1.32\,10^{-4}$	WM	0.11%	$4.38\,10^{-5}$
7	RU	0.10%	$6.99\,10^{-3}$	RU	0.09%	$3.02\,10^{-3}$	RU	0.09%	$1.37\,10^{-3}$	RU	0.08%	$2.63\,10^{-4}$	RU	0.08%	$1.04\,10^{-4}$	RU	0.08%	$3.28\,10^{-5}$

8	DE	0.10%	6.83×10^{-3}	DE	0.08%	2.76×10^{-3}	DE	0.08%	1.22×10^{-3}	WL	0.07%	2.23×10^{-4}	WL	0.07%	8.88×10^{-5}	DE	0.07%	2.84×10^{-5}
9	WL	0.08%	5.1×10^{-3}	WL	0.07%	2.35×10^{-3}	WL	0.07%	1.08×10^{-3}	DE	0.06%	2.15×10^{-4}	DE	0.06%	8.51×10^{-5}	WL	0.07%	2.67×10^{-5}
10	IN	0.05%	3.2×10^{-3}	IN	0.04%	1.31×10^{-3}	IN	0.04%	5.81×10^{-4}	IN	0.03%	1.03×10^{-4}	IN	0.03%	4.09×10^{-5}	IN	0.04%	1.35×10^{-5}

Table 72: Total Annual Carbon Footprint Distribution of Bitcoin mining in USA by sector

	GWP per transaction per year (MtCO₂-eqv.)																							
O.	**2020**				**2019**				**2018**				**2017**				**2016**				**2015**			
	C.C.	Sector	P.A.D.* (%)	GWP	C.C.	Sector	P.A.D.* (%)	GWP	C.C.	Sector	P.A.D.* (%)	GWP	C.C.	Sector	P.A.D.* (%)	GWP	C.C.	Sector	P.A.D.* (%)	GWP	C.C.	Sector	P.A.D.* (%)	GWP
1	US	Elec. Coal	48.78%	3.324	US	Elec. Coal	50.20%	1.665	US	Elec. Coal	50.55%	7.84×10^{-1}	US	Elec. Coal	51.81%	1.75×10^{-1}	US	Elec. Coal	51.86%	6.97×10^{-2}	US	Elec. Coal	51.07%	2×10^{-2}
2	US	Elec. Gas	35.31%	2.407	US	Elec. Gas	36.35%	1.205	US	Elec. Gas	36.60%	5.67×10^{-1}	US	Elec. Gas	37.52%	1.26×10^{-1}	US	Elec. Gas	37.55%	5.05×10^{-2}	US	Elec. Gas	36.98%	1.44×10^{-2}
3	CN	Elec. Coal	7.34%	5×10^{-1}	CN	Elec. Coal	6.04%	2.00×10^{-1}	CN	Elec. Coal	5.72%	8.87×10^{-2}	CN	Elec. Coal	4.56%	1.54×10^{-2}	CN	Elec. Coal	4.52%	6.08×10^{-3}	CN	Elec. Coal	5.24%	2.05×10^{-3}
4	CN	Iron and Steel	1.64%	1.12×10^{-1}	CN	Iron and Steel	1.35%	4.47×10^{-2}	CN	Iron and Steel	1.28%	1.98×10^{-2}	CN	Iron and Steel	1.02%	3.43×10^{-3}	CN	Iron and Steel	1.01%	1.36×10^{-3}	CN	Iron and Steel	1.17%	4.57×10^{-4}
5	CN	Steam-Hot W. Sply.	0.69%	4.70×10^{-2}	US	Elec. Petroleum	0.58%	1.93×10^{-2}	US	Elec. Petroleum	0.59%	9.10×10^{-3}	US	Elec. Petroleum	0.60%	2.03×10^{-3}	US	Elec. Petroleum	0.60%	8.09×10^{-4}	US	Elec. Petroleum	0.59%	2.32×10^{-4}
6	US	Elec. Petroleum	0.57%	3.86×10^{-2}	CN	Steam-Hot W. Sply.	0.57%	1.88×10^{-2}	CN	Steam-Hot W. Sply.	0.54%	8.33×10^{-3}	US	Electricity by biomass and waste	0.55%	1.86×10^{-3}	US	Electricity by biomass and waste	0.55%	7.41×10^{-4}	US	Electricity by biomass and waste	0.54%	2.12×10^{-4}
7	US	Electricity by biomass and waste	0.52%	3.53×10^{-2}	US	Electricity by biomass and waste	0.53%	1.77×10^{-2}	US	Electricity by biomass and waste	0.54%	8.33×10^{-3}	CN	Steam-Hot W. Sply.	0.43%	1.44×10^{-3}	CN	Steam-Hot W. Sply.	0.43%	5.71×10^{-4}	CN	Steam-Hot W. Sply.	0.49%	1.92×10^{-4}
8	CN	O. Machinery and Computers	0.41%	2.78×10^{-2}	CN	O. Machinery and Computers	0.34%	1.11×10^{-2}	CN	O. Machinery and Computers	0.32%	4.92×10^{-3}	CN	O. Machinery and Computers	0.25%	8.52×10^{-4}	CN	O. Machinery and Computers	0.25%	3.37×10^{-4}	CN	O. Machinery and Computers	0.29%	1.13×10^{-4}
9	CN	Rubber and plastic	0.40%	2.72×10^{-2}	CN	Rubber and plastic	0.33%	1.09×10^{-2}	CN	Rubber and plastic	0.31%	4.83×10^{-3}	CN	Rubber and plastic	0.25%	8.37×10^{-4}	CN	Rubber and plastic	0.25%	3.31×10^{-4}	CN	Rubber and plastic	0.29%	1.11×10^{-4}
10	CN	Chemicals nec	0.29%	1.97×10^{-2}	CN	Chemicals nec	0.24%	7.88×10^{-3}	CN	Chemicals nec	0.23%	3.49×10^{-3}	US	Bituminous Coal	0.21%	7.22×10^{-4}	US	Bituminous Coal	0.22%	2.88×10^{-4}	US	Bituminous Coal	0.21%	8.27×10^{-5}
11	US	Bituminous Coal	0.20%	1.39×10^{-2}	US	Bituminous Coal	0.21%	6.91×10^{-3}	US	Bituminous Coal	0.21%	3.25×10^{-3}	CN	Chemicals nec	0.18%	6.05×10^{-4}	CN	Chemicals nec	0.18%	2.39×10^{-4}	CN	Chemicals nec	0.21%	8.06×10^{-5}
12	CN	Air transport services	0.19%	1.27×10^{-2}	CN	Air transport services	0.15%	5.09×10^{-3}	CN	Air transport services	0.15%	2.25×10^{-3}	CN	Air transport services	0.12%	3.91×10^{-4}	CN	Air transport services	0.12%	1.55×10^{-4}	CN	Air transport services	0.13%	5.20×10^{-5}
13	CN	Bituminous Coal	0.18%	1.24×10^{-2}	CN	Bituminous Coal	0.15%	4.95×10^{-3}	CN	Bituminous Coal	0.14%	2.19×10^{-3}	CN	Bituminous Coal	0.11%	3.81×10^{-4}	CN	Bituminous Coal	0.11%	1.51×10^{-4}	CN	Bituminous Coal	0.13%	5.07×10^{-5}
14	CN	Other mineral products	0.16%	1.12×10^{-2}	CN	Other mineral products	0.14%	4.47×10^{-3}	CN	Other mineral products	0.13%	1.98×10^{-3}	CN	Other mineral products	0.10%	3.44×10^{-4}	CN	Other mineral products	0.10%	1.36×10^{-4}	CN	Other mineral products	0.12%	4.57×10^{-5}
15	CN	Supporting transport	0.12%	7.86×10^{-3}	CN	Supporting transport	0.10%	3.15×10^{-3}	US	Transportation services via pipelines	0.09%	1.44×10^{-3}	US	Transportation services via pipelines	0.10%	3.20×10^{-4}	US	Transportation services via pipelines	0.10%	1.28×10^{-4}	US	Transportation services via pipelines	0.09%	3.66×10^{-5}
16	CN	Elec. Gas	0.10%	6.88×10^{-3}	US	Transportation services via pipelines	0.09%	3.07×10^{-3}	CN	Supporting transport	0.09%	1.39×10^{-3}	US	Retail trade	0.08%	2.70×10^{-4}	US	Retail trade	0.08%	1.08×10^{-4}	CN	Supporting transport	0.08%	3.22×10^{-5}
17	CN	Inland transportation	0.09%	6.16×10^{-3}	CN	Elec. Gas	0.08%	2.75×10^{-3}	CN	Elec. Gas	0.08%	1.22×10^{-3}	CN	Supporting transport	0.07%	2.41×10^{-4}	CN	Supporting transport	0.07%	9.55×10^{-5}	US	Retail trade	0.08%	3.09×10^{-5}

18	US	Transportation services via pipelines	0.09%	6.16×10^{-3}	US	Retail trade	0.08%	2.59×10^{-3}	US	Retail trade	0.08%	1.22×10^{-3}	CN	Elec. Gas	0.06%	2.11×10^{-4}	CN	Elec. Gas	0.06%	8.36×10^{-5}	CN	Elec. Gas	0.07%	2.81×10^{-5}
19	CN	Sea transportation	0.08%	5.35×10^{-3}	CN	Inland transportation	0.07%	2.46×10^{-3}	CN	Inland transportation	0.07%	1.09×10^{-3}	CN	Inland transportation	0.06%	1.89×10^{-4}	CN	Inland transportation	0.06%	7.48×10^{-5}	CN	Inland transportation	0.06%	2.52×10^{-5}
20	US	Retail trade	0.08%	5.22×10^{-3}	CN	Sea transportation	0.07%	2.14×10^{-3}	CN	Sea transportation	0.06%	9.49×10^{-4}	CN	Sea transportation	0.05%	1.65×10^{-4}	CN	Sea transportation	0.05%	6.51×10^{-5}	CN	Sea transportation	0.06%	2.19×10^{-5}

f) India

Table 73: Carbon Footprint Distribution of Bitcoin mining in India per transaction by country

Order	GWP per transaction per year (kgCO₂-eqv.)								
	2018			2017			2016		
	C.C.	P.A.D.* (%)	GWP	C.C.	P.A.D.* (%)	GWP	C.C.	P.A.D.* (%)	GWP
1	IN	91.36%	242.034	IN	93.06%	42.278	IN	93.16%	13.187
2	CN	7.68%	20.355	CN	6.14%	2.787	CN	6.05%	8.56×10^{-1}
3	WA	0.13%	0.335	WA	0.10%	4.69×10^{-2}	WA	0.10%	1.45×10^{-2}
4	JP	0.13%	0.334	JP	0.10%	4.6×10^{-2}	JP	0.10%	1.41×10^{-2}
5	US	0.11%	0.280	US	0.09%	4.01×10^{-2}	US	0.09%	1.23×10^{-2}
6	WM	0.10%	0.272	WM	0.09%	3.88×10^{-2}	WM	0.09%	1.2×10^{-2}
7	KR	0.10%	0.270	KR	0.08%	3.78×10^{-2}	KR	0.08%	1.16×10^{-2}
8	ID	0.08%	0.203	ID	0.07%	3.34×10^{-2}	ID	0.07%	1.04×10^{-2}
9	DE	0.06%	0.163	DE	0.05%	2.27×10^{-2}	DE	0.05%	6.98×10^{-3}
10	RU	0.05%	0.136	RU	0.04%	1.95×10^{-2}	RU	0.04%	6.02×10^{-3}

Table 74: Carbon Footprint Distribution of Bitcoin mining in India per transaction by sector in Supply Chain

O.	GWP per transaction per year (kgCO₂-eqv.)											
	2018				2017				2016			
	C.C.	Sector	P.A.D.* (%)	GWP	C.C.	Sector	P.A.D.* (%)	GWP	C.C.	Sector	P.A.D.* (%)	GWP
1	IN	Elec. Coal	86.85%	230.084	IN	Elec. Coal	88.47%	40.192	IN	Elec. Coal	86.85%	230.084
2	CN	Elec. Coal	4.38%	11.615	CN	Elec. Coal	3.50%	1.590	CN	Elec. Coal	4.38%	11.615
3	IN	Elec. Gas	3.32%	8.801	IN	Elec. Gas	3.38%	1.537	IN	Elec. Gas	3.32%	8.801
4	CN	Iron and Steel	0.98%	2.597	CN	Iron and Steel	0.78%	3.56×10^{-1}	CN	Iron and Steel	0.98%	2.597
5	IN	Electricity by biomass and waste	0.49%	1.308	IN	Electricity by biomass and waste	0.50%	2.29×10^{-1}	IN	Electricity by biomass and waste	0.49%	1.308
6	IN	Bituminous Coal	0.42%	1.122	IN	Bituminous Coal	0.43%	1.96×10^{-1}	IN	Bituminous Coal	0.42%	1.122
7	CN	Steam-Hot W. Sply.	0.41%	1.092	CN	Steam-Hot W. Sply.	0.33%	1.50×10^{-1}	CN	Steam-Hot W. Sply.	0.41%	1.092
8	CN	O. Machinery and Computers	0.24%	6.44×10^{-1}	CN	O. Machinery and Computers	0.19%	8.80×10^{-2}	CN	O. Machinery and Computers	0.24%	6.44×10^{-1}
9	CN	Rubber and plastic	0.24%	6.32×10^{-1}	CN	Rubber and plastic	0.19%	8.66×10^{-2}	CN	Rubber and plastic	0.24%	6.32×10^{-1}
10	CN	Chemicals nec	0.17%	4.59×10^{-1}	CN	Chemicals nec	0.14%	6.30×10^{-2}	CN	Chemicals nec	0.17%	4.59×10^{-1}

#	C.C.		P.A.D.* (%)	GWP	C.C.		P.A.D.* (%)	GWP	C.C.		P.A.D.* (%)	GWP
11	CN	Air transport services	0.11%	$2.95\ 10^{-1}$	CN	Air transport services	0.09%	$4.04\ 10^{-2}$	CN	Air transport services	0.11%	$2.95\ 10^{-1}$
12	CN	Bituminous Coal	0.11%	$2.89\ 10^{-1}$	CN	Bituminous Coal	0.09%	$3.97\ 10^{-2}$	CN	Bituminous Coal	0.11%	$2.89\ 10^{-1}$
13	CN	Other mineral products	0.10%	$2.60\ 10^{-1}$	CN	Other mineral products	0.08%	$3.56\ 10^{-2}$	CN	Other mineral products	0.10%	$2.60\ 10^{-1}$
14	CN	Supporting transport	0.07%	$1.83\ 10^{-1}$	IN	Coking Coal	0.06%	$2.93\ 10^{-2}$	CN	Supporting transport	0.07%	$1.83\ 10^{-1}$
15	IN	Coking Coal	0.06%	$1.68\ 10^{-1}$	CN	Supporting transport	0.06%	$2.50\ 10^{-2}$	IN	Coking Coal	0.06%	$1.68\ 10^{-1}$
16	CN	Elec. Gas	0.06%	$1.60\ 10^{-1}$	ID	Sub-Bituminous Coal	0.05%	$2.33\ 10^{-2}$	CN	Elec. Gas	0.06%	$1.60\ 10^{-1}$
17	CN	Inland transportation	0.05%	$1.43\ 10^{-1}$	CN	Elec. Gas	0.05%	$2.19\ 10^{-2}$	CN	Inland transportation	0.05%	$1.43\ 10^{-1}$
18	ID	Sub-Bituminous Coal	0.05%	$1.34\ 10^{-1}$	CN	Inland transportation	0.04%	$1.96\ 10^{-2}$	ID	Sub-Bituminous Coal	0.05%	$1.34\ 10^{-1}$
19	CN	Sea transportation	0.05%	$1.26\ 10^{-1}$	IN	Elec. Petroleum	0.04%	$1.78\ 10^{-2}$	CN	Sea transportation	0.05%	$1.26\ 10^{-1}$
20	CN	Coke Oven	0.04%	$1.15\ 10^{-1}$	CN	Sea transportation	0.04%	$1.73\ 10^{-2}$	CN	Coke Oven	0.04%	$1.15\ 10^{-1}$

Table 75: Total Annual Carbon Footprint Distribution of Bitcoin mining in India by country

	Total GWP per year (MtCO$_2$-eqv.)										
Order	2018			2017			2016				
	C.C.	P.A.D.* (%)	GWP	C.C.	P.A.D.* (%)	GWP	C.C.	P.A.D.* (%)	GWP		
1	IN	91.36%	$5.52\ 10^{-2}$	IN	93.06%	$1.11\ 10^{-1}$	IN	93.16%	$1.37\ 10^{-2}$		
2	CN	7.68%	$4.64\ 10^{-3}$	CN	6.14%	$7.3\ 10^{-3}$	CN	6.05%	$8.9\ 10^{-4}$		
3	WA	0.13%	$7.62\ 10^{-5}$	WA	0.10%	$1.23\ 10^{-4}$	WA	0.10%	$1.5\ 10^{-5}$		
4	JP	0.13%	$7.61\ 10^{-5}$	JP	0.10%	$1.2\ 10^{-4}$	JP	0.10%	$1.47\ 10^{-5}$		
5	US	0.11%	$6.37\ 10^{-5}$	US	0.09%	$1.05\ 10^{-4}$	US	0.09%	$1.28\ 10^{-5}$		
6	WM	0.10%	$6.2\ 10^{-5}$	WM	0.09%	$1.02\ 10^{-4}$	WM	0.09%	$1.24\ 10^{-5}$		
7	KR	0.10%	$6.17\ 10^{-5}$	KR	0.08%	$9.89\ 10^{-5}$	KR	0.08%	$1.21\ 10^{-5}$		
8	ID	0.08%	$4.63\ 10^{-5}$	ID	0.07%	$8.75\ 10^{-5}$	ID	0.07%	$1.08\ 10^{-5}$		
9	DE	0.06%	$3.71\ 10^{-5}$	DE	0.05%	$5.94\ 10^{-5}$	DE	0.05%	$7.25\ 10^{-6}$		
10	RU	0.05%	$3.1\ 10^{-5}$	RU	0.04%	$5.12\ 10^{-5}$	RU	0.04%	$6.26\ 10^{-6}$		

Table 76: Total Annual Carbon Footprint Distribution of Bitcoin mining in India by sector

O.	Total GWP per year (MtCO$_2$-eqv.)												
	2018				2017				2016				
	C.C.	Sector	P.A.D.* (%)	GWP	C.C.	Sector	P.A.D.* (%)	GWP	C.C.	Sector	P.A.D.* (%)	GWP	
1	IN	Elec. Coal	86.85%	$5.24\ 10^{-2}$	IN	Elec. Coal	88.47%	$1.05\ 10^{-1}$	IN	Elec. Coal	86.85%	$5.24\ 10^{-2}$	
2	CN	Elec. Coal	4.38%	$2.65\ 10^{-3}$	CN	Elec. Coal	3.50%	$4.16\ 10^{-3}$	CN	Elec. Coal	4.38%	$2.65\ 10^{-3}$	
3	IN	Elec. Gas	3.32%	$2.01\ 10^{-3}$	IN	Elec. Gas	3.38%	$4.03\ 10^{-3}$	IN	Elec. Gas	3.32%	$2.01\ 10^{-3}$	
4	CN	Iron and Steel	0.98%	$5.92\ 10^{-4}$	CN	Iron and Steel	0.78%	$9.31\ 10^{-4}$	CN	Iron and Steel	0.98%	$5.92\ 10^{-4}$	
5	IN	Electricity by biomass and waste	0.49%	$2.98\ 10^{-4}$	IN	Electricity by biomass and waste	0.50%	$5.99\ 10^{-4}$	IN	Electricity by biomass and waste	0.49%	$2.98\ 10^{-4}$	
6	IN	Bituminous Coal	0.42%	$2.56\ 10^{-4}$	IN	Bituminous Coal	0.43%	$5.13\ 10^{-4}$	IN	Bituminous Coal	0.42%	$2.56\ 10^{-4}$	
7	CN	Steam-Hot W. Sply.	0.41%	$2.49\ 10^{-4}$	CN	Steam-Hot W. Sply.	0.33%	$3.92\ 10^{-4}$	CN	Steam-Hot W. Sply.	0.41%	$2.49\ 10^{-4}$	
8	CN	O. Machinery and Computers	0.24%	$1.47\ 10^{-4}$	CN	O. Machinery and Computers	0.19%	$2.31\ 10^{-4}$	CN	O. Machinery and Computers	0.24%	$1.47\ 10^{-4}$	

#	C.C.	Sector	P.A.D.	GWP	C.C.	Sector	P.A.D.	GWP	C.C.	Sector	P.A.D.	GWP
9	CN	Rubber and plastic	0.24%	$1.44\ 10^{-4}$	CN	Rubber and plastic	0.19%	$2.27\ 10^{-4}$	CN	Rubber and plastic	0.24%	$1.44\ 10^{-4}$
10	CN	Chemicals nec	0.17%	$1.05\ 10^{-4}$	CN	Chemicals nec	0.14%	$1.65\ 10^{-4}$	CN	Chemicals nec	0.17%	$1.05\ 10^{-4}$
11	CN	Air transport services	0.11%	$6.73\ 10^{-5}$	CN	Air transport services	0.09%	$1.06\ 10^{-4}$	CN	Air transport services	0.11%	$6.73\ 10^{-5}$
12	CN	Bituminous Coal	0.11%	$6.60\ 10^{-5}$	CN	Bituminous Coal	0.09%	$1.04\ 10^{-4}$	CN	Bituminous Coal	0.11%	$6.60\ 10^{-5}$
13	CN	Other mineral products	0.10%	$5.93\ 10^{-5}$	CN	Other mineral products	0.08%	$9.32\ 10^{-5}$	CN	Other mineral products	0.10%	$5.93\ 10^{-5}$
14	CN	Supporting transport	0.07%	$4.16\ 10^{-5}$	IN	Coking Coal	0.06%	$7.67\ 10^{-5}$	CN	Supporting transport	0.07%	$4.16\ 10^{-5}$
15	IN	Coking Coal	0.06%	$3.82\ 10^{-5}$	CN	Supporting transport	0.06%	$6.54\ 10^{-5}$	IN	Coking Coal	0.06%	$3.82\ 10^{-5}$
16	CN	Elec. Gas	0.06%	$3.64\ 10^{-5}$	ID	Sub-Bituminous Coal	0.05%	$6.09\ 10^{-5}$	CN	Elec. Gas	0.06%	$3.64\ 10^{-5}$
17	CN	Inland transportation	0.05%	$3.26\ 10^{-5}$	CN	Elec. Gas	0.05%	$5.73\ 10^{-5}$	CN	Inland transportation	0.05%	$3.26\ 10^{-5}$
18	ID	Sub-Bituminous Coal	0.05%	$3.05\ 10^{-5}$	CN	Inland transportation	0.04%	$5.13\ 10^{-5}$	ID	Sub-Bituminous Coal	0.05%	$3.05\ 10^{-5}$
19	CN	Sea transportation	0.05%	$2.87\ 10^{-5}$	IN	Elec. Petroleum	0.04%	$4.66\ 10^{-5}$	CN	Sea transportation	0.05%	$2.87\ 10^{-5}$
20	CN	Coke Oven	0.04%	$2.62\ 10^{-5}$	CN	Sea transportation	0.04%	$4.53\ 10^{-5}$	CN	Coke Oven	0.04%	$2.62\ 10^{-5}$

g) Sweden

Table 77: Carbon Footprint Distribution of Bitcoin mining in Sweden per transaction by country

Order	GWP per transaction per year (kgCO₂-eqv.)					
	2017			2016		
	C.C.	P.A.D.* (%)	GWP	C.C.	P.A.D.* (%)	GWP
1	CN	72.10%	2.798	CN	71.88%	$8.6\ 10^{-1}$
2	SE	9.71%	$3.77\ 10^{-1}$	SE	9.83%	$1.18\ 10^{-1}$
3	WA	2.12%	$8.23\ 10^{-2}$	WA	2.13%	$2.55\ 10^{-2}$
4	WM	2.04%	$7.92\ 10^{-2}$	WM	2.05%	$2.46\ 10^{-2}$
5	RU	1.75%	$6.8\ 10^{-2}$	RU	1.77%	$2.11\ 10^{-2}$
6	US	1.41%	$5.46\ 10^{-2}$	US	1.41%	$1.69\ 10^{-2}$
7	JP	1.33%	$5.17\ 10^{-2}$	JP	1.33%	$1.59\ 10^{-2}$
8	DE	1.24%	$4.83\ 10^{-2}$	DE	1.25%	$1.5\ 10^{-2}$
9	KR	1.05%	$4.08\ 10^{-2}$	KR	1.05%	$1.26\ 10^{-2}$
10	IN	0.55%	$2.12\ 10^{-2}$	IN	0.55%	$6.58\ 10^{-3}$

Table 78: Carbon Footprint Distribution of Bitcoin mining in Sweden per transaction by sector in Supply Chain

O.	GWP per transaction per year (kgCO₂-eqv.)							
	2017				2016			
	C.C.	Sector	P.A.D.* (%)	GWP	C.C.	Sector	P.A.D.* (%)	GWP
1	CN	Elec. Coal	41.00%	1.591	CN	Elec. Coal	40.87%	$4.89\ 10^{-1}$
2	CN	Iron and Steel	9.21%	$3.57\ 10^{-1}$	CN	Iron and Steel	9.18%	$1.10\ 10^{-1}$
3	CN	Steam-Hot W. Sply.	3.86%	$1.50\ 10^{-1}$	CN	Steam-Hot W. Sply.	3.85%	$4.60\ 10^{-2}$
4	SE	Electricity by hydro	2.27%	$8.80\ 10^{-2}$	SE	Electricity by hydro	2.30%	$2.75\ 10^{-2}$
5	CN	O. Machinery and Computers	2.26%	$8.75\ 10^{-2}$	SE	Electricity by nuclear	2.26%	$2.70\ 10^{-2}$

6	CN	Rubber and plastic	2.24%	$8.71\ 10^{-2}$	CN	O. Machinery and Computers	2.25%	$2.69\ 10^{-2}$
7	SE	Electricity by nuclear	2.23%	$8.65\ 10^{-2}$	CN	Rubber and plastic	2.24%	$2.68\ 10^{-2}$
8	CN	Chemicals nec	1.62%	$6.29\ 10^{-2}$	CN	Chemicals nec	1.62%	$1.93\ 10^{-2}$
9	SE	Electricity by solar thermal	1.57%	$6.09\ 10^{-2}$	SE	Electricity by solar thermal	1.59%	$1.90\ 10^{-2}$
10	CN	Air transport services	1.06%	$4.11\ 10^{-2}$	CN	Air transport services	1.06%	$1.26\ 10^{-2}$
11	CN	Bituminous Coal	1.02%	$3.95\ 10^{-2}$	CN	Bituminous Coal	1.02%	$1.21\ 10^{-2}$
12	CN	Other mineral products	0.93%	$3.60\ 10^{-2}$	CN	Other mineral products	0.92%	$1.11\ 10^{-2}$
13	CN	Supporting transport	0.65%	$2.51\ 10^{-2}$	CN	Supporting transport	0.64%	$7.70\ 10^{-3}$
14	CN	Elec. Gas	0.56%	$2.19\ 10^{-2}$	CN	Elec. Gas	0.56%	$6.72\ 10^{-3}$
15	DE	Sea transportation	0.51%	$1.99\ 10^{-2}$	DE	Sea transportation	0.51%	$6.15\ 10^{-3}$
16	CN	Inland transportation	0.51%	$1.96\ 10^{-2}$	CN	Inland transportation	0.50%	$6.03\ 10^{-3}$
17	CN	Sea transportation	0.50%	$1.95\ 10^{-2}$	CN	Sea transportation	0.50%	$6.01\ 10^{-3}$
18	SE	Sea transportation	0.44%	$1.72\ 10^{-2}$	SE	Sea transportation	0.45%	$5.36\ 10^{-3}$
19	SE	Wholesale trade	0.44%	$1.71\ 10^{-2}$	SE	Wholesale trade	0.45%	$5.34\ 10^{-3}$
20	WA	Sea transportation	0.44%	$1.69\ 10^{-2}$	WA	Sea transportation	0.44%	$5.24\ 10^{-3}$

Table 79: Total Annual Carbon Footprint Distribution of Bitcoin mining in Sweden by country

Order	Total GWP per year (MtCO$_2$-eqv.)					
	2017			2016		
	C.C.	P.A.D.* (%)	GWP	C.C.	P.A.D.* (%)	GWP
1	CN	72.10%	$5.82\ 10^{-4}$	CN	71.88%	$2.8\ 10^{-4}$
2	SE	9.71%	$7.84\ 10^{-5}$	SE	9.83%	$3.83\ 10^{-5}$
3	WA	2.12%	$1.71\ 10^{-5}$	WA	2.13%	$8.29\ 10^{-6}$
4	WM	2.04%	$1.65\ 10^{-5}$	WM	2.05%	$7.99\ 10^{-6}$
5	RU	1.75%	$1.41\ 10^{-5}$	RU	1.77%	$6.88\ 10^{-6}$
6	US	1.41%	$1.14\ 10^{-5}$	US	1.41%	$5.5\ 10^{-6}$
7	JP	1.33%	$1.08\ 10^{-5}$	JP	1.33%	$5.18\ 10^{-6}$
8	DE	1.24%	$1.0\ 10^{-5}$	DE	1.25%	$4.87\ 10^{-6}$
9	KR	1.05%	$8.47\ 10^{-6}$	KR	1.05%	$4.09\ 10^{-6}$
10	IN	0.55%	$4.41\ 10^{-6}$	IN	0.55%	$2.14\ 10^{-6}$

Table 80: Total Annual Carbon Footprint Distribution of Bitcoin mining in Sweden by sector

O.	Total GWP per year (MtCO$_2$-eqv.)							
	2017				**2016**			
	C.C.	**Sector**	**P.A.D.* (%)**	**GWP**	**C.C.**	**Sector**	**P.A.D.* (%)**	**GWP**
1	CN	Elec. Coal	41%	$3.31\ 10^{-4}$	CN	Elec. Coal	40.87%	$1.59\ 10^{-4}$
2	CN	Iron and Steel	9.21%	$7.43\ 10^{-5}$	CN	Iron and Steel	9.18%	$3.58\ 10^{-5}$
3	CN	Steam-Hot W. Sply.	3.86%	$3.11\ 10^{-5}$	CN	Steam-Hot W. Sply.	3.85%	$1.50\ 10^{-5}$
4	SE	Electricity by hydro	2.27%	$1.83\ 10^{-5}$	SE	Electricity by hydro	2.30%	$8.94\ 10^{-6}$
5	CN	O. Machinery and Computers	2.26%	$1.82\ 10^{-5}$	SE	Electricity by nuclear	2.26%	$8.78\ 10^{-6}$
6	CN	Rubber and plastic	2.24%	$1.81\ 10^{-5}$	CN	O. Machinery and Computers	2.25%	$8.75\ 10^{-6}$
7	SE	Electricity by nuclear	2.23%	$1.80\ 10^{-5}$	CN	Rubber and plastic	2.24%	$8.71\ 10^{-6}$
8	CN	Chemicals nec	1.62%	$1.31\ 10^{-5}$	CN	Chemicals nec	1.62%	$6.29\ 10^{-6}$
9	SE	Electricity by solar thermal	1.57%	$1.27\ 10^{-5}$	SE	Electricity by solar thermal	1.59%	$6.18\ 10^{-6}$
10	CN	Air transport services	1.06%	$8.54\ 10^{-6}$	CN	Air transport services	1.06%	$4.11\ 10^{-6}$
11	CN	Bituminous Coal	1.02%	$8.22\ 10^{-6}$	CN	Bituminous Coal	1.02%	$3.95\ 10^{-6}$
12	CN	Other mineral products	0.93%	$7.48\ 10^{-6}$	CN	Other mineral products	0.92%	$3.60\ 10^{-6}$
13	CN	Supporting transport	0.65%	$5.21\ 10^{-6}$	CN	Supporting transport	0.64%	$2.51\ 10^{-6}$
14	CN	Elec. Gas	0.56%	$4.55\ 10^{-6}$	CN	Elec. Gas	0.56%	$2.19\ 10^{-6}$
15	DE	Sea transportation	0.51%	$4.14\ 10^{-6}$	DE	Sea transportation	0.51%	$2.00\ 10^{-6}$
16	CN	Inland transportation	0.51%	$4.08\ 10^{-6}$	CN	Inland transportation	0.50%	$1.96\ 10^{-6}$
17	CN	Sea transportation	0.50%	$4.06\ 10^{-6}$	CN	Sea transportation	0.50%	$1.96\ 10^{-6}$
18	SE	Sea transportation	0.44%	$3.57\ 10^{-6}$	SE	Sea transportation	0.45%	$1.74\ 10^{-6}$
19	SE	Wholesale trade	0.44%	$3.56\ 10^{-6}$	SE	Wholesale trade	0.45%	$1.74\ 10^{-6}$
20	WA	Sea transportation	0.44%	$3.51\ 10^{-6}$	WA	Sea transportation	0.44%	$1.71\ 10^{-6}$

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