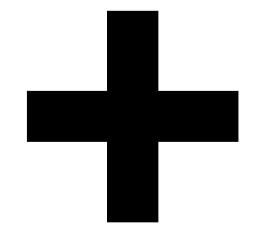
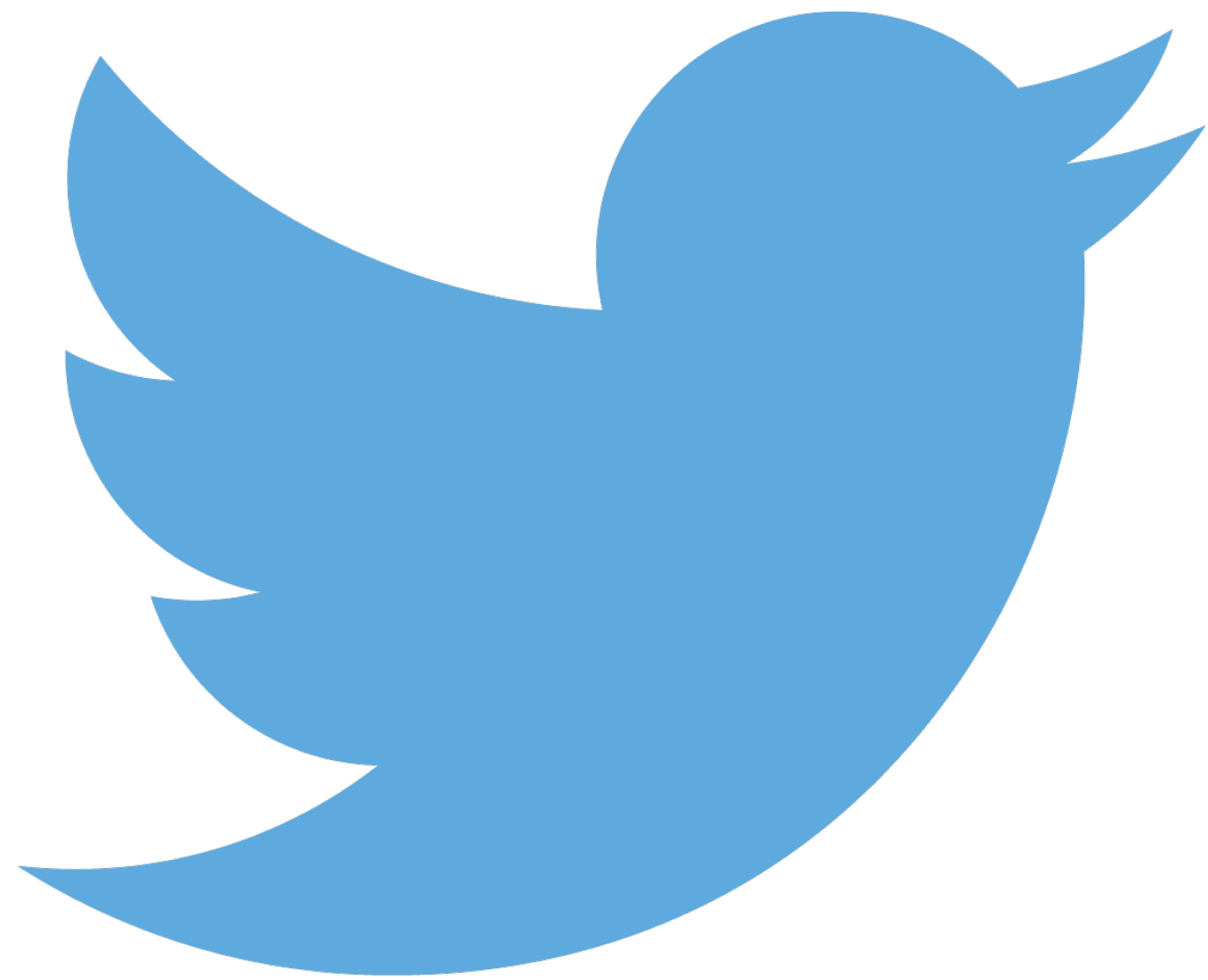


#JFOKUS



WHO AM I?





@CHRISTHALINGER

COMPILER ENGINEER



@CHRISTHALINGER

compiler | kəm'pīlər |

noun

- 1 a person who produces a list or book by assembling information or written material collected from other sources: *this passage was revised in different ways by later compilers.*



compiler | kəm'pīlər |

noun

- 1 a person who produces a list or book by assembling information or written material collected from other sources: *this passage was revised in different ways by later compilers.*
- 2 *Computing* a program that converts instructions into a machine-code or lower-level form so that they can be read and executed by a computer: *conversion would require more than just running it through a different compiler.*



Optimizing compiler

From Wikipedia, the free encyclopedia

In [computing](#), an **optimizing compiler** is a [compiler](#) that tries to minimize or maximize some attributes of an [executable](#) computer program. Common requirements are to minimize a [program's](#) execution time, [memory](#) requirement, and [power](#) consumption (the last two being popular for [portable computers](#)).



PERFORMANCE



**PERFORMANCE
AND
OUR IMPACT**



SOFTWARE DEVELOPMENT TODAY



@CHRISTHALINGER

What are sprints?

A sprint is a short, time-boxed period when a scrum team works to complete a set amount of work. Sprints are at the very heart of scrum and agile methodologies, and getting sprints right will help your agile team ship better software with fewer headaches.



"Sprints make projects more manageable, allow teams to ship high-quality work faster and more frequently, and gives them more flexibility to adapt to change."



"Sprints make projects more manageable, allow teams to ship high-quality work faster and more frequently, and gives them more flexibility to adapt to change."



A STORY...



@CHRISTHALINGER

ZERO



@CHRISTHALINGER

Escape analysis

From Wikipedia, the free encyclopedia

In [compiler optimization](#), **escape analysis** is a method for determining the dynamic scope of [pointers](#) – where in the program a pointer can be accessed. It is related to [pointer analysis](#) and [shape analysis](#).



**KNOW YOUR COMPILER OPTIMIZATIONS
AND
DON'T BE TOO SMART**



[HTTPS://EN.WIKIPEDIA.ORG/WIKI/OPTIMIZING_COMPILER](https://en.wikipedia.org/wiki/Optimizing_compiler)

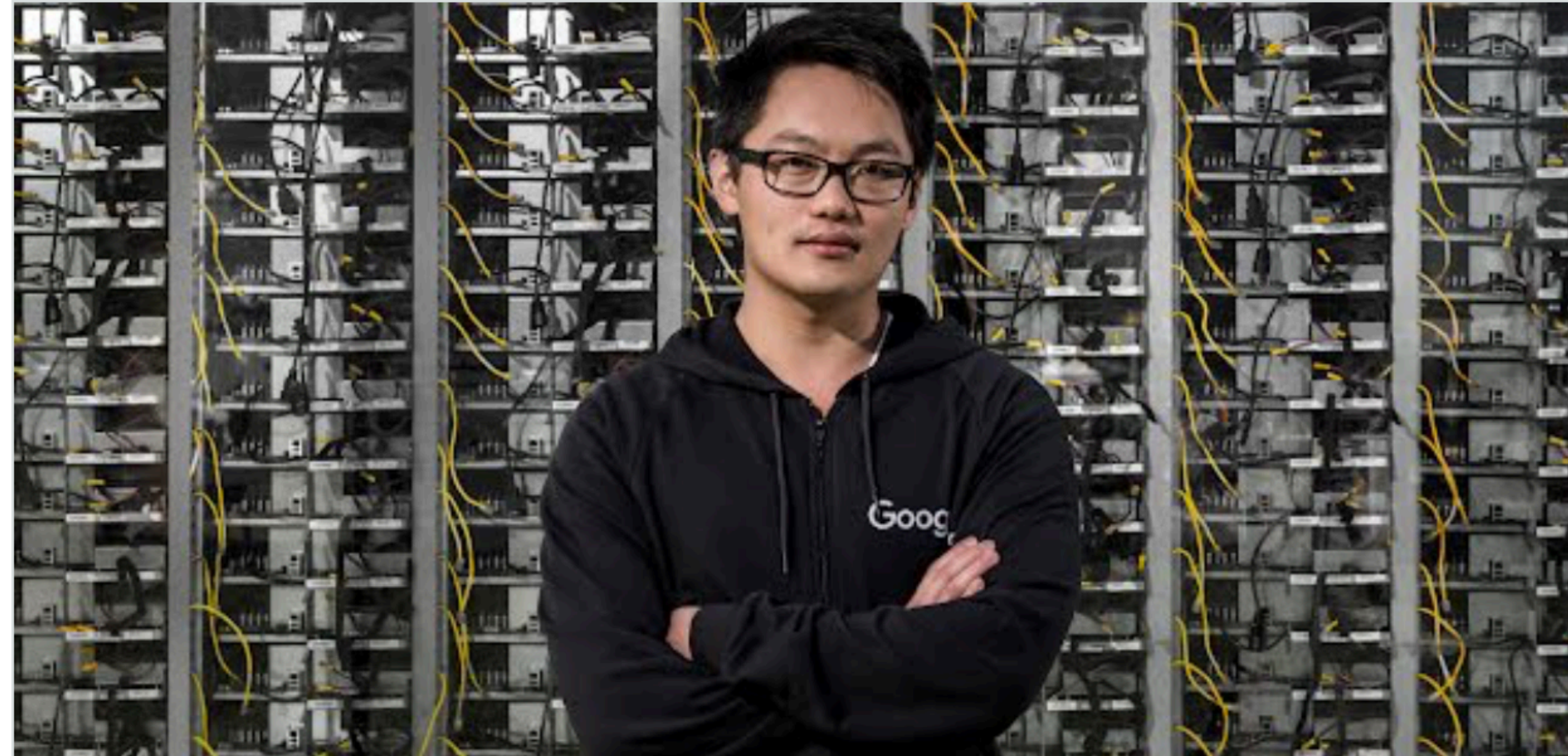


@CHRISTHALINGER

DATA CENTER ELECTRICITY USAGE



@CHRISTHALINGER

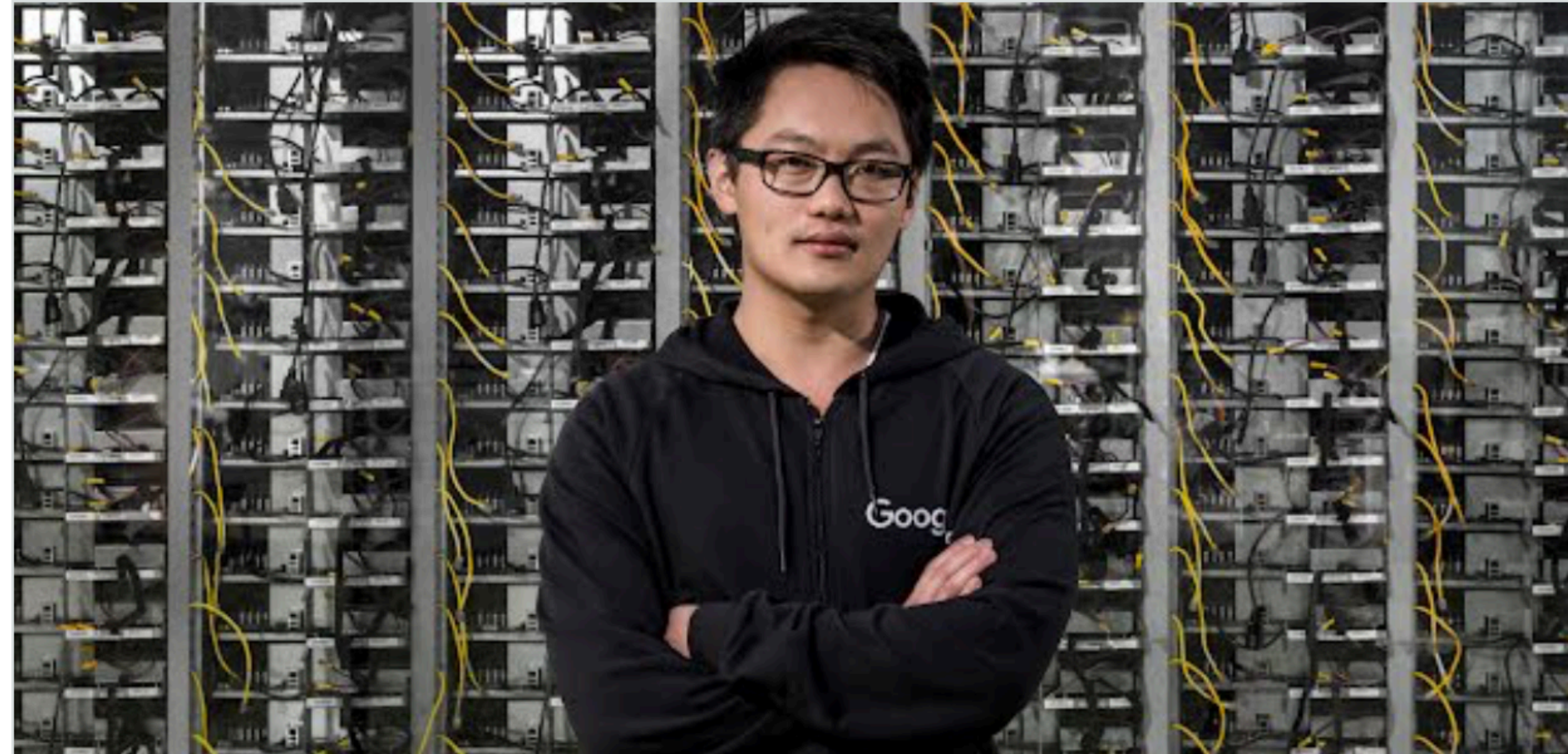


Data centers and machine learning

The virtual world is built on physical infrastructure, and all those racks of humming servers use vast amounts of energy. Together, all existing data centers use roughly 2% of the world's electricity; if left unchecked, this energy demand could grow as rapidly as internet use. So making data centers run as efficiently as possible is a very big deal — and that's what we set out to do.

[READ MORE](#) ↗





Data centers and machine learning

The virtual world is built on physical infrastructure, and all those racks of humming servers use vast amounts of energy. Together, all existing data centers use roughly 2% of the world's electricity; if left unchecked, this energy demand could grow as rapidly as internet use. So making data centers run as efficiently as possible is a very big deal — and that's what we set out to do.

[READ MORE](#) ↗



9,000 terawatt hours (TWh)

ENERGY FORECAST

Widely cited forecasts suggest that the total electricity demand of information and communications technology (ICT) will accelerate in the 2020s, and that data centres will take a larger slice.

- Networks (wireless and wired)
- Production of ICT
- Consumer devices (televisions, computers, mobile phones)
- Data centres

20.9% of projected electricity demand



THE GOOD...



@CHRISTHALINGER

GOOGLE

Renewable Energy

We're sourcing clean energy for a better future.

In 2017, Google achieved a major milestone: purchasing 100% renewable energy to match our annual electricity consumption for global operations, including our data centers and offices. Our large-scale procurement of wind and solar power is a cornerstone of our sustainability efforts, and has made Google the world's largest corporate buyer of renewable energy. To date, we've signed more than 30 long-term contract commitments to buy energy from wind and solar farms, resulting in nearly \$5 billion in investment across four continents.

Although our 100% renewable milestone signifies that we buy enough renewable energy over the course of a year to match our annual electricity consumption, it does not mean that our facilities are matched with renewable energy in every hour of every day. To compensate for times and places in which the wind slows or sunlight fades, we currently buy a surplus of renewable energy at other times and in other places. Our ultimate goal, however, is to source enough carbon-free energy to match our electricity consumption in all places, at all times. We are actively exploring strategies to achieve 24/7 carbon-free energy for all of our data centers, and are carefully tracking our progress toward that aspiration.



[HTTPS://WWW.GOOGLE.COM/ABOUT/DATACENTERS/RENEWABLE](https://www.google.com/about/datacenters/renewable)

@CHRISTHALINGER



Urs Hölzle

@uhoelzle



Last year we broke ground on a new data center in Alabama, whose energy consumption will be matched by two new solar farms being constructed nearby. The site used to be a coal plant, which was demolished today (cool video below).

waff.com/2019/09/27/tva...



TVA safely implodes Widows Creek Coal Stacks

The Tennessee Valley Authority announced the safe demolition of two 500-foot coal stacks and two boilers at its shuttered Widows

waff.com

♡ 218 10:10 PM - Sep 27, 2019



💬 37 people are talking about this



AMAZON

Keeping up with our commitment to 100% renewable energy

We've made a lot of progress on this commitment. AWS exceeded 50% renewable energy usage for 2018.

In addition to the renewable energy projects below, AWS has [announced](#) four new wind farms and one new solar farm. These [projects](#) – two in Ireland, one in Sweden, and two in the United States – will total over 297 megawatts (MW), with expected generation of over 830,000 megawatt hours (MWh) of renewable energy annually.

Once complete, these wind and solar farms, combined with AWS's nine previous renewable energy projects, are expected to generate more than 2,900,000 MWh of renewable energy annually.



MICROSOFT

Today, we are announcing that we will nearly double our internal carbon fee to \$15 per metric ton on all carbon emissions. This internal Microsoft “tax” was established in 2012 to hold our business divisions financially responsible for reducing their carbon emissions.

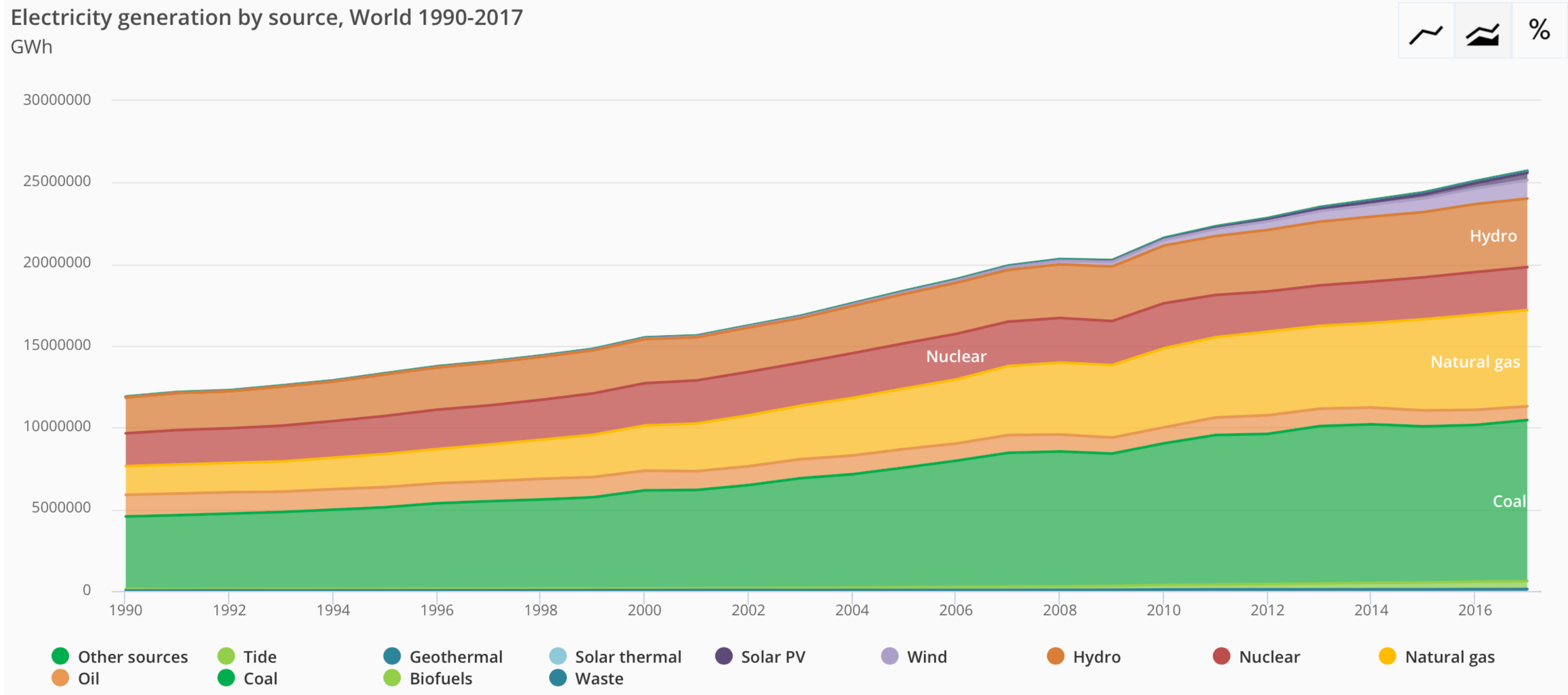


THE BAD...

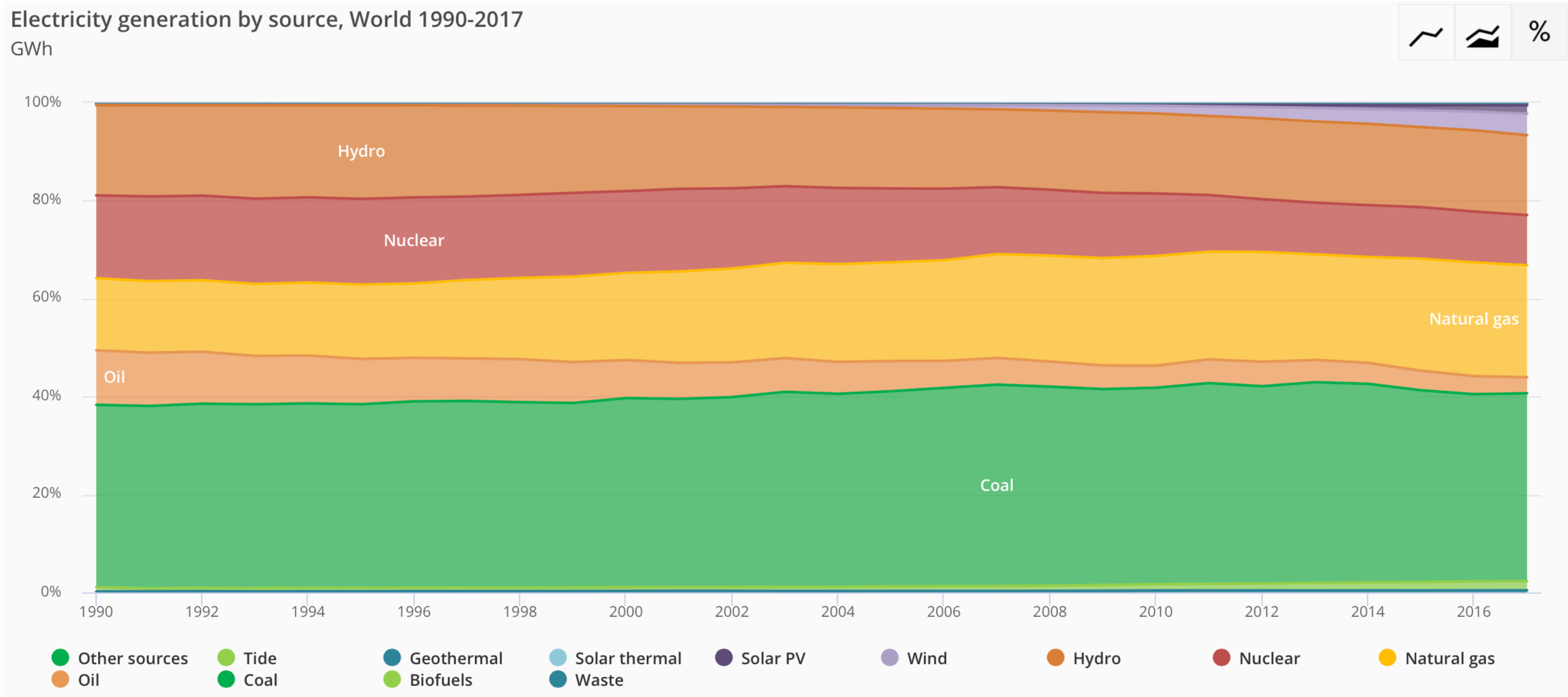


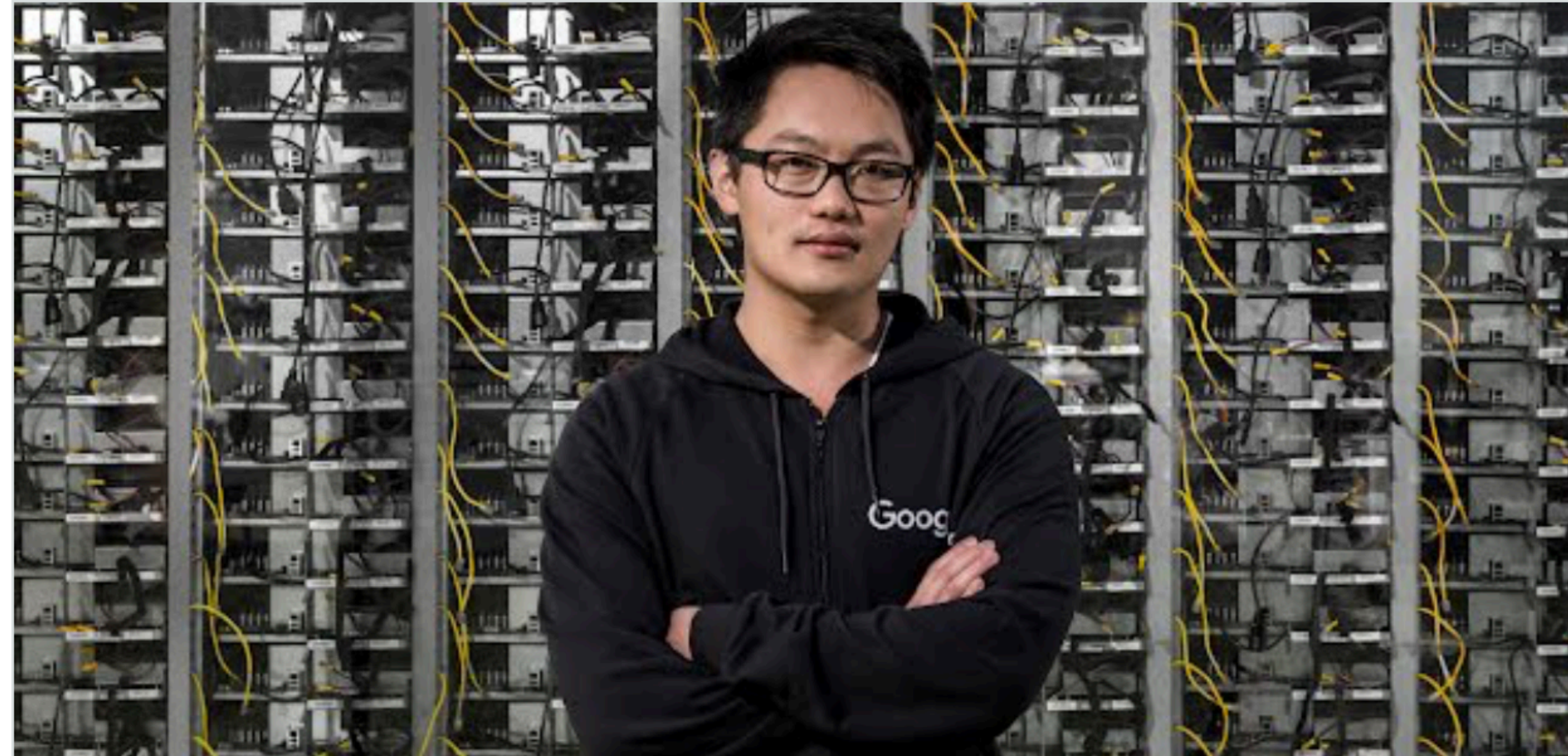
@CHRISTHALINGER

INTERNATIONAL ENERGY AGENCY



INTERNATIONAL ENERGY AGENCY





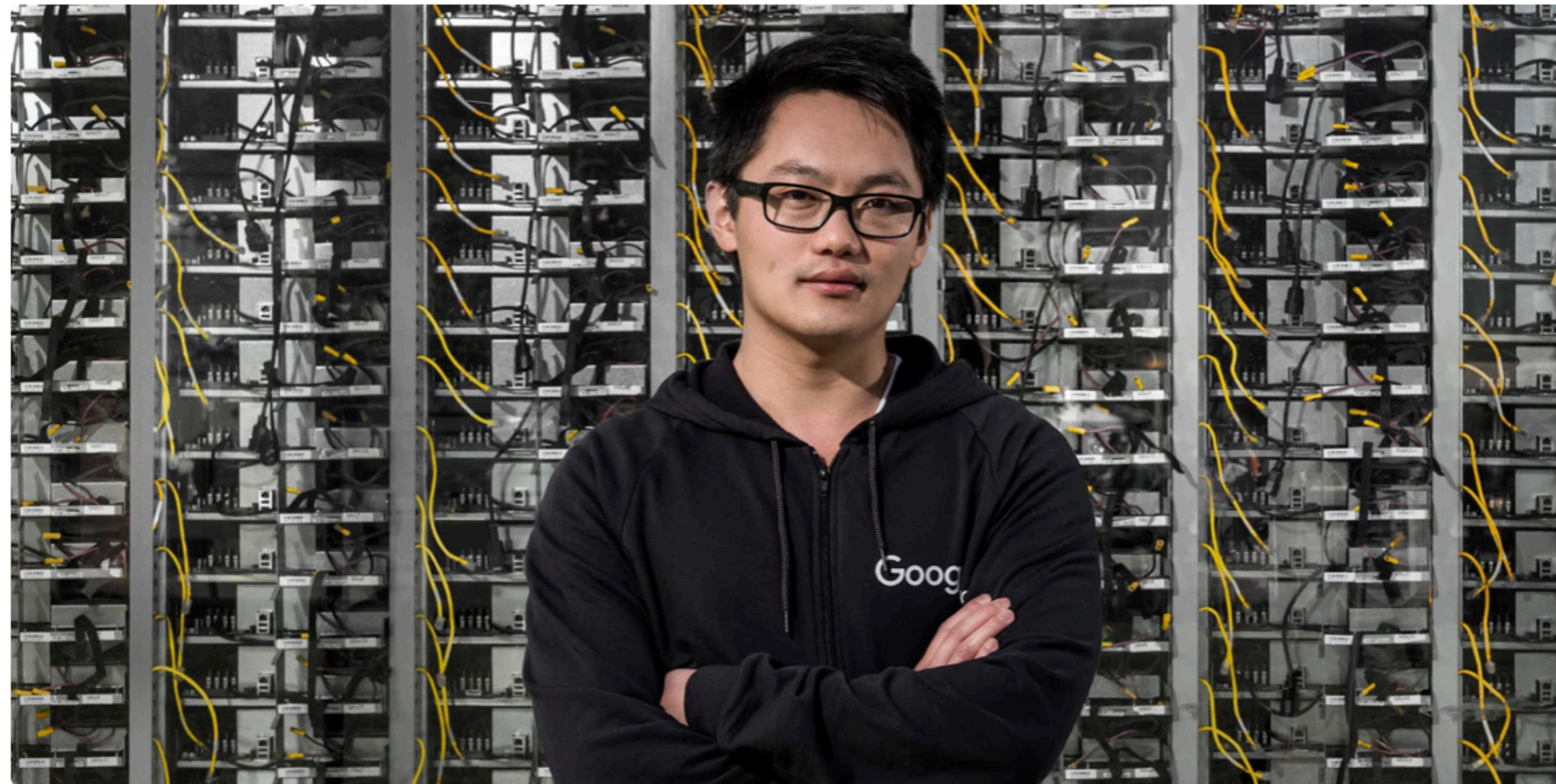
Data centers and machine learning

The virtual world is built on physical infrastructure, and all those racks of humming servers use vast amounts of energy. Together, all existing data centers use roughly 2% of the world's electricity; if left unchecked, this energy demand could grow as rapidly as internet use. So making data centers run as efficiently as possible is a very big deal — and that's what we set out to do.

[READ MORE](#) ↗



Machine learning finds new ways for our data centers to save energy



[HTTPS://SUSTAINABILITY.GOOGLE/PROJECTS/MACHINE-LEARNING/](https://sustainability.google/projects/machine-learning/)

@CHRISTHALINGER

By spring 2014, Google data centers used 50% less energy than the industry average. Which of course meant the next question was whether they could run even leaner. An efficiency engineer named Jim Gao, his interest piqued by an online class on machine learning, decided to find out.



Just 10 pieces of equipment,
each with 10 settings, would
have 10 to the 10th power, or
10 billion, possible
configurations — a set of
possibilities far beyond the
ability of anyone to test for
real.



Eighteen months later, the models have been piloted at multiple facilities and **have produced** a 40% reduction in energy used for cooling and 15% reduction in overall energy overhead. Although one of these pilots has already succeeded in bringing the PUE at one of Google's test data centers to a new low, the growing DCIQ team believes it has only scratched the surface of machine learning's more general applications.

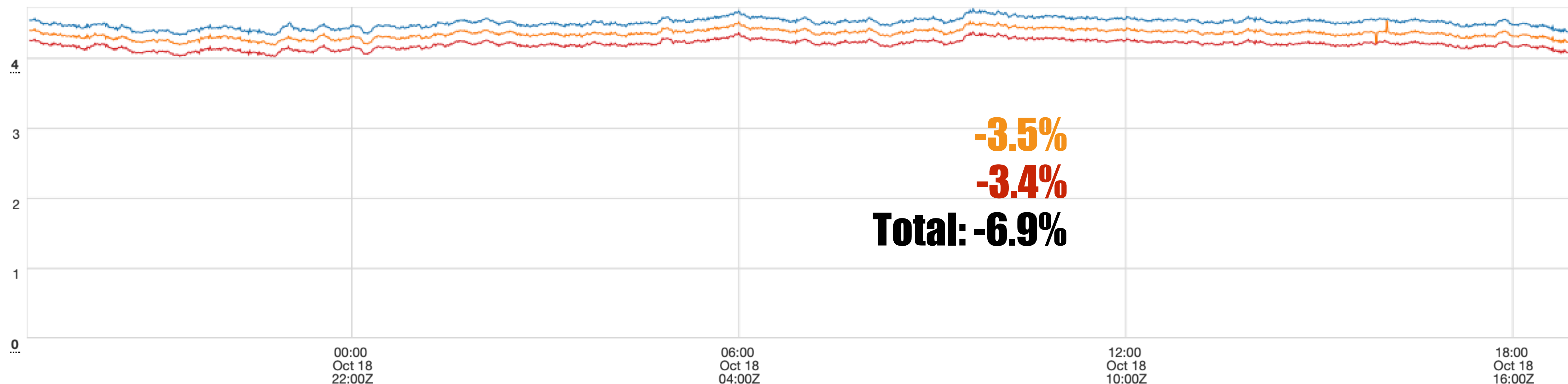


A TWITTER EXAMPLE...



TWEET SERVICE: ALLOCATED BYTES/TWEET

movingavg(10)

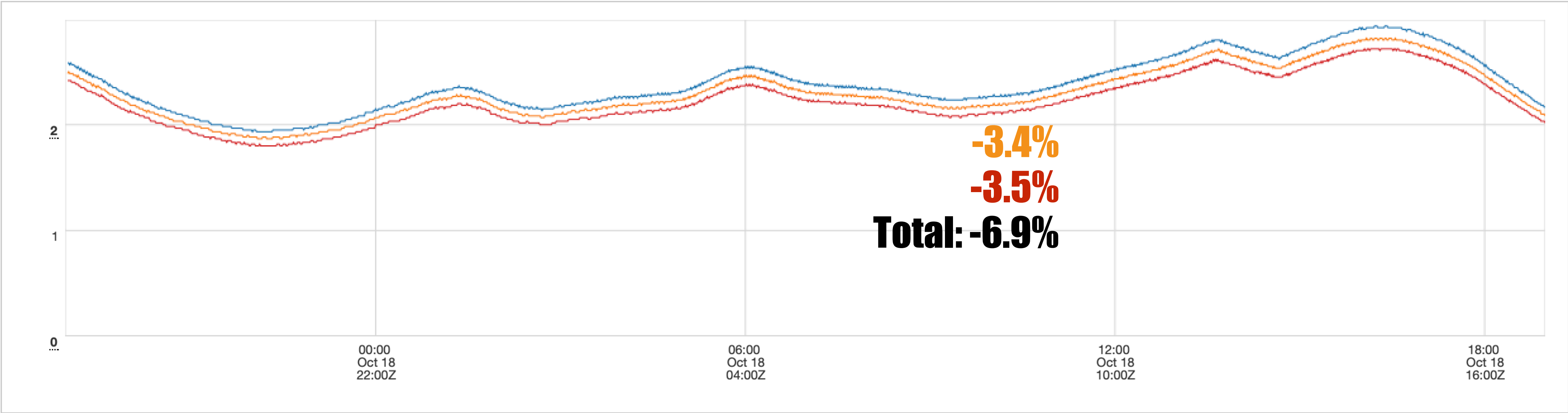


C2 Graal Autotune

@CHRISTHALINGER

TWEET SERVICE: PS SCAVENGE CYCLES

movingavg(60)

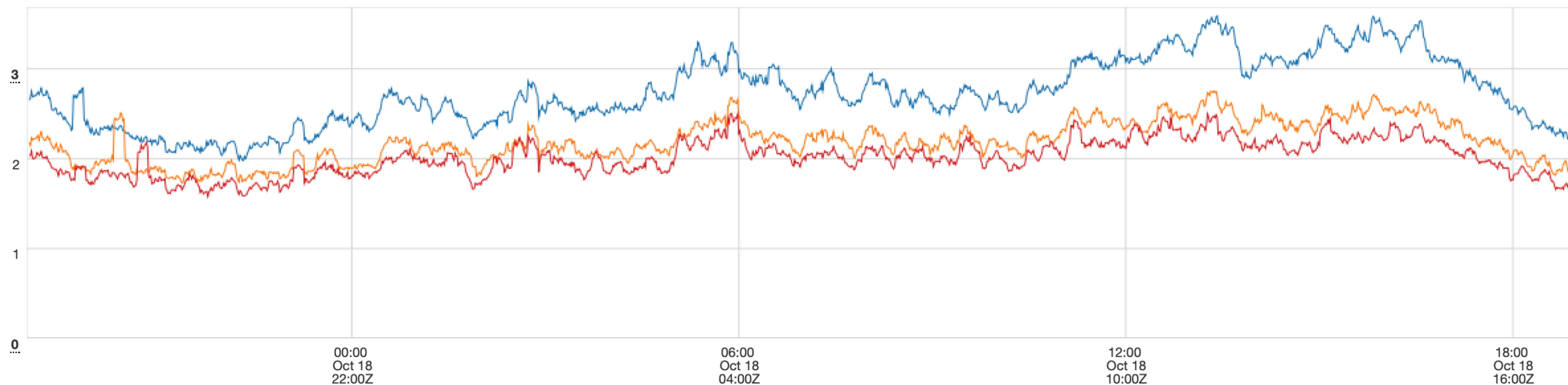


C2 Graal Autotune

@CHRISTHALINGER

TWEET SERVICE: LATENCY P99

movingavg(10)

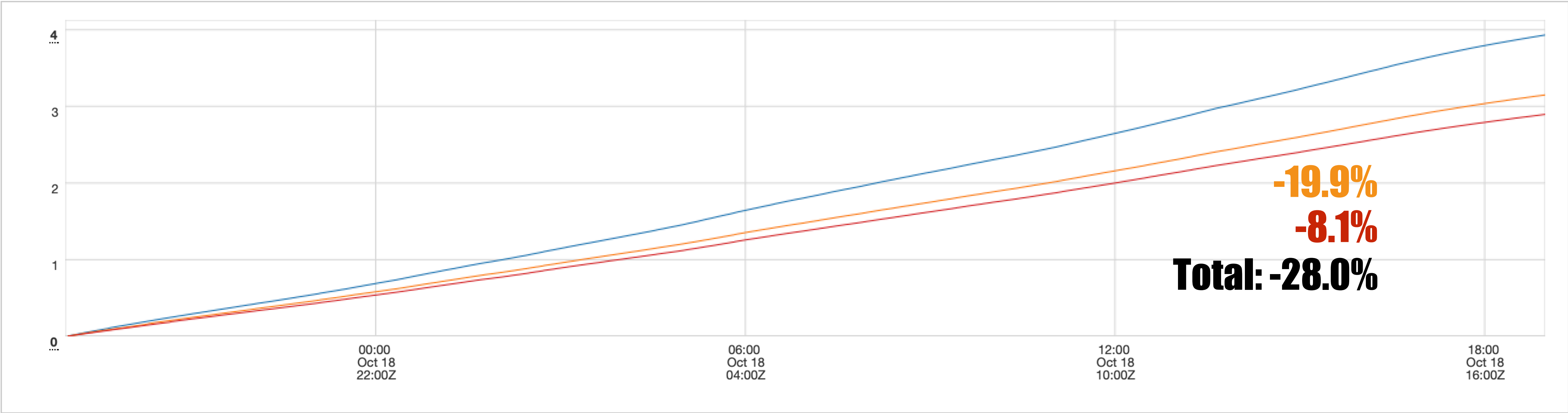


■ C2 ■ Graal ■ Autotune

@CHRISTHALINGER

TWEET SERVICE: LATENCY P99

integrate()

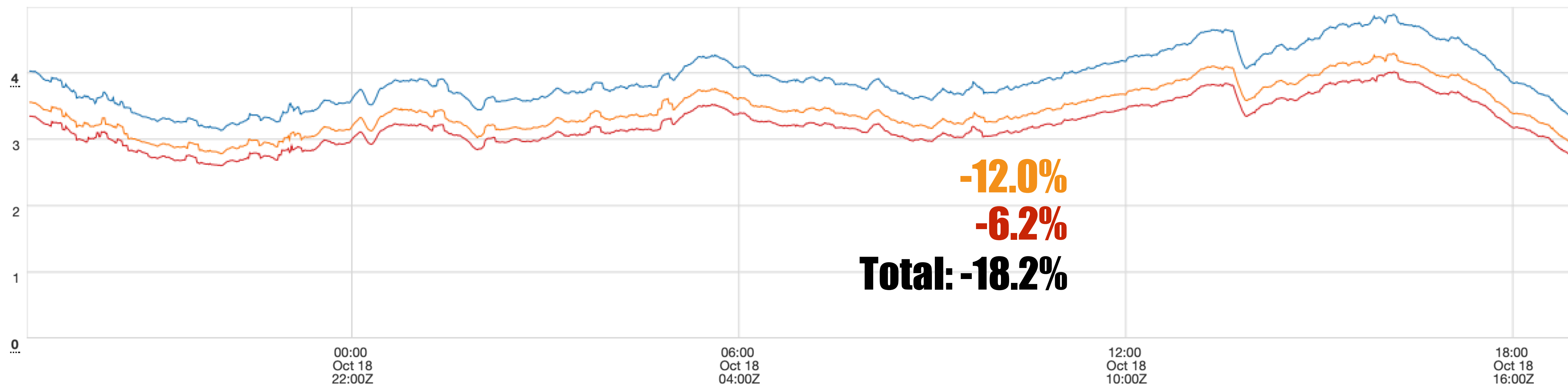


 C2  Graal  Autotune

@CHRISTHALINGER

TWEET SERVICE: USER CPU TIME

movingavg(10)



 C2  Graal  Autotune

@CHRISTHALINGER

18% FEWER MACHINES AND LESS ELECTRICITY



@CHRISTHALINGER



[HTTPS://WWW.CCN.COM/WP-CONTENT/UPLOADS/2018/05/BITCOIN-MINING-ASIC.JPG](https://www.ccn.com/wp-content/uploads/2018/05/bitcoin-mining-asic.jpg)

@CHRISTHALINGER



Digiconomist
@DigiEconomist



The [#energy](#) footprint for one [#Bitcoin](#) transaction (606 KWh) equates to:
-1 US household 20 days (DE: 63, CN: 170)[#CarbonFootprint](#)
per TX: 288 KG
-720,021 VISA transactions
-48,001 hours of watching Youtube[#Ewaste](#) per TX: 94 grams
[bitcoinenergyconsumption.com](#)



Bitcoin Energy Consumption Index - Digico...

The Bitcoin Energy Consumption Index provides the latest estimate of the total energy consumption of the Bitcoin network.

[digiconomist.net](#)

♡ 2 3:53 PM - Sep 29, 2019



[See Digiconomist's other Tweets](#)

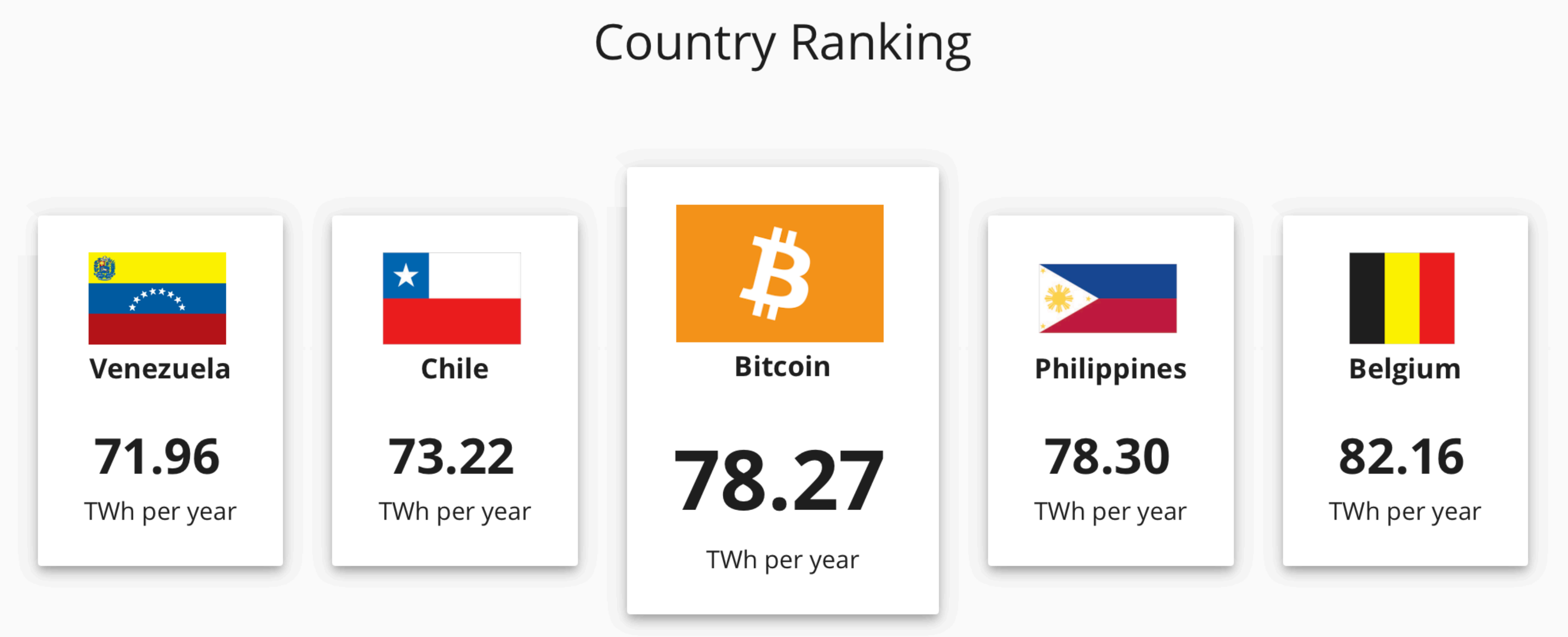


CAMBRIDGE BITCOIN ELECTRICITY CONSUMPTION INDEX

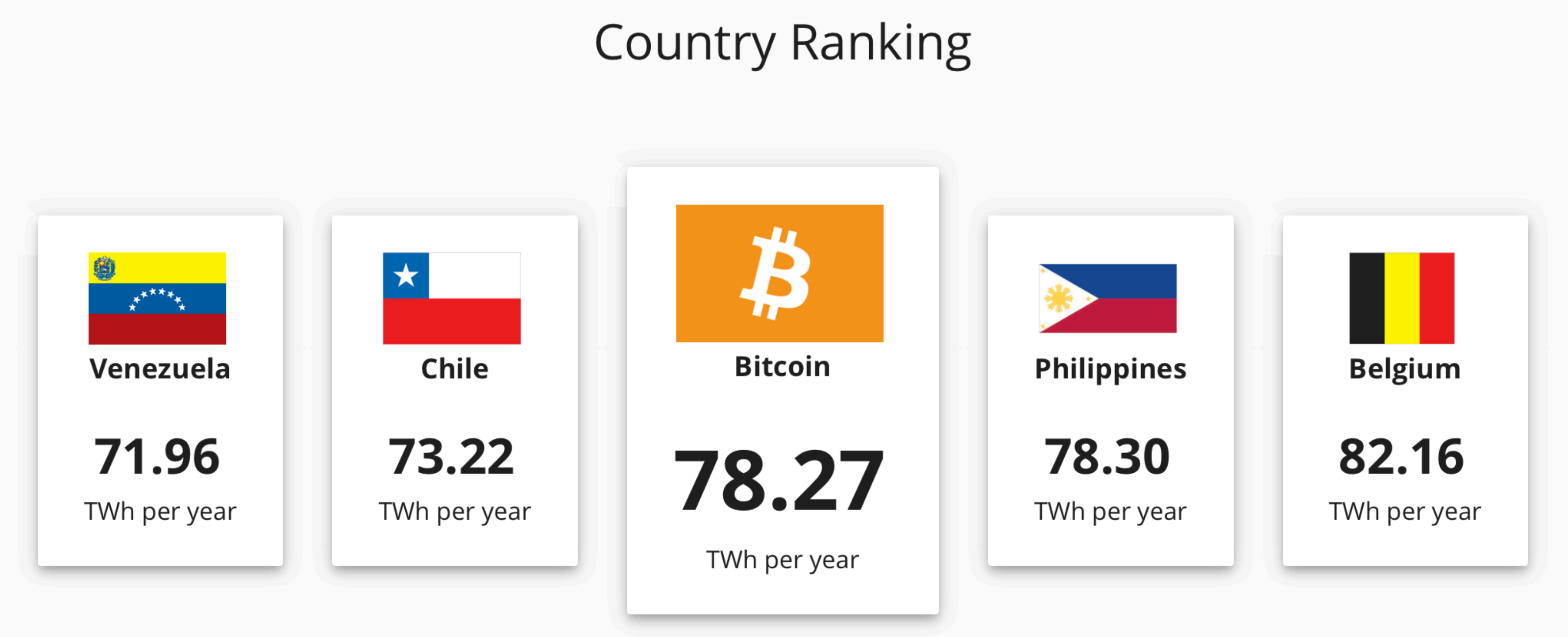
78.27 TWH PER YEAR



CAMBRIDGE BITCOIN ELECTRICITY CONSUMPTION INDEX



CAMBRIDGE BITCOIN ELECTRICITY CONSUMPTION INDEX

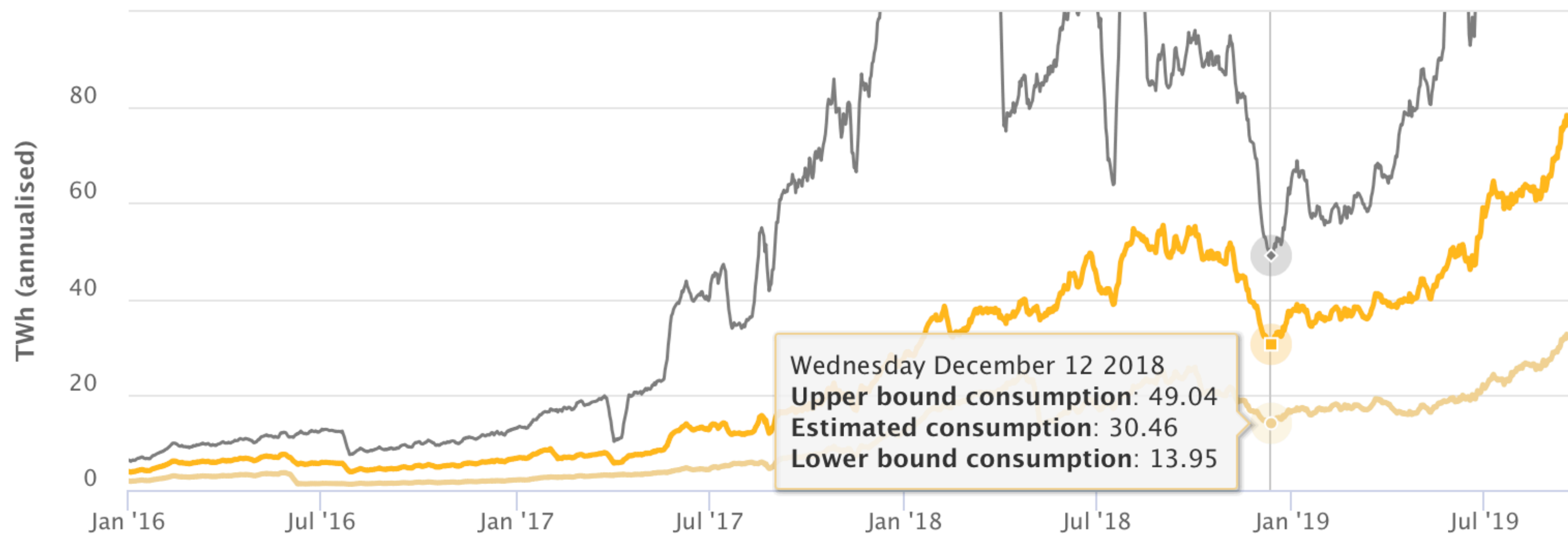
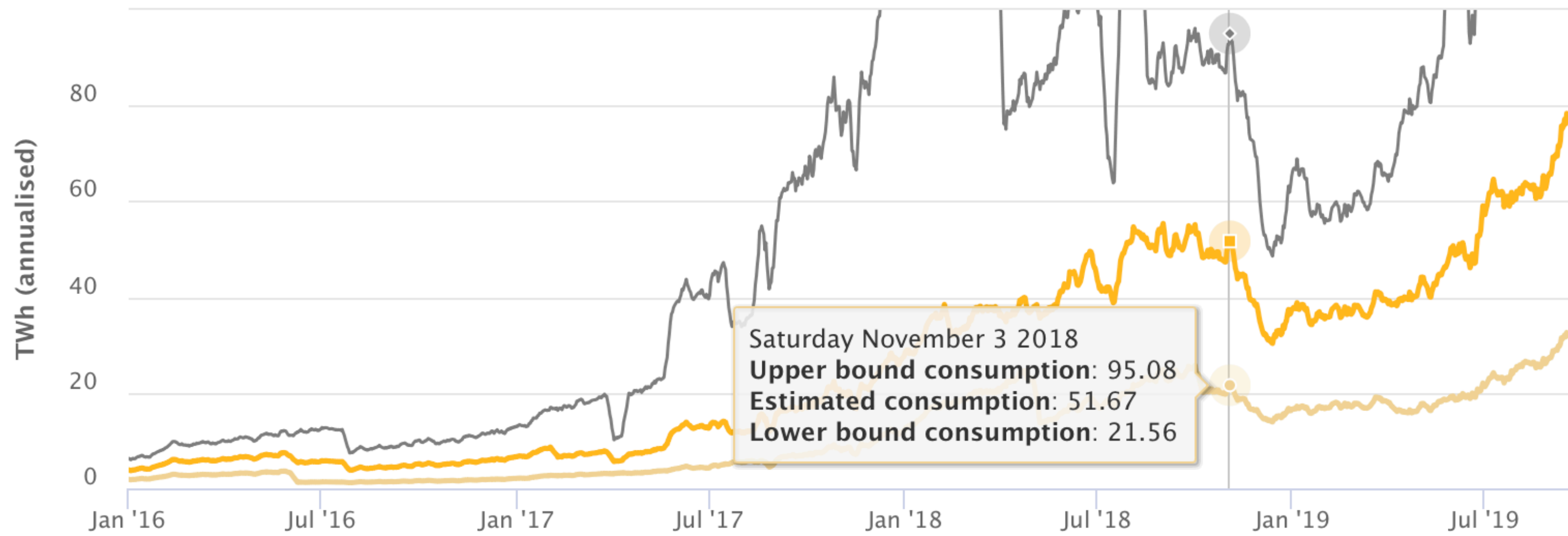


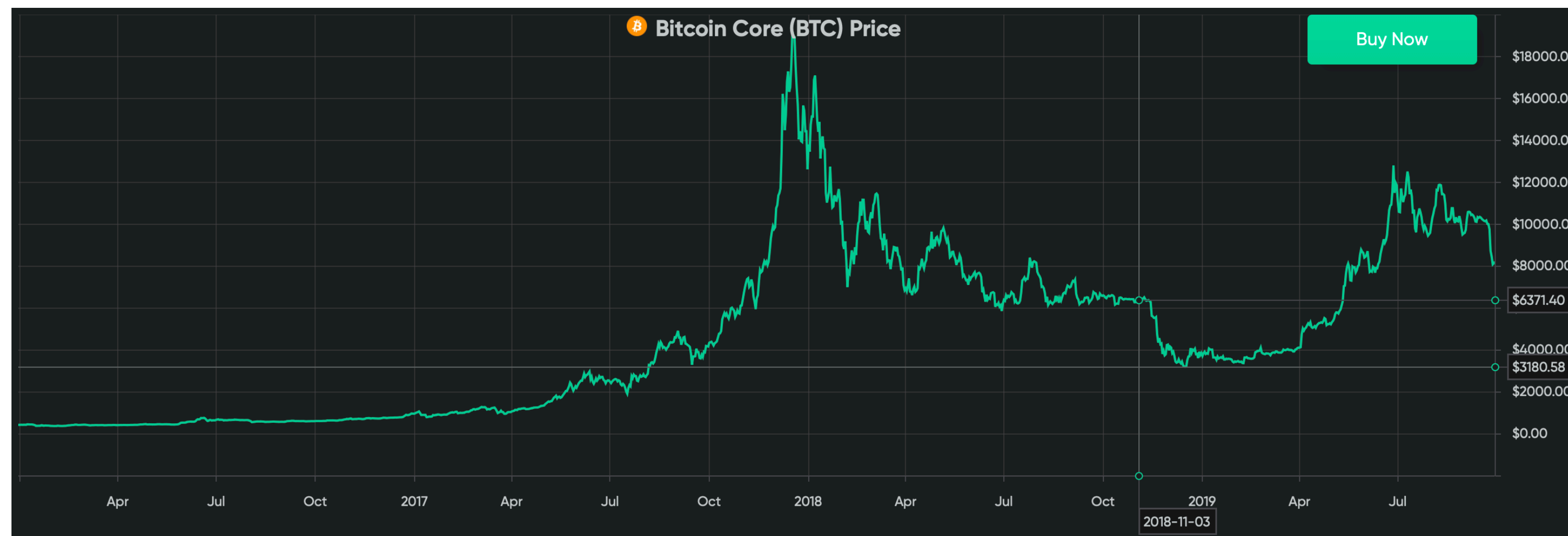
31.5 million 17.4 million 101 million 11.4 million













THE COST TO MINE 1 BITCOIN BASED ON THE AVERAGE ELECTRICITY RATE PER COUNTRY

ALBANIA	\$3.894	IRELAND	\$11.103	RWANDA	\$8.922
AMERICAN SAMOA	\$10.706	ISRAEL	\$6.087	SAUDI ARABIA	\$3.172
ARGENTINA	\$4.560	ITALY	\$10.310	SERBIA	\$3.133
AUSTRALIA	\$9.913	JAMAICA	\$7.867	SINGAPORE	\$5.936
BAHRAIN	\$16.773	JAPAN	\$8.723	SLOKAVIA	\$4.746
BANGLADESH	\$2.379	JORDAN	\$9.913	SLOVENIA	\$7.645
BELARUS	\$2.177	KAZAKHSTAN	\$2.835	SOLOMON ISLANDS	\$16.209
BELGIUM	\$13.482	KIRIBATI	\$12.966	SOUTH AFRICA	\$5.948
BOSNIA AND HERZEGOVINA	\$4.084	KOSOVO	\$3.133	SOUTH KOREA	\$26.170
BRAZIL	\$6.741	KUWAIT	\$1.983	SPAIN	\$11.103
BRUNEI	\$4.758	LAOS	\$4.845	SRI LANKA	\$11.630
BULGARIA	\$4.362	LATVIA	\$7.122	SURINAM	\$2.956
CAMBODIA	\$8.327	LIECHTENSTEIN	\$8.164	SWEDEN	\$4.746
CANADA, ONTARIO	\$3.965	LITHUANIA	\$5.155	SWITZERLAND	\$7.494
CHILE	\$9.120	LUXEMBOURG	\$7.693	TAHITI	\$11.103
CHINA	\$3.172	MACEDONIA	\$3.914	TAIWAN	\$3.774
COLOMBIA	\$7.157	MALAYSIA	\$5.147	THAILAND	\$4.943
COOK ISLANDS	\$15.861	MALTA	\$6.079	TONGA	\$14.671
CROATIA	\$5.551	MARSHALL ISLANDS	\$14.751	TRINIDAD AND TOBAGO	\$1.190
CURAÇAO	\$11.896	MEXICO	\$7.645	TURKEY	\$4.984
CYPRUS	\$8.723	MOLDOVA	\$4.651	TURKS AND CAICOS ISLANDS	\$14.033
DENMARK	\$14.275	MONTENEGRO	\$6.384	TUVALU	\$14.493
EGYPT	\$3.172	MYANMAR	\$1.983	UGANDA	\$7.637
ESTONIA	\$5.551	NEPAL	\$3.569	UKRAINE	\$1.852
ETHIOPIA	\$2.855	NETHERLANDS	\$9.449	UNITED ARAB EMIRATES	\$3.569
FIJI	\$5.155	NEW ZEALAND	\$7.593	UNITED KINGDOM	\$8.402
FINLAND	\$7.122	NICARAGUA	\$8.613	UNITED STATES	\$4.758
FRANCE	\$7.930	NIGERIA	\$5.321	URUGUAY	\$8.723
GEORGIA	\$3.316	NIUE	\$17.566	UZBEKISTAN	\$1.788
GERMANY	\$14.275	NORWAY	\$7.784	VANUATU	\$13.085
GIBRALTAR	\$5.710	PAKISTAN	\$7.137	VENEZUELA	\$531
GREECE	\$9.120	PALAU	\$9.053	VIETNAM	\$4.717
GUYANA	\$10.627	PAPUA NEW GUINEA	\$9.913	WESTERN SAMOA	\$12.689
HONG KONG	\$7.930	PARAGUAY	\$3.140	ZAMBIA	\$3.569
HUNGARY	\$5.365	PERU	\$4.140		
ICELAND	\$4.746	PHILIPPINES	\$7.137		
INDIA	\$3.274	POLAND	\$6.931		
INDONESIA	\$4.329	PORTUGAL	\$10.825		
IRAN	\$3.217	ROMANIA	\$5.698		
IRAQ	\$6.543	RUSSIA	\$4.675		





THE COST TO MINE 1 BITCOIN
 BASED ON THE AVERAGE ELECTRICITY RATE PER COUNTRY

ALBANIA	\$3,894	IRELAND	\$11,103	RWANDA	\$8,922
AMERICAN SAMOA	\$10,706	ISRAEL	\$6,087	SAUDI ARABIA	\$3,172
ARGENTINA	\$4,560	ITALY	\$10,310	SERBIA	\$3,133
AUSTRALIA	\$9,913	JAMAICA	\$7,867	SINGAPORE	\$5,936
BAHRAIN	\$16,773	JAPAN	\$8,723	SLOKAVIA	\$4,746
BANGLADESH	\$2,379	JORDAN	\$9,913	SLOVENIA	\$7,645
BELARUS	\$2,177	KAZAKHSTAN	\$2,835	SOLOMON ISLANDS	\$16,209
BELGIUM	\$13,482	KIRIBATI	\$12,966	SOUTH AFRICA	\$5,948
BOSNIA AND HERZEGOVINA	\$4,084	KOSOVO	\$3,133	SOUTH KOREA	\$26,170
BRAZIL	\$6,741	KUWAIT	\$1,983	SPAIN	\$11,103
BRUNEI	\$4,758	LAOS	\$4,845	SRI LANKA	\$11,630
BULGARIA	\$4,362	LATVIA	\$7,122	SURINAM	\$2,956
CAMBODIA	\$8,327	LIECHTENSTEIN	\$8,164	SWEDEN	\$4,746
CANADA, ONTARIO	\$3,965	LITHUANIA	\$5,155	SWITZERLAND	\$7,494
CHILE	\$9,120	LUXEMBOURG	\$7,693	TAHITI	\$11,103
CHINA	\$3,172	MACEDONIA	\$3,914	TAIWAN	\$3,774
COLOMBIA	\$7,157	MALAYSIA	\$5,147	THAILAND	\$4,943
COOK ISLANDS	\$15,861	MALTA	\$6,079	TONGA	\$14,671
CROATIA	\$5,551	MARSHALL ISLANDS	\$14,751	TRINIDAD AND TOBAGO	\$1,190
CURAÇAO	\$11,896	MEXICO	\$7,645	TURKEY	\$4,984
CYPRUS	\$8,723	MOLDOVA	\$4,651	TURKS AND CAICOS ISLANDS	\$14,033
DENMARK	\$14,275	MONTENEGRO	\$6,384	TUVALU	\$14,493
EGYPT	\$3,172	MYANMAR	\$1,983	UGANDA	\$7,637
ESTONIA	\$5,551	NEPAL	\$3,569	UKRAINE	\$1,852
ETHIOPIA	\$2,855	NETHERLANDS	\$9,449	UNITED ARAB EMIRATES	\$3,569
FIJI	\$5,155	NEW ZEALAND	\$7,593	UNITED KINGDOM	\$8,402
FINLAND	\$7,122	NICARAGUA	\$8,613	UNITED STATES	\$4,758
FRANCE	\$7,930	NIGERIA	\$5,321	URUGUAY	\$8,723
GEORGIA	\$3,316	NIUE	\$17,566	UZBEKISTAN	\$1,788
GERMANY	\$14,275	NORWAY	\$7,784	VANUATU	\$13,085
GIBRALTAR	\$5,710	PAKISTAN	\$7,137	VENEZUELA	\$531
GREECE	\$9,120	PALAU	\$9,053	VIETNAM	\$4,717
GUYANA	\$10,627	PAPUA NEW GUINEA	\$9,913	WESTERN SAMOA	\$12,689
HONG KONG	\$7,930	PARAGUAY	\$3,140	ZAMBIA	\$3,569
HUNGARY	\$5,365	PERU	\$4,140		
ICELAND	\$4,746	PHILIPPINES	\$7,137		
INDIA	\$3,274	POLAND	\$6,931		
INDONESIA	\$4,329	PORTUGAL	\$10,825		
IRAN	\$3,217	ROMANIA	\$5,698		
IRAQ	\$6,543	RUSSIA	\$4,675		

RANKING

- 1. Venezuela \$531
- 2. Trinidad and Tobago \$1,190
- 3. Uzbekistan \$1,788
- ...
- n-2. Bahrain \$16,773
- n-1. Niue \$17,566
- n. South Korea \$26,170



PERFORMANCE TUNING HAS AN IMPACT



@CHRISTHALINGER

**STOP EVERY NOW AND THEN
AND
THINK ABOUT THE IMPACT OF YOUR WORK**



