



Sustainability and AWS

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20.9.2023



Agenda

- Amazon's Sustainability Pledge
- AWS and Sustainability
- Real life story

Further and Faster, Together

September 19, 2019

Amazon and Global Optimism announced The Climate Pledge, a commitment to meet the goals of the Paris Agreement 10 years early—and achieve net-zero carbon by 2040. Amazon is a co-founder and first signatory of The Climate Pledge.

**THE
CLIMATE
PLEDGE**





With 400+ signatories from around the world.



With 22+ signatories
from the Nordics &
Benelux.





The Pledge Commitments

- 01 Regular Reporting**
Measure and publicly report greenhouse gas emissions on a regular basis.
- 02 Carbon Elimination**
Implement decarbonization strategies in line with the Paris Agreement through real business changes and innovations, including efficiency improvements, renewable energy, materials reductions, and other carbon emissions elimination strategies.
- 03 Credible Offsets**
Neutralize any remaining emissions with additional, quantifiable, real, permanent, and socially beneficial offsets to achieve net-zero annual carbon emissions by 2040.

At a Glance - Amazon's commitment to sustainability

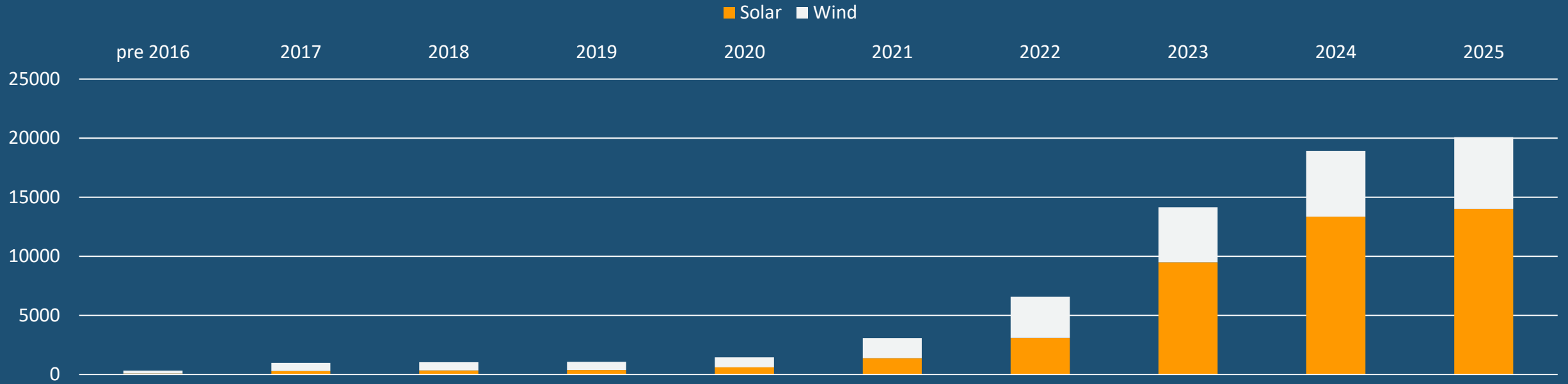
Nordics Focus

<p>Stockholm Region powered by over 95% renewable energy</p>	<p>Powering Operations with 100% renewable energy by 2025</p> <p>progress 07/23: 90%</p>	<p>9 Windfarm projects in Sweden/Finland that will add >950 MW of renewable energy to the grid</p>	<p>80% lower carbon footprint, 5x more energy efficient in EU</p>
<p>Stockholm Region use evaporative cooling systems, i.e. for more than 95% of the year, AWS uses no water to cool ARN</p>	<p>Provided \$4M for a Swedish water conservation project to protect against flooding, boost water quality and biodiversity</p>		<p>Reaching net carbon zero by 2040, 10 years ahead of Paris Agreement</p>
<p>400+ Global Renewable Energy Projects</p>	<p>2022 World's largest purchaser of renewable energy 20+GW (13M homes in EU)</p>		<p>Since 2015, reduced packaging weight by 38% and eliminated over 2 million tons of packaging</p>



Renewable energy

Total megawatts installed by year, as of January 2023.



400+

Global renewable energy projects

20+

Once online, 20+ GW total renewable capacity

90%

Renewable energy reached across our business in 2022



Renewable Energy Optimization (REO)

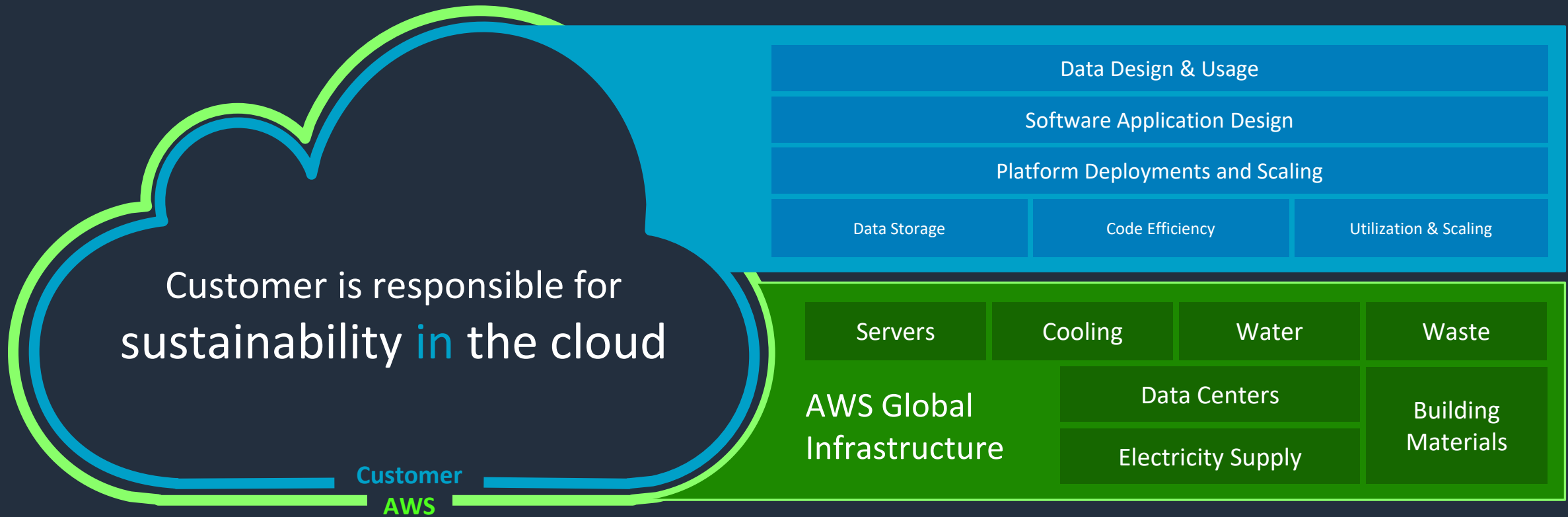
By 2025, Amazon expects using REO across its global fleet could deliver additional clean energy equivalent to a 200-megawatt (MW) wind farm



AWS and Sustainability



Share your sustainability responsibility with AWS



AWS is responsible for sustainability **of** the cloud



Sustainability OF the Cloud

Carbon reduction opportunity

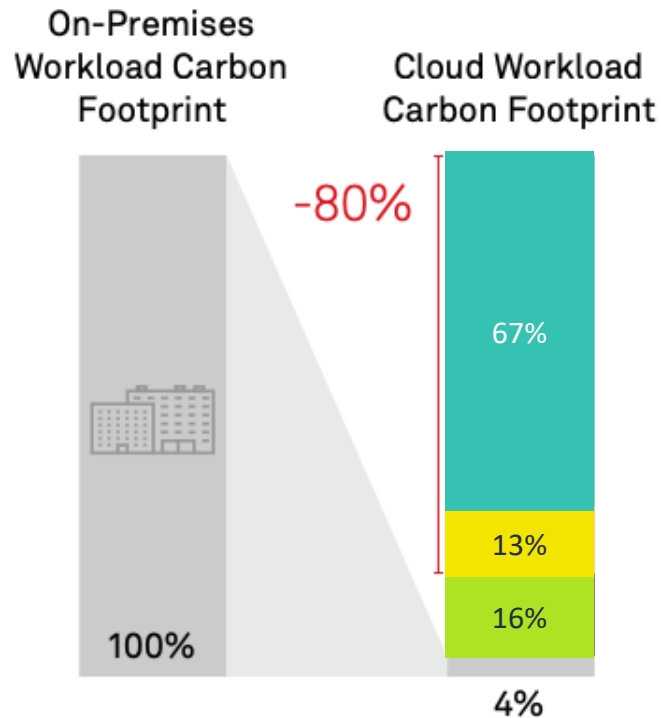
AWS can lower the workload carbon footprint of average on-premises data centers by nearly 80% today and up to 96% once AWS is powered with 100% renewable energy



Find all the reports on aws.amazon.com/sustainability/resources/

Europe: Carbon reduction opportunity

AWS up to 5 times more energy efficient than typical EU enterprise infrastructure



Cloud servers are responsible for the largest energy reduction, more than 67%, due to being more energy-efficient and more highly utilized

AWS data center facilities account for another 13% reduction by using power and cooling systems that are more efficient, bringing energy savings to 80%

As AWS continues to increase its renewable energy globally, that could further reduce the carbon footprint of workloads moved to cloud by up to 16%

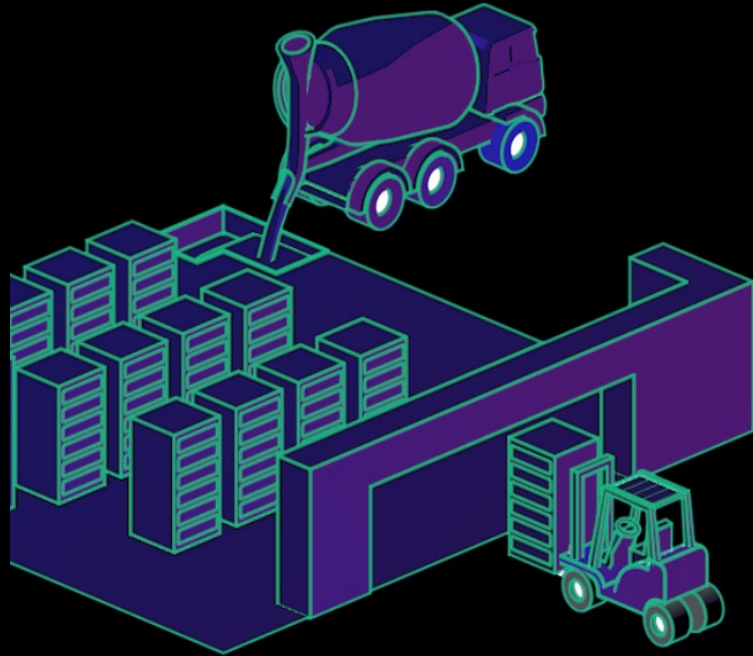
Efficiency from Chip to Grid

Source: 451 Research, a part of S&P Global Market Intelligence, Saving Energy in Europe by Using Amazon Web Services, 2021





Reducing carbon emissions across our global operations

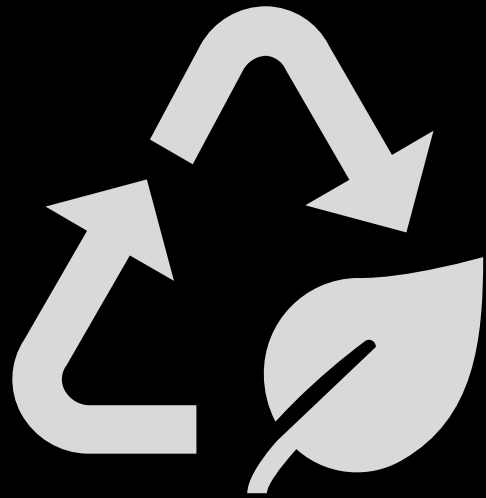


16 data centers constructed using lower-carbon concrete and **10** using lower-carbon steel

Backup generators at data centers powered with renewable fuels, reducing emissions by up to **90%**

Lower lifecycle impacts of silicon-based devices from materials to manufacturing

Electricity consumed in **19** AWS Regions was attributed to **100%** renewable energy



Embracing a circular economy

Design. We eliminate excess materials, increase recycled and biobased content, and plan for reuse from the start.

Operate. We extended the life of our servers from **4 years to 5** and our networking equipment from **5 years to 6**.

Recover. Our reverse logistics hubs test, repair, and recirculate equipment back to data centers or to be sold for reuse by third parties.



Water stewardship

Water efficiency. **0.19** liters of water per kilowatt-hour
water use efficiency for AWS data centers

~~Sustainable water sources. **20** data centers globally
use recycled water for cooling~~

~~Water reuse. Reuse discharged water from our data
centers in communities~~

~~Water replenishment. AWS has returned **2.4 billion**
liters of water to communities through replenishment
projects~~



Sustainability IN the cloud

Using AWS Services in a sustainable way
Sustainably Pillar of the Well-Architected Framework
Customer carbon footprint tool

Graviton, Inferentia, and Trainium

Graviton3-based Elastic Compute Cloud instances use up to **60% less energy** than comparable Amazon EC2 instances

AWS's Inferentia machine learning chip is up to **54% more energy-efficient** than comparable instances

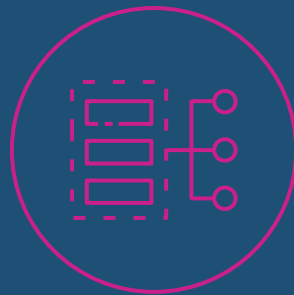
Models built on Trainium use up to **29% less energy** than comparable instances



Focus domains of AWS Well-Architected Sustainability pillar



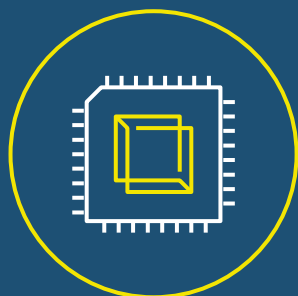
Region selection



Alignment to demand



Data



Hardware & services



Software & architecture



Process & culture

ENERGY EFFICIENCY ACROSS PROGRAMMING LANGUAGES

HOW DOES ENERGY, TIME, AND MEMORY RELATE?

The tools and graphical data pointed by this page are included in the research paper "Energy Efficiency across Programming Languages: How does Energy, Time and Memory Relate?", accepted at the *International Conference on Software Language Engineering (SLE)* - Rui Pereira, Marco Couto, Francisco Ribeiro, Rui Rua, Jácome Cunha, João Paulo Fernandes, and João Saraiva

[1] [Measuring Framework & Benchmarks](#)

[2] [Complete Set of Results](#)

Original work in SLE'17

Home Results Setup Q

[3] [Setup](#)

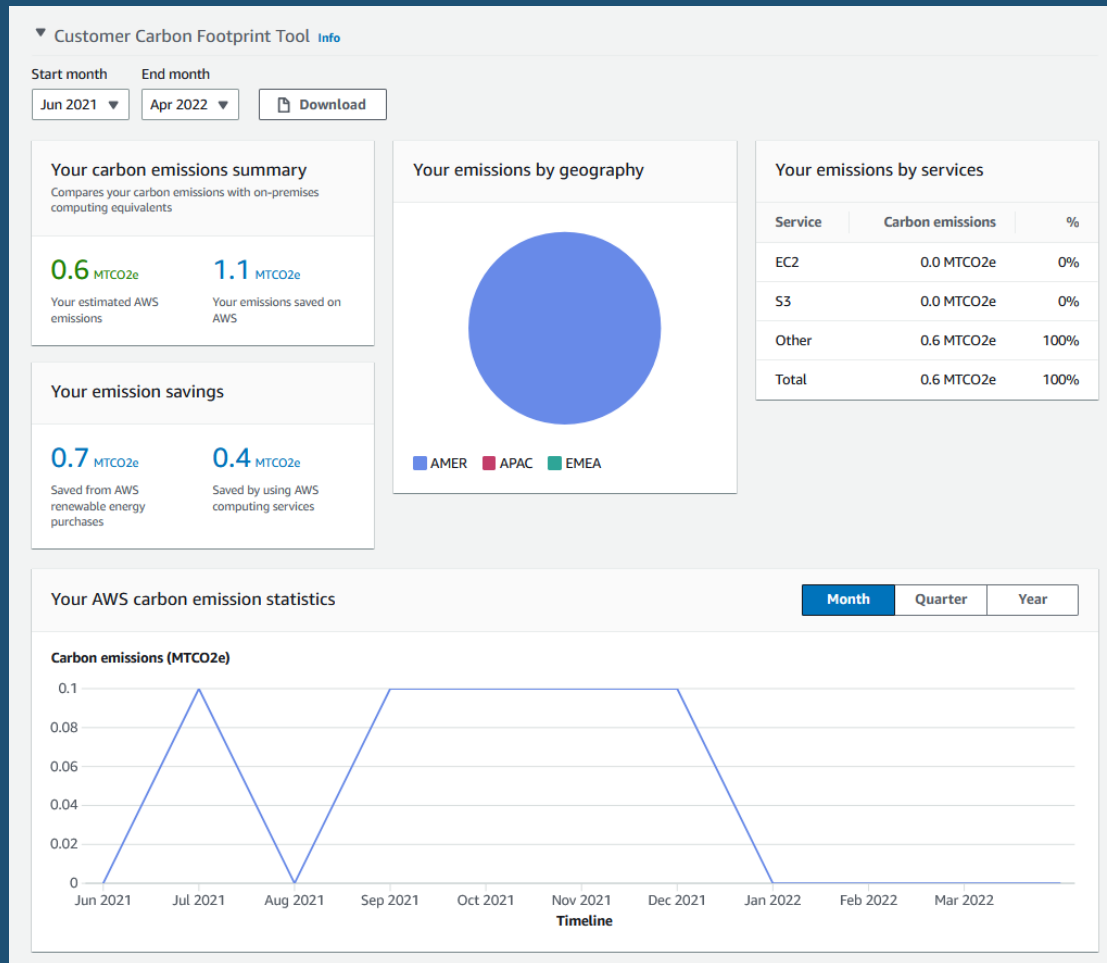
UPDATED COMPILER / INTERPRETER VERSIONS (2020)

Language	Execution	Compiler/Interpreter	Previous Version	Release Version
Haskell	Compiled	ghc	8.0.2	8.8.1
Julia	Compiled	julia	-	1.3.1
OCaml	Compiled	ocamlopt	4.05.0	4.09.0
Rust	Compiled	rustc	1.16.0	1.40.0
Erlang	VM	erlang	7.3.1.2	10.6.1
F#	VM	dotnet	1.0.1	3.1
Lisp	VM	SBCL	1.3.3	1.4.3
Racket	VM	raco	6.8	7.5
Perl	Interpreted	perl	5.24.0	5.30.1
Ruby	Interpreted	ruby	2.4.1	2.7.0p0

A. DATA TABLES

binary-trees					binary-trees					
	Energy	Time	Ratio	MB		CPU \bar{x}	CPU σ	DRAM \bar{x}	DRAM σ	Time σ
(e) Rust \downarrow_1	45.14	1157	0.039	195	Rust	41.28	0.28	3.86	0.13	20.32
(v) Erlang \downarrow_3	87.25	2830	0.031	459	Erlang	76.68	0.20	10.57	0.14	52.29
(v) F# $\downarrow_1 \downarrow_6$	97.94	6691	0.015	719	F#	78.49	0.66	19.45	0.16	66.79
(e) OCaml $\uparrow_1 \uparrow_3$	105.90	3427	0.031	147	Ocaml	89.91	0.24	15.99	0.21	33.24
(e) Lisp $\downarrow_1 \uparrow_1$	148.85	10862	0.014	370	Lisp	115.83	0.70	33.01	0.05	16.19
(v) Racket \downarrow_2	170.58	12165	0.014	487	Racket	127.19	0.84	43.39	0.18	66.32
(e) Julia $\uparrow_2 \downarrow_1$	240.01	8324	0.029	643	Julia	205.55	0.79	34.47	0.09	44.42
(e) Haskell $\uparrow_1 \uparrow_1$	252.53	11717	0.022	548	Haskell	209.41	6.00	43.12	0.59	166.76
(i) Ruby \uparrow_6	778.93	25082	0.031	347	Ruby	704.70	9.09	74.23	1.24	499.86
(i) Perl	3,462.37	93466	0.037	2164	Perl	3,202.13	28.10	260.24	1.59	624.24

AWS customer carbon footprint tool



Calculate carbon emissions generated from your AWS workloads

Understand historical carbon footprint and review changes in emissions over time

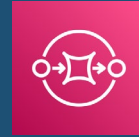
Forecast changes as Amazon stays on a path to 100% renewable energy by 2025

Services & patterns to optimize for Utilization

- Serverless APIs
- Asynchronous calls
- Horizontal scaling
- Stateless applications
- Serverless compute, storage, databases



AWS IoT Core



Amazon Simple Queue Service



Amazon API Gateway



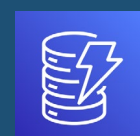
Amazon EventBridge



AWS Lambda



Amazon EC2 Auto Scaling



Amazon DynamoDB



AWS AppSync



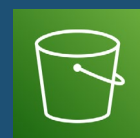
AWS Step Functions



AWS Fargate



AWS Batch



Amazon Simple Storage Service (S3)

APIs

Integration

Compute

Database/ Storage



Sustainability THROUGH the Cloud

AWS enables sustainability transformation
Access and leverage sustainability data

The Open Data Sponsorship Program covers the cost to store and distribute the world's most valuable, impactful data

We work with data providers and data users who seek to:



Democratize access
to data by making it
available for analysis on
AWS



Encourage the
development of **communities** that
benefit from access
to shared datasets



Develop new cloud-native
techniques, formats, and tools
that **lower the cost**
of working with data

ASDI: Making access to data faster, cheaper, and easier

ASDI helps researchers, scientists, and innovators around the world advance their work on sustainability-related research by providing publicly available, free access to important scientific data.



MAXAR



NREL
NATIONAL RENEWABLE ENERGY LABORATORY



FINNISH METEOROLOGICAL
INSTITUTE



Climate data projections



Air quality



Sea surface temperature



Weather forecasts and records



Water



Environmental indicators



Satellite imagery



Energy



Ocean forecasts





“ We are very excited to launch a solution to help transform the food and agriculture value chain by paving the way for a more resilient, regenerative and net-zero carbon future.

Leo Bastos
Global Commercial
Ecosystems Lead,
Bayer Crop Science

Case study: Bayer Crop Science

AWS built the digital carbon footprint measurement solution

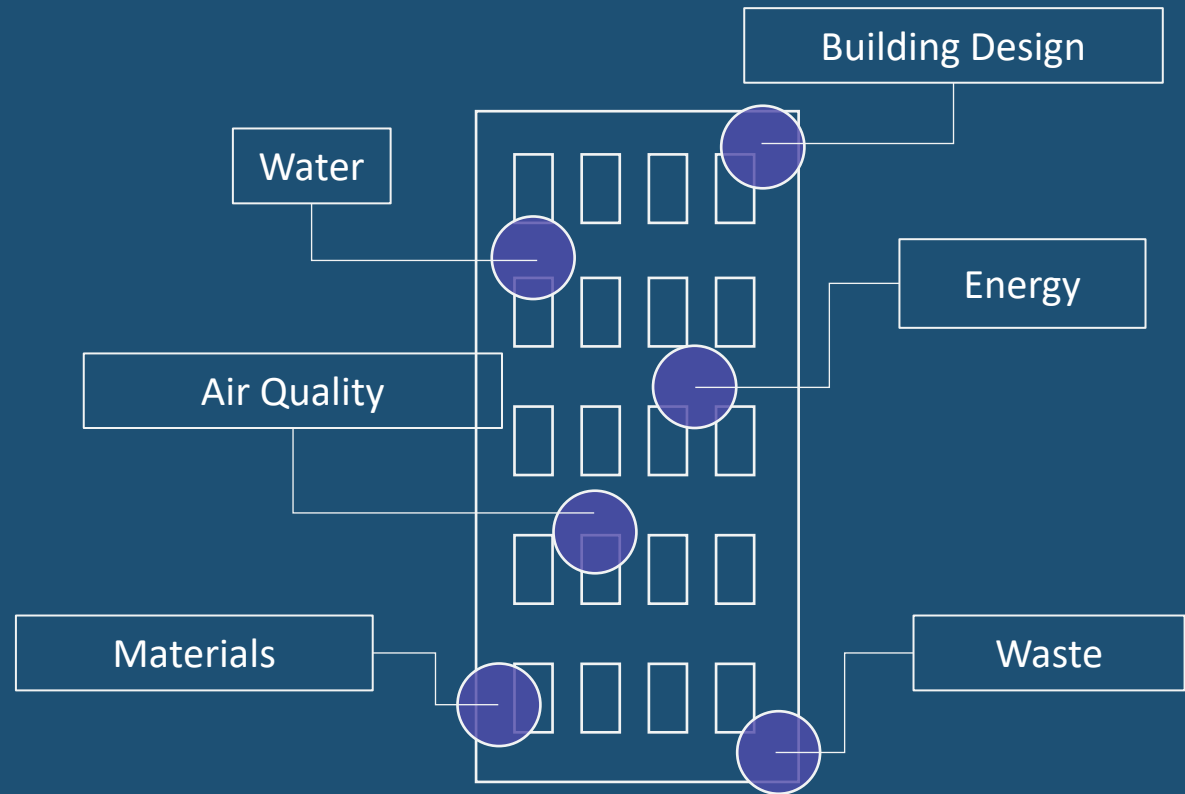
Carbon emissions data tracked for farmed corn from farm to processor, and then to final purchaser

Supply chain digital transparency for Scope 3 emissions

Solution example: Sustainable building management

Leverage data collection to ensure buildings are operating at maximum efficiency.

Design systems to minimize valuable resource consumption and reduce waste.



Leveraging data collection (IoT sensors, BMS), AI & ML to ensure buildings are operating at maximum efficiency to reduce carbon footprint and material consumption.

So...how do you measure the CO2 emissions of your application?



Final Thought...

“We can’t cut down rainforests forever. And anything we can’t do forever is by definition unsustainable.”

- David Attenborough
- A Life on Our Planet



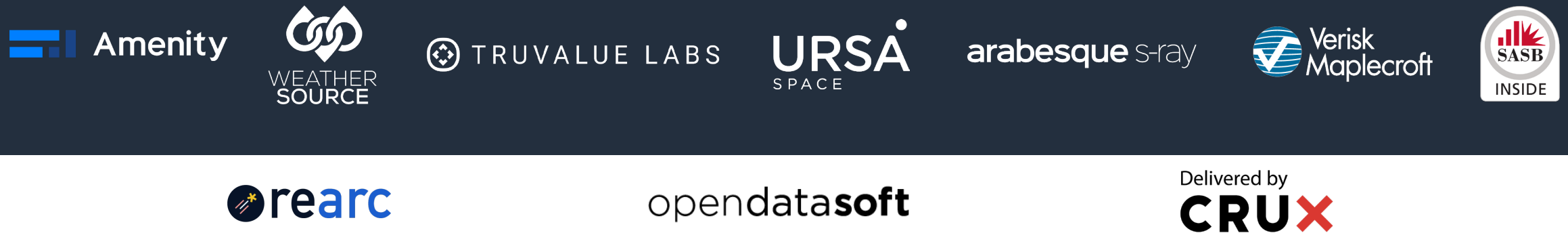
Thank you!

For more case studies and other AWS sustainability news
visit our website.

aws.amazon.com/sustainability

Subscription on AWS data exchange

Easily find, subscribe to, and use sustainability data in the cloud



No cost and paid data licenses for weather, demographics, ESG score, earth insights, climate, human rights & political risk indices, and more

Consolidate data licensing and centralized data management

