Carbon Aware Computing Insights from the UBS Project

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About me

Graduated in electrical engineering







The carbon aware project



https://www.linkedin.com/pulse/how-hackathon-slowly-saving-world-will-buchanan/

CARBON-AWARE COMPUTING WHITEPAPER

How UBS succeeded in measuring and reducing carbon emissions of their core Risk platform



https://greensoftware.foundation/articles/carbon-aware-computingwhitepaper-how-ubs-succeeded-in-measuring-and-reducing-car

Carbon Aware SDK

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n-Software-Foun	dation / carbon-aware-sdk Public			Ļ	
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	a docs	Merge branch 'dev' into publish-openapi-spec	yesterday		
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	samples	Merge pull request #256 from microsoft/173/sdkAccessBoundaries	yesterday		
	scripts	Merge pull request #264 from microsoft/224/add-ps-scripts	last month		
	src src	Merge branch 'dev' into publish-openapi-spec	yesterday		
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	CONTRIBUTING.md	Fix .md violations on existing files	2 months ago		
	LICENSE	Create LICENSE	6 months ago		
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- GSF OSS project
- Targeted to Enterprises integrating carbon aware data from external APIs
- Single API, abstracts API vendor specifics
- Supports multiple data sources
 ElectricityMaps, WattTime and JSON

https://github.com/Green-Software-Foundation/carbon-aware-sdk#readme

Software Sustainability Actions – Carbon Awareness



Carbon Aware Optimization patterns

Temporal shifting

Optimize impact by shifting workloads based on Carbon Intensity prediction



UBS Risk platform

How UBS succeeded in measuring and reducing carbon emissions of their core Risk platform



Temporal shifting

Validate the case before start coding!

What is the carbon intensity potential for the region?

Do business requirements allow workload shifting?



Challenges

- Multiple APIs available which to choose?
- API data accuracy
- Customer business impact?
 - Cloud no granular carbon reporting from cloud service providers reflecting carbon aware optimizations
 - Cloud no direct OPEX incentives for carbon aware compute options from cloud service providers
 - How to measure impact?

How clean is the operational energy of Azure?

MSFT ESG Report 2022 Slide 12

www.microsoft.com/en-us/corporateresponsibility/sustainability/report

🗩 Our commitment

Reducing direct emissions

We will reduce our Scope 1 and 2 emissions to near zero by increasing energy efficiency, decarbonization, and reaching 100 percent renewable energy by 2025.

Reducing value chain emissions By 2030, we will reduce our Scope 3 emissions by more than half from

a 2020 baseline.

Replacing with 100/100/0 carbon-free energy

By 2030, 100 percent of our electricity consumption will be matched by zero carbon energy purchases 100 percent of the time.

Removing the rest of our emissions

to all our historical emissions.

By 2030, Microsoft will remove more carbon than it emits.

By 2050, we will remove an amount of carbon equivalent



Net zero Scope 1 and 2 emissionsIns to near zero by increasing
aching 100 percent renewableOur Scope 1 and 2¹ emissions remained proportional with business growth in FY22.² More than
95 percent of our Scope 2 emissions were reduced by renewable energy from power purchase
agreements (PPAs), green tariff programs, and unbundled renewable energy certificates.InsScope 3 emissions increased by 0.5 percent
Our value chain or Scope 3 emissions increased slightly at 0.5 percent, despite a 25 percent
increase in purchased goods and services due to business growth. This result was driven
by improvements in our operations, telemetry-based measurement, renewable energy
investments, sustainable aviation fuel purchases, and procurement of unbundled renewable
energy certificates (RECs).³bon-free energy
issumption will be matched
cent of the time.I3.5 GW of carbon-free energy
In FY22, we signed new Power Purchase Agreements (PPAs) around the globe, bringing our
total portfolio of carbon-free energy to over 13.5 GW, including more than 135 projects in
16 countries.issionsOver 1.4M metric tons of carbon removal

We contracted 1,443,981 metric tons of carbon removal in FY22. We also made first-of-theirkind multi-year forward offtake commitments to carbon removal, which we view as the model for scaling the industry.

"More than **95 percent of our Scope 2 emissions** were reduced by **renewable energy from power purchase agreements (PPAs)** ..."

"By 2030, 100 percent of our electricity consumption will be matched by zero carbon energy purchases 100 percent of the time"

There is a disconnect between carbon accounting and grid realitiesLearn more about it at https://energytag.org/

Carbon Aware Computing challenges in the cloud

Think about the DC capacity planning of cloud service providers



Carbon Aware Computing challenges in the cloud

Think about the DC capacity planning of cloud service providers



Carbon Aware Computing challenges in the cloud

Think about the DC capacity planning of cloud service providers



UBS - Addressing missing impact reporting

Carbon Intensity gCO2eq/kWh



UBS - Addressing missing impact reporting



UBS - Addressing missing impact reporting



Software Carbon Intensity (SCI) ISO certified

provides a methodology how to apply Carbon Intensity measures to software workloads





E: Energy consumed by a software system for a functional unit of work [kWh]

- I: Location-Based Marginal Carbon Intensity [gCO2eq/kWh]
- M: Embodied emissions of a software system
- R: Functional unit

SCI spec: github.com/Green-Software-Foundation/software_carbon_intensity

UBS - Batch job [R] - envisioned SCI sustainability journey

	Crawl	Walk	Run (full score)
SCI score	SCI = I	SCI = (E*I) per R	SCI = ((E * I) + M) per R
SCI reporting	Relative Impact (%)	Absolute Impact (gCO ₂)	Absolute Impact full score (gCO ₂)

 Enable Developers to quantify relative (%) impact when time shifting Jobs

- Enable Developers to quantify absolute impact partial SCI score (gCO2) excluding embodied emissions when time shifting Jobs
- Enable Developers to compare and optimize VM types for Jobs based on absolute impact partial SCI score
- Enable Developers to compare absolute impact on Job Code optimizations

- Enable Developers to quantify absolute impact full score (gCO2) including embodied emissions by time shifting Jobs
- Enable Developers to compare and optimize VM types for Jobs based on **full score** absolute impact
- Enable Developers to compare absolute impact full score on Job Code optimization

Impact Framework Docs

Impact Framework

Green

Software Foundation



- The impact framework is an extensible way to measure carbon impacts and report SCI scores in a composable way.
- Impact Framework versus Carbon Aware SDK?

https://if.greensoftware.foundation/

Carbon Aware Computing

Opportunities beyond optimizing the impact of software • Cloud & Edge optimize the carbon impact of software itself

• Smart Factories

optimize the impact of systems controlled by software

• Smart Energy Edge

optimize OPEX for companies running hybrid energy concepts

Decarbonizing the grid

decoupling the economy from fossil resources and reducing cost of energy



- Green Software Foundation
 <u>https://greensoftware.foundation/</u>
- SCI Spec https://github.com/Green-Software-Foundation/software_carbon_intensity
- Carbon Aware Compute Whitepaper
 https://greensoftware.foundation/articles/carbon-aware-computing-whitepaper-how-ubs-succeeded-in-measuring-and-reducing-car
- Carbon Aware SDK
 https://github.com/Green-Software-Foundation/carbon-aware-sdk#readme
- Integrating Energy Chart open data from Fraunhofer ISE into the Carbon Aware SDK <u>https://www.carbon-aware-computing.com</u>
- GSF Impact Framework
 https://if.greensoftware.foundation/