

# Carbon Aware Computing Insights from the UBS Project

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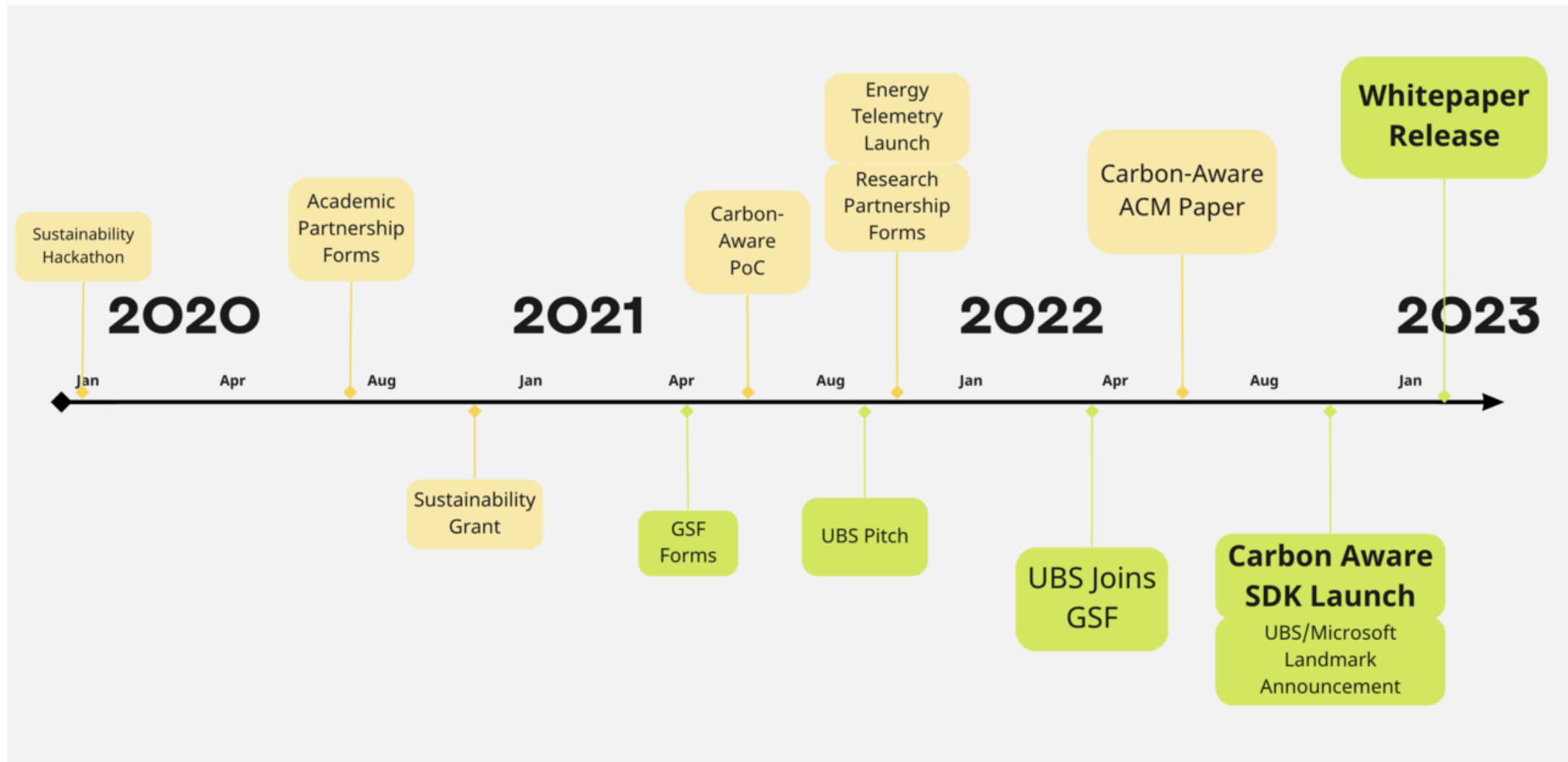
# About me

Graduated in electrical engineering

 1999-2023 Technical Program Management



# The carbon aware project



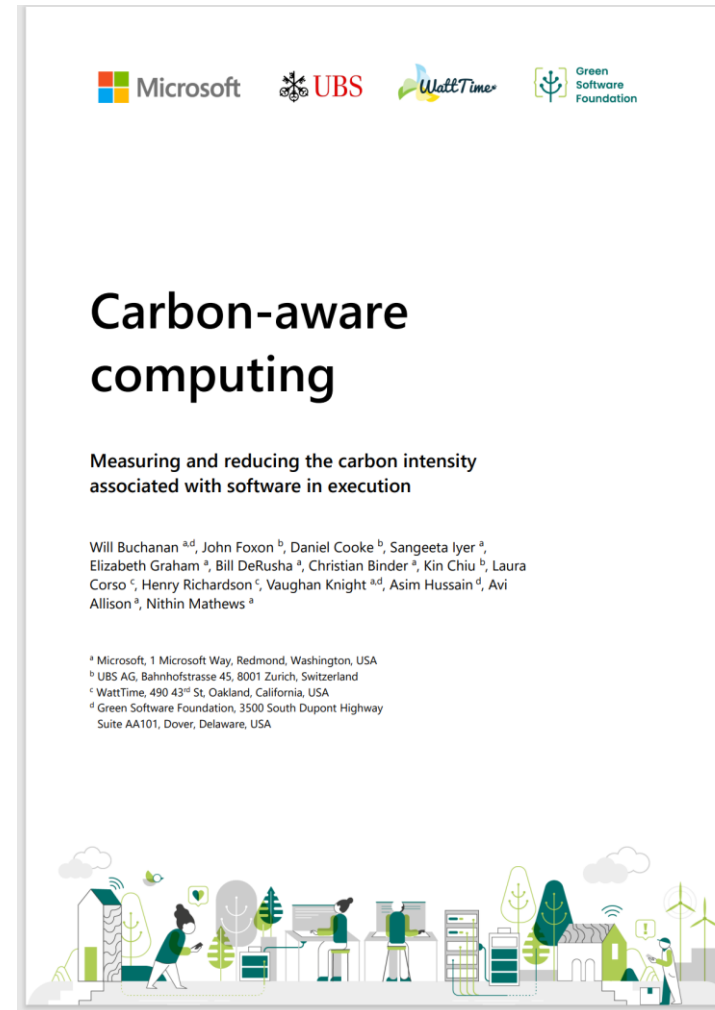
<https://www.linkedin.com/pulse/how-hackathon-slowly-saving-world-will-buchanan/>

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# CARBON-AWARE COMPUTING WHITEPAPER

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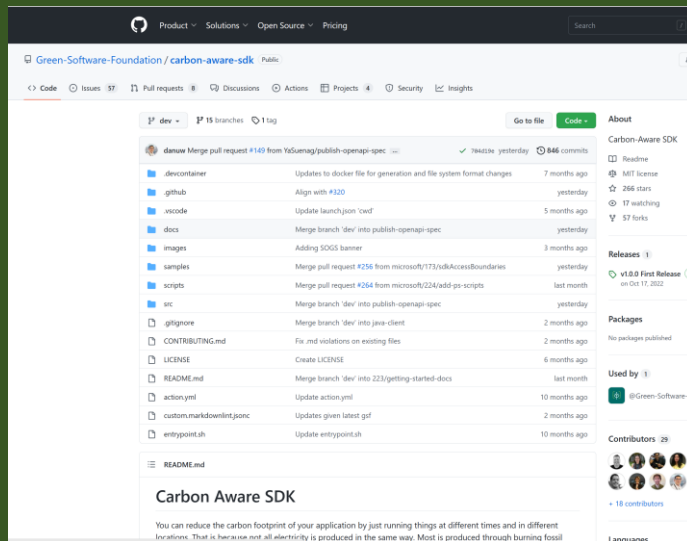
How UBS succeeded in  
measuring and reducing  
carbon emissions of their  
core Risk platform



<https://greensoftware.foundation/articles/carbon-aware-computing-whitepaper-how-ubs-succeeded-in-measuring-and-reducing-car>

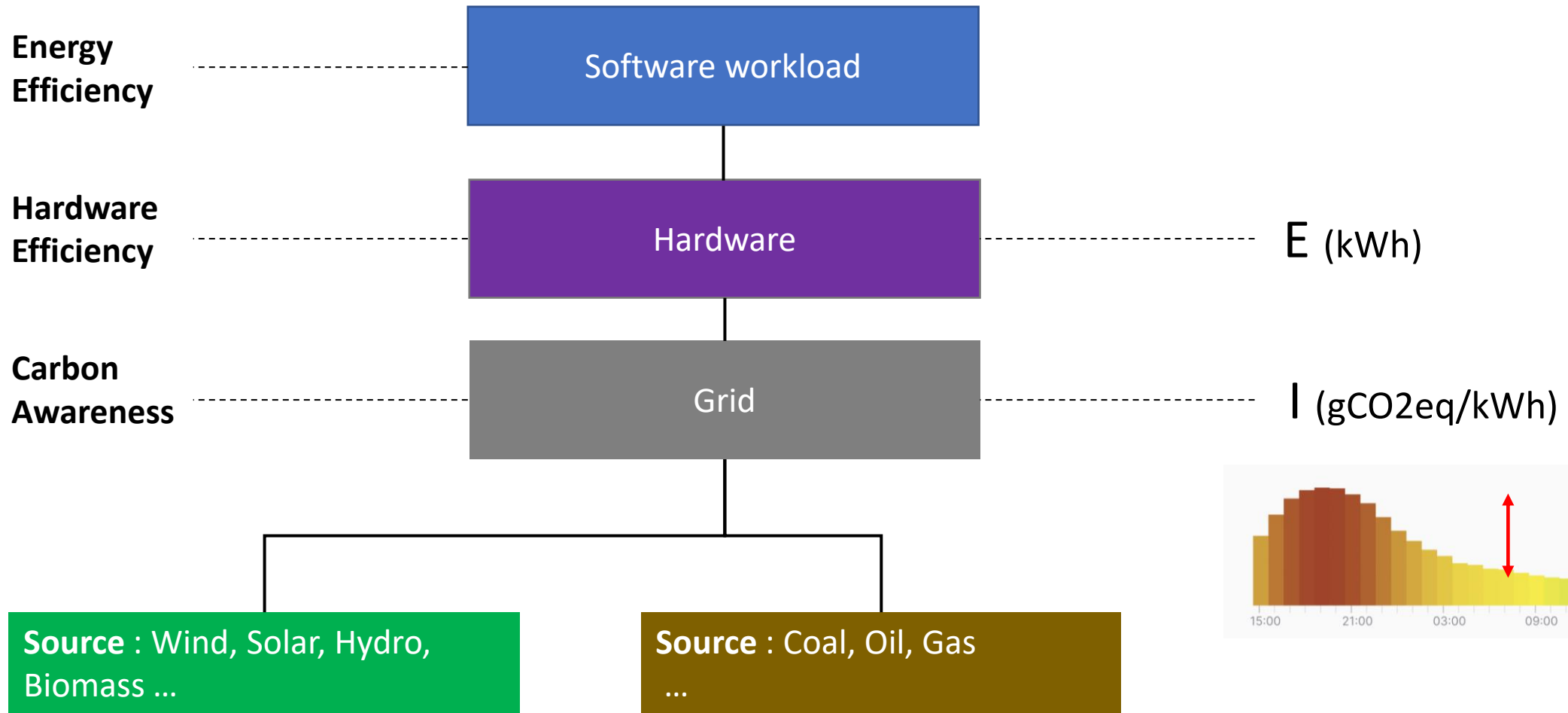
# Carbon Aware SDK

- 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>

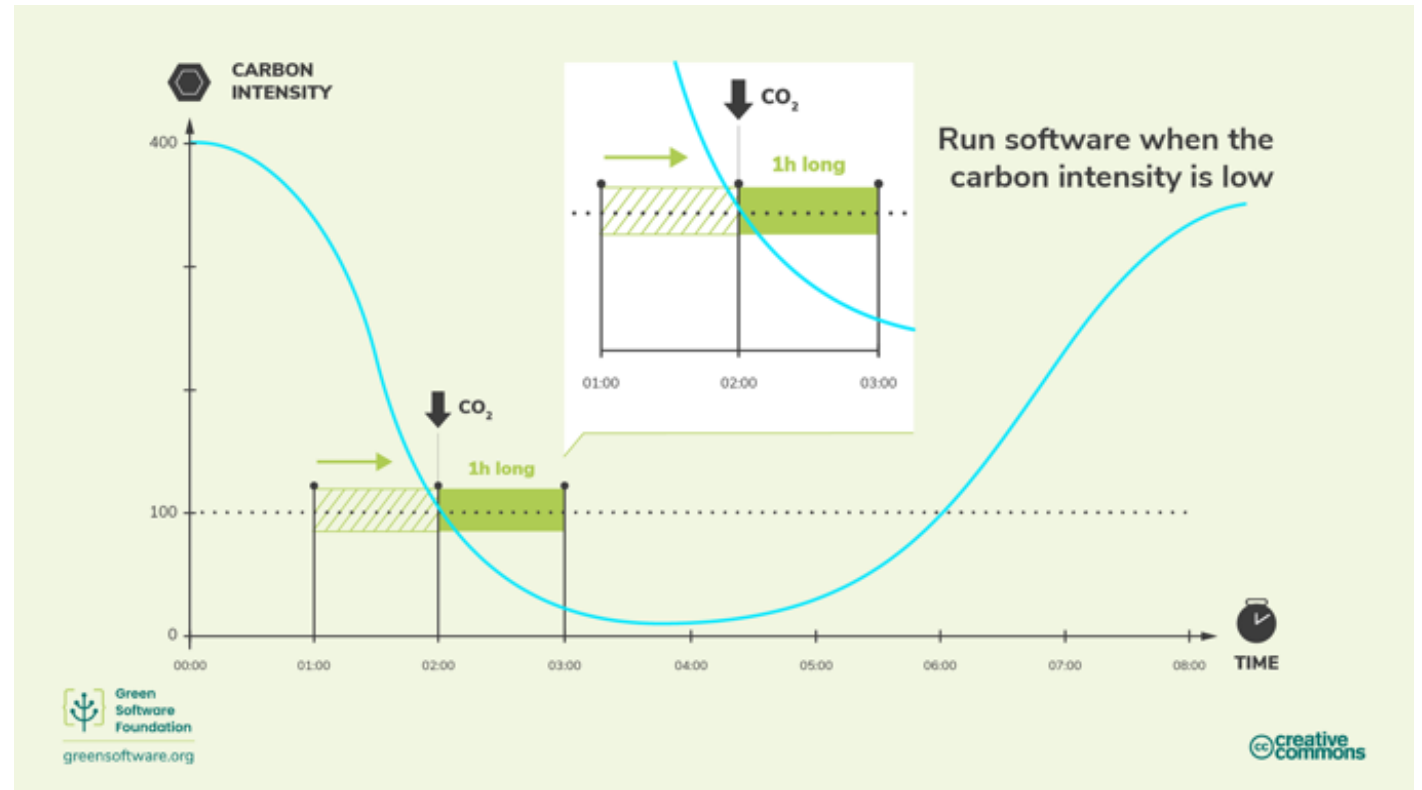
# Software Sustainability Actions – Carbon Awareness



# Carbon Aware Optimization patterns

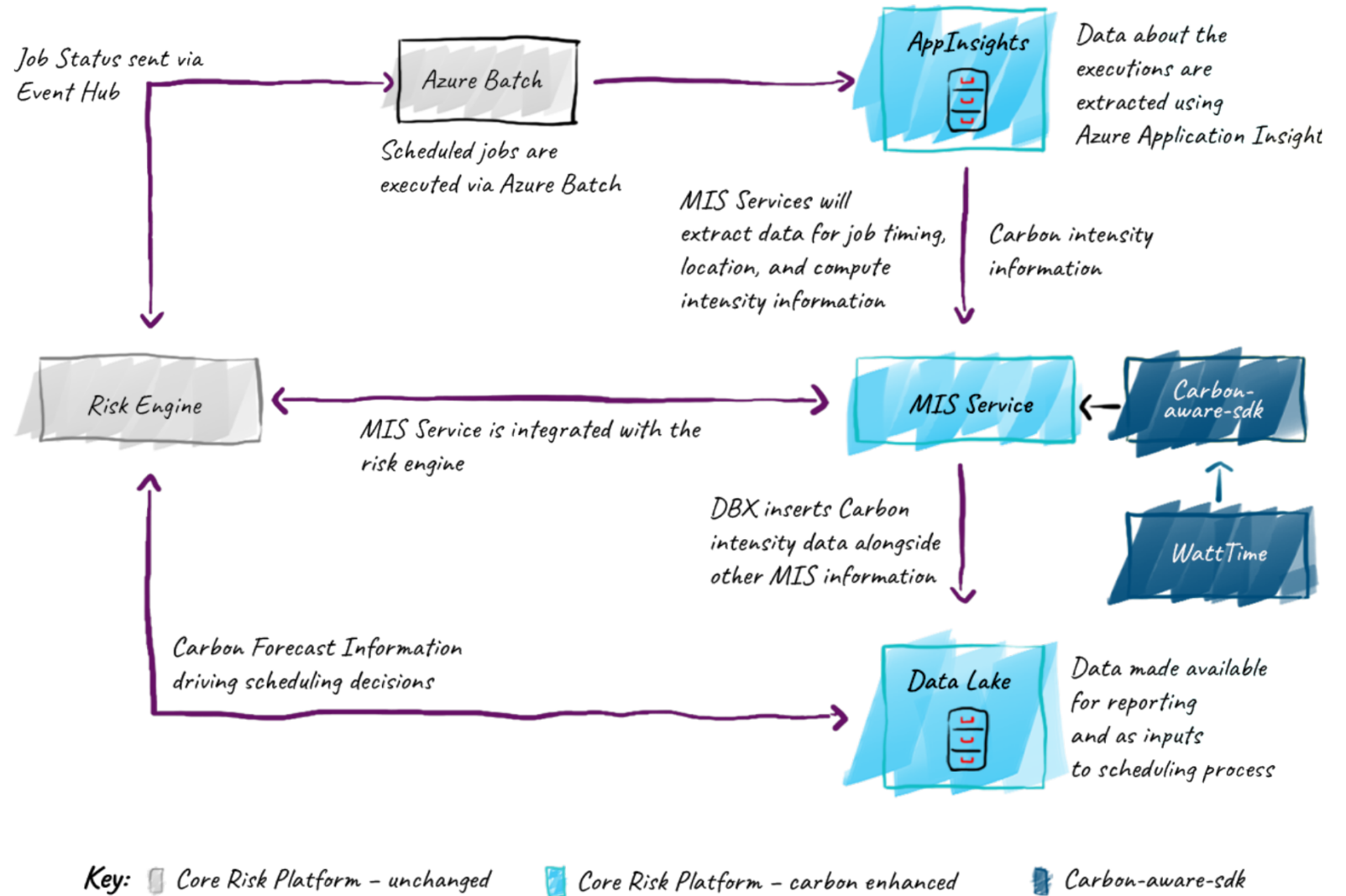
## Temporal shifting

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



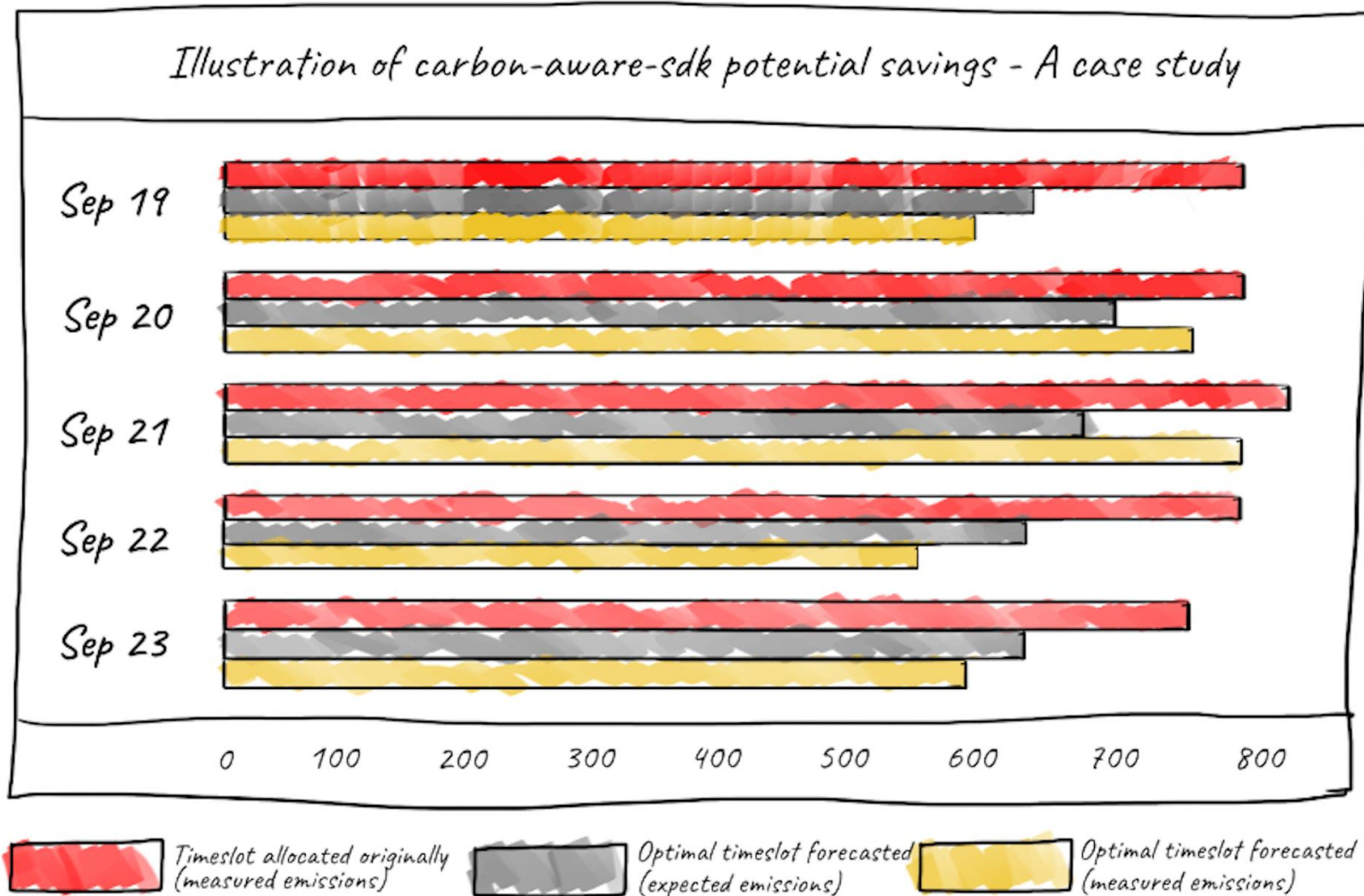


## Temporal shifting

Validate the case before start coding!

What is the carbon intensity potential for the region?

Do business requirements allow workload shifting?



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## Challenges

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- 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/corporate-responsibility/sustainability/report](https://www.microsoft.com/en-us/corporate-responsibility/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

By 2030, Microsoft will remove more carbon than it emits. By 2050, we will remove an amount of carbon equivalent to all our historical emissions.

### Our progress

#### Net zero Scope 1 and 2 emissions

Our Scope 1 and 2<sup>1</sup> emissions remained proportional with business growth in FY22.<sup>2</sup> 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.

#### Scope 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).<sup>3</sup>

#### 13.5 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.

#### Over 1.4M metric tons of carbon removal

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

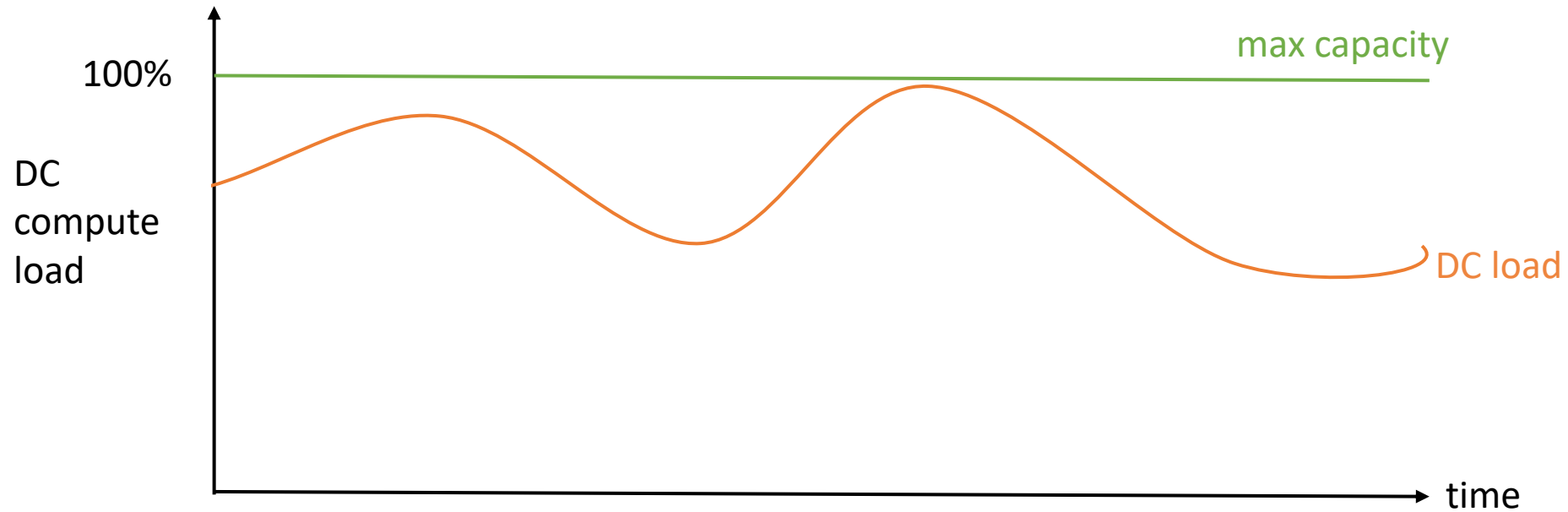
“More than **95 percent of our Scope 2 emissions** were reduced by **renewable energy from power purchase agreements (PPAs)** ...”

“**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 realities*  
Learn more about it at <https://energytag.org/>

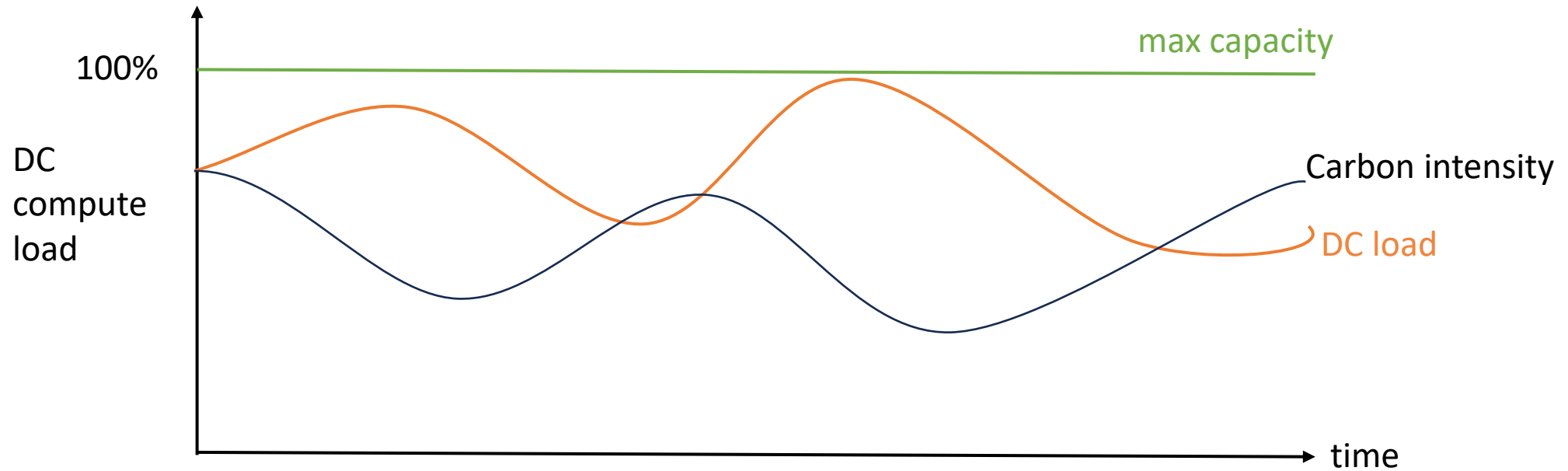
# Carbon Aware Computing challenges in the cloud

*Think about the DC capacity planning of cloud service providers*



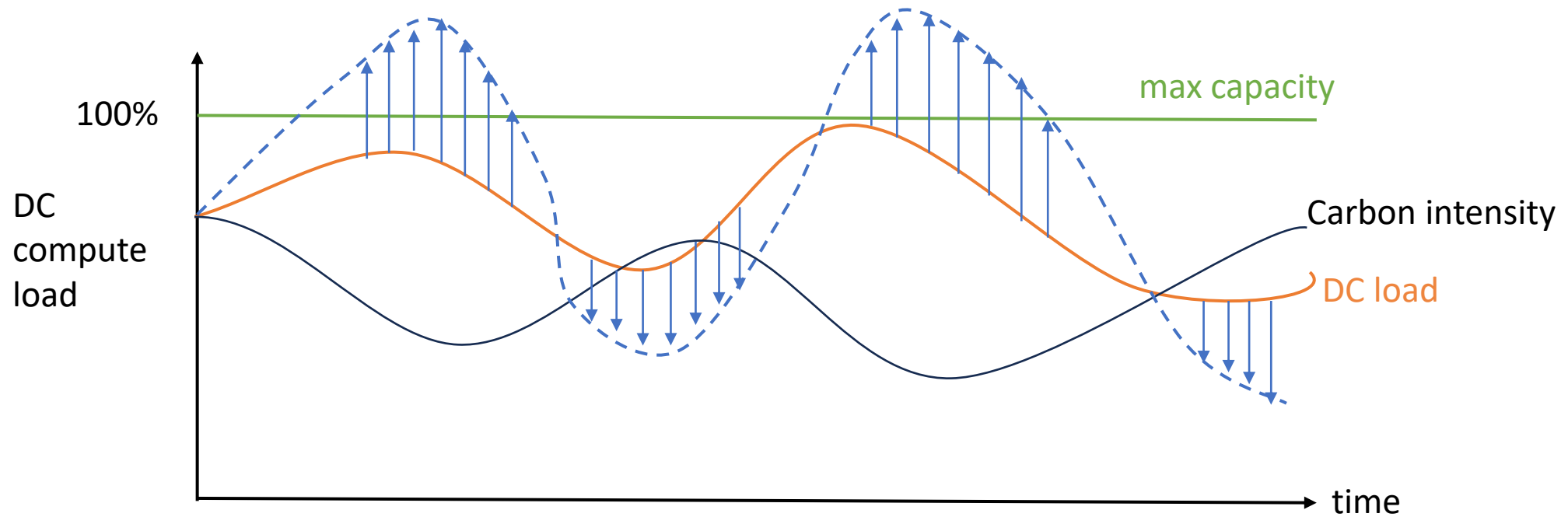
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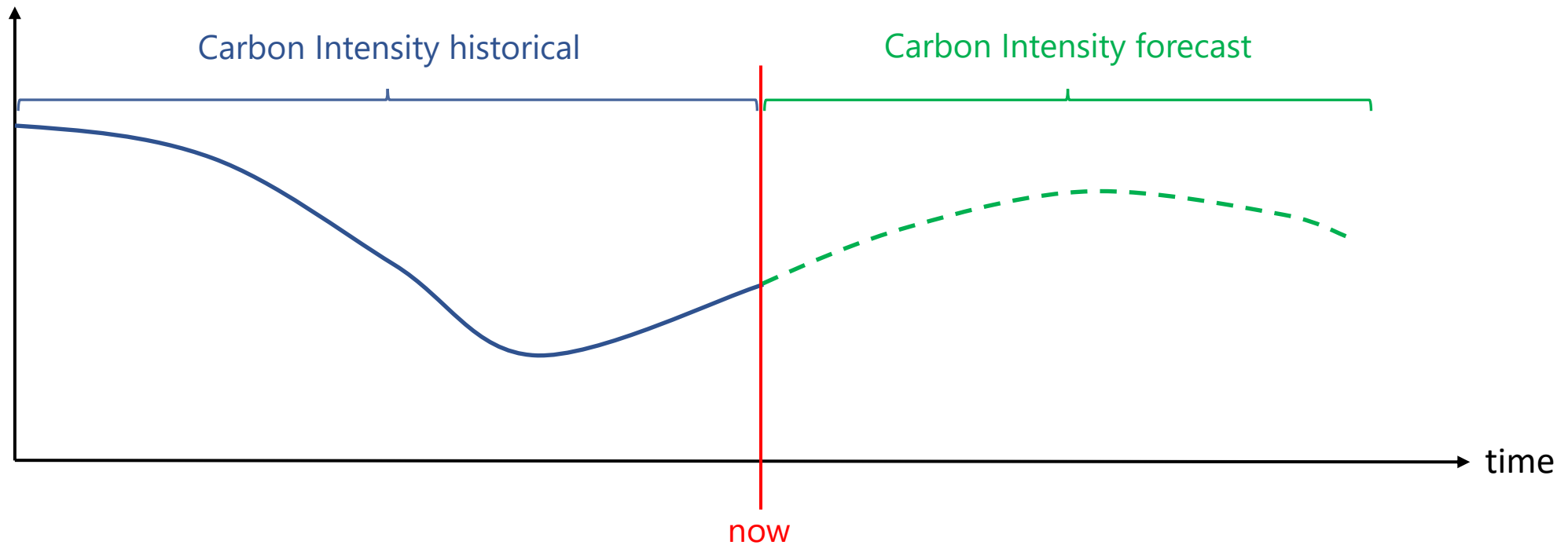
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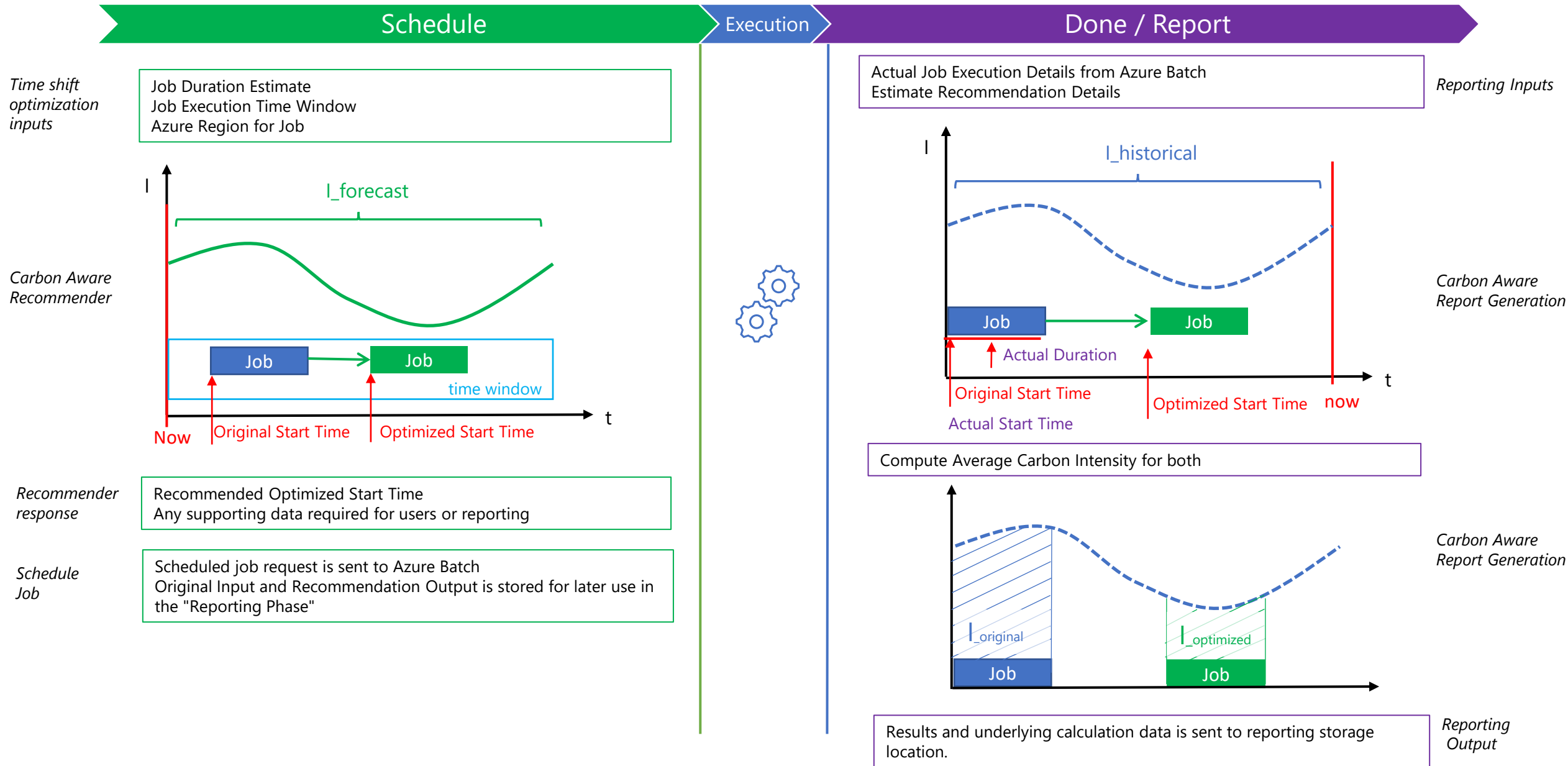


# UBS - Addressing missing impact reporting

Carbon Intensity  
 $\text{gCO}_2\text{eq/kWh}$

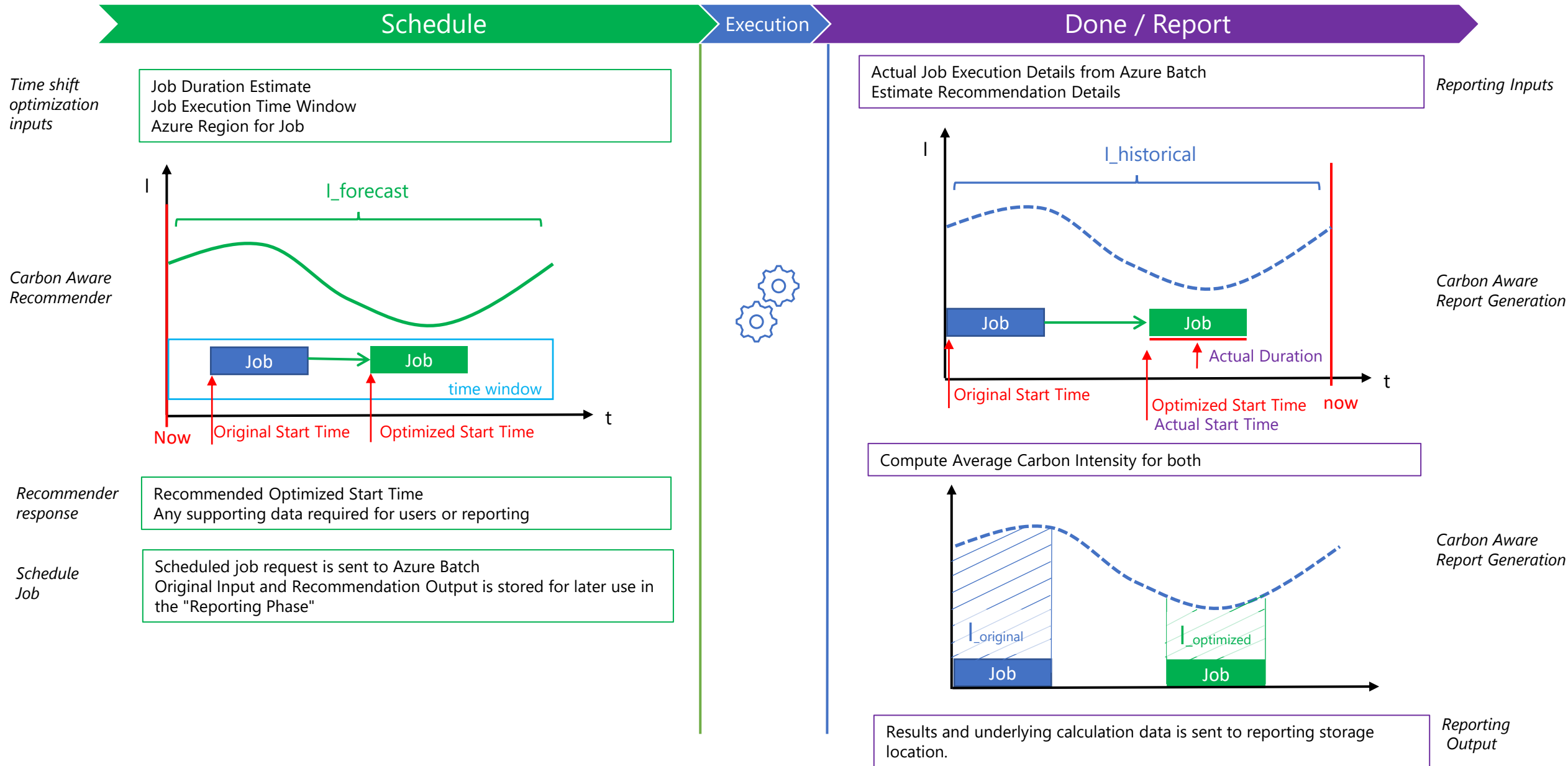


# UBS - Addressing missing impact reporting





# UBS - Addressing missing impact reporting



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## Software Carbon Intensity (SCI) ISO certified

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



$$SCI = ((E * I) + M) / R$$

gCO<sub>2</sub>eq / R

kWh

gCO<sub>2</sub>eq/kWh

gCO<sub>2</sub>eq

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

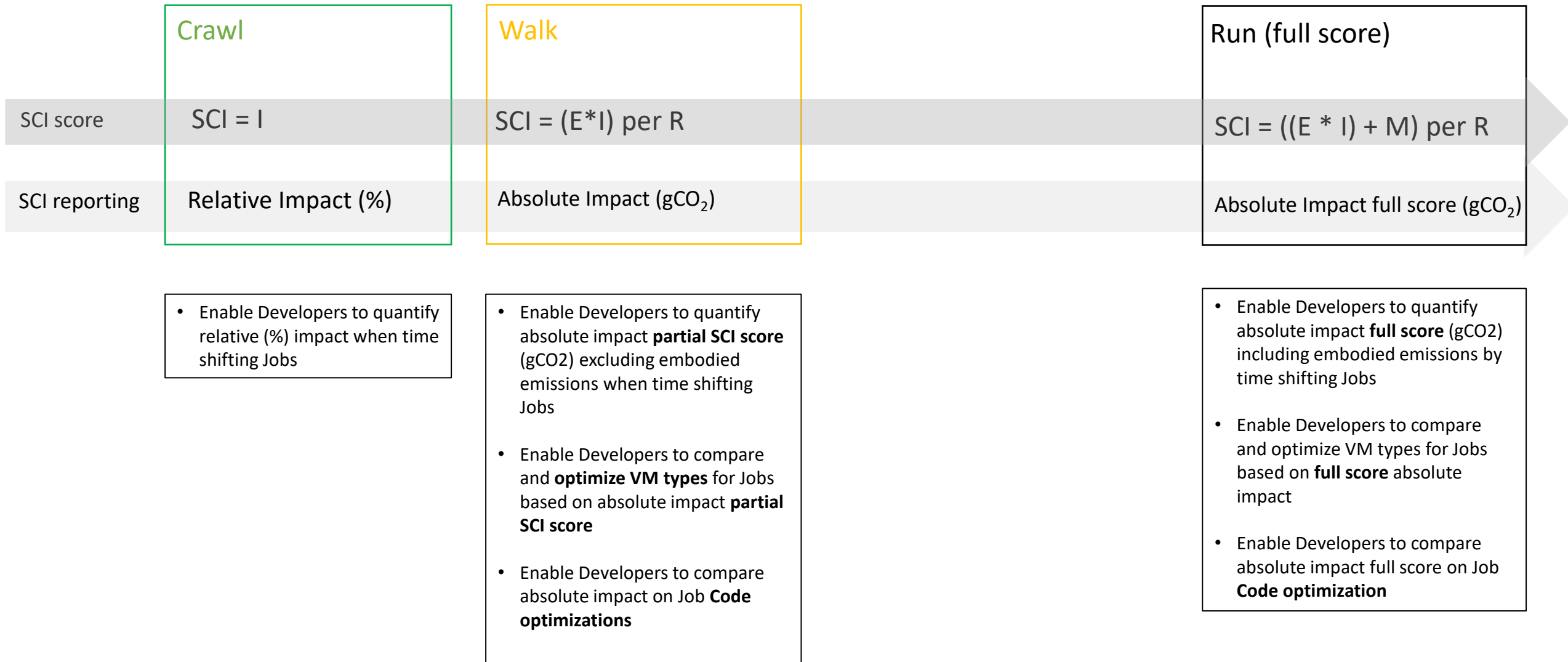
**I:** Location-Based Marginal Carbon Intensity [gCO<sub>2</sub>eq/kWh]

**M:** Embodied emissions of a software system

**R:** Functional unit

SCI spec: [github.com/Green-Software-Foundation/software\\_carbon\\_intensity](https://github.com/Green-Software-Foundation/software_carbon_intensity)

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



# Impact Framework



## Impact Framework

Documentation

Video Walkthrough - 5min



### Measure

Measure the energy and carbon impacts of your applications.



### Monitor

Continuous integration allows you to track your impact over time.



### Mitigate

Scenario testing can support your mitigation strategy and quantify its effect.

- 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/>

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# Carbon Aware Computing

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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

# Q&A

- Green Software Foundation  
<https://greensoftware.foundation/>
- SCI Spec  
[https://github.com/Green-Software-Foundation/software\\_carbon\\_intensity](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  
<https://www.carbon-aware-computing.com>
- GSF Impact Framework  
<https://if.greensoftware.foundation/>