AMZ302

Measuring for change: Carbon footprinting at Amazon scale

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Amazon

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Agenda

Our commitments

Our approach

Moving forward



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Our commitments



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THE CLIMATE PLEDGE

Paris… 10 years Early

THE CLIMATE PLEDGE

Paris... 10 years early

1 Measure and report greenhouse gas emissions on a regular basis

THE CLIMATE PLEDGE

Paris… 10 years early

2 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 emission elimination strategies

THE CLIMATE PLEDGE

Paris… 10 years early

3 Neutralize any remaining emissions with additional, quantifiable, real, permanent, and socially beneficial offsets to achieve net zero annual carbon emissions by 2040

Milestone goals along the way to net zero



100%

Net zero carbon by 2040

Deploying our technology and people to reach net zero carbon across Amazon by 2040, one decade ahead of the Paris agreement



100%

Renewable energy by 2030

Investing in wind and solar to reach 100% renewable energy across all business operations by 2030, and on path to meet that goal early by 2025



50%

Shipment net zero carbon by 2030

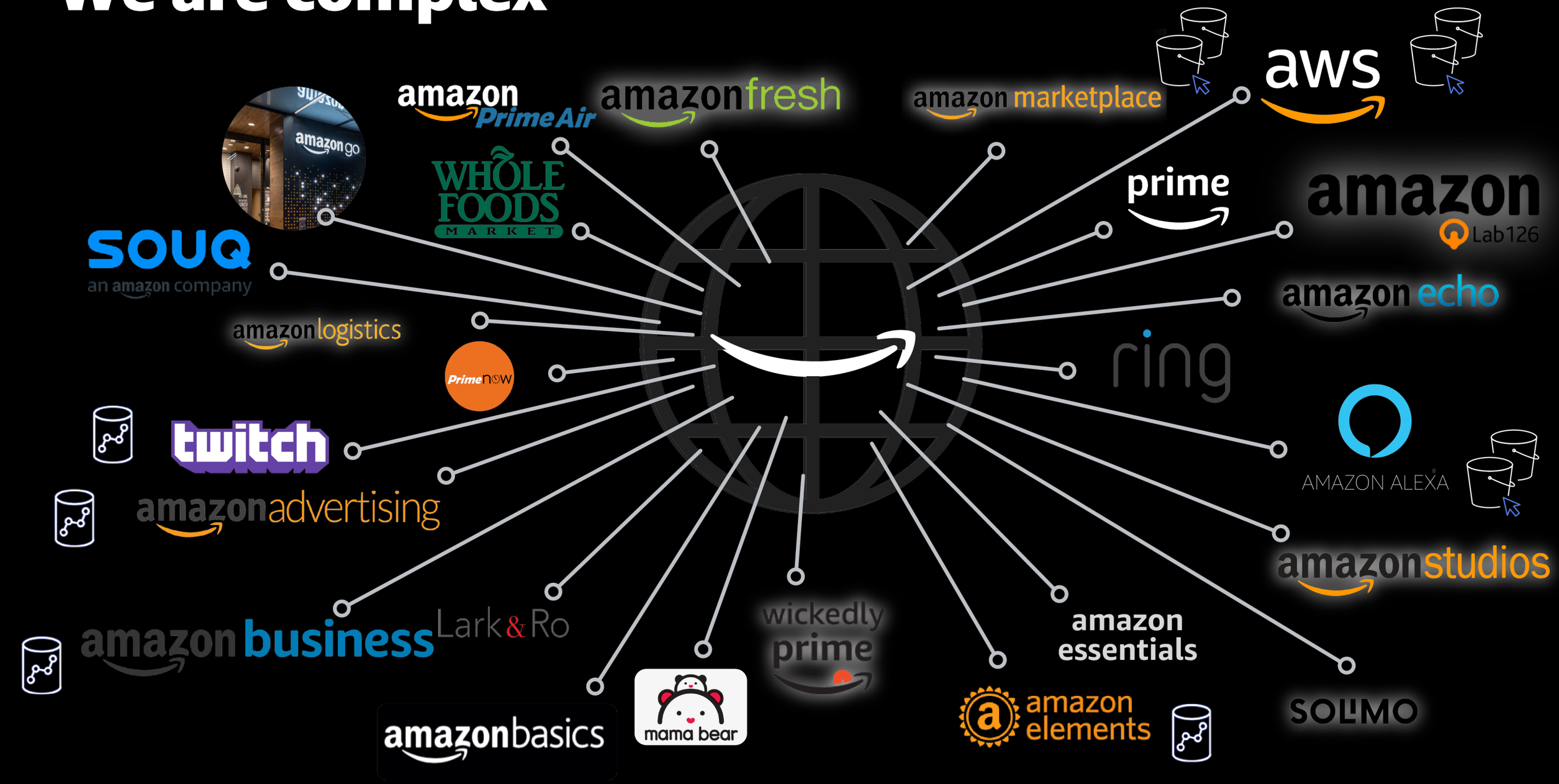
Our vision to make all Amazon shipments net zero carbon, with 50% of all shipments net zero carbon by 2030

Our approach



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We are complex



So we focus on decisions

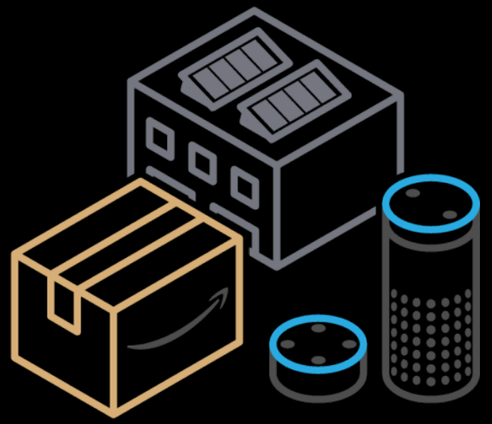
AND PRIORITIZE OUR EFFORTS FOR IMPACT



We built a carbon system of record

TO TRACK AMAZON'S CARBON EMISSIONS, DIVING ALL THE WAY DOWN TO INDIVIDUAL SHIPMENTS, SERVERS, DEVICES, AND MORE

What are our emissions hotspots?



How do we perform over time?



How do we reduce our impact at scale?



The science

What we measure

Five models work together to provide a detailed view of our footprint.



Financial

A nimble, top down financial model that helps us see the big picture and prioritize where we should dive deep.



Transportation

We track the emissions resulting from shipping products to Amazon warehouses, between warehouses, and outbound to our customers' homes, Amazon lockers, and other pickup points.



Electricity

We account for the impacts of the energy consumed by our offices, data centers, and warehouses, as well as the benefits of the renewable energy we generate around the globe.



Packaging

We look carefully at the materials and processes behind all the boxes, mailers, and other packaging items Amazon adds to the products we sell.



Devices

We have a detailed view of our devices' manufacturing, use, and end-of-life phases.

How does mode of transport impact emissions?

$$ef_{transportation} = (E_F + E_C)_j \gamma_i + \frac{(E_{Man} + E_{Main} + E_{EOL})_i}{VKT_i}$$

- $E_F + E_P + E_C E_C$ = Emissions from fuel combustion
- E_F = Emissions from feedstock and fuel production
- Y_i = Energy consumption rate of the vehicle (energy per mile travelled)
- E_{Man} = Emissions from vehicle manufacture
- E_{Main} = Emissions from maintaining a vehicle
- E_{EOL} = Emissions from vehicle end-of-life
- VKT_i = Lifetime miles travelled by a vehicle

$$ef_{package} = \sum_{j=1}^{J} \rho_{A,j} \cdot A_j \cdot ef_{MAT,j} + \sum_{k=1}^{K} m_k ef_k + + ef_{Transport} + e$$

- $\rho_{A,j}$ = Areal density (kg / m²) of each main packaging materials, J
- A_j = Surface area of the blank for each main packaging material in the package (m²)
- $ef_{MAT,j}$ = Emissions per kg of each main packaging material (e.g. corrugate)
- ef_k = Emissions factor for any other inputs *K* (ink, adhesive, label) with mass m_k.
- $ef_{Transport}$ = Emissions from transporting the box to Amazon's warehouses
- $ef_{Manufacture}$ = Emissions from manufacturing the box
- ef_{EOL} = Emissions from end-of-life activities (e.g. recycling)

$$ef_{electricity} = \sum_{l=1}^{L} \sum_{k=1}^{K} \frac{(E_C + E_{fuel} + E_{infr})_{k,l}}{kWh_{k,l}}$$

FOR A POWERPLANT *k* IN A REGION:

- l, E_c = Emissions from combusting fuel
- E_{fuel} = Emissions from fuel production
- E_{infr} = Allocated emissions from constructing and maintaining the power plant
- $kWh_{k,l}$ = Electricity generated by each power plant in a given year

$$ef_{device} = \sum_{j=1}^{J} \frac{m_j * ef_{MAT,j}}{L_j} + ef_{process} + ef_{assembly} + kWh_{life} \cdot ef_{electricity} + ef_{EOL}$$

A component of a device is made from *J* constituent materials (e.g. copper, silicon, polycarbonate)

The impact of each material *j* is calculated by multiplying the mass of each material m_j by the impact of producing that material $ef_{MAT,j}$ and adjusted for material losses L_j

- $ef_{process}$ & $ef_{assembly}$ = Emissions from processing and assembling the components
- kWh_{life} = Lifetime electricity use of each device
- ef_{EOL} = Emissions from end-of-life recycling or disposal

$$ef_{\text{dollar based}} = By + BAy + BA^2y + BA^3y + \cdots = B\sum_{n=0}^{\infty} A^n y$$

B= Direct emissions for each sector of the economy
(e.g. truck transport, electronic computer manufacturing)

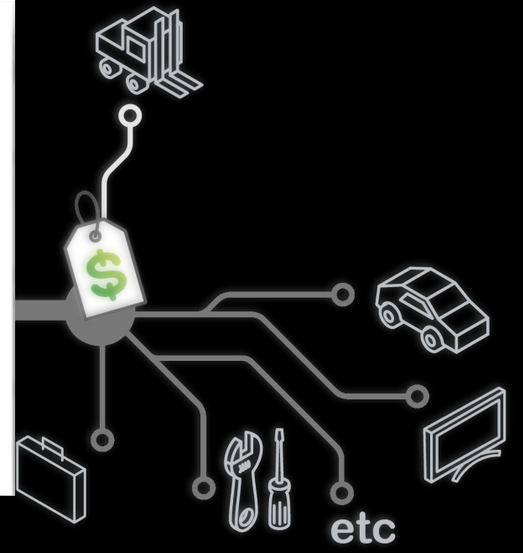
A=Matrix of direct input requirements for all sectors

Y= Demand for one dollar of goods or services for a particular sector

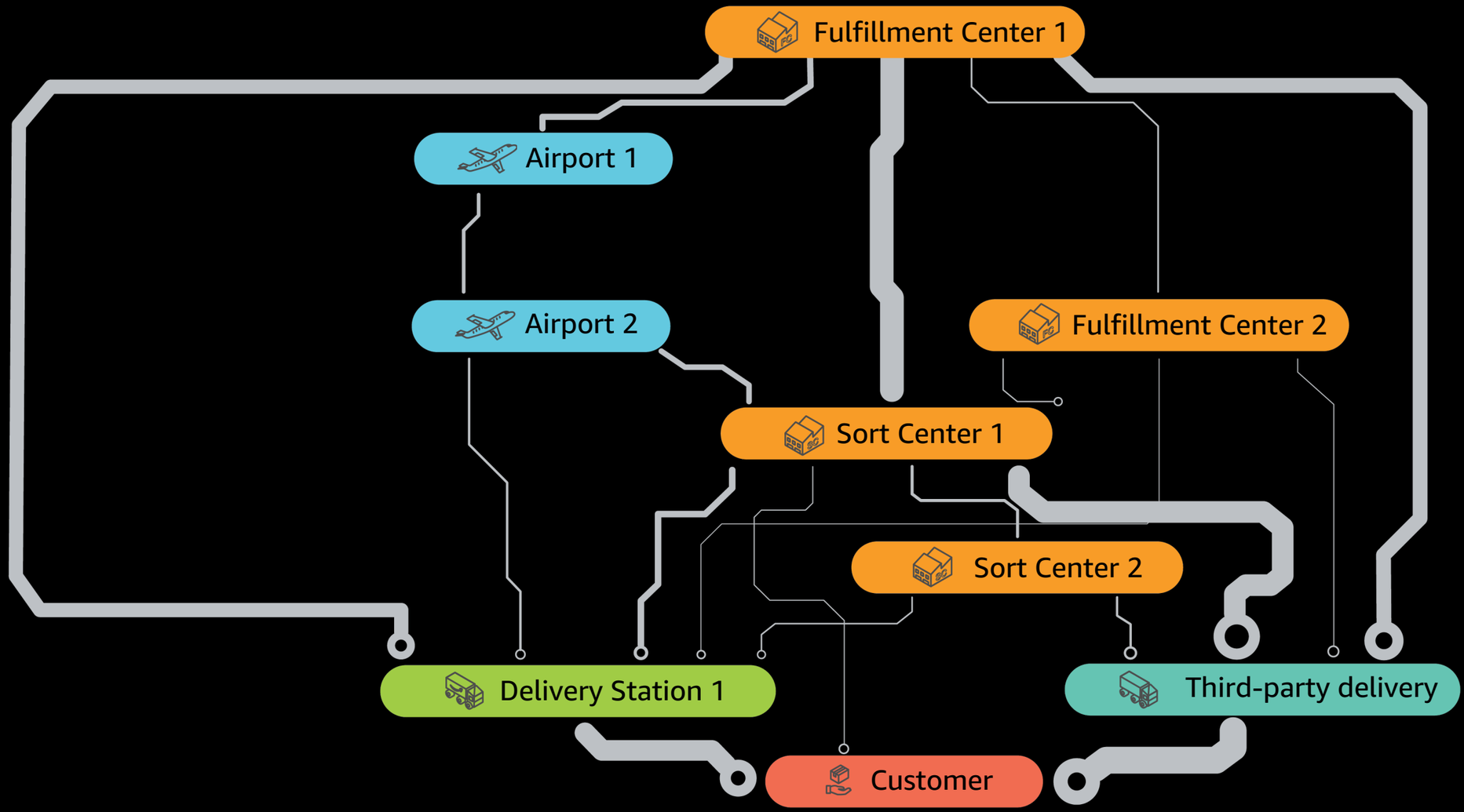


$$ef_{transportation} = (E_F + E_C)_j \gamma_i + \frac{(E_{Man} + E_{Main} + E_{EOL})_i}{VKT_i}$$

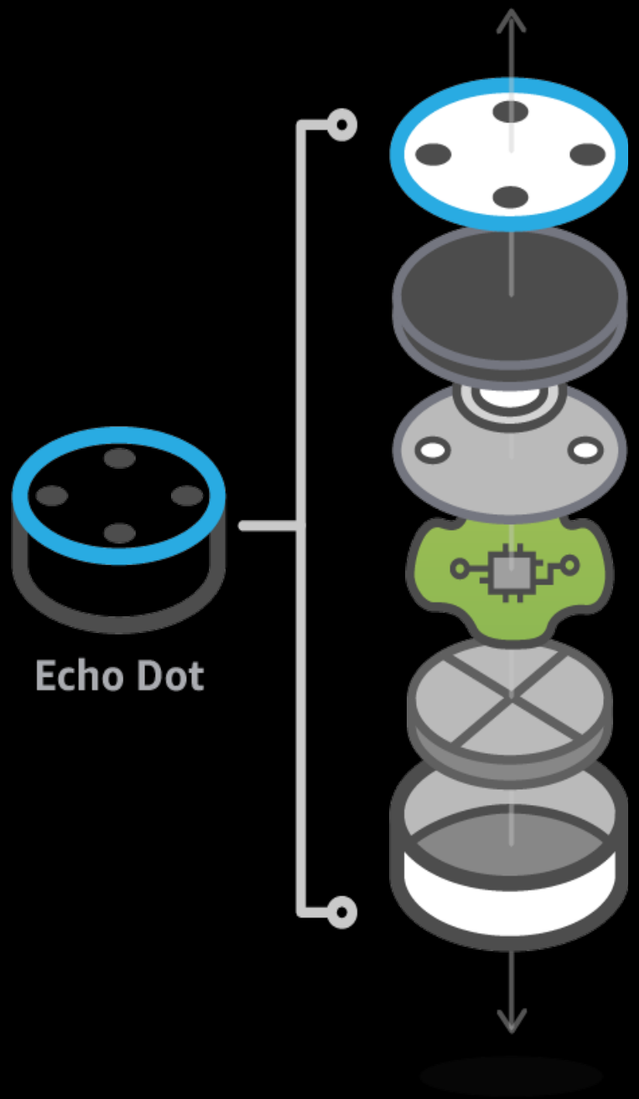
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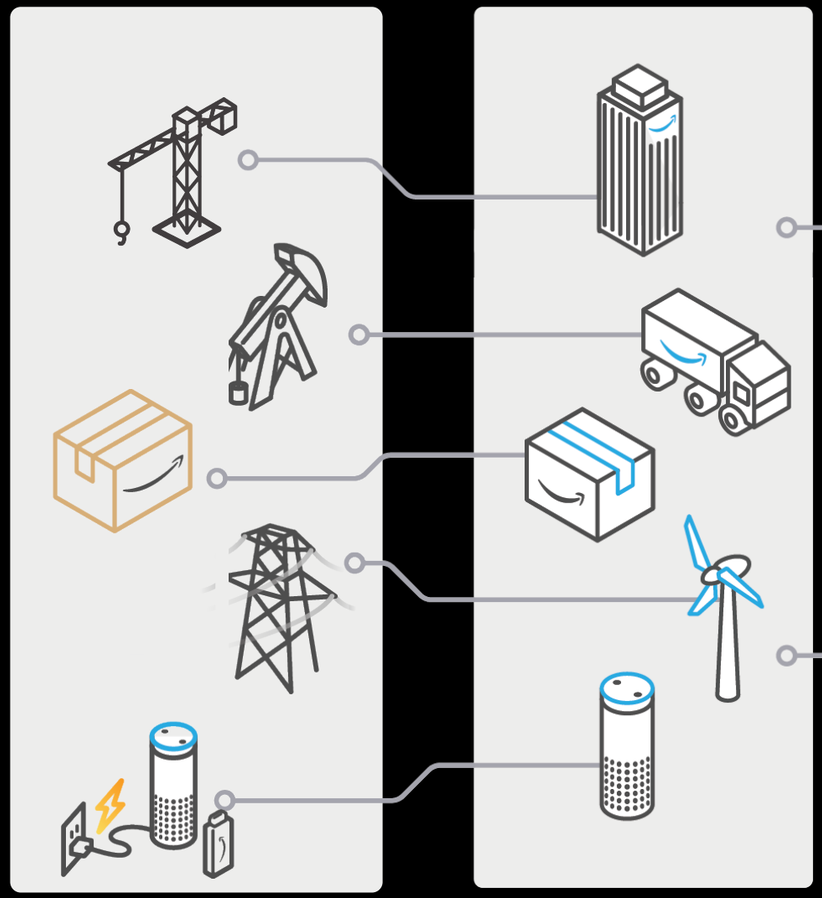
Tracking the flow of units



Alexa, what's contributing to your emissions?



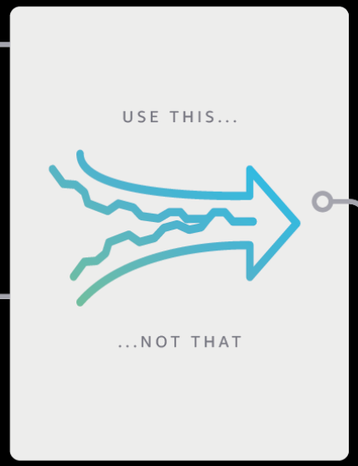
Science meets technology



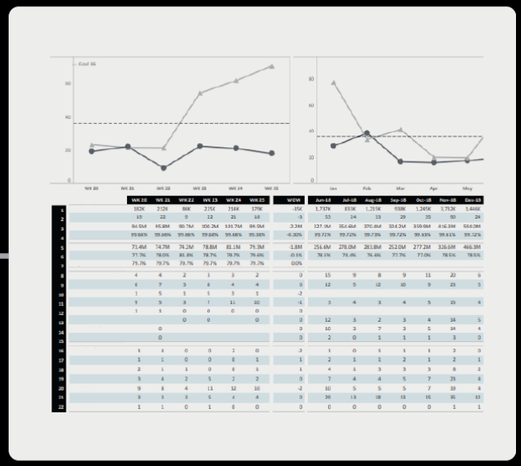
Carbon-emitting activities

Emission model layer

A growing set of models and a software system allow us to calculate an integrated corporate carbon footprint



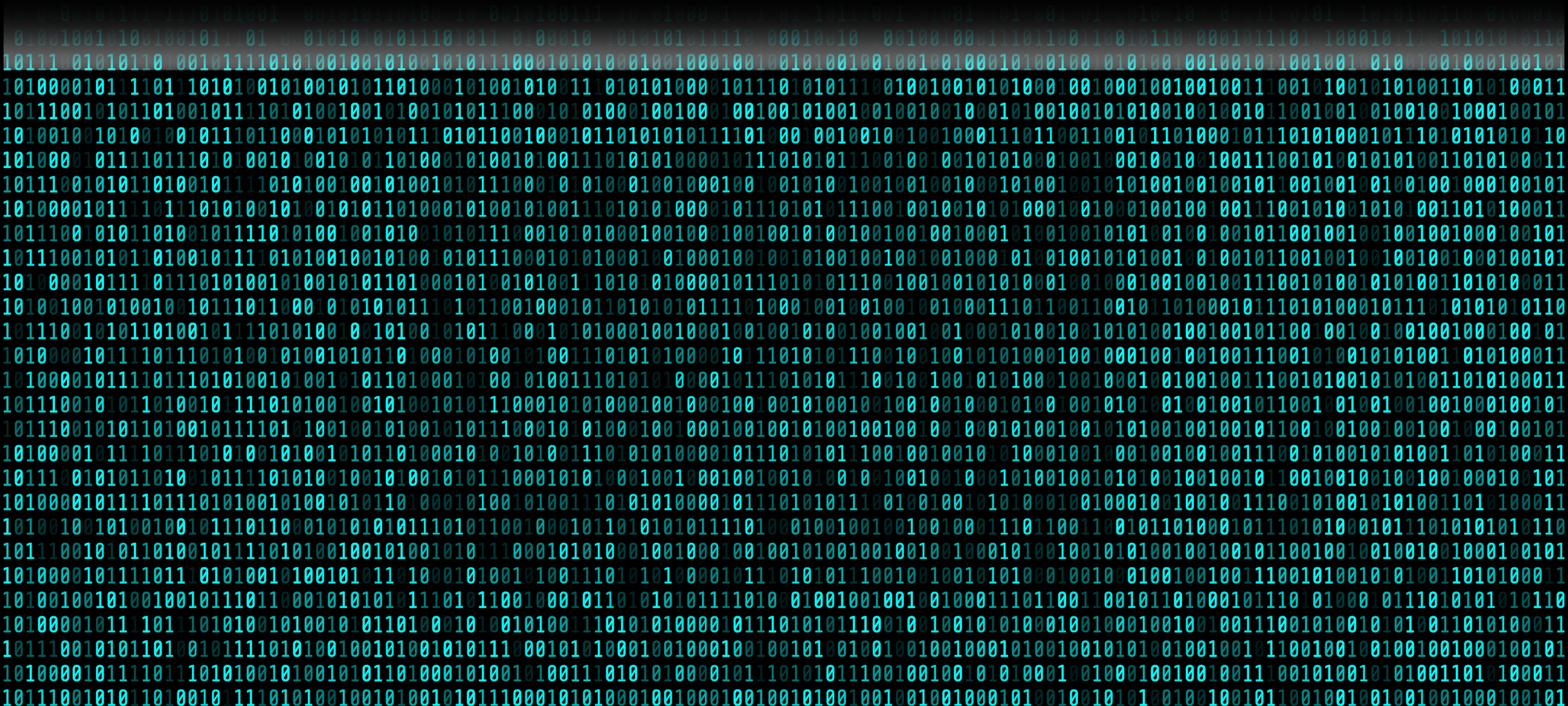
Orchestration layer



Overall corporate carbon assessment

The data is never perfect

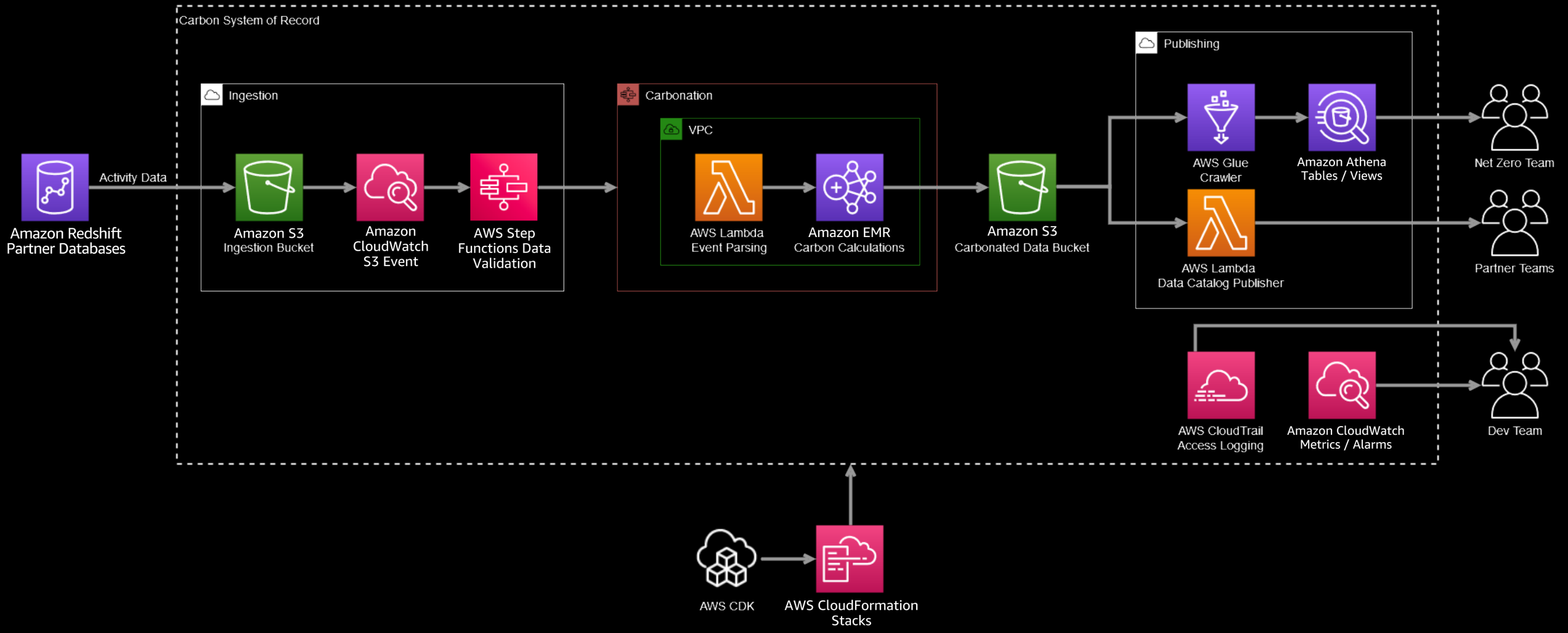
AND SOMETIMES WE DON'T HAVE IT



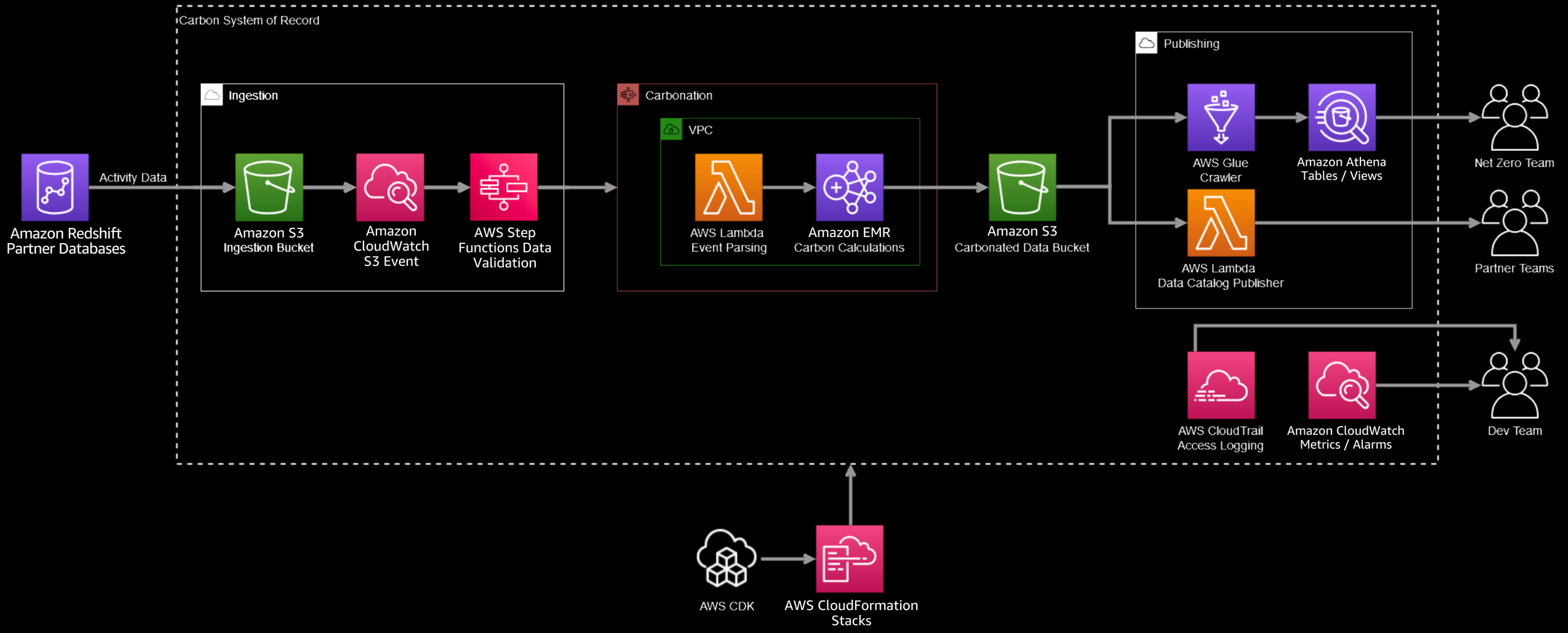
Data contracts



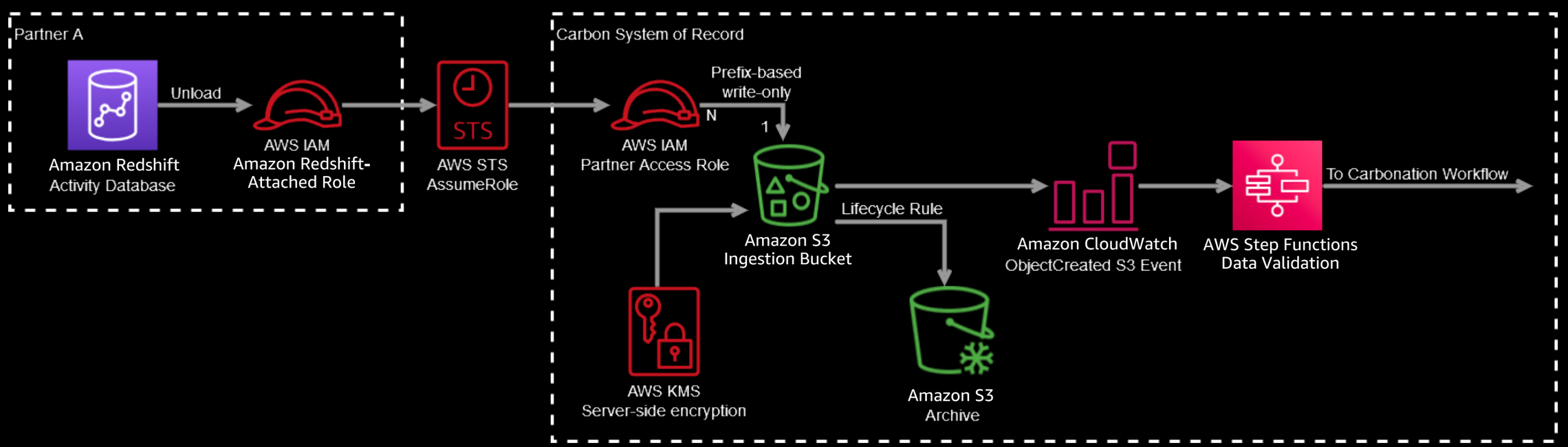
System overview



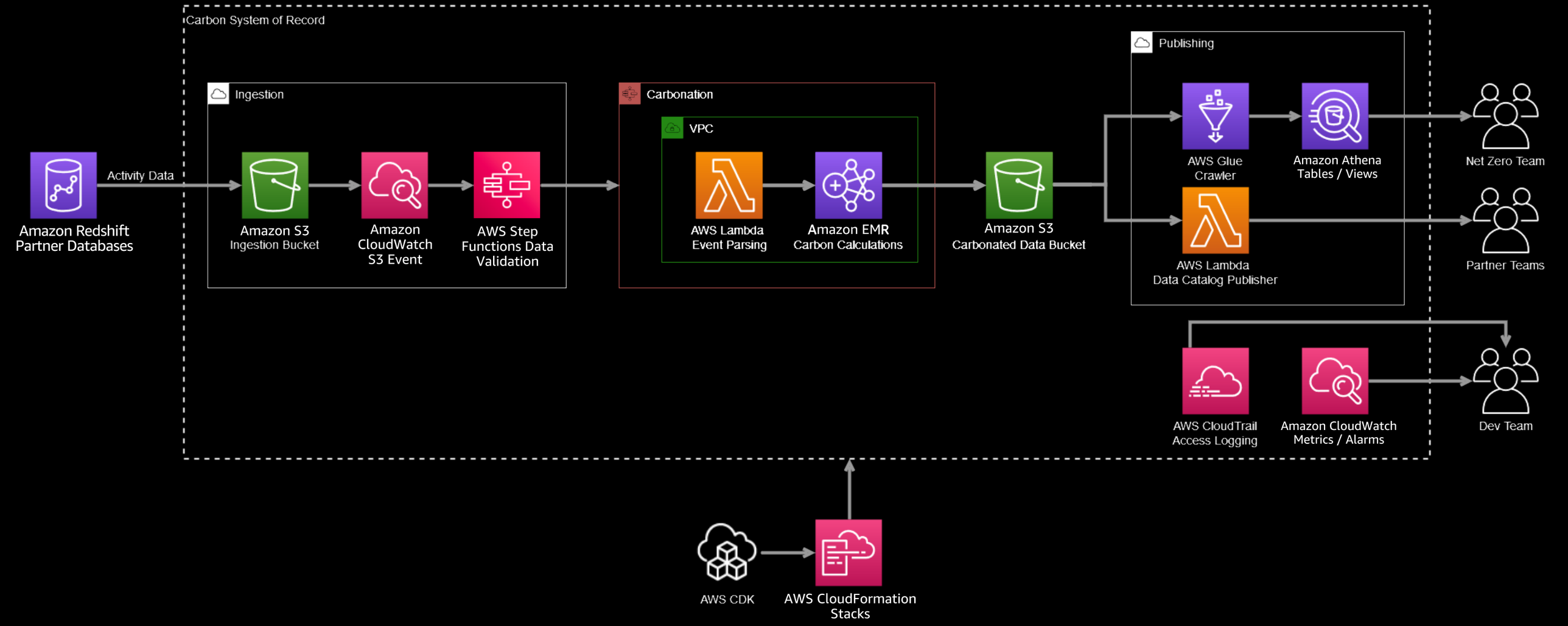
Data ingestion



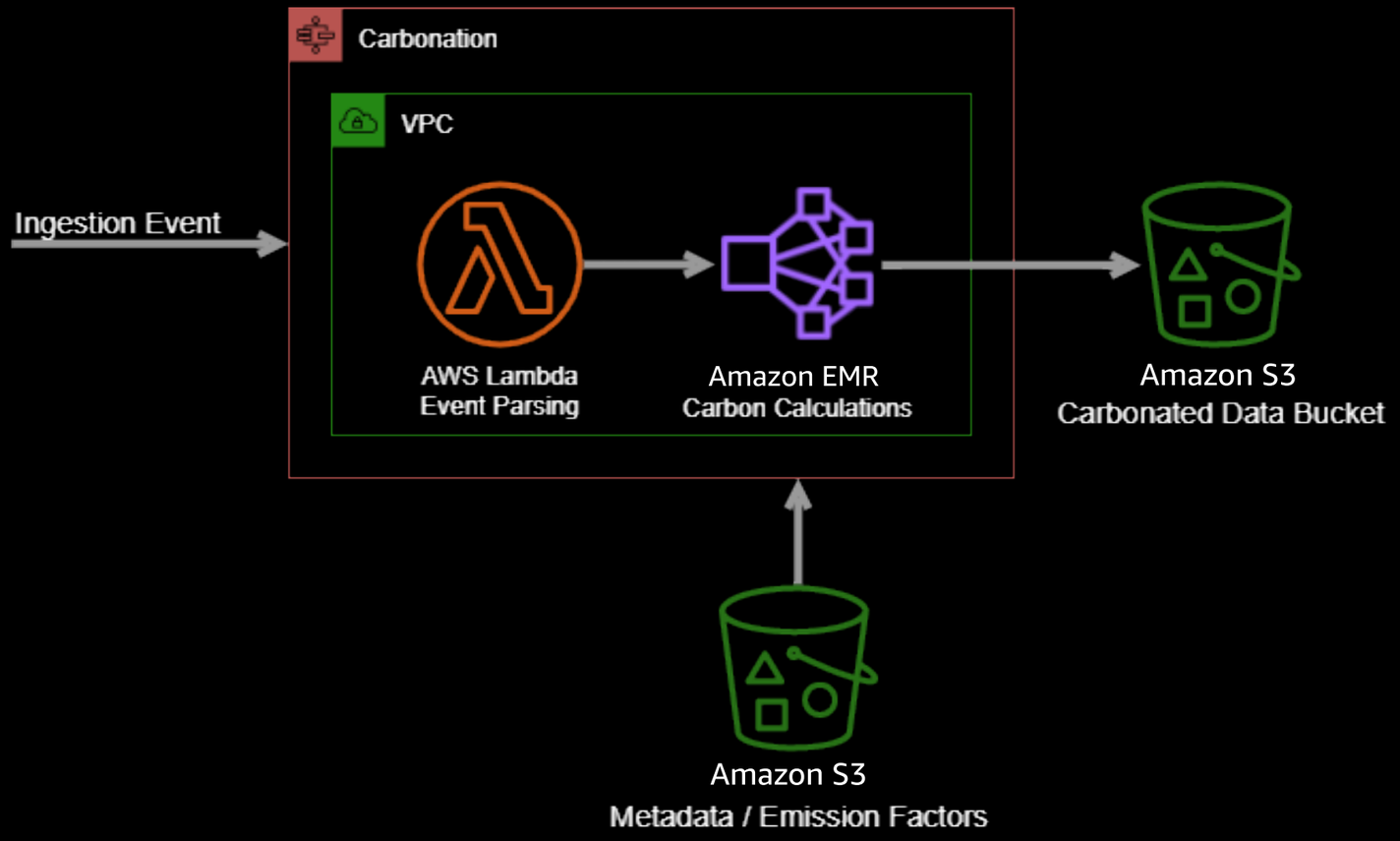
Data ingestion



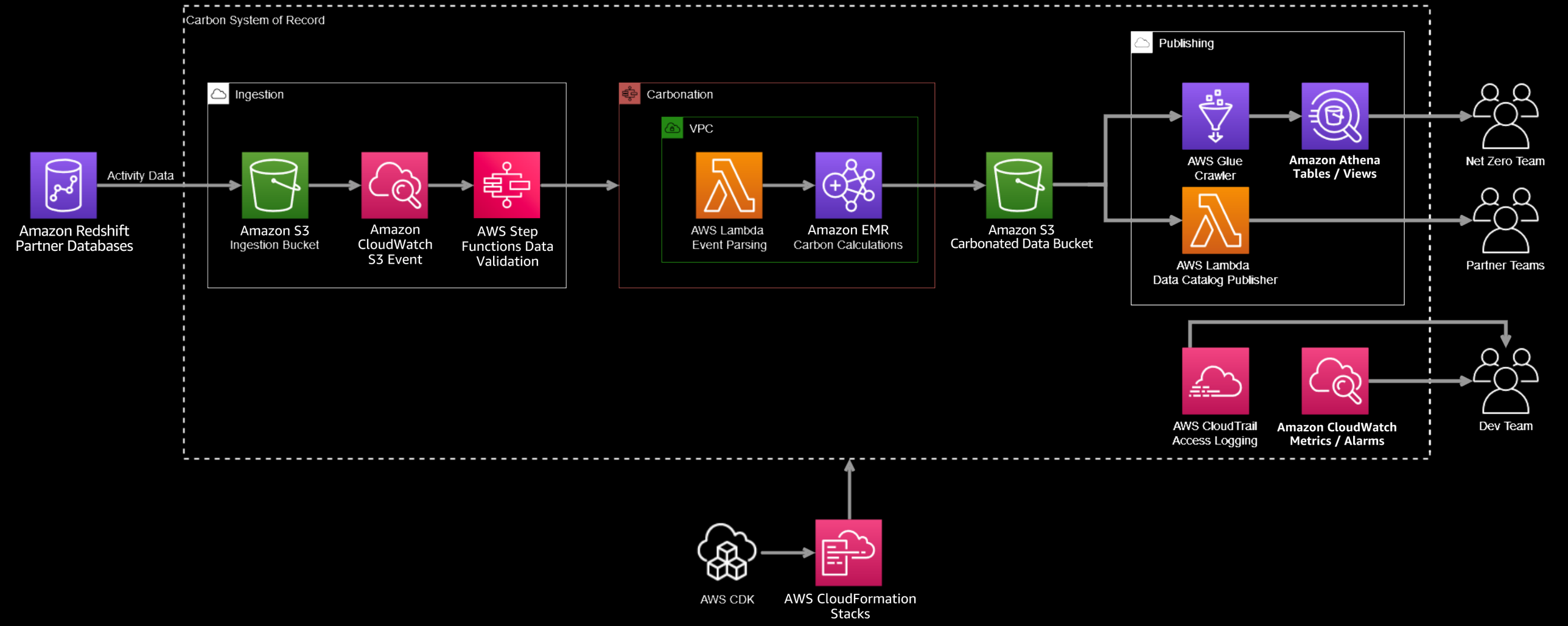
Orchestration and computation



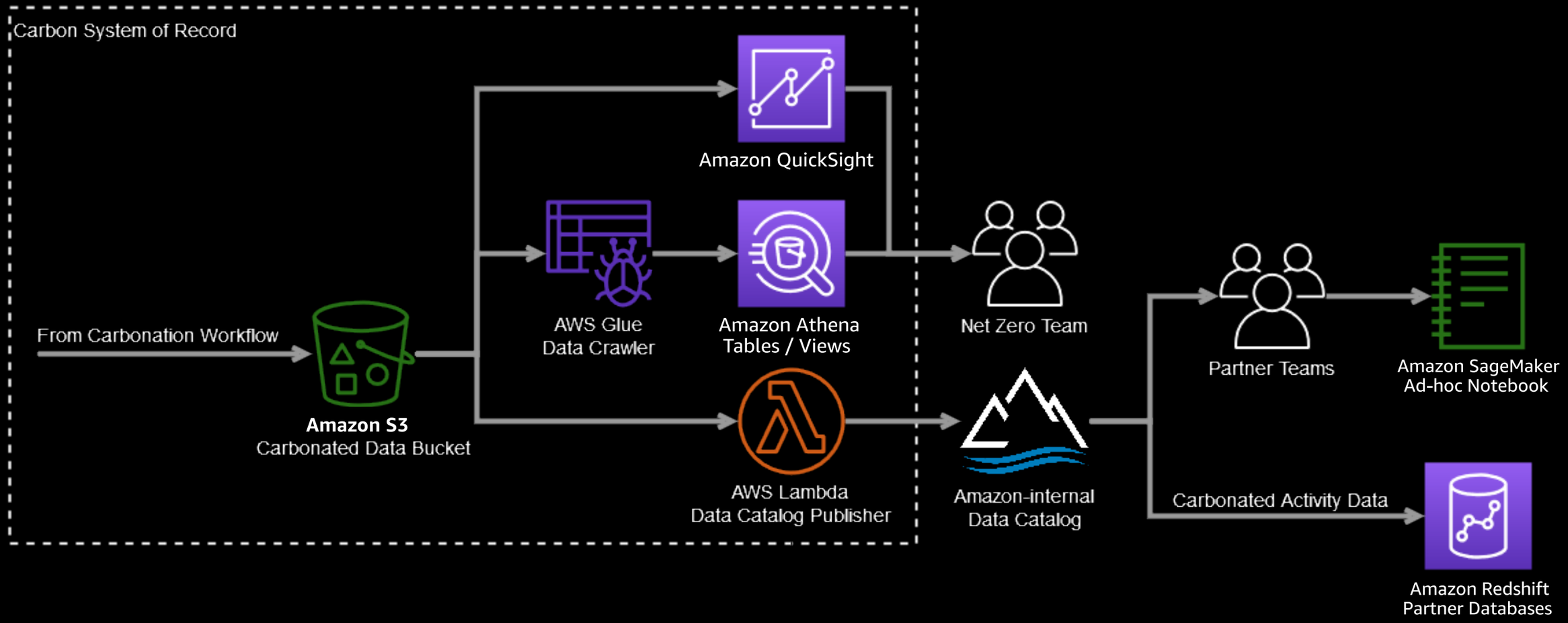
Orchestration and computation



Surfacing the outputs

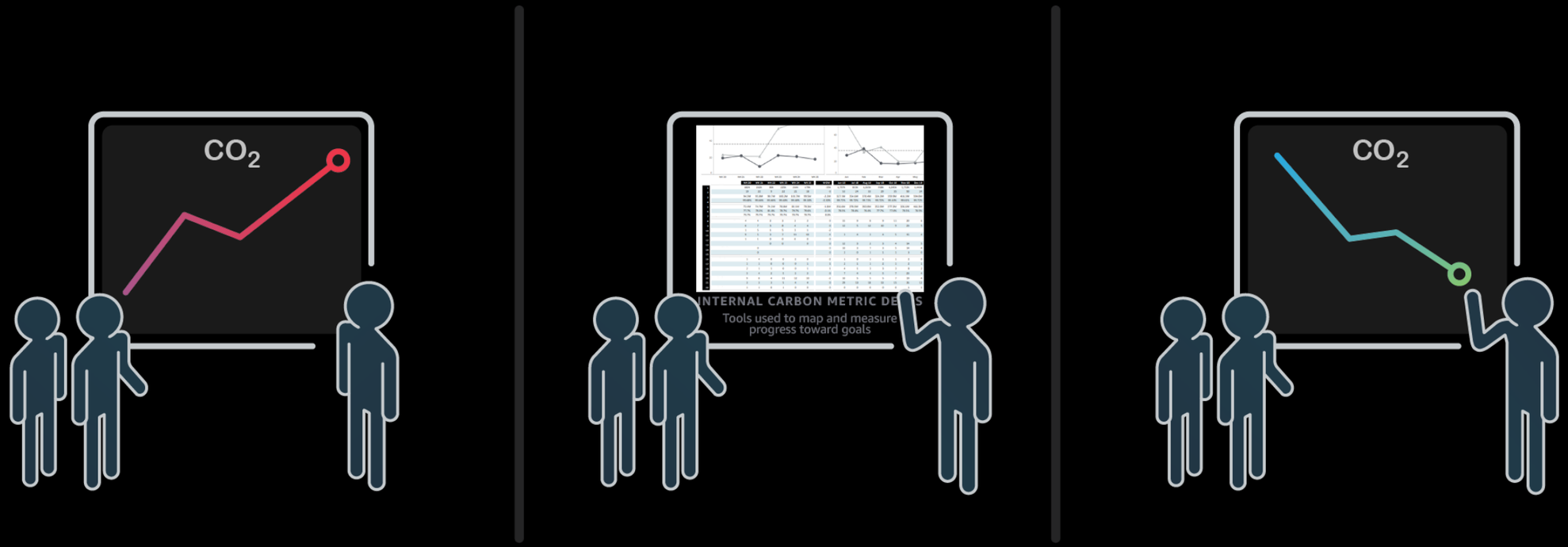


Surfacing the outputs



Reporting is not enough

WE HAD TO DESIGN TO DIRECT CHANGE



Insights and options



Packaging is not a top source of carbon – but is a big customer concern

Innovation potential

Dematerialize and right-size packaging



Same-day shipping is our lowest carbon shipment option

Innovation potential

Optimize inventory placement for local

Moving forward



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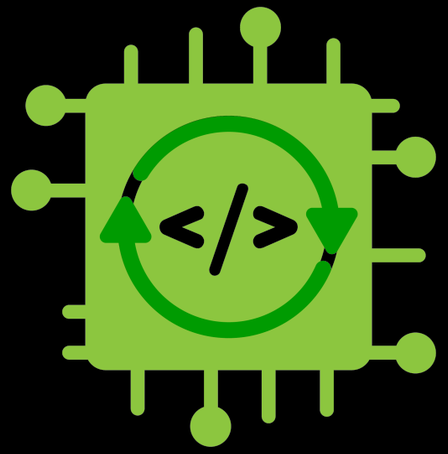
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Continuing challenges and opportunities

Continue to increase accuracy of measurement and expand decision-making support



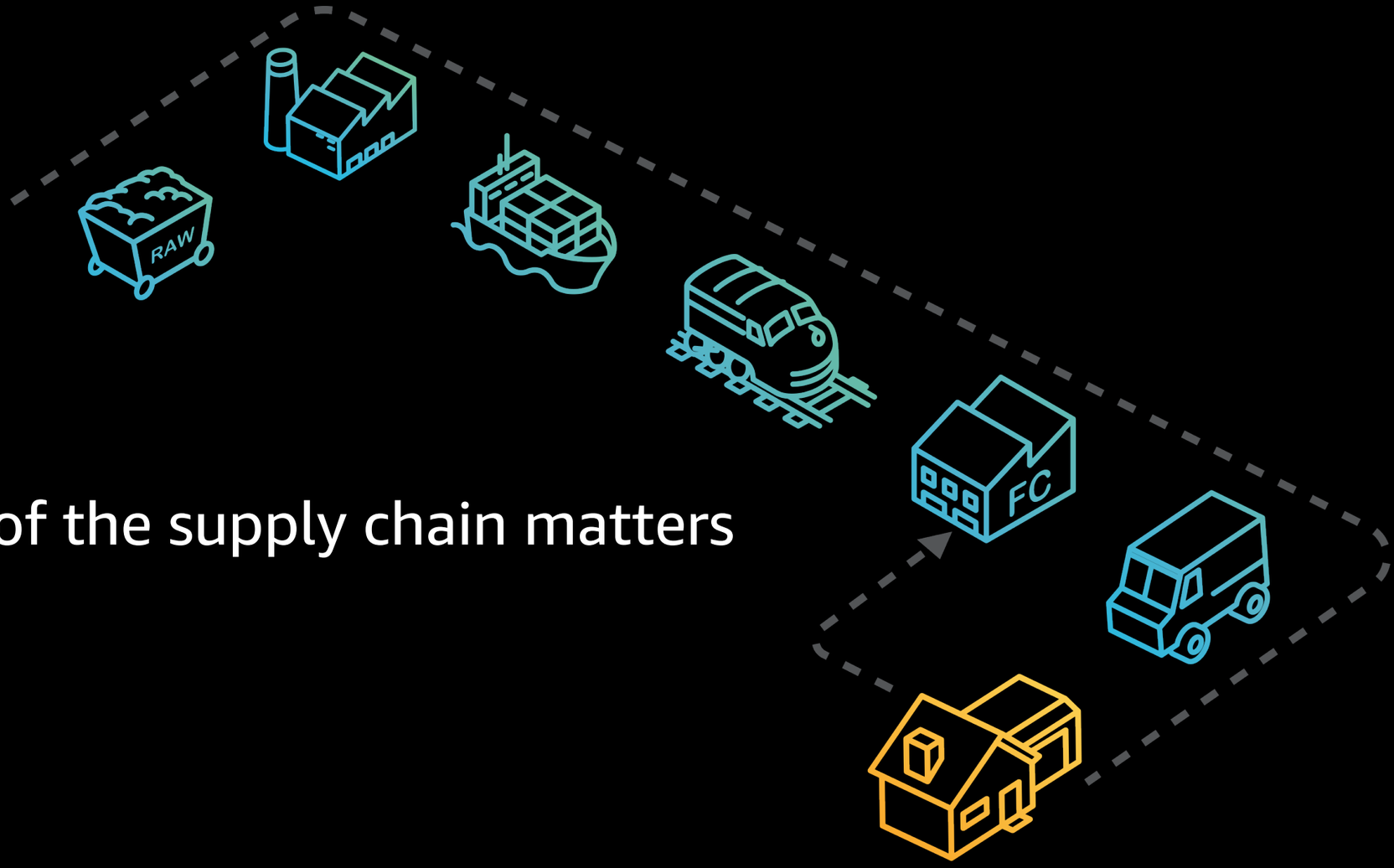
Continue to embed sustainability deeper into the business



Innovate on behalf of our customers



None of us can do this alone



Every step of the supply chain matters

Working together to drive change

DEMONSTRATING DEMAND AND STIMULATING INVESTMENT IN GREEN TECHNOLOGIES

THE CLIMATE PLEDGE

Paris… 10 years Early



RIGHT NOW Climate Fund

The Nature Conservancy

Thank you!



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