3-LEVERS OF EMISSION CONTROL-MODELING FRAMEWORK: MODELING GHG EMISSIONS WHEN DIRECT MEASUREMENT IS NOT POSSIBLE

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PROBLEM & MOTIVATION

Requirements

Corporate Sustainability Reporting Directive (CSRD) Requirements:

✓ Report GHG emissions for Life Cycle Assessment (LCA).
✓ Measure GHG emissions for Scope 1, 2, and 3 categories.
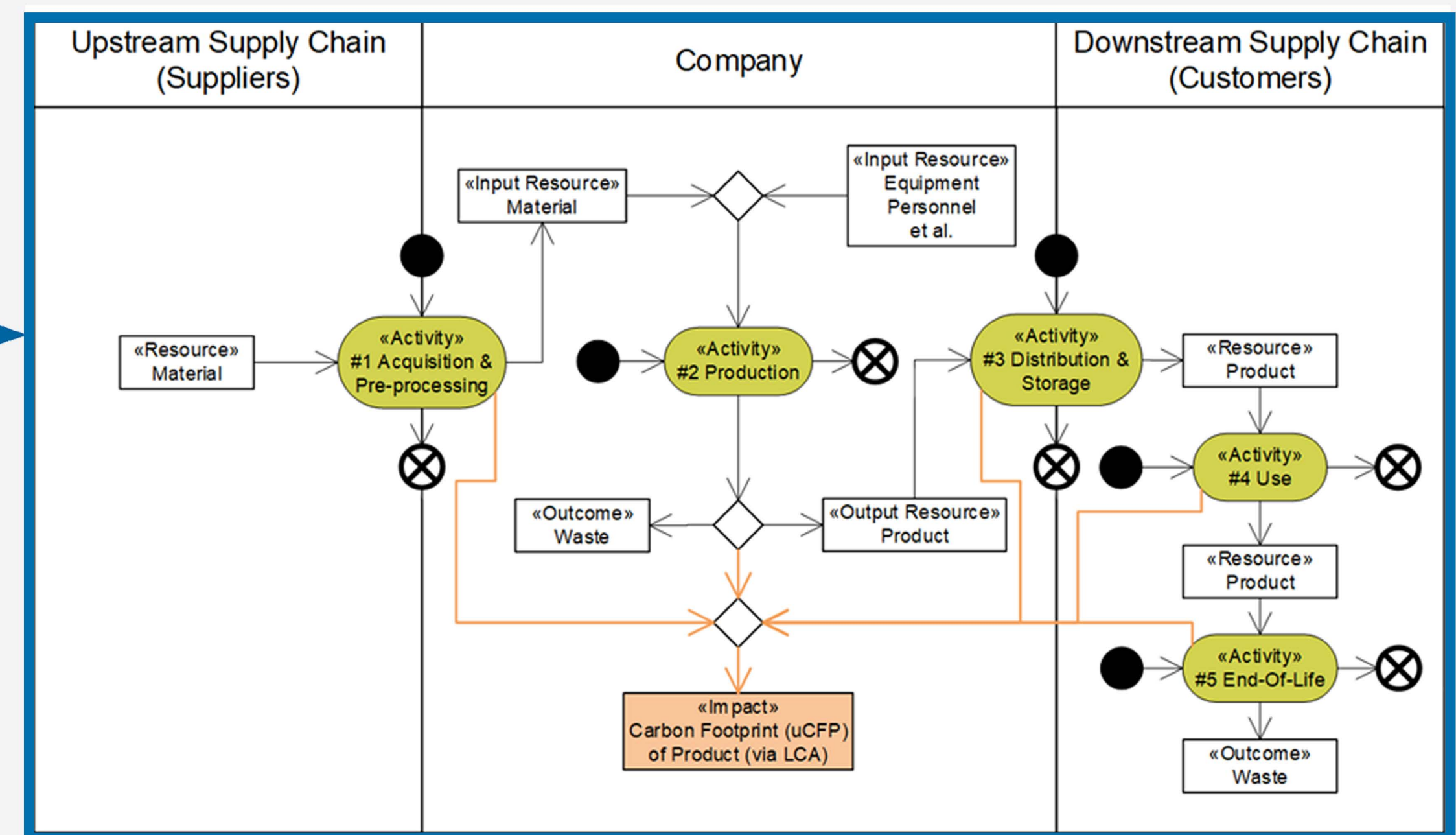✓ Disclose GHG emissions in CO_2 equivalence (CO_2eq).

Challenge

How to measure LCA when direct measurement is not possible?

↳ **Suggested Solutions**
  1. ISO's Environmental Management System
 **2.** Kaplan's E-Liability Accounting System

Initiatives covering **GHG Indirect Measerement**. But no precise measurement of all scope categories is addressed

PRIMARY OBJECTIVE

Extending E-Liability Accounting System via utilization of the innovative 3 Levers of Emission Control (3-LoEC)-modeling framework, where adequate measurement metrics are specified to address the indirect measurement of GHG emission.

CONCEPTUAL DESIGN

3-LoEC-Modeling Framework: GHG Emission Measurement Metrics
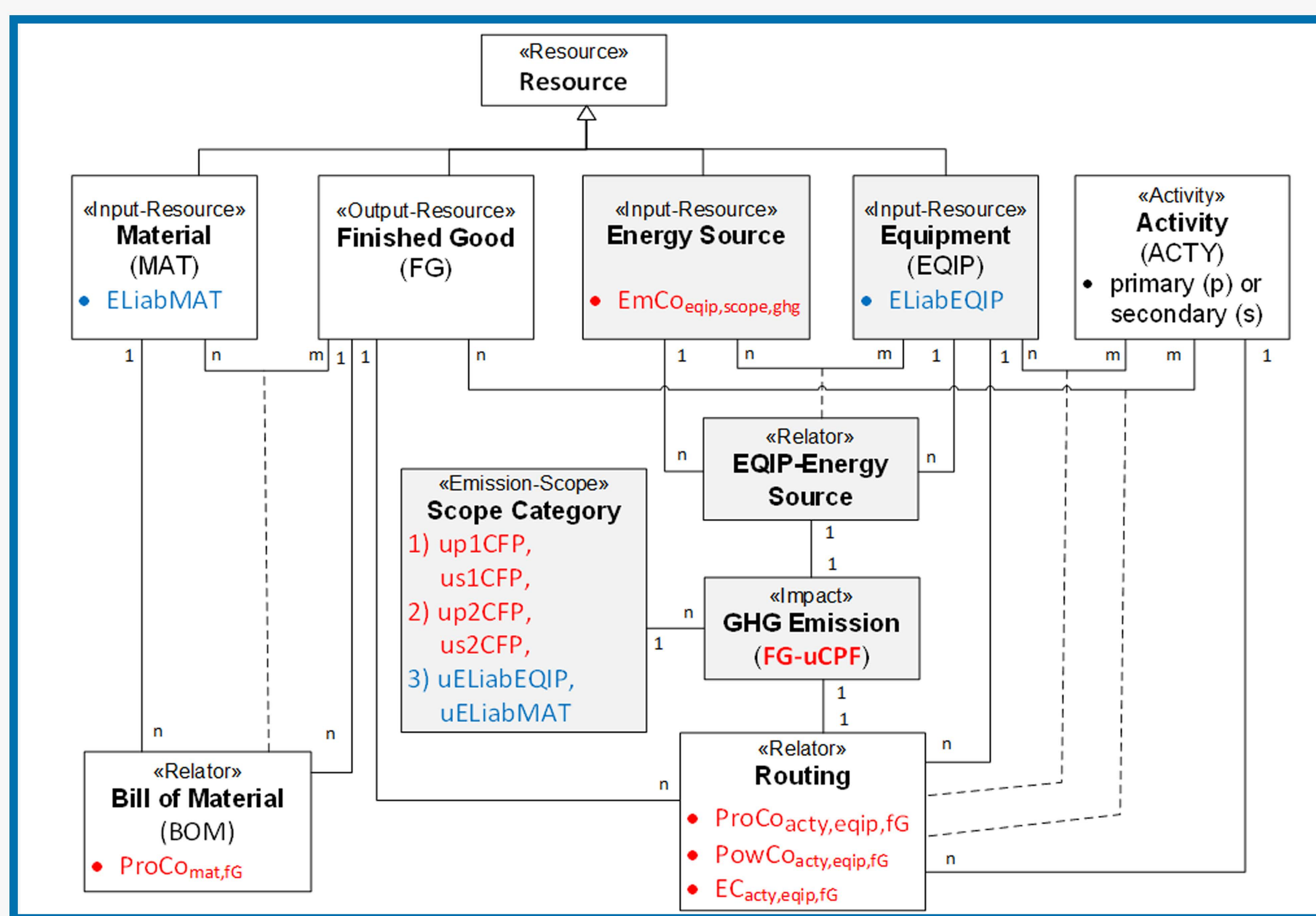
OPERATIONAL DESIGN

Activity-Based (AB)-Energy Consumption Metrics

✓ **Time-Driven (TD)-Energy Consumption (ec):** Calculated via integral multiplication **(.)** of Activity's Production Coefficient (**ProCo**) (**d**) with Equipment's varying Power Coefficient (**PowCo**) (**p**).

$$ec_{acty,res,fG} = d_{acty,res,fG} \cdot p_{acty,res,fG}$$

✓ **Resource Consumption-Driven (RCD)-Energy Consumption (ec):** Calculated via integral multiplication **(.)** of Activity's Production Coefficient (**ProCo**) (**a**) with Equipment's varying Power Coefficient (**PowCo**) (**q**).

$$ec_{acty,res,fG} = a_{acty,res,fG} \cdot q_{acty,res,fG}$$

✓ **Unit Carbon Footprint (uCFP) for scope 1&2:** Energy Consumption times Emission Coefficient (**EmCo**)(**e**).

$$uCFP_{acty,res,fG} = ec_{acty,res,fG} * e_{res,scope,ghg}$$

Activity-Based (AB)-E-Liability Allocation Metrics

✓ **FG-unit E-Liability of consumed material (uELiabMAT):** constructed via allocating **ELiabMAT** times Activity's Production Coefficient (**ProCo**) (**d**).

✓ **FG-unit E-Liability of used equipment (uELiabEQIP):** constructed via depreciation of **ELiabEQIP** and multiplication with Activity's Production Coefficient (**ProCo**) (**d**).

FG-uCFP: Sum of Finished Goods uCFPs and uELiabilities.

DEMONSTRATION & VALIDATION

Injection molding of food-bowls using Injection Molding equipment (IME).

1. AB-Energy Consumption for activity's average power ($p_{acty(avg)}$) using simple multiplication **(*)**.

$$ec = d * p_{acty(avg)}$$
$$= 3.33 * 44.25 = 147.50$$

2. AB-Energy Consumption for activity's varying power ($p_{acty(i)}$) using integral multiplication **(.)**.

→ IME operates with (**i**) activity levels.

$$ec = d \cdot p = \sum_i d_{acty(i)} * p_{acty(i)}$$
$$= (1.66 * 53.1) + (1.66 * 35.4)$$
$$= 147.5$$

Fulfilled Requirements

CSRD reporting requirements including:

✓ GHG Indirect measurement is addressed using adequate measurement metrics.
✓ Scope 1, 2, and 3 emission categories are covered.
✓ GHG Emission measured in CO_2eq.

REFERENCES

1. GHG Protocol (2011), Corporate Value Chain (Scope 3) Accounting and Reporting Standard.
2. GHG Protocol (2011), GHG Protocol Product Life Cycle Accounting and Reporting Standard.
3. Kaplan and Ramanna (2021), Accounting for Climate Change.
4. Kaplan and Anderson (2007), Time-Driven Activity-Based Costing: A Simpler and More Powerful Path to Higher Profits.
5. Baumüler and Schwaiger (2023), Activity-Based Product Carbon Footprint Measurement with the 3-Levers of Emission Control (3-LoEC)-Metrics.

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