



Keeping Track of Clean Energy: Economy Wide Consistency

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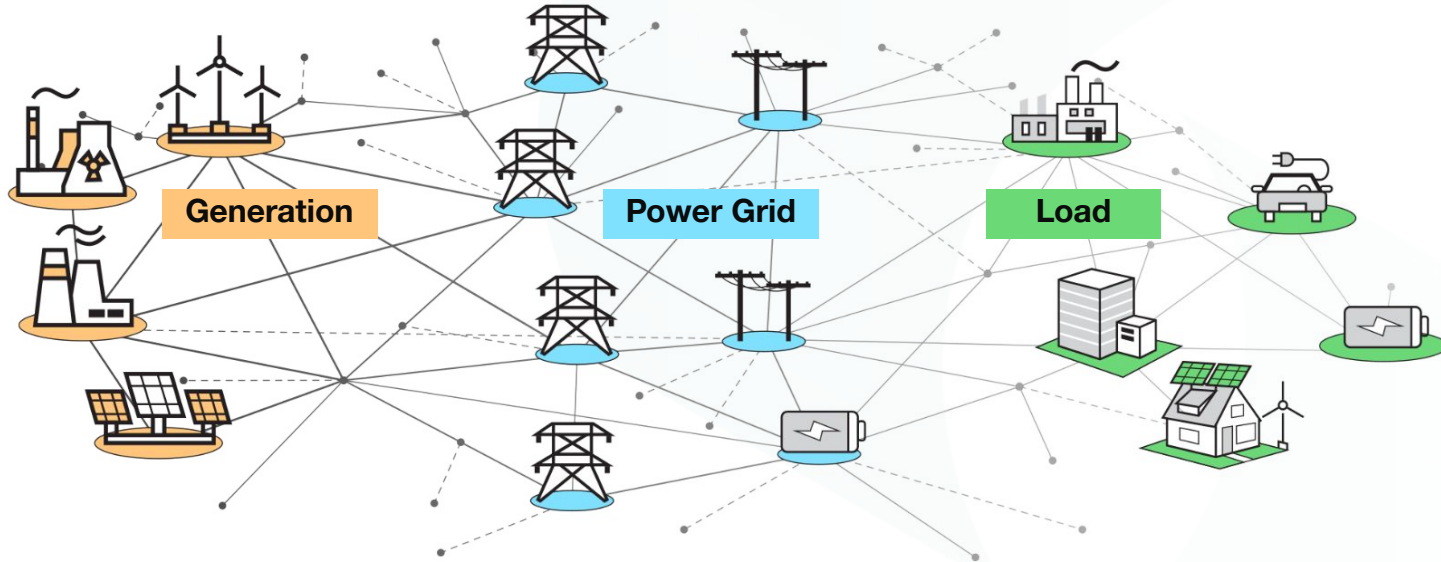
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Tracking GHG in the Electric Sector

Inventory and allocation are the two main problems



Scope 1 (Direct GHG)

Measured on the supply side
EPA AMPD/CEMS
Inventory Problem

Scope 2 (Indirect GHG)

Calculated on the demand side
Corporate reporting, SEC disclosure, green H2, line losses
Allocation Problem: different frameworks and methods exist

Three GHG Accounting Frameworks

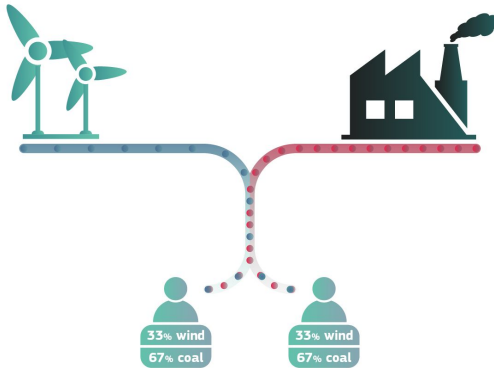
There is no one number that fits all

Attributional Accounting

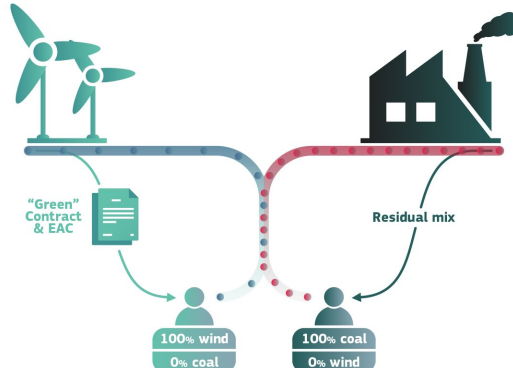
How much CO₂ should I be responsible for as a result of using electricity?

*Relevant for Scope 2 GHG reporting**

Location-based Method



Market-based Method

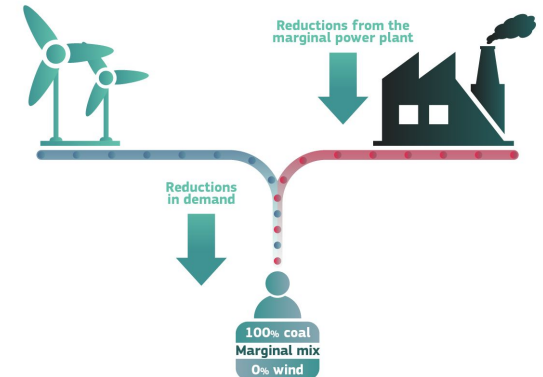


Consequential Accounting

How much CO₂ is my intervention avoiding?

*Relevant for avoided emissions from projects**

Marginal Method



* See [WRI guidance for important distinctions between](#) Scope 2 GHG Inventory Accounting and Avoided Emissions estimated with Consequential Accounting.

Three Pictures of Demand-Side GHG

They are complementary and have different use cases

$$CO_2(t) = energy(t) * grid\ emission\ factor(t)$$

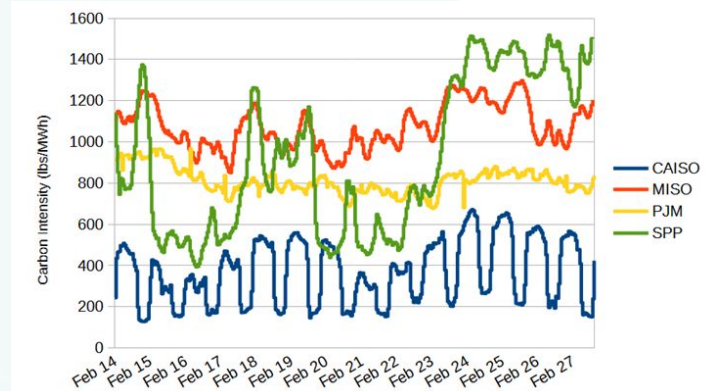
	Location-based	Market-based	Consequential
Feature	A physical picture of power generation and distribution	A contractual picture of power purchases and attribute claims	A counter-factual picture of an intervention with a baseline
Calculation Approaches	Grid average EFs	EACs/RECs, market-based EFs, residual mix/EFs	Grid marginal EFs (short-run, long-run)
Data Sources	EPA eGRID, some ISOs, EIA, IEA, 3rd parties	Utilities/LSEs, EEI, self-calculated	EPA eGRID, EPA AVERT, NREL Cambium, some ISOs, 3rd parties
Example Use Cases	Corporate Scope 2 reporting, SEC, state inventory	Corporate Scope 2 reporting, SEC, 24/7 clean energy targets, green H2, RPS, state inventory	CA SGIP, carbon-aware DR, EV, storage programs

Today's EFs are annual and regional, but they have become much more dynamic in **time** and variant in **location**

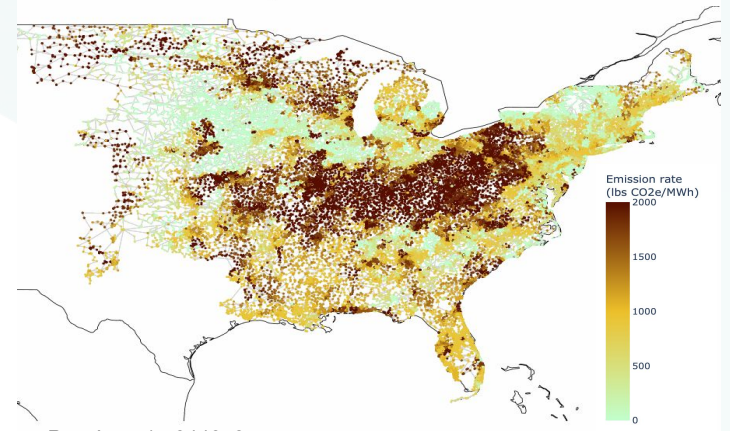
Trends in Location-based Accounting

The physical picture

1. Hourly tracking is emerging
 - Annual accounting could mis-estimate emissions by up to 35%*
 - EIA and some ISOs already publish hourly carbon data on the BA level
2. Zonal/nodal tracking is emerging
 - Example: Upstate NY is ~50% NYISO average, while NYC is ~1.25X NYISO average
 - MISO worked with Singularity to explore nodal-level carbon tracking for the first time
3. Open issues
 - Inconsistent data (annual vs hourly, EIA vs ISO vs EPA, import/export)
 - Sometimes entities misuse it by double counting clean energy for which they have already sold the associated EACs/RECs.



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*Gregory J Miller et al, [Hourly accounting of carbon emissions from electricity consumption](#), 2022 Environ. Res. Lett. 17 044073

Trends in Market-based Accounting

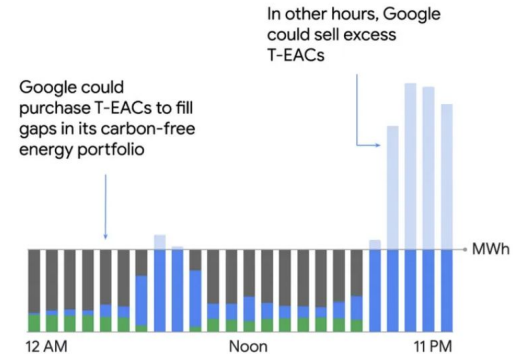
The contractual picture

1. 24/7 carbon clean energy (CFE) is emerging
 - From *annual* matching to *hourly* matching
 - Big techs, federal government (EO 14057), cities, CCAs, utilities, 45V
2. Hourly RECs/EACs are emerging to support the implementation of 24/7 CFE
 - Some regiseries (M-RETs, PJM-GATS) already support hourly RECs/EACs retirement
3. Open issues
 - Boundaries, deliverability, residual mix
 - Liquefiable hourly RECs/EACs markets
 - From tracking only renewable generation to *all generation*
 - From tracking only generation to *both generation and consumption*

24-hour snapshot

Energy profile of Iowa data center on a day in March

- Grid carbon-based energy
- Grid carbon-free energy
- Google-contracted wind
- Excess Google-contracted wind

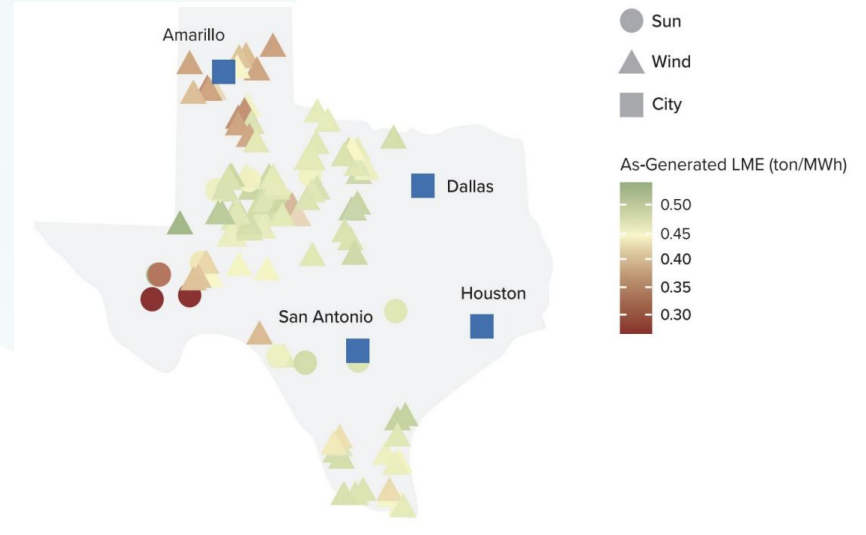


Source: Google

Trends in Consequential Accounting

The counterfactual picture

1. Locational marginal emissions (LME) is emerging
 - From *BA* level to *nodal* level
 - For real-time control decision making such as EV charging, storage, DR
 - PJM publishes LME data with caveats
2. Long-run marginal emissions is emerging
 - From *operating* marginal to *build* margin
 - For project siting (data center, solar, wind)
 - NREL Cambium
3. Open issues
 - Various models may generate contradictory and confusing results
 - Hard to validate
 - Sometimes used improperly as offsets in Scope 2 accounting
 - Scope 4?



Source: Oates, Spees. Locational Marginal Emissions: A Force Multiplier for the Carbon Impact of Clean Energy Programs. May 2021



- Be aware of the accounting framework when discussing GHG emissions.
- Never ever mix location-based, market-based, consequential GHG numbers.
- The two major trends in GHG tracking are time and location granularities.
- PUC commissioners have a critical role to play to ensure transparent, credible, and consistent GHG tracking in the electric sector.

THANK YOU!