...like barcodes for product CO2e declarations
The Carbon-ML project is developing an open-source ecosystem to provide declarations of measurements for embodied carbon in any product or service.

Carbon-ML is incubated by Carbon Finance Labs in partnership with Oxy Low Carbon Ventures with a goal to evolve into an independently governed project.

Carbon Finance Labs
- A finance and technology incubator creating climate change solutions. Our impact comes from a global network of resources and knowledge built over decades spent in the carbon, finance and technology sectors.

Oxy Low Carbon Ventures
- Oxy Low Carbon Ventures, LLC (OLCV), a subsidiary of Occidental, Petroleum
The Problem: Measuring, Reporting, Tracking Embodied Carbon in Products is a mess.

Numerous measurements, policies, mandates, systems, etc. all designed to measure carbon emissions – but lack consistency between them.

Carbon focus today is mainly at the Company, not the individual Product level.

Currently, carbon embodied in making products remains hidden across supply chains.
Problem: embodied CO2e Data = No Context

What you said:
“<Chips> have 20g of CO2e/Kg”

What they heard:
“<Chips> have 20g of CO2e/Kg.”

Which chips? How Calculated? How verified? Who said that? When was it said?

Telephone game problem:
Message intent & context is lost at each hand-off
Today Context gets re-mapped at each handoff: structured data w/ context could help

<Key, Value> pair can provide context for what is being tagged

<Foodchips, potato5667>
<Producer, Frito Lay>
<CO2e/KG, 20 g>
<LCA Method, Cradle: gate 5074>
<Verified by, Auditco llc>
The Vision

Carbon data flowing between all product related system interactions while maintaining context.

Solution: an open-source global ecosystem: An extensible schema using existing product taxonomies, enabling trusted and visible declarations of embodied carbon in every product at all points & actors across supply chains.
The Goal: Make Embodied Carbon Data Sharing Easy

• An evolving ecosystem using an extensible schema to reference existing product taxonomies to declare measured embodied carbon (CO2e) that is trusted and visible, open-source, adaptable for easy implementation, and technology agnostic.

• Empowered private and public sector actors producing and/or consuming trackable declarations of the embodied carbon for any product across supply chains.

• Embodied carbon information shown on product labels so that companies, consumers, suppliers, governments, etc. make better choices.
The Outcomes

Major Actor changes:
- Corporate purchasing
- Customer pressure
- Government policy

Products & Economic impact:
- New goods & services
- Growth in voluntary carbon market

New behaviors:
- Better Understanding of embodied carbon
- Conversations & trust
- New Choices made
Carbon-ML Guiding Principles

- Carbon-ML combines declaring, measuring, tracking and tracing embodied carbon within any product with the development of an ecosystem using:
  - an extensible schema and
  - underlying related taxonomies
  - open-source technical code;
  - Using principles from climate, product, sustainability, and technology taxonomies.

- A primary principle is ecosystem adaptability for local, regional, and country based norms.
  - And, for the evolving ecosystem’s schema and taxonomies, as related ecosystems, products, supply chains evolve. Basically tracking and tracing embodied carbon at each branching point....for each tree as each branch changes.

- Other principles include non-proprietary (technology agnostic), language commonality, active collaboration with corporate / govts, standardized measure and metric use, and open and robust governance.
Carbon-ML

Ecosystem: Schema & Taxonomies
Schema = intelligent context

- Re-use data from other systems leading to faster integrations
- Repurpose existing schemas and data contexts
- Data retains value/context and is exchangeable between systems
- CO2e Data objects with context are shared and utilized to automat forms submissions & reporting
- Continual machine learning about changes in CO2e flows with contextual inference
**Context = tag & taxonomy**

- **XML TAG** (eXtensible Markup Language)
  - Machine readable `<Key, Value>` pair associated with an attribute.
  - `<GS1_food, twix_candy_bar123123987908>`

- **Taxonomy** (structure, context)
  - Meta data tags to define things
  - Approved / recognized formally or informally. Example GS1* = 100m FMCG barcodes
  - Provides external context for “what” is being tagged.
  - `<GS1_food, xxxx>, <GS1_soap, xxxx>, <GS1_beer, xxxx>`

*GS1* is non-profit industry group maintaining product codes for 100 million FMCG (fast moving consumer goods)
What is Carbon Reporting Markup Language <CarML>?

- CarML enables shared context for reporting embodied carbon data objects.
- CarML is open-source XML: standard for how product / service information about CO2e is created, processed, distributed, declared and shared.
- Useful for many product / service handoffs

<table>
<thead>
<tr>
<th></th>
<th>Business</th>
<th>Government</th>
<th>Machine</th>
<th>Consumer</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Business</td>
<td>B to B</td>
<td>B to G</td>
<td>B to M</td>
<td>B to C</td>
<td>B to Other</td>
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<td>Government</td>
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<tr>
<td>Consumer</td>
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<td>C to G</td>
<td>C to M</td>
<td>C to C</td>
<td>C to Other</td>
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<td>Other</td>
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<td>Other to G</td>
<td>Other to M</td>
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</tbody>
</table>

- <CarML> creates interactive / intelligent CO2e data
- Essentially a “Bar Code” for Embodied Carbon information for products/services
Carbon-ML Ecosystem: Root Schema points to/uses Unique Taxonomies

Why (goal of the declaration)

Who
- Made the declaration
- Verified (3rd party)

What is being declared

How
- How Many / much of a product is the declaration for
- How long (duration)

When
- When was the declaration made
- When does the declaration expire

Where
- Where is the product service origin.
- Where does the service terminate

CO2e product consumer/customs/etc.
- Other EPDtype or goal

CO2e /kg
- What is the product or service

Quantity
- Amount KG... (SI)
Carbon-ML Ecosystem - Why declaration or state is made/updated

- Why the event (change in CO2e) happened (process description)
- Why carbon was added / altered
- Why a good or service was updated or changed
- Can include non-carbon add events:
  - Legal state changes/assignments
  - Logical changes/assignements
  - Examples: Duty paid, package certified, audit completed, auditor verified etc.
Carbon-ML Ecosystem - Who (entity said / did a thing)

Declaring Carbon Related Fact(s)
- Corporations
- Commodity producers
- Governments
- Regulators
- NGO’s IGO
- Researchers
- Verifiers such as auditors

Ecosystem Roles
- Owners of a product or service
- Consumer of a product or service
- Procurement agents
- Carbon registrar or issuer
- Verifier or reviewer (entity)
- Product innovators
- Individual viewer or observer
Carbon-ML Ecosystem - What impacts a CO2e declaration

What products and services are being referenced, identification schema may include:
- ISO Codes
- GS1 (barcodes)
- SIC or standard descriptors of service definitions
- LCA references

What type of activity or process is being conducted

What is the CO2e impact on the goods or services
Carbon-ML Ecosystem - How was this fact about CO2e assessed / derived

1. HOW DID A CARBON FACTOR CHANGE
2. WHAT WAS THE CO2e AMOUNT & LCA TYPE METHODOLOGY USED
3. MAY INCLUDE ASSIGNMENT OF OFFSETS/REMOVAL INSTRUMENTS TO PRODUCTS
Carbon-ML Ecosystem - When a CO2e fact occurs or is declared

Point in Time event: ISO standard time convention

Relative elapsed time:
Relative to the location where something occurred,
As an absolute reference to an event.

Examples:
1. Process start, end, completion
2. Product event
3. Time of system and data entry update
4. Service initiation, completion
5. Product or process expiration
6. Credit remediation expiration
Carbon-ML Ecosystem -
Where did the activity occur

- Point or Service Route
- A point along the supply chain
- GIS/ISO standards for maps / geo locations
Examples and Use Cases
Barcodes for product CO2e declarations

What we are talking about.

Product GS1 100m FMCG

LCA data taxonomy

Reuters entity library

Key, Value

Xml.1.0 <carml 0.1>

(Product GS1),<12312319879087>
<LCA method>,<CandyBar>
(Corporate entity),<12312Mars.inc>
(CO2e/ kg ),<540g/kg>

Manufacturer

Distributor

Customs Agent

Retailer
**XML = Open Extensible Schema: any taxonomy**

- `<taxonomy>`: What we are talking about.
- `Widgets=Steel, chemicals, travel hydrogen, cheese…….`
- `How we measured CO2e.`
- `Who declared /verified etc.`

**<CaRML> reference XSD w/ Taxonomy pointers**

- `<Product Any>,<widget9087>`
- `<LCA method>,<widget>`
- `<Corporate entity>,<12312Acme.inc>`
- `<CO2e/ kg >,<540g/kg>`

**Xml.1.0 <carml0.1>**

**Key, Value**
- `<Product Any>,<widget9087>`
- `<LCA method>,<widget>`
- `<Corporate entity>,<12312Acme.inc>`
- `<CO2e/ kg >,<540g/kg>`

**Manufacturer**
- **Distributor**
- **Customs Agent**
- **Retailer**
<table>
<thead>
<tr>
<th><strong>Root declaration</strong></th>
<th><strong>Schema(s) context</strong></th>
<th><strong>Key</strong></th>
<th><strong>Value data</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>What we are talking about</strong></td>
<td>&lt;GS1_FMCG_database&gt;, &lt;Fuels_industry_schema&gt;, &lt;plastics_industry&gt;, &lt;Metals_association&gt;</td>
<td>&lt;GS1_Food_item&gt;</td>
<td>&lt;Twix_bar_1023&gt;</td>
</tr>
<tr>
<td><strong>Who made the declaration, verification, attestation</strong></td>
<td>&lt;Reuters_entity&gt;, &lt;govt_XYZ_lookup&gt;, &lt;insert_favorite&gt;</td>
<td>&lt;UK entity&gt;</td>
<td>&lt;Mars co. 502934&gt;</td>
</tr>
<tr>
<td><strong>How was CO2e measured LCA, LCI method</strong></td>
<td>&lt;Open_LCA&gt;, &lt;EU_regulatory_LCI&gt;, &lt;new_schema_metric_tool&gt;</td>
<td>&lt;food 10244 method&gt;</td>
<td>&lt;Cradle 2 gate&gt;</td>
</tr>
<tr>
<td><strong>How much CO2e was reports</strong></td>
<td>&lt;CaRML&gt;, &lt;other_reporting_EPC&gt;, &lt;ISO_schema&gt;</td>
<td>&lt;CO2e KG&gt;</td>
<td>&lt;0.015&gt;</td>
</tr>
<tr>
<td><strong>When did this occur</strong></td>
<td>&lt;ISO_Time_conventions&gt;</td>
<td>&lt;GMT&gt;</td>
<td>&lt;15:02:32&gt;</td>
</tr>
<tr>
<td><strong>Where did this occur</strong></td>
<td>&lt;ISO_GPS_location_convention&gt;</td>
<td>&lt;long,Lat&gt;</td>
<td>&lt;34.092,-118.328&gt;</td>
</tr>
<tr>
<td><strong>?????</strong></td>
<td>&lt;Extensible_open_schema&gt;</td>
<td></td>
<td></td>
</tr>
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</table>
# Carbon-ML Use Cases

<table>
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<tr>
<th>Use Case</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>FMCG Labeling with GS1</strong></td>
<td>Carbon-ML supporting GS1 would allow for the “labelling” of approximately 100 million consumer products out of the box and be integrated with many inventory/supply chain systems.</td>
</tr>
<tr>
<td><strong>International Trade / Customs &amp; Border Agents</strong></td>
<td>Carbon-ML supporting international trade/customs and border agents, policies such as the EU Carbon Border Adjustment Mechanism (CBAM)</td>
</tr>
<tr>
<td><strong>Materials / Supplies Purchasing Decisions</strong></td>
<td>Carbon-ML supporting measurement &amp; labeling of embodied carbon within a product or service at every point along the supply chain.</td>
</tr>
<tr>
<td><strong>Financial Markets / Investment Decisions</strong></td>
<td>Carbon-ML supporting financial markets investment decision making by providing more accurate tracing and tracking, and comparable representations of embodied carbon within products and services by companies.</td>
</tr>
<tr>
<td><strong>Government and State Regulators</strong></td>
<td>Carbon-ML supporting Government and State regulators understanding of carbon related data, standardized data allows for better comparability and tracking of embodied carbon within products and services.</td>
</tr>
</tbody>
</table>

- Processing managers can compare based on Carbon quality
- Consumers can make more informed decisions
- More accurate and standardized assessment of reporting of embodied carbon in products in line with customs carbon border policies
- Purchasing managers can make more informed procurement decisions
- Goods and services can be compared based on embodied carbon
- Asset managers can make more informed decisions relating to portfolio carbon footprint
- Shareholders have greater understanding of corporate impact profile
- Better assessment of procurement processes and service provider selections
- Better assessment of legislation, regulations, and enforcement
Get Involved!

- To learn more about the Carbon-ML project, contact us at info@carbon-ml.org, and share:
  - Your interest:
    - Participate as Industry advisor
    - Participate from standards/taxonomy organization
    - Participate providing governance oversight
    - Participate providing technology expertise
    - Mailing list only
  - If you would like to participate, how would you like to contribute to Carbon-ML, what areas of expertise do you have, have you worked on a standards or taxonomy project before
  - What carbon data problem you would like to see solved
Thank you!
Carbon-ML <CarML>
Schema & Ecosystem Summary

- <CarML>: An open extensible markup language supporting a collection of new or ideally existing schema to ease structured machine communications and declarations about the carbon CO2e associated with all economic activities at the individual product and/or service level.
- The <CarML> extensible schema evolves by using existing product taxonomies, not being fully prescriptive of any one solution or interpretation.
- <CarML> is transparent providing machine readable CO2e data. This accelerates reporting across supply chains, creating awareness of carbon and enables efforts to reduce CO2e to create new higher valued products and services.
- There is no <CarML> schema terminal solution. <CarML> is extensible and designed for usability and extension such that only part of the tool or tags needs implementation to get benefits.
- Early <CarML> schemas will be shaped from key industry and policy stakeholders building on schemas and taxonomies in use by other industries and software solutions.
- Non-proprietary. No one should own a language.