



TEC: Transparent Emissions Calculation Toolkit

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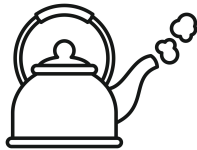


Carbon Emissions Calculation

- Quantifying **carbon emissions** plays a vital role in monitoring progress towards Net Zero
- Real-world observations of **activity data** and associated **emission conversion factors** are one of the main tools in this monitoring effort

Emissions Calculation Formula

GHG emissions = activity data x emission conversion factor



$$\begin{array}{ccccccc}
 & \mathbf{0.021} & & \mathbf{0.11} & & \mathbf{0.19} & \\
 & \mathbf{kg\ CO_2} & = & \mathbf{KWh} & \times & & \\
 & \mathbf{eq} & & \mathbf{?} & & \mathbf{?} &
 \end{array}$$



Carbon Emissions Calculators

- Carbon Emissions Calculators lack the **transparency mechanisms** to enable auditing of carbon emissions calculations at a **highly granular level**

myclimate
Calculate your flight emissions!

From *
To *
Via

Roundtrip
 One way

Number of passengers
1

Economy Class
 Business Class
 First Class

CALCULATE

United Nations
Climate Change

Fuels
Combustion of fuels in owned or controlled stationary equipment such as boilers, furnaces, burners, turbines, heaters, incinerators, engines, flares

Do NOT include here the combustion of fuels in transportation devices such as automobiles, trucks, buses, trains, airplanes, boats, ships, barges, vessels, etc.

Please enter the amount for each applicable fuels

Type	Fuel	Unit	Factor	Amount	kg CO2e
Gaseous fuels	CNG	litres	0.44423		-
Gaseous fuels	LNG	litres	1.15623		-
Gaseous fuels	LPG	litres	1.55709		-
Gaseous fuels	Natural gas	cubic metres	2.02135		-
Gaseous fuels	Natural gas (100% mineral blend)	cubic metres	2.03473		-
Gaseous fuels	Other petroleum gas	litres	0.94441		-
Liquid fuels	Aviation spirit	litres	2.33048		-
Liquid fuels	Aviation turbine fuel	litres	2.54514		-

Disclaimer Info and sources Report Your organisation Fuels Bioenergy

Cool Farm
My assessments
New assessment Aggregation My projects

global-breeding-farm_2023
Beef Cattle Finished product: 0 kilograms Type: Global breeding farm

General Production **Herd** Grazing Feed Manure Energy Transport

2. Your herd

Please fill in the average number of animals on the farm for the reference year, the number of animals sold and the number purchased.
Note, the average daily weight gain can be customised in the farm settings.

Live weight unit: kilograms

Category	On-farm animals		Purchased animals		Sold animals	
	Number	Live weight	Number	Starting weight	Number	Finishing weight
Suckler cows	0		0	0	0	0
Meat calves younger than 1 year	0		0	0	0	0
Replacement heifers	0		0	0	0	0



Key challenges

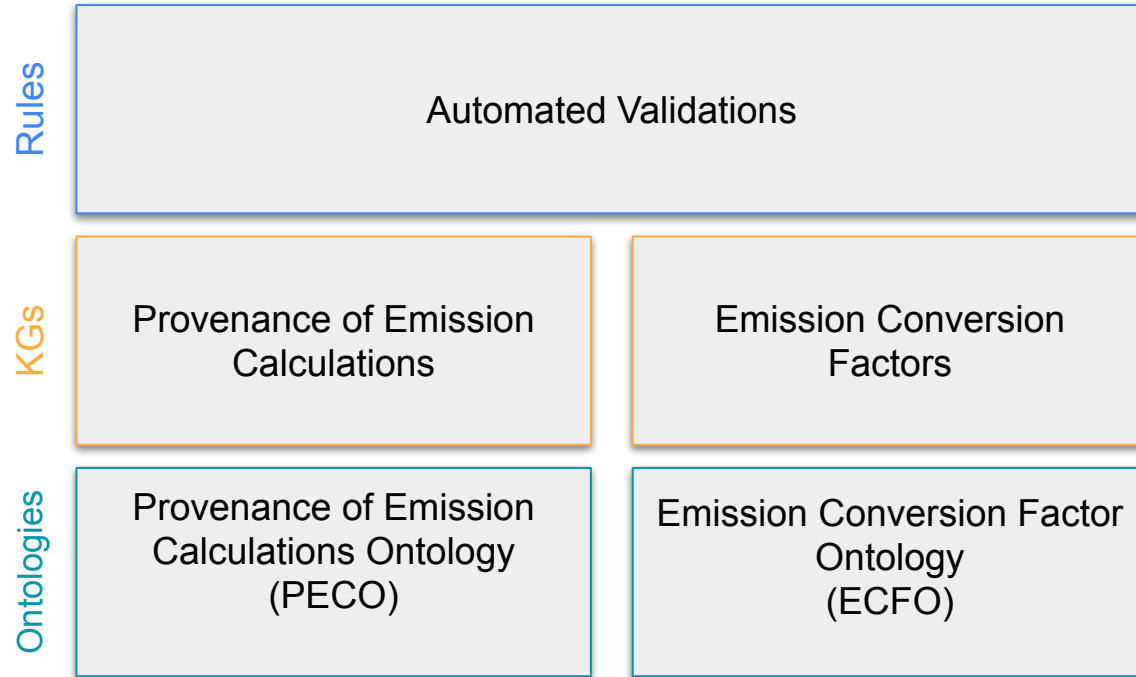
- **Auditing** emissions calculation process
 - Proxy measurements
 - Methodology assumptions
 - Up to date conversion factors
- Data **provenance** and **trust**
- Comparison of emissions scores produced by **different tools**



TEC Toolkit

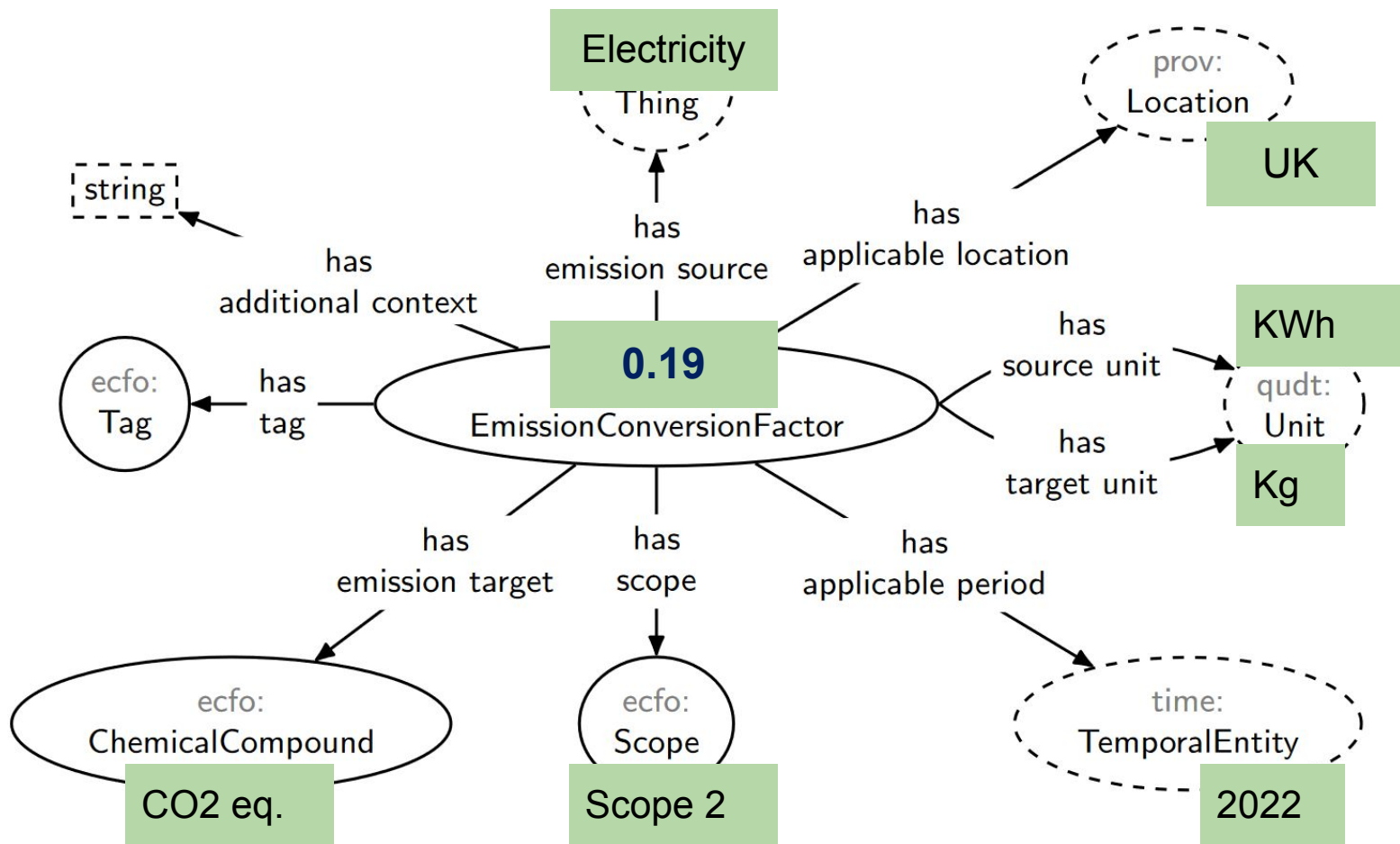


TEC Toolkit Technology Stack





ECFO Ontology

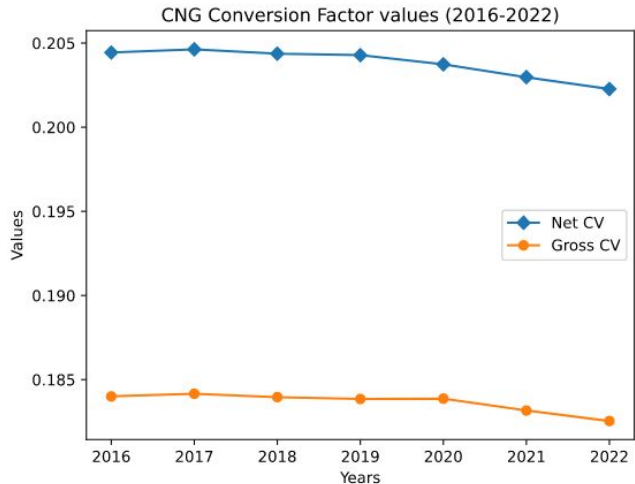




ECF Knowledge Graph

Emission Conversion Factors KG

- Transformed data sources to RDF using **RML mappings**
- Some CF properties aligned to **Wikidata** entities
- Over **42k** CF mostly for period **2016 - 2022**



RDF explorer Home Query

https://w3id.org/ecfkg/UK/BEIS/2019/CF_1

Outgoing relations

rdfs:label	CNG kWh (Gross CV)
rdf:type	ecfo:EmissionConversionFactor
http://purl.org/dc/elements/1.1/publisher	Department for Business Energy and Industrial Strategy (BEIS)
rdf:value	0.18385
prov:wasDerivedFrom	https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/904214/conversion-factors-2019-flat-file-v01-02.xls
ecfo:hasApplicableLocation	United Kingdom
ecfo:hasApplicablePeriod	https://w3id.org/ecfkg/UK/BEIS/2019/applicablePeriod/2019-01-01T00%3A00%3A00/2019-12-31T23%3A59%3A59
ecfo:hasEmissionSource	Gaseous_fuels_CNG Gaseous_fuels_CNG
ecfo:hasEmissionTarget	carbon dioxide equivalent
ecfo:hasScope	scope 1
ecfo:hasSourceUnit	kilowatt hour
ecfo:hasTag	Fuels Gaseous fuels CNG
ecfo:hasTargetUnit	kilogram
ecfo:hasAdditionalContext	Energy - Gross CV



Data Validation

- Runs **Datalog rules** to detect violations of conditions according to ECFO

Example

(from domain experts)

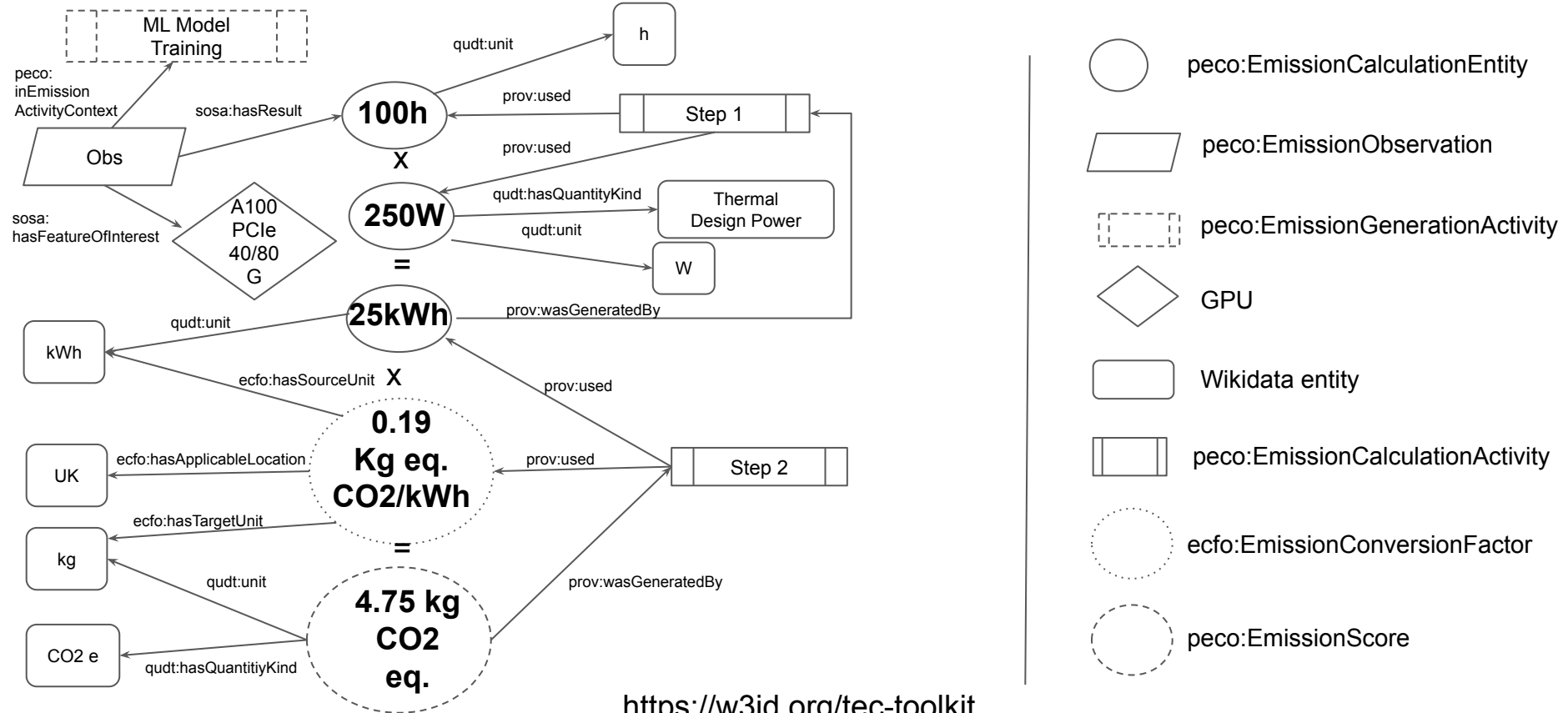
Identify conversion factors (conflictingCF) where the **Net CV** value is less than the **Gross CV** value

```
eov:conflictingCF( ?CF_Net, ?CF_Gross ) :-  
  
    eov:sameCF( ?CF_Net, ?CF_Gross ),  
    ecfo:hasAdditionalContext( ?CF_Net, "Energy - Net  
                                   CV" ),  
    ecfo:hasAdditionalContext( ?CF_Gross, "Energy - Gross  
                                   CV" ),  
    ecfo:hasEmissionTarget( ?CF_Net, ?EmissionTarget ),  
    ecfo:hasEmissionTarget( ?CF_Gross, ?EmissionTarget ),  
    ecfo:hasTargetUnit( ?CF_Net, ?TargetUnit ),  
    ecfo:hasTargetUnit( ?CF_Gross, ?TargetUnit ),  
    rdf:value( ?CF_Net, ?Value_Net ),  
    rdf:value( ?CF_Gross, ?Value_Gross ),  
    ?Value_Net < ?Value_Gross .
```



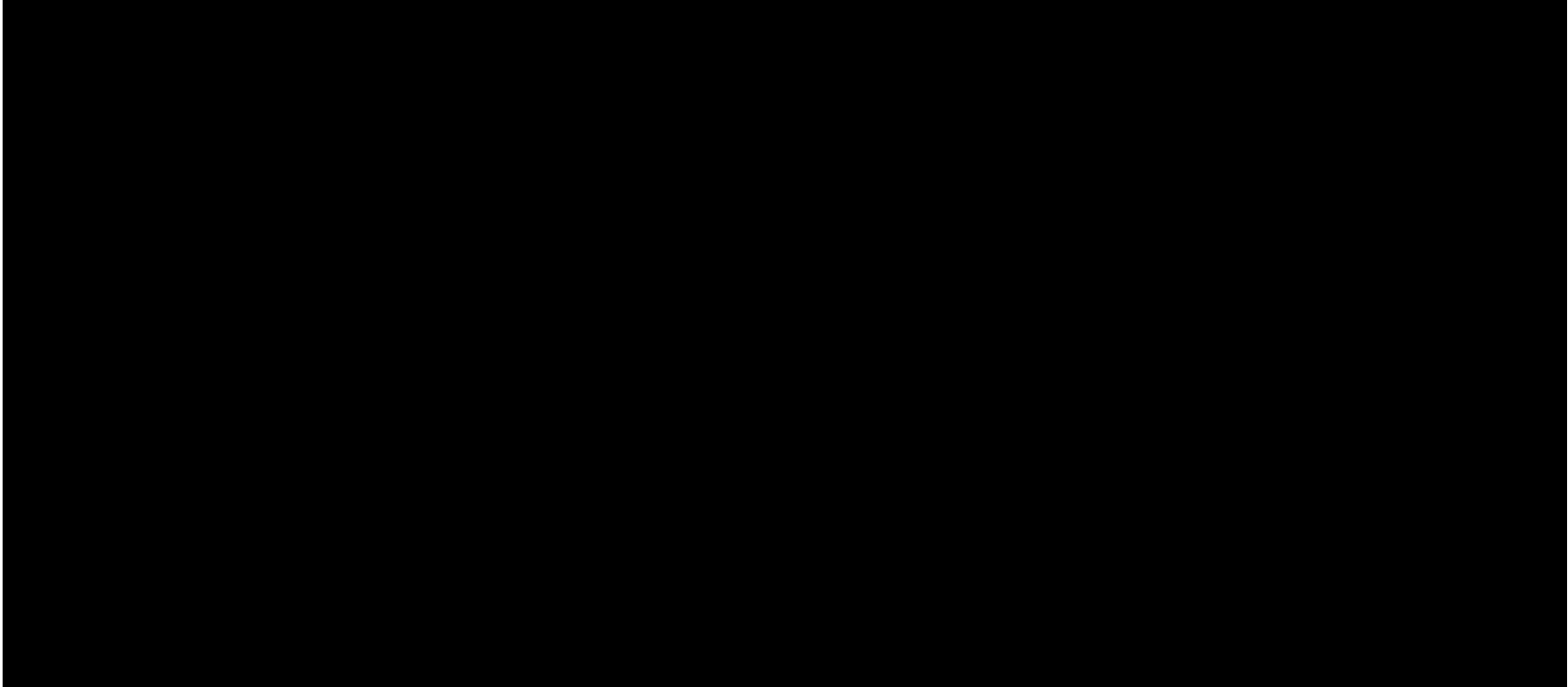
PECO Ontology

Carbon footprint of ML model Training





Semantic Machine Learning Impact Calculator





Future & Ongoing Work

- Integration of additional datasets of CFs (EPA, IPCC, etc.)
 - EPA is already ongoing work!
- Apply TEC Toolkit in additional domains such as AgriFood and manufacturing
E.g. EATS (<https://eats.org.uk>), UK FIRES (<https://ukfires.org>), and national ML domain (<https://inesdata-project.eu>)
- Develop open source mappings and libraries to help developers of carbon emissions calculators integrate transparency mechanisms
- Automating (or semi-automating) emissions calculation process and carbon footprint assessment and analysis