Farm Explorer: A Tool for Calculating Transparent Greenhouse Gas Emissions

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Background

Calculating **Green House Gas (GHG) emissions** requires real-world data observations quantifying various aspects of business activities and methodologies for transforming activity data into GHG estimates.

Reported emissions estimates may differ depending on:

- calculation methodology
- software used
- geopolitical location
- applicable emissions conversion factors (ECFs)
- the type of reported GHG emissions

Calculation Formula

Activity Data
x
Emissions Conversion Factor
=
Emissions Score

Problem

Provenance of emissions calculations in machine-understandable formats could enhance the transparency of GHG reporting; however, no domain-specific models for describing such traces exist.

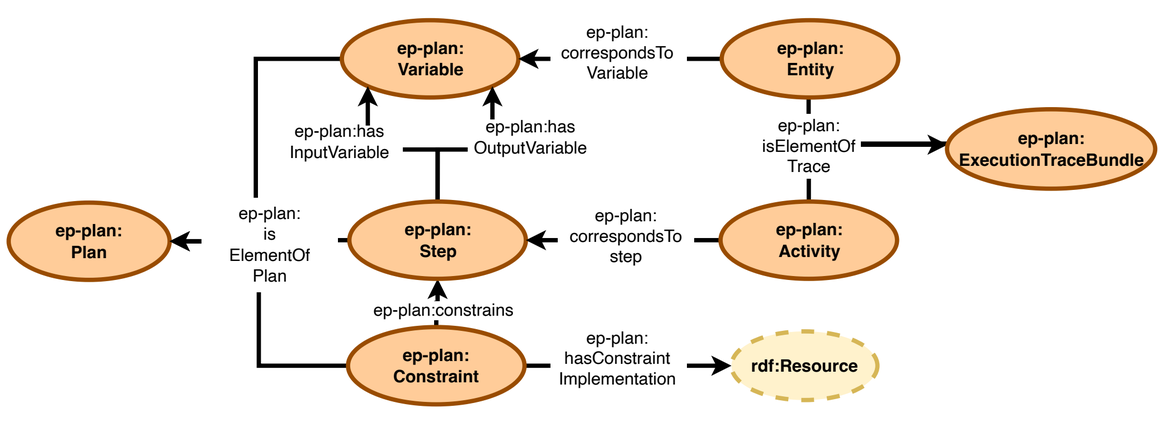
Solution - https://tec-toolkit.github.io

Transparent Emissions Calculations (TEC) toolkit enables modelling, sharing, querying, and validation of semantic provenance descriptions of GHG emissions calculation processes.

Intended Uses: (1) Integrating data resources required to perform and analyse the results of emissions calculations from heterogeneous sources, and support their comparison;
(2) Supporting transparency by providing tools to record provenance of reported emissions values;
(3) Supporting the automated validations of emissions calculations to reduce errors.

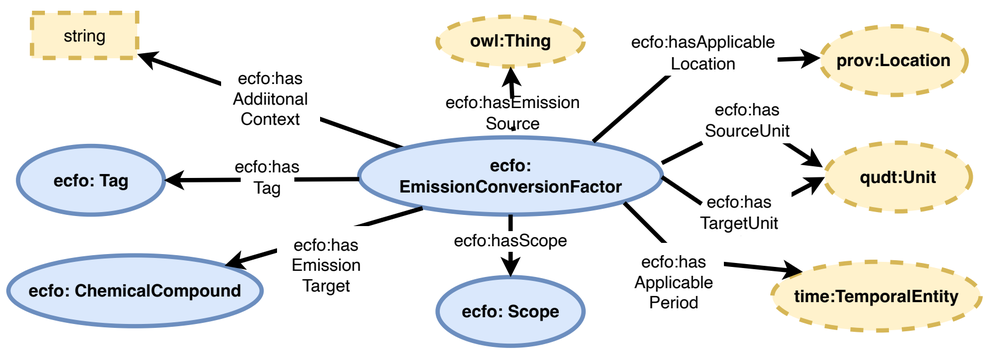
EP-PLAN - Extended Provenance Plan Ontology

EP-Plan (https://w3id.org/ep-plan) extends W3C PROV-O to enable descriptions of abstract plans and corresponding execution traces. Furthermore, constraints associated with planned steps may be defined which we use to guide the execution of the emissions calculation formulas.



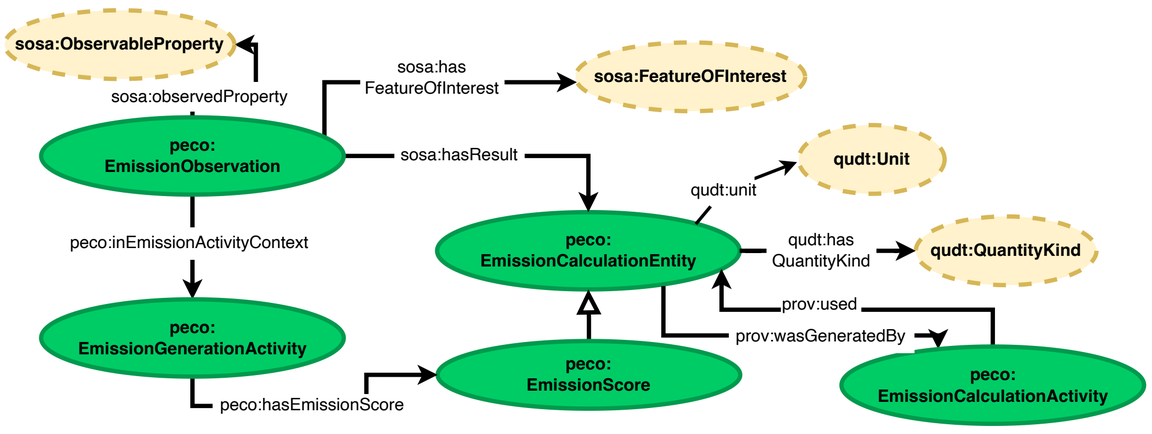
ECFO - Emission Conversion Factors Ontology

ECFO (https://w3id.org/ecfo) aims to provide a generic model for describing the values of ECFs and their metadata.



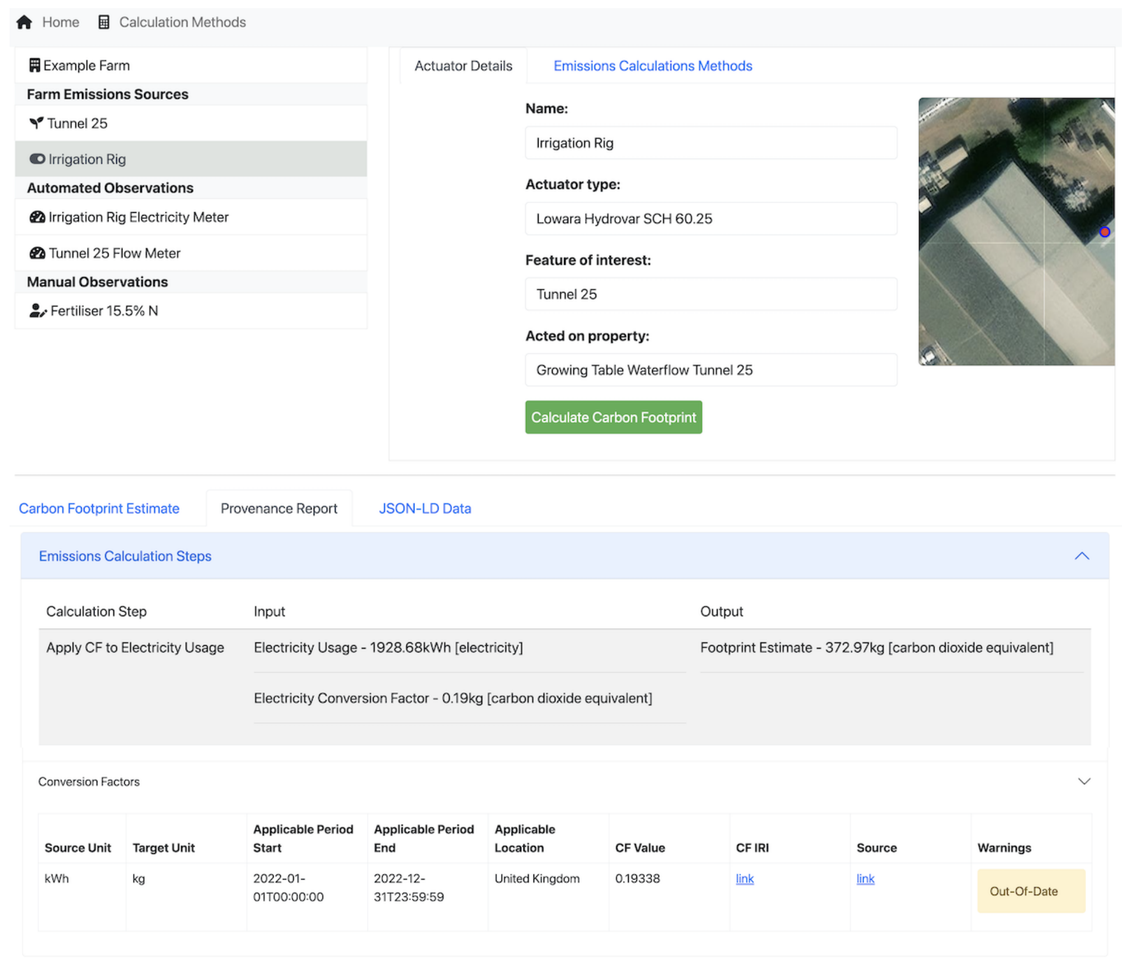
PECO - Provenance of Emissions Calculation Ontology

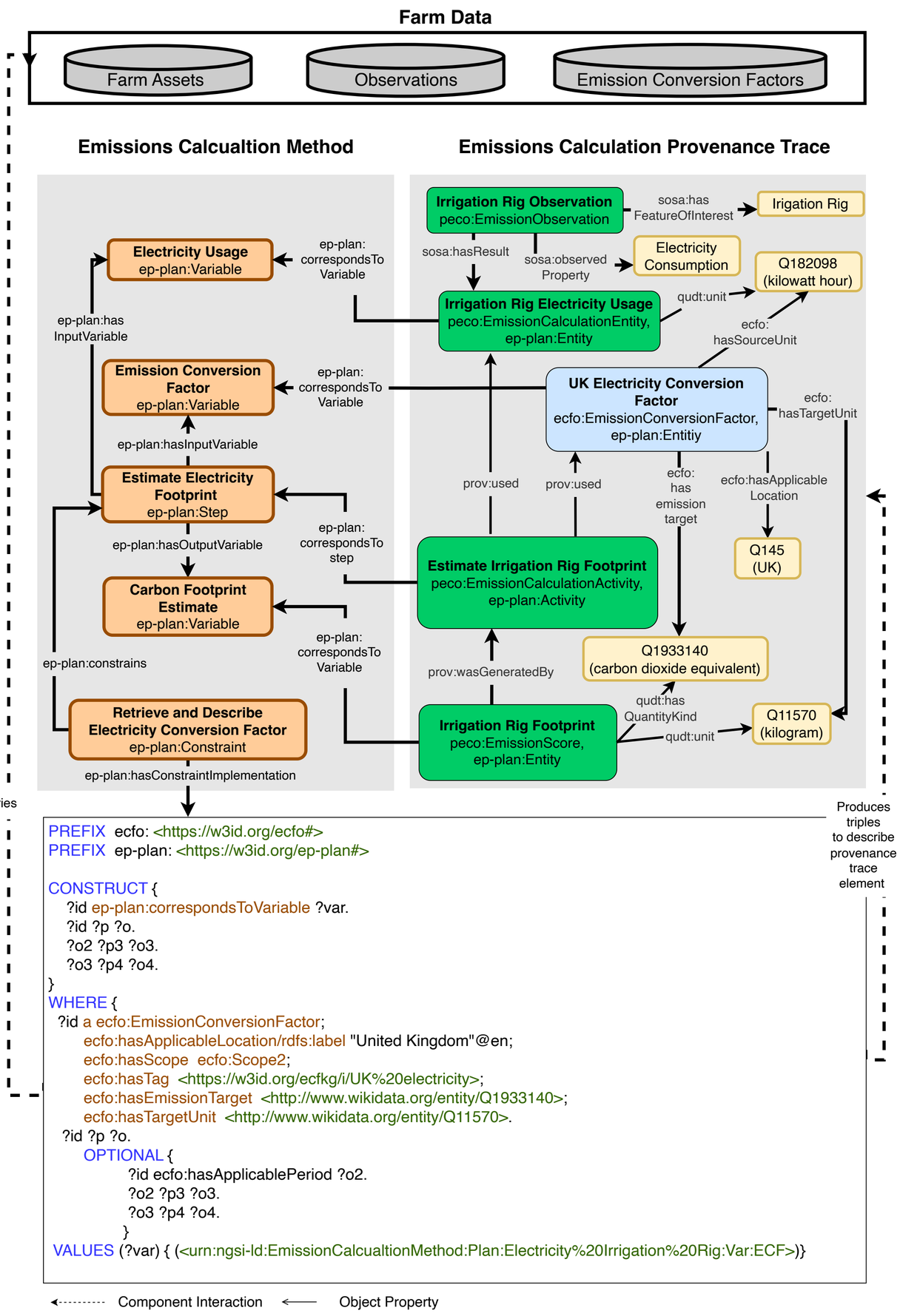
PECO (https:w3id.org/peco) describes provenance traces of carbon emissions calculations by capturing the activity data and calculation steps used to estimate the emissions.



Applications & Current Work

To demonstrate and evaluate our solutions, we are developing a semantic data management tool with UK farmers to enable detailed and automated transparent analysis of carbon footprint associated with individual parts of the farm operation.





Future Work

Unresolved challenges include:

- automatic alignment of appropriate conversion factors to specific assets/activities
- descriptions and the integration of process-based and machine learning components for emissions estimates within semantic pipelines
- automatic generation of data processing queries and calculation explanation from provenance traces (e.g., using Large Language Models)

Related Publications

- Markovic, M., Garijo, D., Germano, S., Naja, I. (2023). TEC: Transparent Emissions Calculation Toolkit. In: Payne, T.R., et al. The Semantic Web – ISWC 2023. ISWC 2023. Lecture Notes in Computer Science, vol 14266. Springer, Cham.
- Markovic, M., Garijo, D., Edwards, P. and Vasconcelos, W., 2019, October. Semantic modelling of plans and execution traces for enhancing transparency of IoT systems. In 2019 Sixth International Conference on Internet of Things: Systems, Management and Security (IOTSMS) (pp. 110-115). IEEE.

Acknowledgements

This work was supported by the UK Engineering and Physical Sciences Research Council [grant numbers EP/V042270/1, EP/V050869/1, EP/S019111/1].