



Swansea University  
Prifysgol Abertawe



**sustain**  
future steel manufacturing research hub

## **UNRMS: Considerations for steel recycling**

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**RESOURCE MANAGEMENT WEEK  
2024**



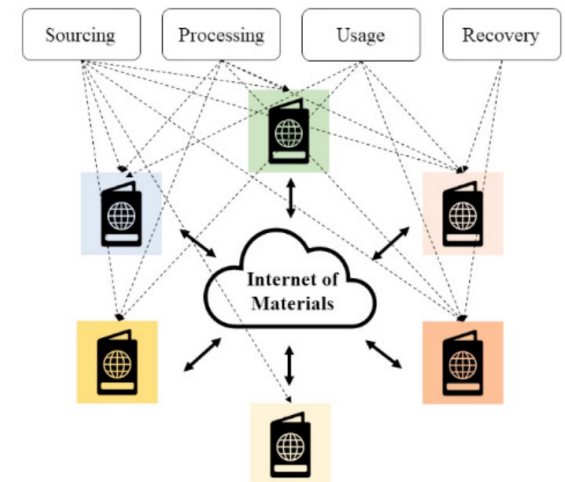
**UNECE**

# Activity Summary



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- Generation of ferrous resource quality & VIU data (~10s of Kts sample) for UK sources.
- Development and dissemination of characterisation & quality standards for ferrous anthropogenic resources.
- Attributable and consequential MFA / LCA.
- Report via UK ICE SRM for implementation of UNFC & UNRMS to these anthropogenic sources & best practice in materials passporting.



# Steel - Anthropogenic Ferrous Resource Management (Global Picture)



## Demand for Steel



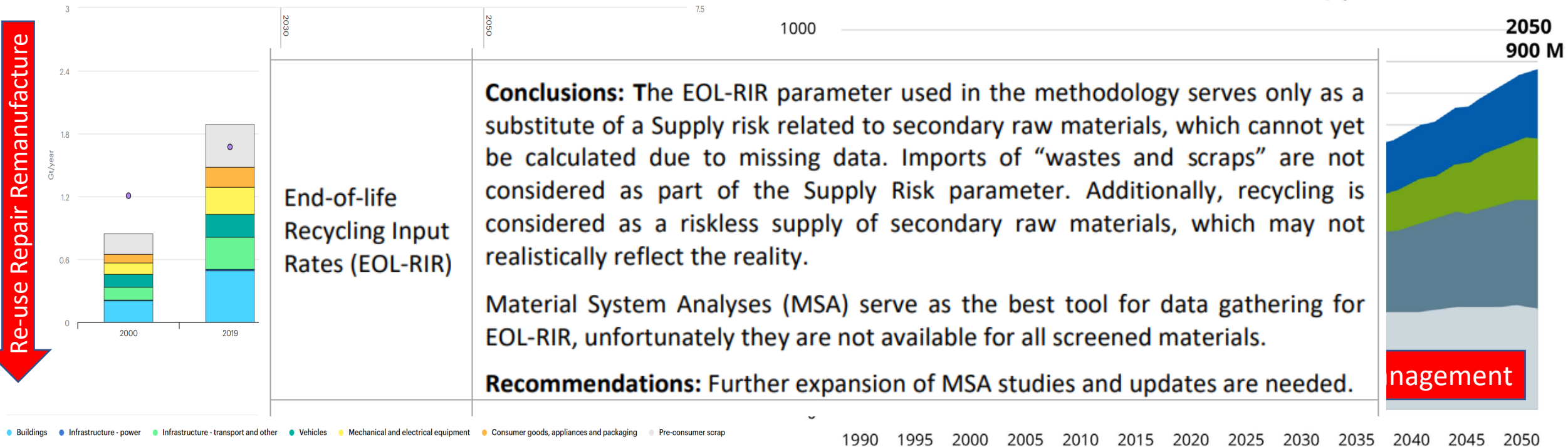
## Resource Availability



Global end-use steel demand and in-use steel stock by scenario, 2000-2050

### End-of-life scrap availability

Rest of the world Other Asia China EU + North America + Japan



\*Demand (~2.2bn tonnes @SDS) – Scrap Supply (1.3bn tonnes) = 1 billion tonnes.

**In the UK:** Abundance of domestic scrap: ~10-11MT PA, in a global market of ever reducing availability (EU WSR, China EAFs)



# Steel Recycling (Challenge)

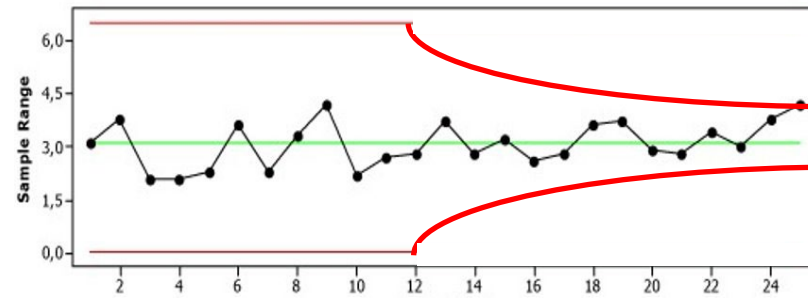
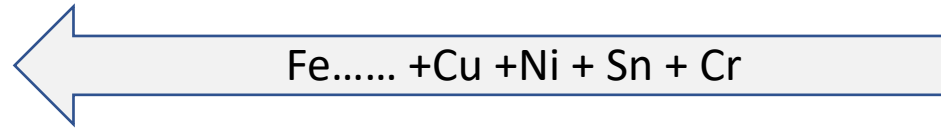


Steel products & services of today are not likely to be the same in 2050, neither will product and resource standards.

Historical Trend



Competitive Advantage



Current Consequences



Carbon based materials    Ceramic Materials

Optically similar metals    High Density Materials

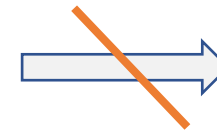
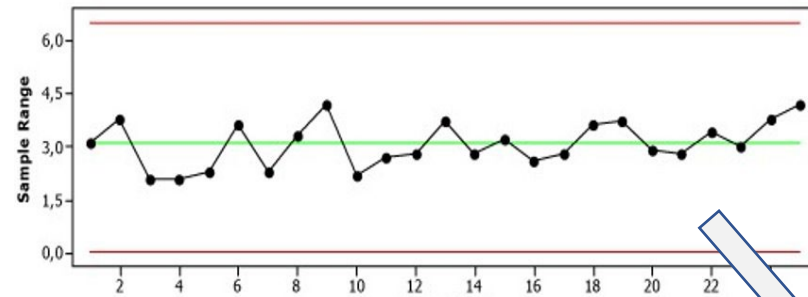
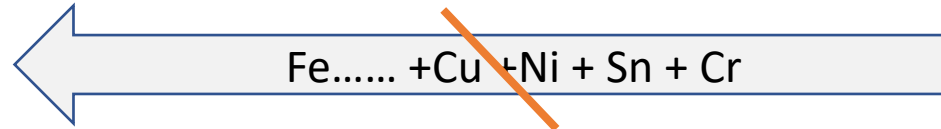
# Steel Recycling (Solution)



Historical Trend

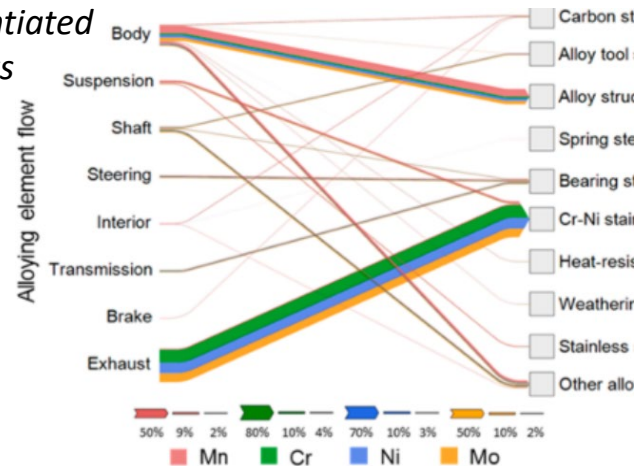
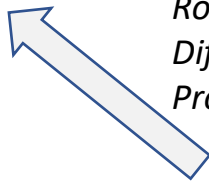


Competitive Advantage



Future Trend

Robust & Differentiated Products



The Materials Passport / UNFC / UNRMS



Re-Use, Repair & Re-Manufacture



# Current (UK) Scrap Steel Specifications



0A



1



2



3A



3B



4A



4C



4D



4E



4F



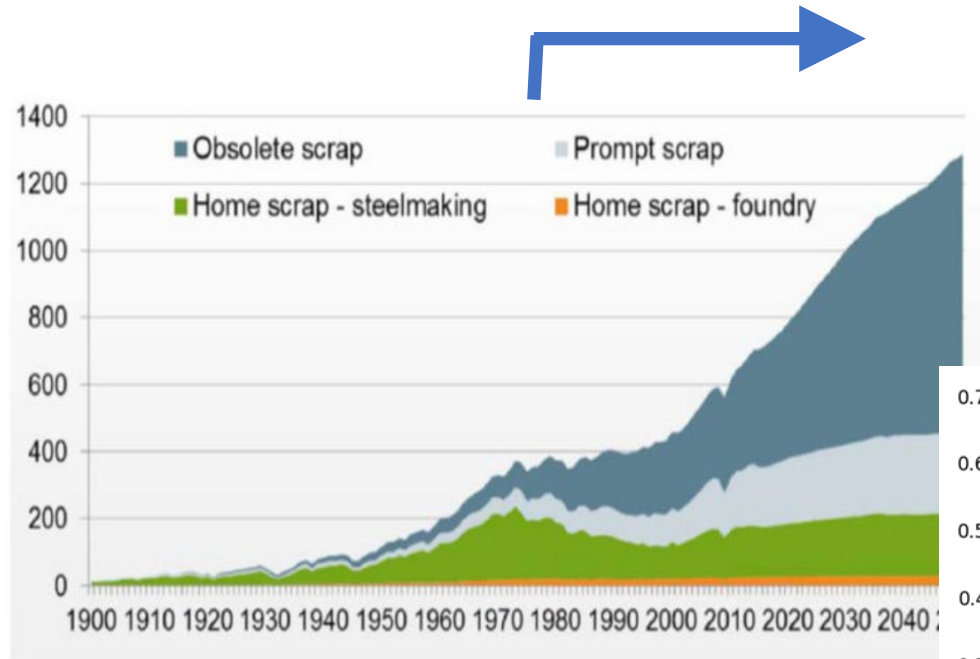


# Scrap: Quality vs Quantity – G Axis



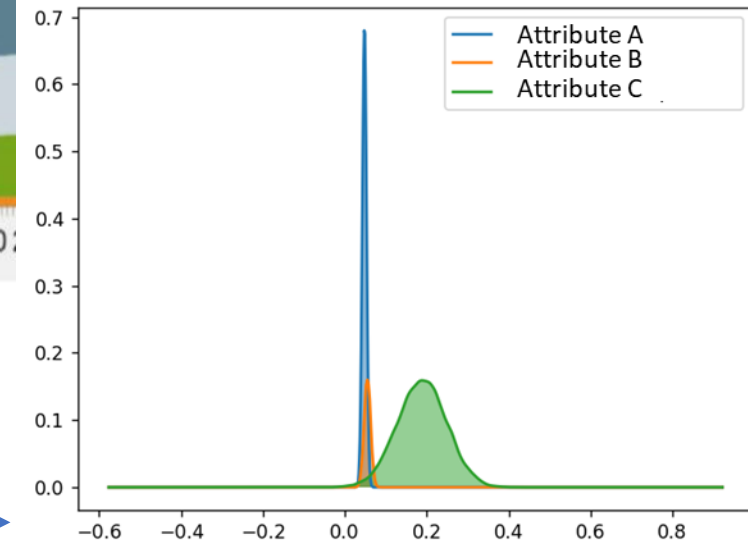
## Confidence in Estimate

Steel Route	UK Proportion	Inherent Copper
BOF Steel	70%	<0.05%
EAF Steel	10%	0.20%
	10%	0.30%
	10%	0.40%
<b>Total</b>		<b>&lt;0.125%</b>



## Statistical Modelling

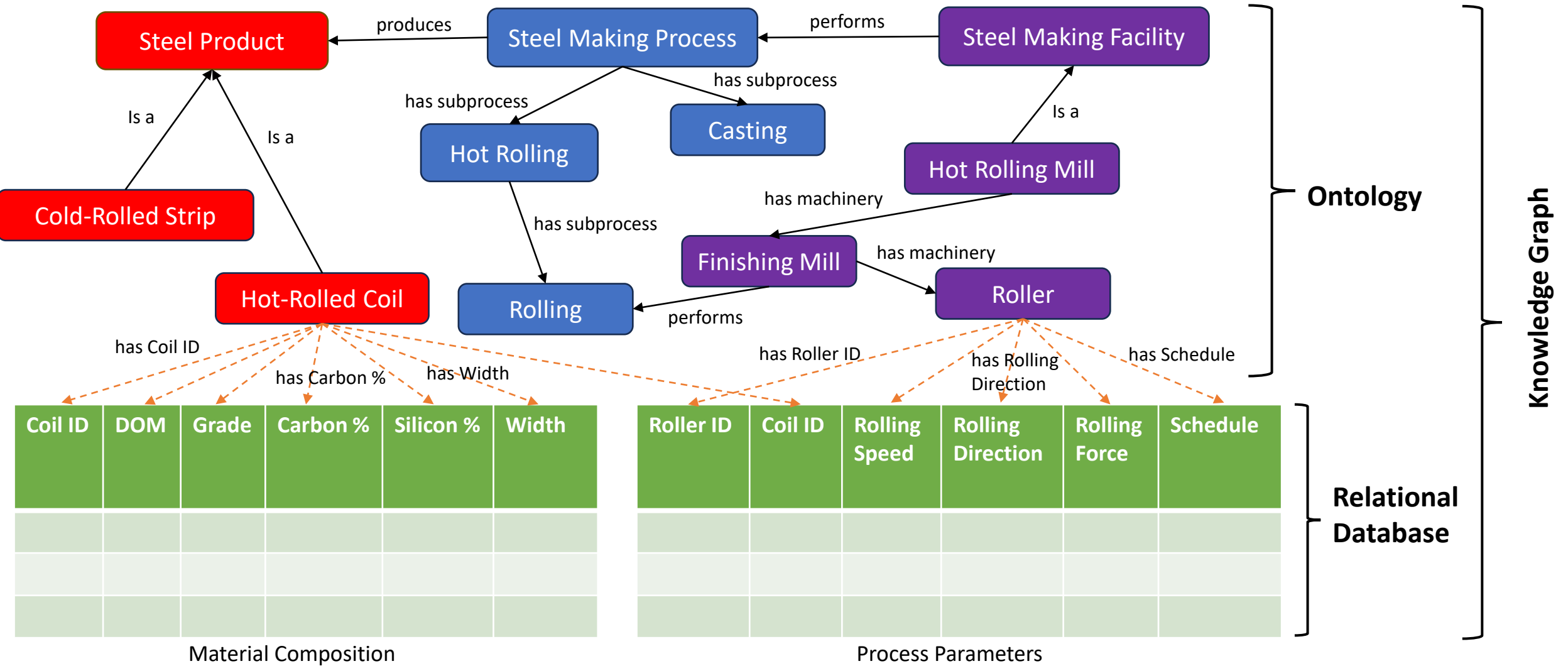
### Position in uncertainty range



Estimated Inventories

Multi-scale Sampling & Measurement

# Data Integration using Ontologies





# Data Aggregation via Knowledge Graphs



Large Language Models  
(GPT 3.5)



Query

Query  
Result

Query Language (SPARQL)

```
SPARQL query editor
SPARQL Query
PREFIX owl: <http://www.w3.org/2002/07/owl#>
PREFIX rdf: <https://www.w3.org/1999/02/22-rdf-syntax-ns#>
PREFIX xml: <http://www.w3.org/XML/1998/namespace>
PREFIX xsd: <http://www.w3.org/2001/XMLSchema#>
PREFIX obda: <https://w3id.org/obda/vocabulary#>
PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#>
PREFIX skos: <http://www.w3.org/2004/02/skos/core#>
PREFIX time: <http://www.w3.org/2006/time#>
PREFIX cros: <http://www.semanticweb.org/ontologies/2021/6/CROS#>

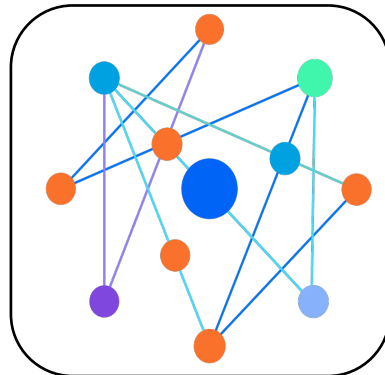
SELECT ?Diameter
WHERE {
  ?roll cros:hasRollID ?rollid .
  ?roll cros:hasDiameter ?diameter .
  MINUS {
    ?roll cros:hasGrindRoll ?grind .
  }
}
GROUP BY ?Diameter
having (count(?Diameter) > 2)

Show 100 or all results. Use short IRIs
```

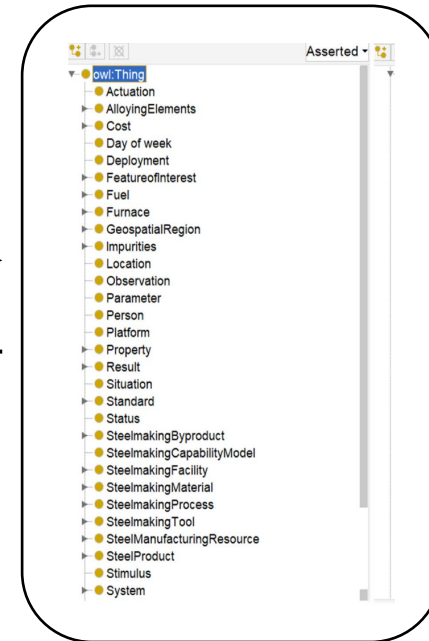
Query

Query  
Result

Virtual Knowledge Graph  
(Ontop)



Ontology (Protégé)



Mapping

Database



# Summary



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- Recycling rate is limited by composition as well as availability leading to large differences in CO<sub>2</sub>e as function of primary iron demand %.
- Active supply chain management is therefore essential to avoid value destruction and enable decarbonisation.
- Current scrap quality standards represent a G axis problem, but there are solutions.
- UNRMS implemented with real data represents a far greater data aggregation and processing challenge than UNFC.





UK ICE SRM Circular Economy



University of Exeter



Brunel University London



British Geological Survey



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**SAVE THE DATE**  
SUSTAIN Conference 2024  
**SUSTAINABILITY IN STEEL**  
8th-10th July 2024  
Swansea University Bay Campus

Register your interest



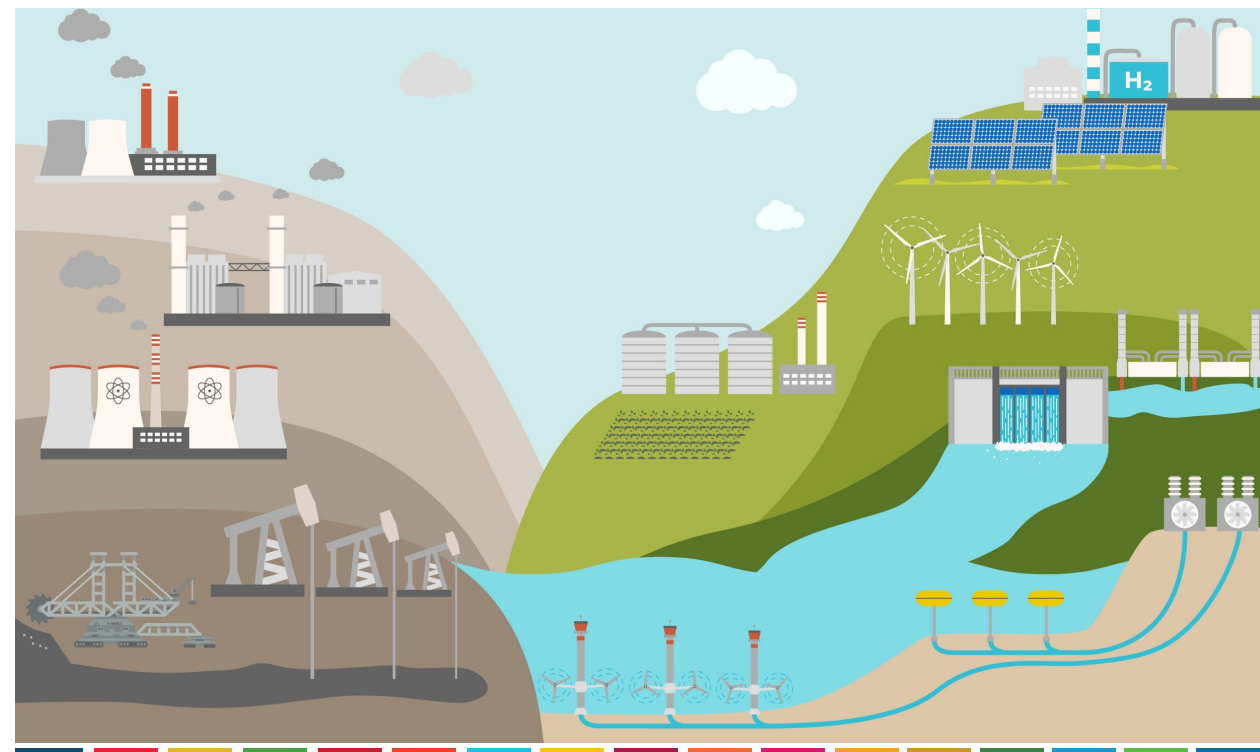

THE VIEWS EXPRESSED ARE THOSE OF PROFESSOR CAMERON PLEYDELL-PEARCE AND DO NOT NECESSARILY REFLECT THE VIEWS OF THE UNITED NATIONS.

# Thank you!

Professor Cameron Pleydell-Pearce

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Date 24 | 04 | 2024, Geneva



## RESOURCE MANAGEMENT WEEK 2024



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