UNRMS: Considerations for steel recycling

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Activity Summary

- 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**

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

**Resource Availability**

End-of-life scrap availability

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

**Conclusions:** The EOL-RIR parameter used in the methodology serves only as a substitute of a Supply risk related to secondary raw materials, which cannot yet be calculated due to missing data. Imports of “wastes and scraps” are not considered as part of the Supply Risk parameter. Additionally, recycling is considered as a riskless supply of secondary raw materials, which may not realistically reflect the reality.

**Recommendations:** Further expansion of MSA studies and updates are needed.

**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.

Competitive Advantage

Historical Trend

Current Consequences

Fe...... +Cu +Ni + Sn + Cr
Steel Recycling (Solution)

Historical Trend

Competitive Advantage

Robust & Differentiated Products

Future Trend

The Materials Passport / UNFC / UNRMS

Re-Use, Repair & Re-Manufacture

Fe...... +Cu +Ni + Sn + Cr
Current (UK) Scrap Steel Specifications

0A

1

2

3A

3B

4A

4C

4D

4E

4F
Scrap: Quality vs Quantity – G Axis

### Confidence in Estimate

<table>
<thead>
<tr>
<th>Steel Route</th>
<th>UK Proportion</th>
<th>Inherent Copper</th>
</tr>
</thead>
<tbody>
<tr>
<td>BOF Steel</td>
<td>70%</td>
<td>&lt;0.05%</td>
</tr>
<tr>
<td>EAF Steel</td>
<td>10% 0.20%</td>
<td>10% 0.30%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Total &lt;0.125%</td>
</tr>
</tbody>
</table>

### Statistical Modelling

- Position in uncertainty range
- Estimated Inventories
- Multi-scale Sampling & Measurement
- Confidence in Estimate
- Steel Route: BOF Steel 70% <0.05%, EAF Steel 10% 0.20%, 10% 0.30%, 10% 0.40%, Total <0.125%
- Estimated Inventories
- Statistical Modelling
- Raw Materials: Steel Route UK Proportion Inherent Copper
  - BOF Steel: 70% <0.05%
  - EAF Steel: 10% 0.20%, 10% 0.30%, 10% 0.40%
  - Total: <0.125%
Data Integration using Ontologies

Steel Product
- Hot-Rolled Coil
- Cold-Rolled Strip

Steel Making Process
- Hot Rolling
- Casting
- Finishing Mill

Steel Making Facility

Ontology

Material Composition
- Coil ID
- DOM
- Grade
- Carbon %
- Silicon %
- Width

Process Parameters
- Roller ID
- Coil ID
- Rolling Speed
- Rolling Direction
- Rolling Force
- Schedule

Knowledge Graph

Relational Database
Data Aggregation via Knowledge Graphs

Large Language Models (GPT 3.5) → Query Language (SPARQL) → Virtual Knowledge Graph (Ontop) → Ontology (Protégé) → Database

Mapping

Query Language (SPARQL)

Query Result

Query

Query

Query Result
Summary

- Recycling rate is limited by composition as well as availability leading to large differences in CO$_2$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.
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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