Lessons Learned in Developing an EPD Program for the Asphalt Industry

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Environmental Product Declaration (EPD) Program

- Program operator: National Asphalt Pavement Association
- Product Category Rules
  - A PCR committee of 10 stakeholder (2014–2015)
  - ISO 14025/ EN 15804 compliant: March 2017
- Supporting Life Cycle Assessment
  - ISO 14040 compliant: December 2017
- Automated EPD generation using a web-based tool
  - Verification of software: Completed
Product Category Rules: Challenges

- Identify the following:
  - The scope of the product: HMA + ?
  - System boundary: how far upstream do we go?
  - Data: sources and integrity

- The declared unit: 1 US Ton of Asphalt Mixture
  - Not functional unit
Defining System Boundary

- Motivating question:
  What is the System Boundary for the proposed LCA?

- Various challenges
  - Exclusion criteria
  - Allocation

- Data sources

Guiding principle
What factors do producers have control over
Life Cycle Perspective

Cradle-to-Gate: A1-A3
Challenges in Defining Scope

Motivating question:

*Should the EPD certify one representative mix for all mixes from a plant, or should each specific mix have an EPD? What about different kinds of mixes?*
Challenges in Defining Scope

- Product scope: asphalt mixture
  - Only Hot or Warm Mix
  - Families of mix designs
  - Modified asphalts
  - Quicklime/Lime treatment
  - Warm mix additives
  - Recycled materials
- Meeting DOT specifications
Mix Family Definition

- Reference a baseline virgin mix
- Reduction in virgin binder content by 50%
  - Either by RAP introduction
  - Or by RAP + RAS introduction
- Families defined by initial virgin mix binder content
  - 5% virgin mix
  - 8% virgin mix
Reduction in GWP / 1% reduction in binder content

5% Virgin Mix
- 11.4% - by RAP
- 10.9% - by RAP+RAS

8% Virgin Mix
- 8.8% - by RAP
- 8.4% - by RAP+RAS
Data Types

- Upstream Data: Raw materials and transportation
  - Spans across disparate supply chains
- Plant Operations Data
  - Directly reported by plant managers – energy, mix, product specification
  - Sometimes transportation data included
Challenges: Upstream Data

- Availability
  - US LCI data is limited
  - Open and freely available vs. proprietary data
  - Transparency of datasets
  - Reliability: consistency across shared system boundaries

- Appropriateness
  - Programmatic issues regarding access
  - Comparability of LCA outcomes
Sensitivities to Upstream Reporting

- Allied upstream industries
  - Asphalt binder: critical contributor
- Associated supply chain relationships
  - Additives, rejuvenators, polymers
- Identifying sensitivities to alternative upstream datasets
  - Between 25-30% depending on use of EcoInvent, USLCI and Datasmart
Primary Data: Number of Plants Surveyed

- Excel spreadsheets provided to plants.
- Plant visits: personal meetings with plant managers.
- 51 plants from different regions
  - Plant operating energy consumption
    - Electricity
    - Natural gas
    - Other fuels
  - Plant emissions (estimated using AP-42 – reported by plants)
  - Plant production rate (tons/hour) and efficiency
  - Plant water usage: dust control and as additive
  - Mix design and percentage production
Primary Data Trends: Electricity

Electricity (kWh) vs. Total Production (US Ton)

Av. Electricity kWh/ton

Av. Electricity kWh/ton
Primary Data Trends: Energy

Total Energy (BTU) vs. Total Plant Production (US Ton)

Average Energy Btu/ton

<table>
<thead>
<tr>
<th>Region</th>
<th>Average Energy Btu/ton</th>
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<tbody>
<tr>
<td>NE</td>
<td>3.00E+05</td>
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<tr>
<td>CN</td>
<td>3.00E+05</td>
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<tr>
<td>MW</td>
<td>2.50E+05</td>
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<td>MA</td>
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<tr>
<td>NW</td>
<td>2.50E+05</td>
</tr>
<tr>
<td>SW</td>
<td>2.50E+05</td>
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</tbody>
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Region: NE, CN, MW, MA, NW, SW
Need for Creating Plant Data Inventories

- Plant performance as compared to National and Regional Performance
  - Establishing confidence intervals for reporting
    - Electricity (kWh/ton): $(3.32 \pm 0.5)$ kWh/ton; $(n = 34)$
    - Energy (Btu/ton): $(2.89 \times 10^5 \pm 0.52 \times 10^5)$ Btu/ton. $(n = 32)$
  - Distances travelled:
    - Aggregate: $21.5$ ton-miles/ton (standard error: $7$ ton-miles/ton, $n = 15$)
    - Asphalt binder: $3.9$ ton-miles/ton (standard error: $1.3$ ton-miles/ton, $n = 19$)

- Towards characterizing uncertainty
- Establishing benchmarks for EPD verification
Towards Automated EPD Delivery
Summary

- A PCR was developed for Asphalt Mixtures
  - Challenges with scope and system boundaries addressed
- Challenges with upstream life cycle inventory data
  - Need for transparency and completeness
- Primary data was collected from 51 plants in the US
  - There are meaningful trends in use patterns
  - Foundations of a tool for influencing design
Thank You
Data Trends: Aggregate Production

**Energy Trends for Aggregate Plant**

- **Energy**
  - Equation: $y = 36961x + 3E+09$
  - $R^2 = 0.96507$
- **Electricity**
  - Equation: $y = 1E+06e^{0.7x}$
  - $R^2 = 0.79735$

Plant Production - including capped production (Tonnage)
Bitumen Production Process

1. Extracted Crude Oil (Raw Material)
2. Barge Transportation
3. Refining Process

Energy Source

- 1.00 kg of Petroleum
- Binder + Co Products
- Polymer Modification (Ground Tire Rubber)

We need a placeholder while AI develops LCA

Asphalt Mixture EPD

Issued by AI
Virgin Aggregate

- Extraction/Mining
- Processing
- Transportation

Energy Source (Fuel, Gasoline, Electricity)

Raw Material

Portland Cement Association - Fuel/Electricity Inputs
- Sand and Gravel production: 19,940 Btu/ton
- Coarse Aggregate from crushed stone: 30,469 Btu/ton
Recycled Aggregate

Previous life

Processing

Transportation

Energy Source (Fuel, Gasoline, Electricity)

Recycled Material

- Cut-off allocation method
- RAP Production: (Loader, Grinder & Screen)
  - EPA Study: 20 gal/hr (diesel) @ 350 ton/hr ~ 56,397 Btu/ton
- RAS Production: (Loader, Grinder)
  - EPA Study: 35 gal/hr (diesel) @ 53 ton/hr ~ 200,000 Btu/ton

Not Included