



# **Intersection of Life-Cycle Analysis Data and Emissions Inventories: A Case Study of Mobile Source Fuel Production**

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# Overview

- Context
- Mobile Source Fuel Example
- Today's session

*The views expressed in this presentation are those of the author and do not necessarily represent the views or policies of the U.S. Environmental Protection Agency.*

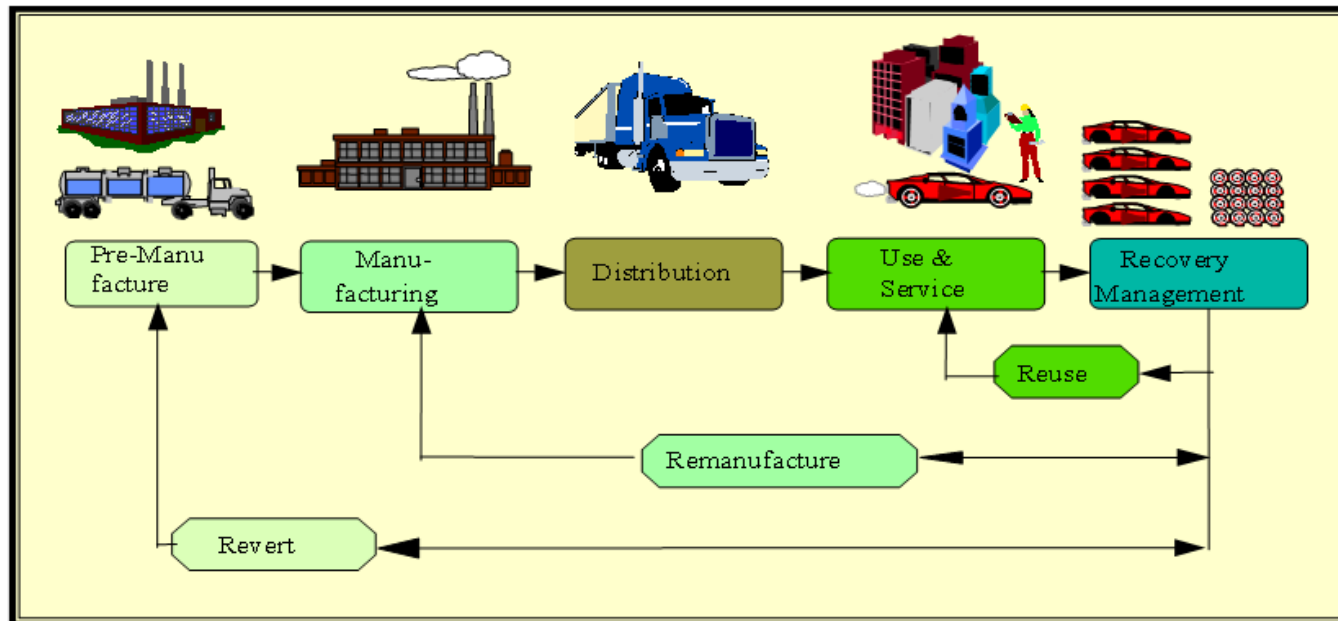
# Context: A Difference of Perspective



<https://xkcd.com/>

Two different perspectives often view the same event (or data) very differently.

# Context: Life Cycle Assessment and Emissions Inventories Perspectives



[http://grimstad.uia.no/puls/climatechange/graphics/lca\\_stages.png](http://grimstad.uia.no/puls/climatechange/graphics/lca_stages.png)

A life cycle perspective sees a series of sub-processes within a defined system boundary.



## Context: Life Cycle Assessment and Emissions Inventories Perspectives



An emissions inventory perspective sees a series of individual sources that may relate to any number of processes. Both perspectives are “right”.

# Context: Life Cycle Assessment (LCA)

- Life cycle perspectives
  - evolved from interest in comparing different options across the business value chain.
  - Today, ISO standards for life cycle assessment (LCA) methods
- Focus
  - processes involved with a particular product without addressing where the processes take place
  - Looking across life cycle stages & media --> Generally focus on only a few pollutants



LCA typically focuses on resources, emissions, and wastes associated with each stage of a product life cycle in order to compare different product choices.



## Context: Emissions Inventories (EI)



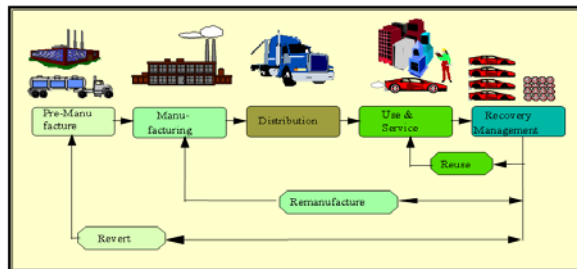
- Emissions Inventories (EI)
  - account for emissions from particular sources
  - Agnostic to larger process of a product life cycle

### Focus:

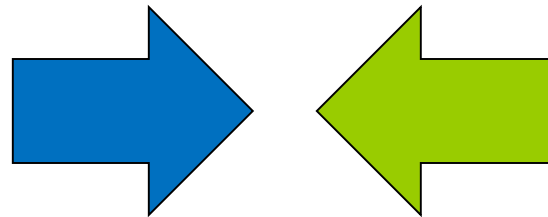
- characterize magnitude of emissions from individual sources
- air quality modeling or mitigation efforts
- number of pollutants included depends on EI

Emissions Inventories (EI) account for emissions from particular sources, regardless of how the source contributes to emissions in a larger process of a product life cycle, in order to inform air quality modeling or mitigation of emissions from specific sources.

## Context: Intersection of LCA and EI



Example product life cycle

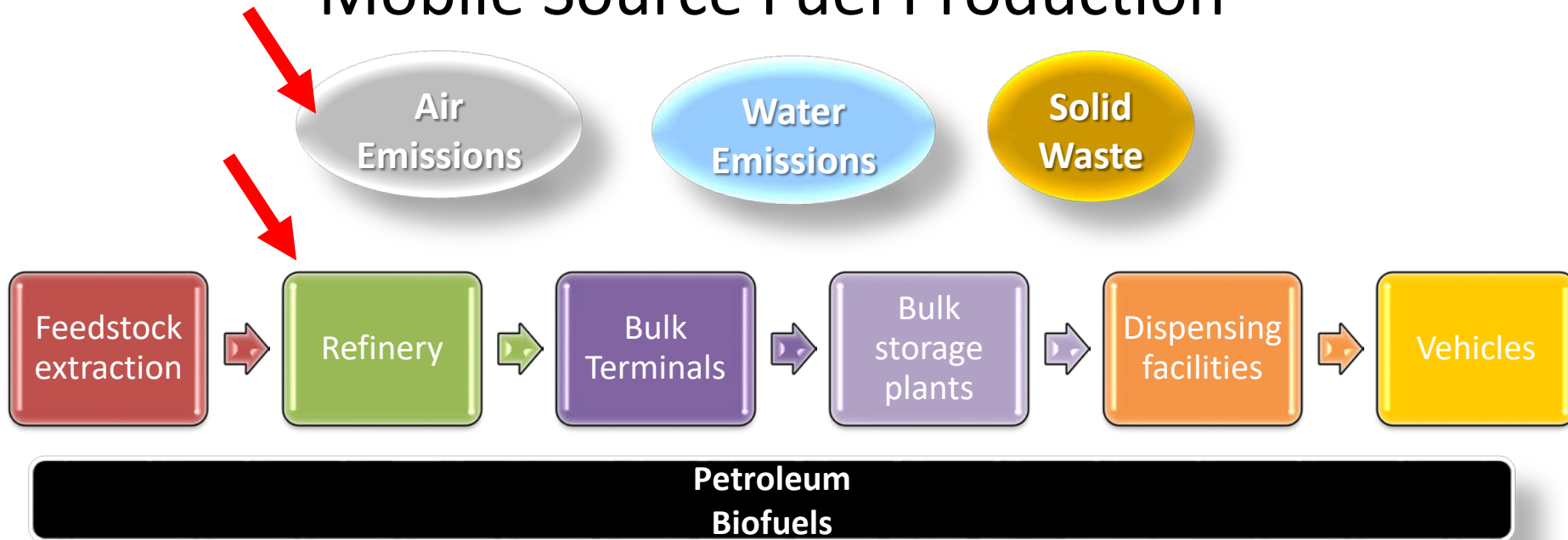


Hypothetical production facilities involved in one step of product life cycle depicted on left

Increasingly useful to look from both LCA and EI perspectives by utilizing data on multiple pollutants emitted in particular locations during a given process.



# Case Study Example: Mobile Source Fuel Production



As an example, we'll look at work in progress to combine LCA & EI perspectives by integrating process-based and inventory data sources; focus today is on petroleum refinery air emissions.



# Air Emissions from Mobile Source Fuel Production at Refineries: Available Data

- Previous work
  - Petroleum refinery emission factors (EFs)
  - Spatial, temporal, & chemical-speciation of EFs
  - National average or very detailed individual facility
- Case Study
  - Utilize National Emissions Inventory (NEI) and GHG Reporting Program (GHG RP) + fuel production data → refinery facility specific EFs from national datasets

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Fuel

journal homepage: [www.elsevier.com/locate/fuel](http://www.elsevier.com/locate/fuel)

A comparative assessment of resource efficiency in petroleum refining

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<sup>c</sup>Jacobs Consultancy Inc.,

**ENVIRONMENTAL Science & Technology**

Article

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**U.S. Refinery Efficiency: Impacts Analysis and Implications for Fuel Carbon Policy Implementation**

Grant S. Forman,<sup>a,\*</sup> Vincent B. DiVita,<sup>b</sup> Jeongwoo Han,<sup>a</sup> Hao Cai,<sup>a</sup> Amgad Elgowainy,<sup>a</sup> and Michael Wang<sup>a</sup>

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**ENVIRONMENTAL Science & Technology**

Article

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**A Spatially and Temporally Explicit Life Cycle Inventory of Air Pollutants from Gasoline and Ethanol in the United States**

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Lots of important work on this topic, some of which we'll hear about in today's session. Case study work takes slightly different approach for several reasons.



# Air Emissions from Mobile Source Fuel Production at Refineries: Case Study Approach

- EI data:
  - petroleum refinery emissions (NEI & GHG RP)
- Life cycle data
  - Quantity of product produced at each refinery
  - Details on product produced at each refinery (e.g., crude oil API gravity, gasoline/diesel split)

**Refinery & Blender Net Production**

Product: Conventional Gasoline    Period-Unit: Annual-Thousand Barrels

Download Series History	Definitions, Sources & Notes	2011	2012	2013	2014	2015	2016	View History
<b>U.S.</b>								
PADD 1		2,202,234	2,170,313	2,265,066	2,374,158	2,411,886	2,468,435	1993-2016
East Coast		615,670	605,047	617,409	640,655	675,080	704,919	1993-2016
Appalachian No. 1		75,689	80,583	81,245	83,207	86,965	88,149	1995-2016
PADD 2		684,032	685,509	715,946	771,975	804,508	823,235	1993-2016
Ind., Ill. and Ky.		421,055	411,012	421,302	459,379	509,943	520,952	1993-2016
Minn., Wis., Nev., Dak., S. Dak.		102,254	101,281	111,400	109,335	117,470	115,530	1993-2016
Okla., Kans., Mo.		159,713	168,216	183,244	192,358	177,093	184,703	1993-2016
PADD 3		618,458	584,479	616,398	637,274	650,772	646,620	1993-2016
Texas Inland		147,322	152,108	174,124	163,661	162,783	159,664	1993-2016
Texas Gulf Coast		212,863	199,144	199,394	207,522	234,668	214,233	1993-2016
La. Gulf Coast		156,317	133,107	135,565	144,139	137,213	143,455	1993-2016
N. La., Ark.		81,094	77,997	80,940	91,255	96,129	108,198	1993-2016
New Mexico		20,862	22,123	26,375	30,697	19,979	21,070	1993-2016
PADD 4		106,793	112,943	116,921	128,457	115,734	114,690	1993-2016
PADD 5		177,281	182,335	198,392	195,797	165,792	178,971	1993-2016

Notes: See Definitions, Sources, and Notes link above for more information on this table.  
Release Date: 5/31/2017  
Next Release Date: 9/29/2017

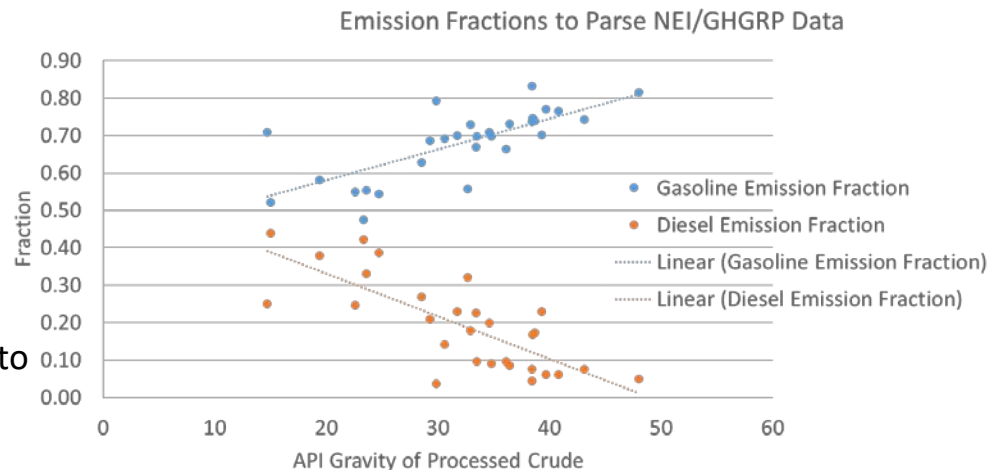
[https://www.eia.gov/dnav/pet/pet\\_pnp\\_refp\\_a\\_EPMOC\\_ypr\\_mbb1\\_a.htm](https://www.eia.gov/dnav/pet/pet_pnp_refp_a_EPMOC_ypr_mbb1_a.htm)

Case study combines EI dataset with data about one of the products moving through an emissions source at a specific life cycle stage (i.e., takes a life cycle perspective on EI data).



## Air Emissions from Mobile Source Fuel Production at Refineries: Case Study Approach

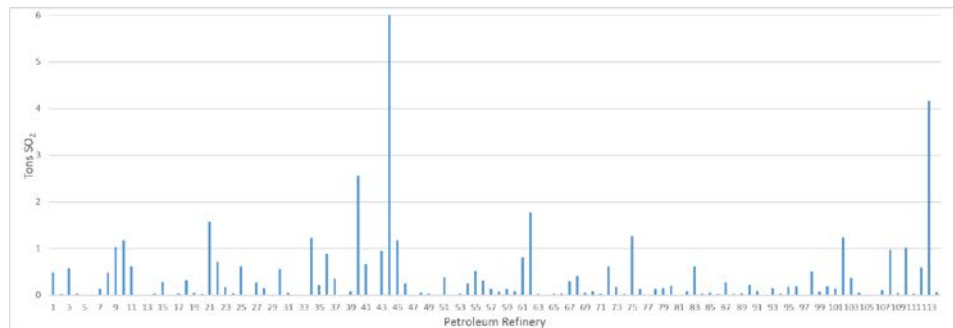
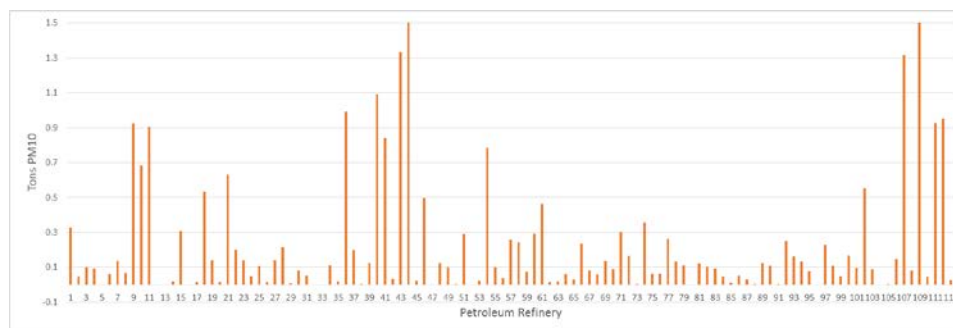
- Dilemma: How to allocate EI data from production of all products to two products (gasoline & diesel)?
- Petroleum Refinery Life Cycle Inventory Model (PRELIM) for predicting refinery performance & emissions (GHGs only)
  - apportions emissions to gasoline or diesel as a function of the crude API gravity
  - we developed reduced form model from PRELIM to allocate GHGRP and NEI emissions for individual refineries
  - used base year production data (Gas/Diesel split and crude use) from EIA to calibrate the model



To allocate emissions from one source type to specific products produced at the source type, we are using an existing model that apportions emissions based on information about feedstock material for the products being produced (API gravity of crude used to produce gasoline and diesel).



## Air Emissions from Mobile Source Fuel Production at Refineries: Case Study Results (Preliminary)



Preliminary case study results allow comparisons of emissions inventories specific to mobile source fuel production across different facilities and pollutant types.



# Intersection of LCA & EI: Today's Discussion

- **Objective:** Share and discuss different approaches to combining life cycle and emissions inventories perspectives.
- **Presenters**
  - Dan Loughlin, US EPA
  - Oge Kaplan, US EPA
  - Chris Tessum, U. Washington (Co-Chair)
  - David Meyer, US EPA
  - Pingping Sun, Argonne National Labs
  - Margaret Zawacki, US EPA
  - Giovanni Di Lullo, U. Alberta



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- Case Study
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    - Rich Cook
    - Molly Zawacki
    - Aman Verma, ORISE (former)
    - Alison Eyth
    - Jeff Vukovich
  - US DOT, Volpe Center
    - Alexis Zubrow
- Today's Session
  - Co-chair: Chris Tessum
    - Organizational support: Rich Cook
  - Presenters:
    - Dan Loughlin, US EPA
    - Oge Kaplan, US EPA
    - Chris Tessum, U. Washington
    - David Meyer, US EPA
    - Pingping Sun, Argonne National Labs
    - Margaret Zawacki, US EPA
    - Giovanni Di Lullo, U. Alberta