Workshop on Environmental Life Cycle Assessment for Pavements: Summary and Next Steps

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Nick Santero - Massachusetts Institute of Technology
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TRB, Toward More Sustainable Highway Infrastructure
January 24, 2011

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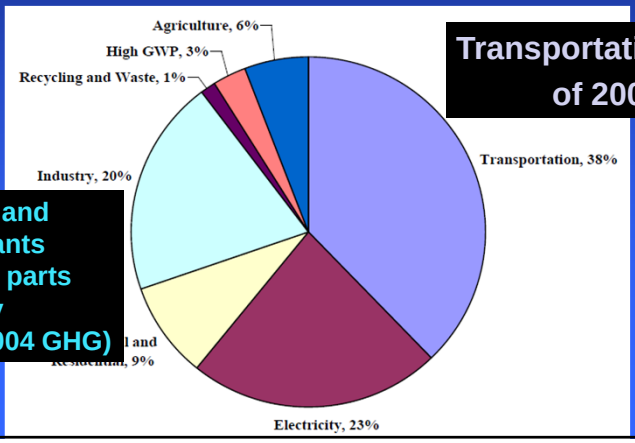
California's AB32 framework
(reaffirmed by voters November 2010)

- AB32 requires
  - 2020 GHG emissions at 1990 levels
  - 2050 GHG emissions at 0.2 x 1990 levels

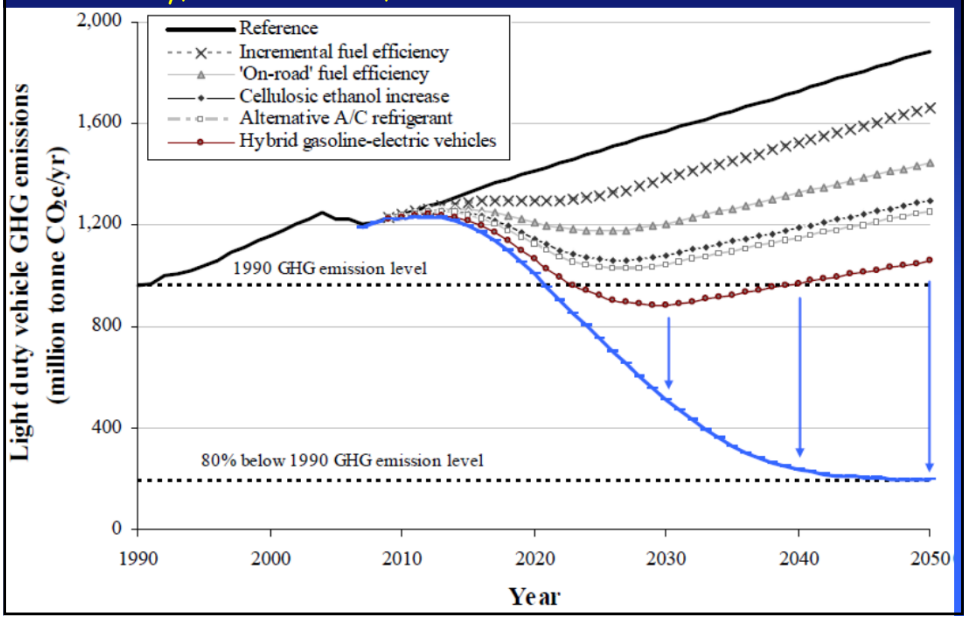


Transportation 38% of 2004 GHG

Refineries and cement plants significant parts of Industry (20% of 2004 GHG)

The "Gap" for Transportation

N. Lutsey, doctoral thesis, UC-Davis



MIRIAM

Models for rolling resistance In Road Infrastructure Asset Management Systems

FEHRL

Road Directorate

UCPRC

TRAFIKVERKET

vti

Statens vegvesen

IFSTTAR

MIRIAM

What is MIRIAM?

Project started in 2009 by 11 partners from Europe, incl two from USA

Pooled, internal funding (so far)

Aims at providing a sustainable, environmentally friendly road infrastructure …….

by reducing rolling resistance – hence lowering CO_2 emissions and increasing energy efficiency

Phase 1: 2010-2011
Sub-projects (preliminary)

1 Measurement methods and source model(s) (Leader: VTI, Sweden)

2 Influence of pavement characteristics on energy efficiency (Leader: AIT, Austria)

3 Importance of Rolling Resistance on efficiency within an LCA framework (Leader: UC Davis, USA)

4 Constraints / Requirements to implementation in Asset Management and LCA systems (Leader: DRI, Denmark)

5 External funding and raising awareness (Leader: DRI, Denmark)

MIRIAM
Models for rolling resistance in Road Infrastructure Asset Management Systems

Three Key Elements of Life Cycle Assessment

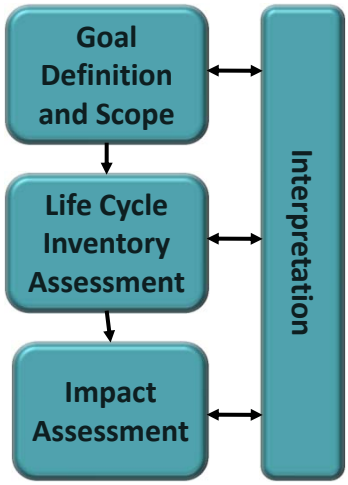
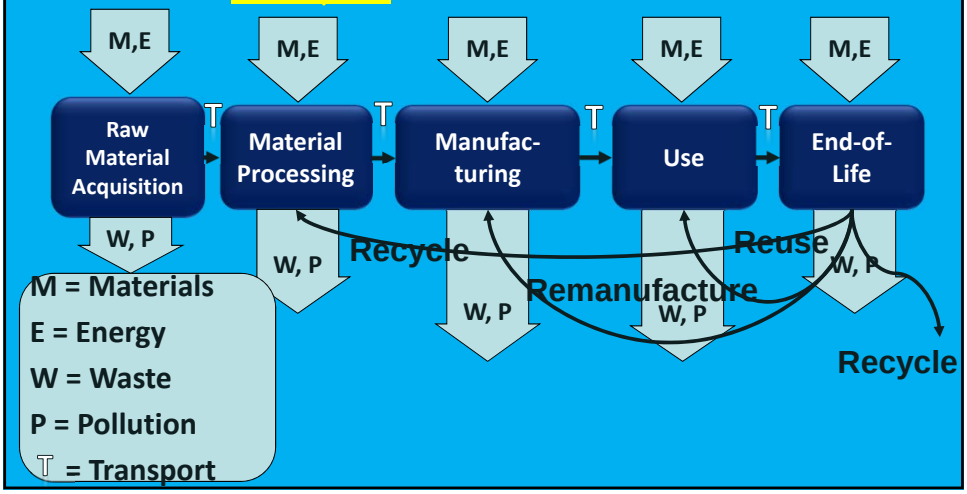


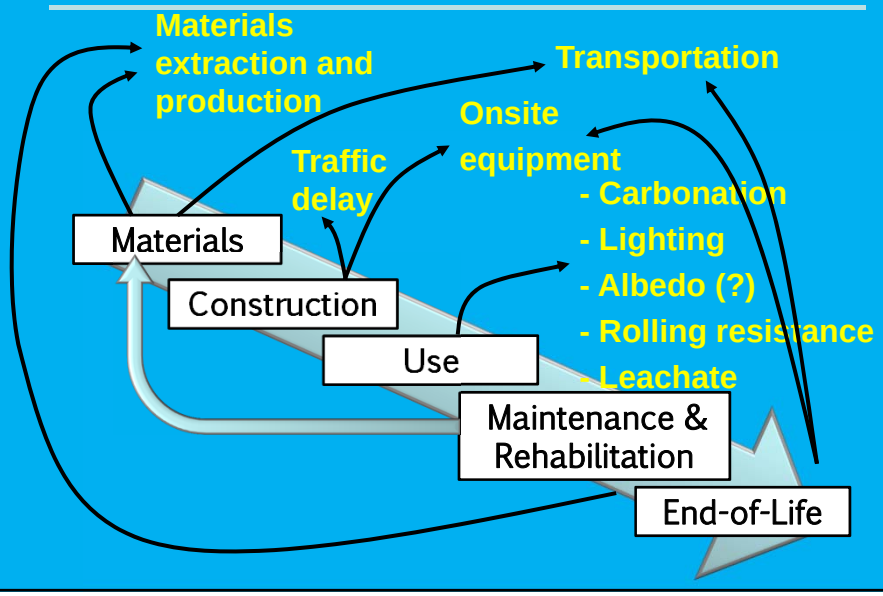
Figure based on ISO 14040 6

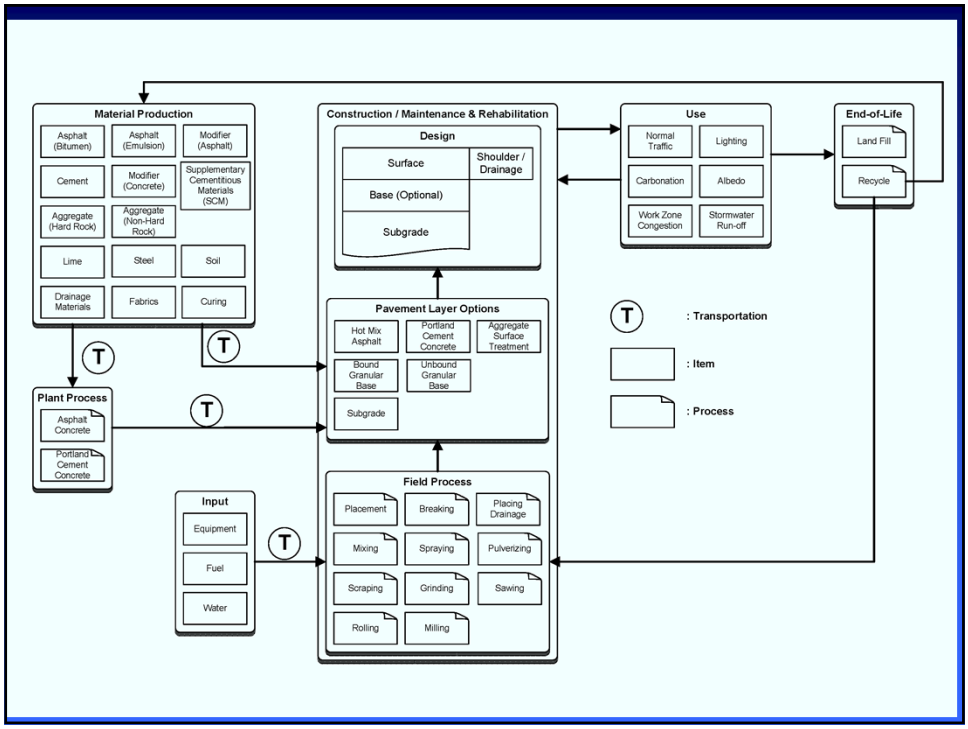
Generic Life Cycle Assessment

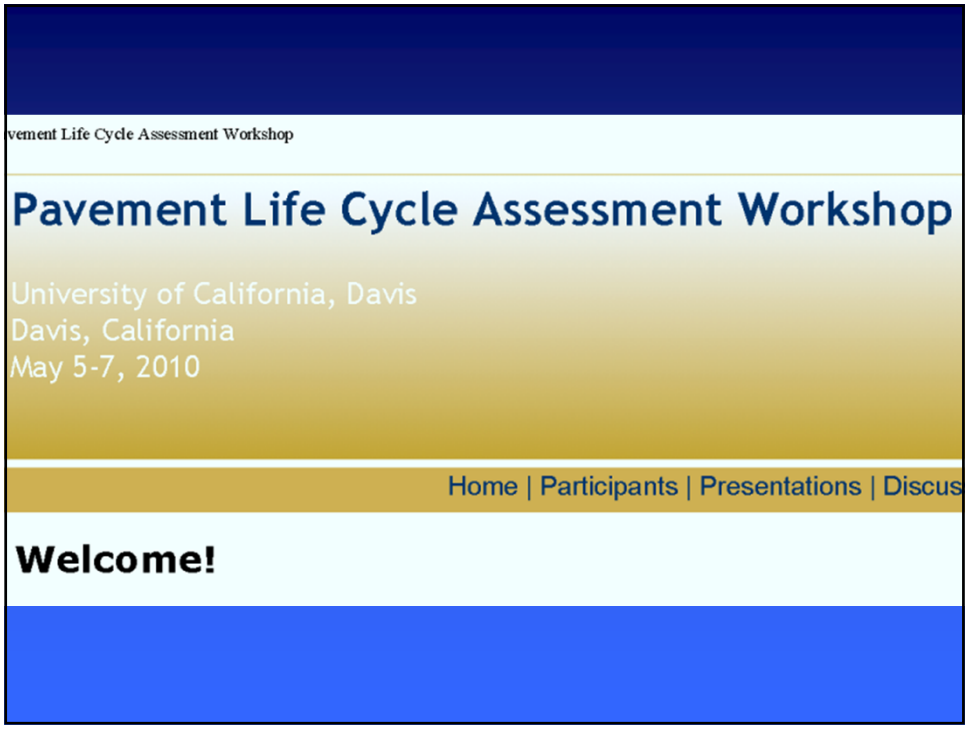
- Evaluates a product or system throughout its entire *life cycle*



The Pavement Life Cycle




Material Production
Asphalt (Bitumen)
Asphalt (Emulsion)
Modifier (Asphalt)
Cement
Modifier (Concrete)
Supplementary Cementitious Materials (SCM)
Aggregate (Hard Rock)
Aggregate (Non-Hard Rock)
Lime
Steel
Soil
Drainage Materials
Fabrics
Curing
Plant Process
Asphalt Concrete
Portland Cement Concrete
Input
Equipment
Fuel
Water
Construction / Maintenance & Rehabilitation
Design
Surface
Shoulder / Drainage
Base (Optional)
Subgrade
Pavement Layer Options
Hot Mix Asphalt
Portland Cement Concrete
Aggregate Surface Treatment
Bound Granular Base
Unbound Granular Base
Subgrade
Field Process
Placement
Breaking
Placing Drainage
Mixing
Spraying
Pulverizing
Scraping
Grinding
Sawing
Rolling
Milling
Use
Normal Traffic
Lighting
Carbonation
Albedo
Work Zone Congestion
Stormwater Run-off
End-of-Life
Land Fill
Recycle
T
: Transportation
: Item
: Process


vement Life Cycle Assessment Workshop
Pavement Life Cycle Assessment Workshop
University of California, Davis
Davis, California
May 5-7, 2010
Home | Participants | Presentations | Discus
Welcome!

LCA Workshop Documents
at www.ucprc.ucdavis.edu/p-lca
Open for public comment

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Collaborators:

ISAP TC APE Asphalt Pavements & Environment

International Society ISCP for Concrete Pavements

Additional Support Provided by:

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Workshop Objectives (1 of 3)

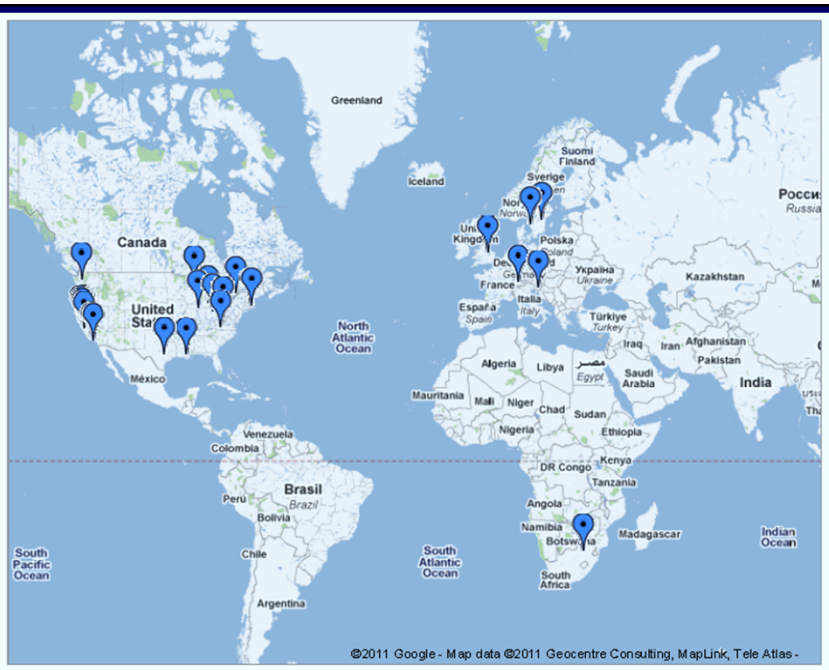
- Research products under development:
  - LCA framework for pavements
  - Summary of system boundaries and assumptions and examination of pros/cons of alternatives
  - Assessment of models/data for each phase of life cycle with regard to project type
  - Documentation requirements for pavement LCA studies sufficient to permit comparison between studies: completeness, assumptions, system boundaries and data/models.

Workshop Objectives (2 of 3)

- Desired Outcomes of the Workshop:
  - Review and discussion of documents prepared by research team (previous slide)
  - Brief presentations and discussion of critical issues for pavement LCA where conflicting practices or gaps in knowledge
  - Summary of areas of consensus and disagreement and documentation of alternative views.

Workshop Objectives (3 of 3)

- Expected benefits of workshop:
  - Improve assumptions, system boundaries, models and data by the research team for the California and Miriam studies
  - Better understanding of LCA among pavement LCA practitioners, sponsors and consumers of pavement LCA information
  - Recommendations for improvement of LCA practice
  - More transparency in the documentation of pavement LCA studies



UCPRC Pavement LCA Workshop Participants

42 views - Unlisted

Organization	Name
Athena Institute	Wayne Trusty
California Air Resources Board	David Edwards
Caltrans Environmental Analysis	Bruce Rymer
Caltrans Environmental Analysis	Jim Andrews
Caltrans Pavement Management	Tom Pyle
Caltrans Research & Innovation	Joe Holland
City of Chicago	Janet Attarian
City of San Jose	Amado Valdez
City of San Jose	Mike Witkovski
County of Los Angeles Pavement Management	Imelda Diaz
CTL Group	Martha VanGeem
Dynatest Consulting Inc	Nick Coetzee
Federal Highway Administration, Asset Management	Nadarajah Sivaneswaran
Federal Highway Administration, Pavement Technology	Gina Ahlstrom
Granite Inc	Chris Robinette
Graniterock Corp	Michael Taylor
Graniterock Corp	Mike Cook
Hanson Aggregates West	Bruce Carter
Holcim Corp	Barry Descheneaux
International Society for Concrete Pavements	Mark Snyder
Lawrence Berkeley National Laboratory	Mel Pomerantz
Lawrence Berkeley National Laboratory	Ronnen Levinson

Massachusetts Insitute of Technology	Alex Loijos
Massachusetts Insitute of Technology	Mehdi Akbarian
Michigan State University	Karim Chatti
Michigan Technical University	Amlan Mukherjee
Sonoma Technologies, contract to Caltrans Environmental Analysis	Mike McCarthy
Swedish National Road and Transport Research Institute, VTI	Robert Karlsson
Swedish Road Administration	Asa Lindgren
Swiss Federal Institute of Technology Zurich	Florian Gschosser
Telfer Oil	Hans Ho
Texas Transportation Institute	Jon Epps
The Right Environment Inc	Jeop Meijer (by phone)
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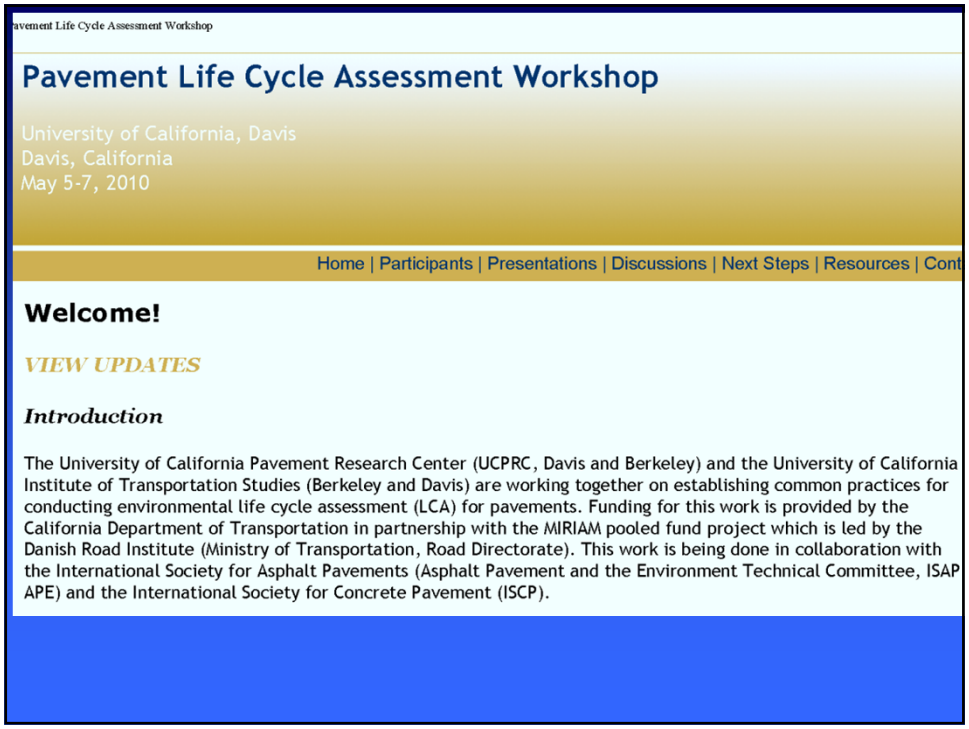
University of California, Berkeley	Arpad Horvath
University of California, Berkeley	Nakul Sathaye
University of California, Davis	Julie Schoenung
University of Nottingham	Tony Parry
University of Pittsburgh	Melissa Bilec
University of Pretoria, South Africa	Wynand Steyn
University of Washington	Steve Muench
University of Washington	Yen Yu Lin
Virginia Polytechnic Institute and State University	Gerardo Flintsch
ZAG Slovenia	Alenka Mauko
ZAG Slovenia	Janko Cretnik



Presentations

- Agenda [PDF]

Introduction

1. Workshop Introduction [P
   Presented by John Harvey

- A review the objectives of this workshop

2. Introduction to Life Cycle Assessment [PDF]
   Presented by Alissa Kendall, Nicholas Santero

- An introduction to LCA, including ISO 14040, and a simple, ge

3. The Pavement LCA Framework Proposed by UC Team [PDF]
   Presented by John Harvey, Alissa Kendall

Materials

4. How to Consider Bitumen Feedstock Energy [PDF]
   Presented by Nicholas Santero

5. Allocation of Impact from Co-Production [PDF]
   Presented by Alissa Kendall, Nicholas Santero

6. Average Data vs. Local Data [PDF]
   Presented by Thomas Van Dam, Alissa Kendall

Use Phase

7. MIRIAM Overview [PDF]
   Presented by John Harvey

8. Pavement Surface and Structural Characteristics and Vehicle Rolling Resistance
   Presented by Karim Chatti

9. Impacts of Pavement Surface Characteristics on Goods and Vehicle Damage
   Presented by Wynand Steyn

Multi-Criteria

10. Multi-Criteria Analysis (LCA and LCCA) and Implementation (PMS and other)
    Presented by Nakul Sathaye

Break-out Discussion Sessions

- Agenda [PDF]
- Full Discussion Summary: available at Resources page.

Briefing

- Preamble to Day 2 [PDF]
  Presented by Alissa Kendall

Q1: Critique the Framework

- Goal (focus on scale and purpose)
- System boundary
- Functional unit
- Assumptions
- Recommended models and data sources

Discussion Summary of Question 1 [PDF]

Q3: Bitumen Feedstock

- How should we interpret bitumen feedstock (or feedstock energy in general)?
- Bitumen as a fuel:
  - Do we consider the increased marginal emissions (CO_2, heavy metals, etc.)?
  - If so, how?
- Is the alternative life of upgrading important? If so, how should be included?

Discussion Summary of Question 3 [PDF]

Q5: Surface Characteristics and Rolling Resistance

- Do we have the right models?
- Can we have the information to adequately include the use phase?
- Beyond direct fuel use, where should the system boundary be drawn regarding ve
- In the document, is the modeling approach outline adequate for consideration of acceleration, deceleration)?

Discussion Summary of Question 5 [PDF]

Q7: Multi-Criteria Decision-Making

- In making a decision, how do you consider both cost and environmental impact?

Discussion Summary of Question 7 [PDF]

Q8: Time Horizon

- The analysis period refers to the time horizon during which the inputs and outputs assoc functional unit for a system or systems are inventoried. The initial construction of each different functional design life, and may be followed by a series of different maintenanc (M&R) activities to preserve its function. Properly assessing the pavement system over a a major challenge. Some proposed approaches to determine the analysis period include:
  - Using 1.5 times the longest functional design life among all alternatives
  - Using minimum next major rehabilitation activity
  - Annualizing/amortizing construction events

Discussion Summary of Question 8 [PDF]

Q10: Recycling Allocation and Material: "Down-cycling"

- Pavement materials may be recycled on-site or through an off-site recycling system. In e the burdens of recycled materials or repurposed to a specific pavement system is challe methods have been proposed in the LCA literature to address this challenge.
- One study considered allocation of recycled materials and assumed that each constructi for the materials it uses.
- A 50/50 method that allocates half the burden of producing and disposing of virgin mate construction event and half to the final construction event, which uses recycled forms o

Discussion Summary of Question 10 [PDF]

Q11: Heat Island Effect

- The heat island effect is the result of a pavement's albedo and emissivity properties:
  - Impact is increased electricity consumption due to cooling demand and increase runoff
- How and when should the heat island effect be included within a pavement LCA?
- Are the current models adequate? Are they scalable to project-level analyses?

Discussion Summary of Question 11 [PDF]

Q14: What are the questions faced by policy-makers and what outcon outcomes from LCA are necessary to answer these questions?

Discussion Summary of Question 14 [P

Next Steps

- Pavement LCA model is under development
- Rolling resistance model is under review
- Traffic model is under review
- Different recycle methods for pavement are under review
- ISO 12006 is under review

Resources

UCPRC Pavement LCA Guideline [PDF]

This UCPRC Pavement LCA Guideline includes:

1. LCA Framework and Standard Assumptions
2. Recommended Models and Data Sources (California or U.S. Focused)
3. Pavement LCA Checklist

To provide your feedback:

- Comment with log-in
- Comment without log-in
- Send comments to UCPRC P-LCA TEAM via Email

UCPRC Pavement LCA Workshop Discussion Summary [P

This UCPRC Pavement LCA Workshop Discussion Summary includes:

1. Main discussions for each question
2. Key outcomes from each discussion
3. UCPRC Pavement LCA team's actions in response to the discussions

Recommendations

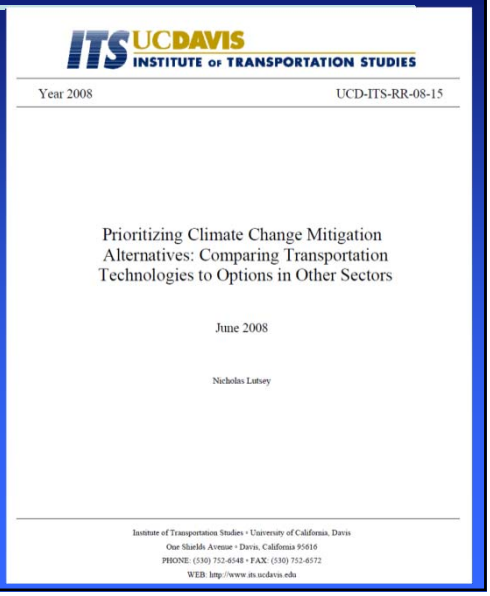
- We need to USE the transparency document checklist as LCA producers, and REQUIRE it as LCA consumers
- Move forward to identify/build regionally applicable data sets and models
- Establish outcome priorities and begin answering those most important questions
- Develop easy to use decision-making tools
  - best practice for distinct scenarios using LCA

Some Likely Alternatives in California to be Analyzed with Framework

- PMS roughness trigger criteria for GHG
  - Overlays, grinding
  - Considering traffic volumes
- Selection of surfacing based on macro-texture
- Design life
  - High-volume routes considering smoothness change
  - Urban streets considering utility cuts
- In-place, plant, secondary recycling considering transportation costs, local materials
- Continuous vs night-time construction windows to minimize delay, increase life and smoothness
- Urban heat island for large, hot cities
- Pavement type (albedo, perviousness, structure, etc) considering functional use and location
  - Highways, streets, parking lots, other paved areas

A framework for policy-making

- **Prioritizing Climate Change Mitigation Alternatives: Comparing Transportation Technologies to Options in Other Sectors.**
- **Lutsey, N. (2008)** Institute of Transportation Studies, University of California, Davis, Research Report UCD-ITS-RR-08-15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Year 2008 UCD-ITS-RR-08-15

Prioritizing Climate Change Mitigation Alternatives: Comparing Transportation Technologies to Options in Other Sectors

June 2008

Nicholas Lutsey

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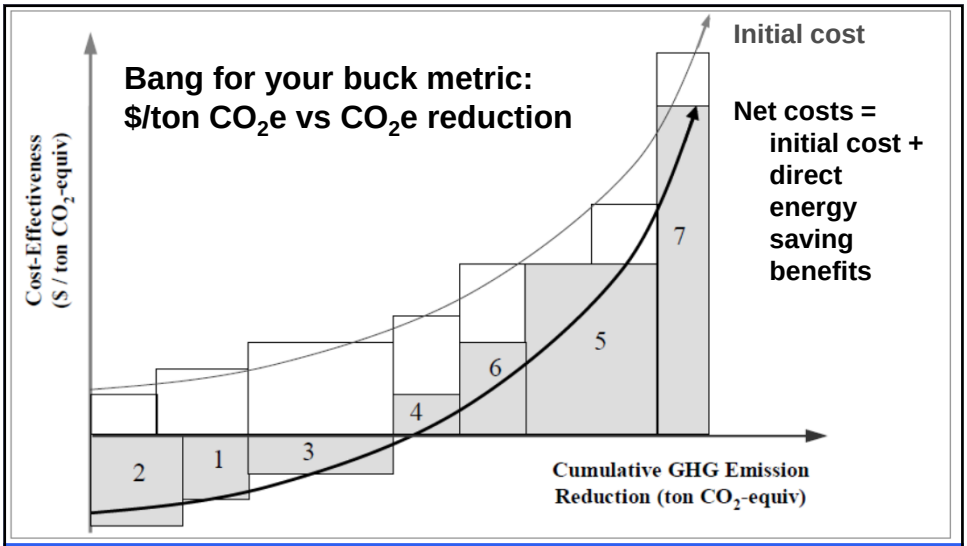
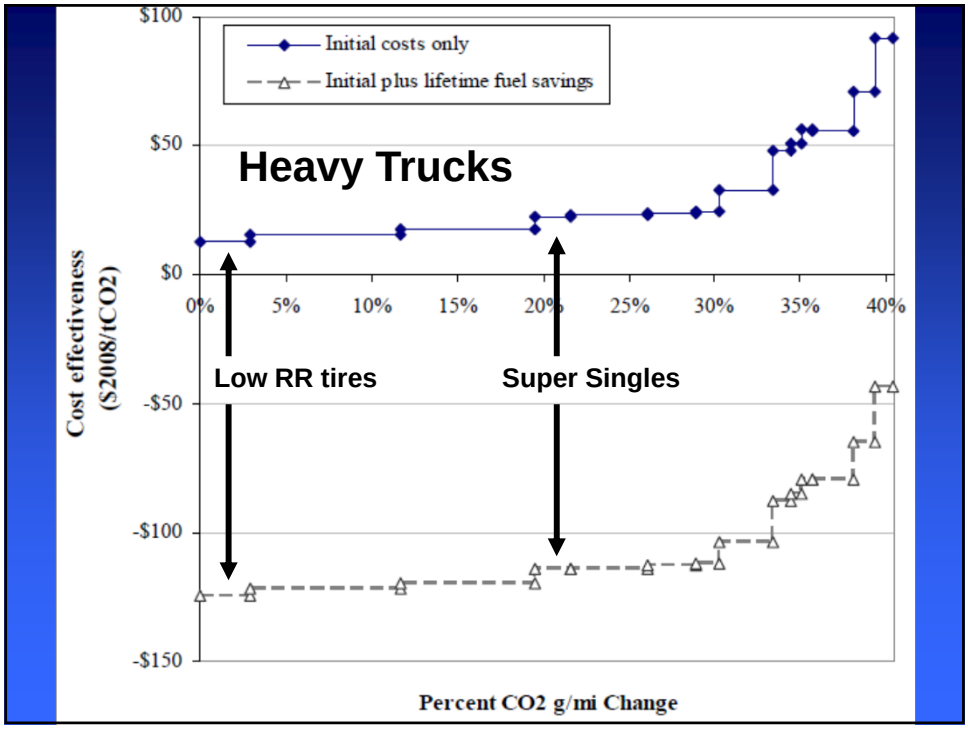


- Some devils in details, but permits quantitative critiques and "what-if" analysis to assess uncertainty in the data
- Lutsey's analysis relative to AB32 targets relative to benchmark 1990 GHG level



LCA Workshop Documents and to provide feedback at www.ucprc.ucdavis.edu/p-lca
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