ISAP Annual Meeting of Technical Committee on Asphalt Pavements and Environment
January 12th, 2014, Washington DC.

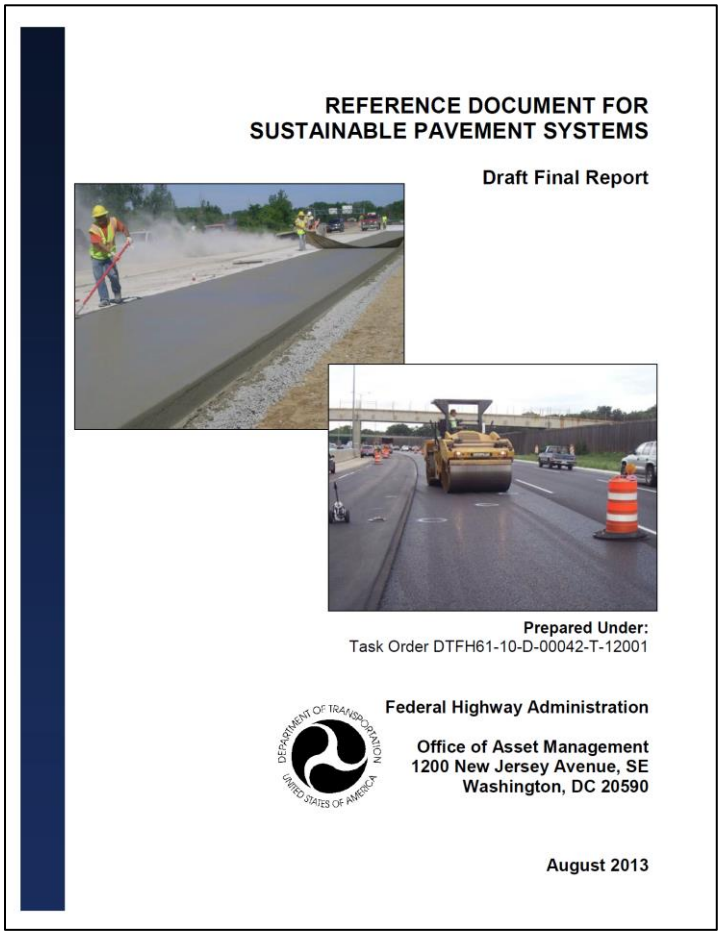
Report on Work Group Activities --LCA

John Harvey

UC Davis

FHWA Reference Documents for More Sustainable Pavements*

- Reference information for the pavement community on environmental considerations, synthesizing the large body of existing knowledge
- Chapters:
  - Concepts of Pavement Sustainability
  - Materials for Paving Applications
  - Design
  - Construction
  - Use Phase
  - Maintenance/Preservation/Rehabilitation Practices
  - End of Life Considerations
  - Pavements in Livable Communities
  - Assessing Pavement Sustainability
  - Summary and Future Needs



*:The exact title for this document is still under discussion.

U.S. Department of Transportation
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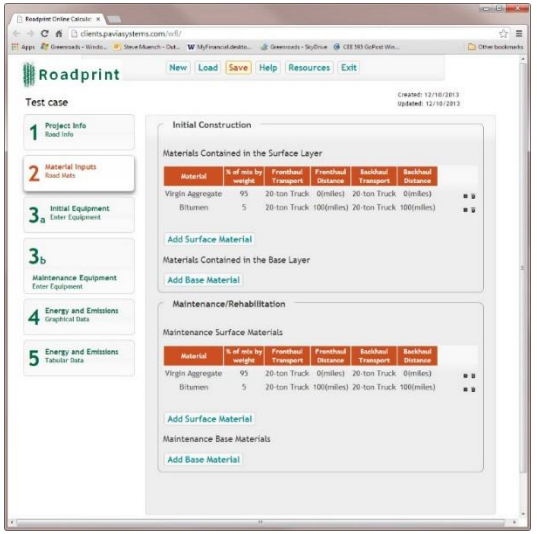
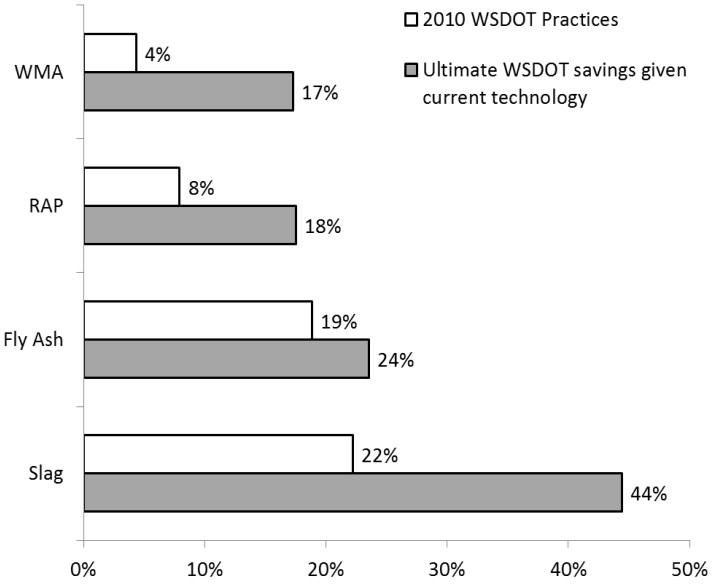
Roadprint: an Online LCA Tool for Pavements

- Sponsors:
  - Washington State DOT (WSDOT)
  - Oregon DOT (ODOT)
  - Western Federal Lands
- Researcher: University of Washington
- Completion date: 2013
- Develop an online LCA tool for pavements
  - Capable of being used by non-LCA pavement engineers in 15 minutes
  - Available online at: http://www.pavementinteractive.org/roadprint/



Impact on GHG Emissions of Evolving WSDOT Pavement Materials Practices from 1990 to 2010

- Sponsor: Washington State DOT (WSDOT)
- Researcher: University of Washington
- Completion date: 2013
- Quantify the change in GHG emissions for WSDOT between 1990 and 2010 due to paving practices
- Uses Roadprint LCA tool



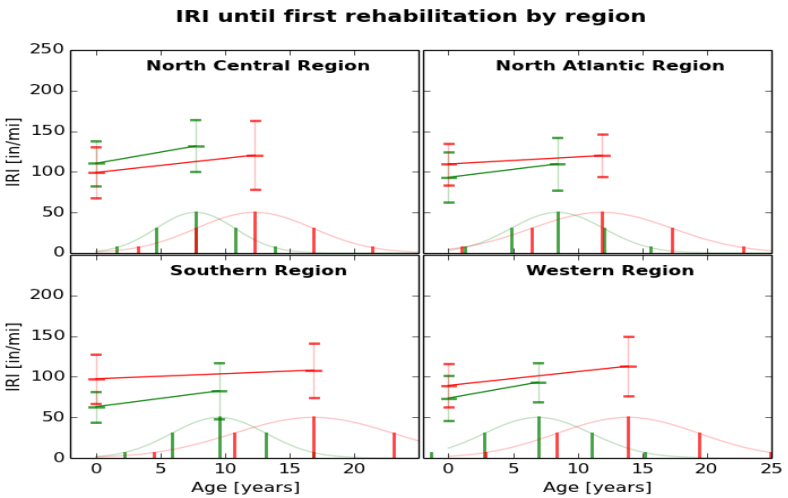
GHG emissions savings for HMA and PCC pavement materials production over 1990 baseline values (all practices were effectively not done in 1990).

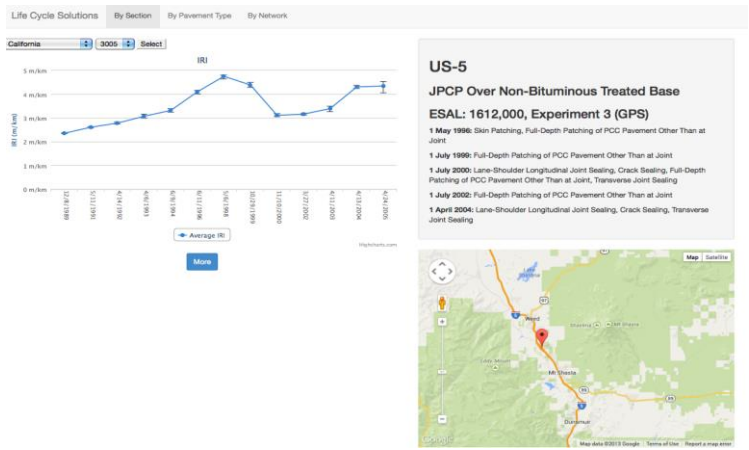
UNIVERSITY of WASHINGTON

Washington State Department of Transportation

Study to Relate IRI Change to Vehicle Fuel Efficiency

- Investigate factors that influence IRI
- Relate fuel efficiency (as a function of change in IRI) to:
  - Maintenance schedules,
  - Pavement type,
  - Regional factors.
- Apply results to Pavement Use Phase LCA
- Web-based interface to easily access and analyze LTPP IRI datasets





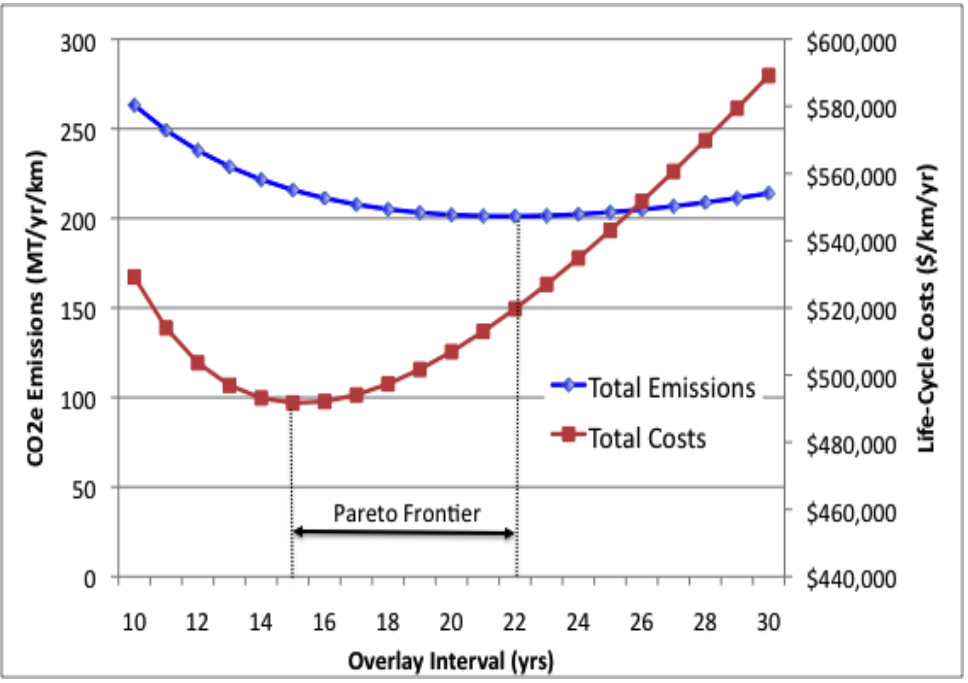
Michigan Tech
Michigan Technological University ®

Pavement M&R schedule optimization based on combined LCA and LCCA

- Modification of LCCA-based dynamic programming with inclusion of LCA
  - Refined the LCA framework into five modules (Material, Construction M&R, Congestion, Usage, End-of-Life)
  - Estimated environmental marginal damage costs based on literature data
  - Developed empirical relationship between roughness effect and vehicle speed based on California data: 1m/km increase of IRI leads to 0.84 km/h decrease of average speed
- Finding: The idea of integrating LCA and LCCA is promising but can be further improved
- Project funded by USF

USF UNIVERSITY OF SOUTH FLORIDA

Pavement Resurfacing Policy for Multi- criteria Minimization of Life-cycle Cost and Greenhouse Gas Emissions



- Jeffrey Lidicker, PhD
- Samer Madanat, PhD
- Arpad Horvath, PhD
- Nakul Sathaye, PhD

- Methodology to quantify tradeoff between saving costs or saving GHG emissions ($/kg CO2e)
- Steady state, continuous optimization
- Scope:
  - Segment or facility based analysis
  - Tailpipe emissions versus resurfacing emissions
  - User costs versus agency costs
  - Asphalt resurfacing only
- Ex: As pavement roughness increases (overlay interval increases), so does user costs and user emissions

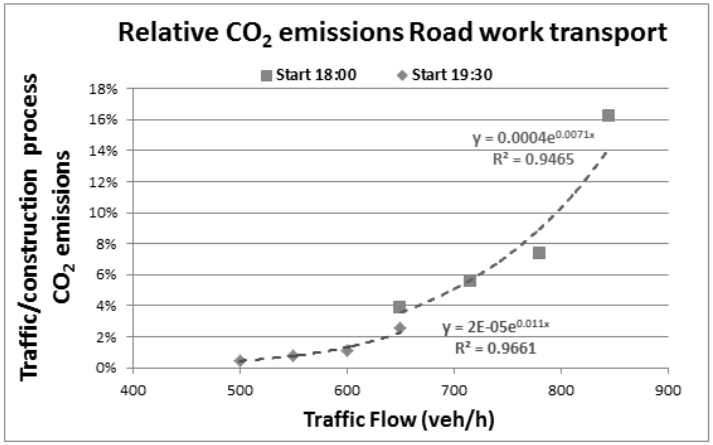
Including traffic delay emissions in pavement LCA

- Case study of UK rural single c/way (median traffic level), was used to compare mill-and-fill rehabilitation emissions with those from traffic delayed at roadworks (above free flow base case), at two start times and for existing and forecast traffic (up to 130%).
- Additional traffic emissions are relatively small but large enough to include in pavement LCA (above 1% threshold).
- Exponential increase with traffic level, shows that at least a hot-spot analysis is required before exclusion from system boundary, especially for long lifetime studies including traffic growth.

NTEC
Nottingham Transportation Engineering Centre

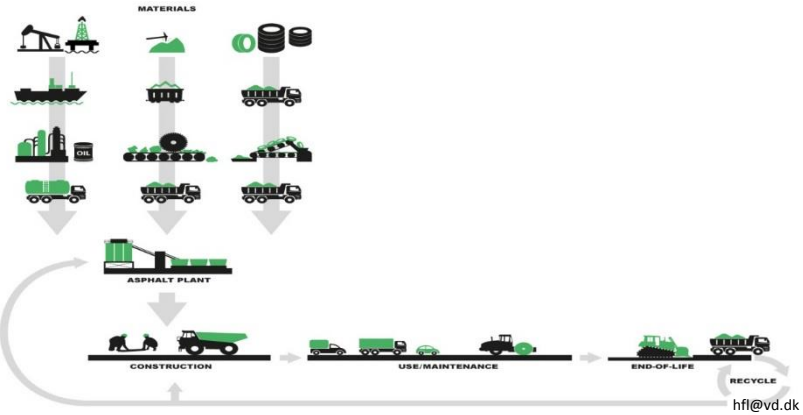
LIVERPOOL JOHN MOORES UNIVERSITY

Newcastle University



PoroElastic Road Surface (PERS): an innovation to Avoid Damages to the Environment (PERSUADE)

- LCA used to assess environmental sustainability of PERS (including polyurethane as binder and granulated rubber from used tires) as compared to conventional pavements.
- Preliminary results show that SMA-mix is more environmental sustainable than polyurethane based PERS-mix.
- Forthcoming LCA research including downstream phases, like paving and end-of-life, and especially the noise reduction obtained by the use of PERS, will give a more holistic picture of the relative environmental sustainability of PERS pavements.
- Project funded by EU.



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Assessment of the Sustainability (LCA) of using Reclaimed Asphalt (RAP) in Asphalt Mixtures

- PhD study at University of Antwerp – Fac. Applied Engineering
- Scope: assessment of the environmental impact (by LCA) when reclaimed asphalt (RAP) is used in hot and warm asphalt mixtures in Flanders (Belgium)
- First step: evaluation of generic simplified tools (accomplished)
  - asPECT, HA CCT, Changer: Limited to the assessment of CO_2eq
  - ECORCE, HA CCT, Changer, PaLATE: Impossible to add materials to the database
  - All: Not capable to compare the impact of small differences (e.g. in the asphalt mixture: mixing temperature, additives)
- Next steps:
  - Full LCA's with robust software (SimaPro) (on-going)
  - Final result: development of an easy-applicable and scientifically based software tool for industrial and governmental users to compare road constructions by LCA

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Paardenmarkt 92, 2000 Antwerpen, Belgium
PhD commission: Prof. Dr. Ing. Wim Van den bergh, Prof. Dr. Johan Braet, Prof. Dr. Ir. Anne Ventura, Prof. Dr. Ir. Amaryllis Audenaert

Universiteit Antwerpen

Riding quality effects on transported freight

- The study intends to demonstrate the potential economic effects of delayed road maintenance and management, leading to deteriorated riding quality and subsequent increased vehicle operating costs, vehicle and freight damage.
- It was concluded that road roughness data can be used in conjunction with appropriate models and relationships to evaluate the economic effect of road use by logistics companies through evaluation of Vehicle Operating Costs and potential damage to vehicles and freight.
- Road owners can evaluate the effect of different levels of construction and maintenance quality control on the outcome of these actions and the general transportation costs and deterioration rates of the infrastructure as affected by riding quality / road roughness.
- Project funded by Caltrans.

MIRIAM

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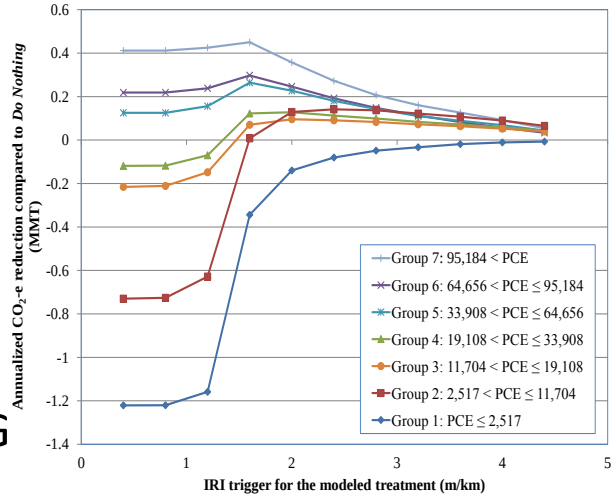
Optimal IRIs to trigger M&R on California Network

- Apply results from the case studies to the network with additional sensitivity analyses.
- Questions to answer:
  - Optimal IRI triggers to minimize the life cycle GHG emission on California highway network.
  - Cost effectiveness of treatments and IRI trigger for each traffic level.
- Models implemented in Caltrans PMS to calculate GHG of pavement M&R.



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Life Cycle Energy and GHG Emissions from Using Wide-base Tires on Trucks

- An LCA framework to evaluate the total energy consumption and GHG emissions from pavement M&R as affected by the use of wide-base tires.
- The preliminary results showed that the wide-base tires have similar or better environmental performance compared with standard dual tires, depending on the failure mode for the pavement.
- Project funded by FHWA.

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Verification of Pavement Structure and Deflection Effects on Vehicle Fuel Economy and GHG Emissions

- Analyze how pavement structure affects vehicle fuel economy and GHG emissions through the pavement deflection.
- Phase I: Work with modelers from MIT, University of Lyons, IFSTTAR, VTI, Symplectic Engineering (Berkeley, CA) and Michigan State University to obtain the modeling results.
- Phase II: Work with Michigan State University on the field experiments in California and verify the modeling results.
- Phase I funded by Caltrans.

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MIT vti SYMPLECTIC ENGINEERING CORPORATION

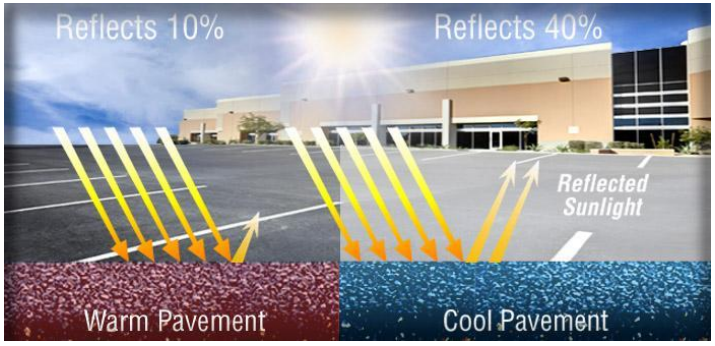
MICHIGAN STATE

IFSTTAR

Caltrans CALIFORNIA DEPARTMENT OF TRANSPORTATION

Life Cycle Assessment and Co-benefits of Cool Pavements

- The pavement albedo can contribute to the urban heat island.
- Develop a decision-making tool for California local governments to assess life-cycle impacts of deploying more cool pavement materials instead of BAU pavement practices.
- Project funded by California Air Resources Board, collocating with Lawrence Berkeley National Laboratory, PE International and USC.



California Environmental Protection Agency
AIR RESOURCES BOARD

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BERKELEY LAB
Lawrence Berkeley National Laboratory

UNIVERSITY OF SOUTHERN CALIFORNIA 1880

PE

Sustainability Rating System of the Illinois Tollway Infrastructure

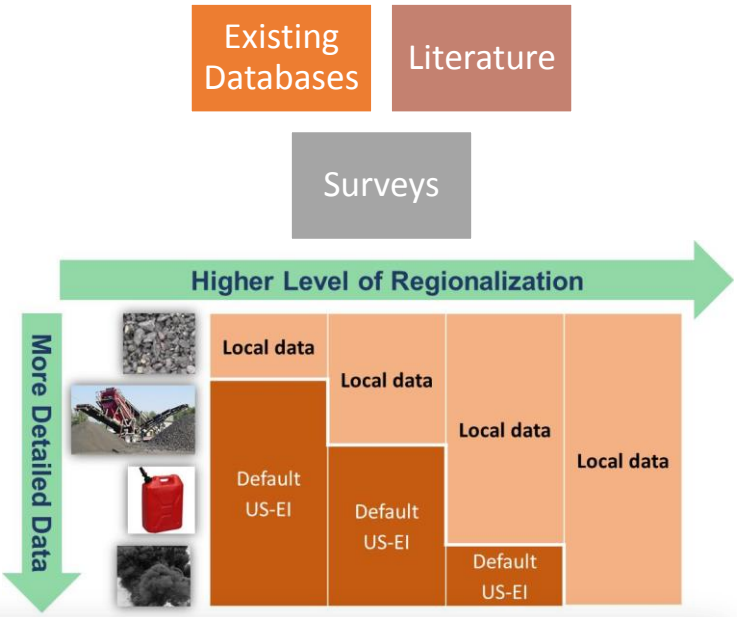
- The goal is to demonstrate the sustainability performance to the public, recommend best practices, and move towards a more sustainable portfolio
- FHWA's INVEST will be adopted by Illinois Tollway
- A roadway/roadside LCA tool is designed including pavement, drainage, structures, lighting, and landscape
- Tools are designed for multiple user types and stages (design, contract, construction)
- Project funded by the Illinois Tollway

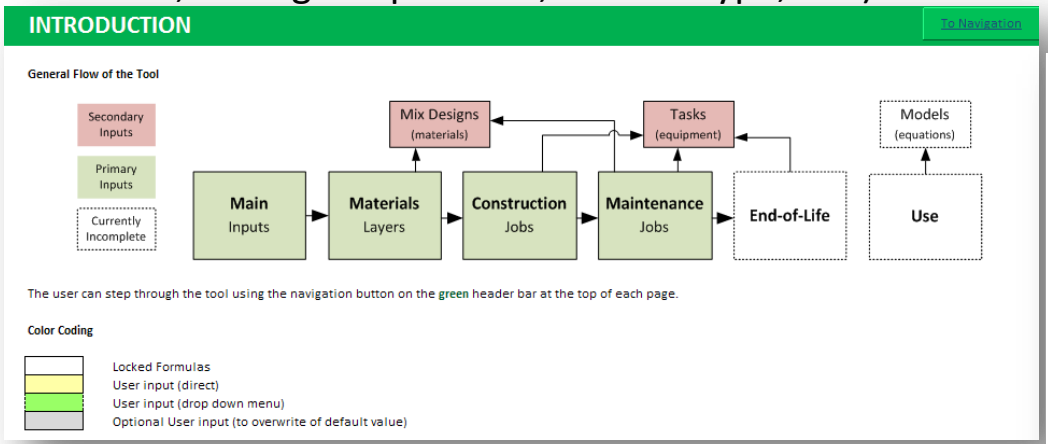
Sustainability Rating System (based on INVEST)

Components of Roadway/Roadside LCA

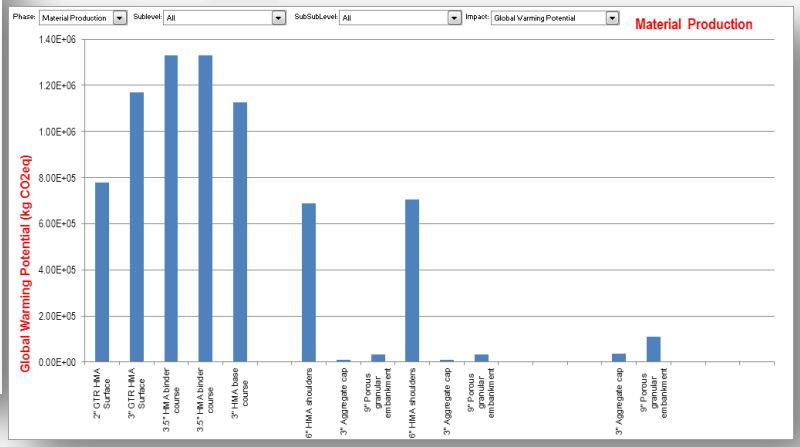
Regionalized LCA Tool for Roadways in Northern Illinois

- A regionalized pavement LCA tool is being developed for the Illinois Tollway
- Developed tool currently incorporates material, construction and maintenance phases – use-phase is in progress
- Inventory data sources: literature, response to regionally-distributed questionnaires, and commercial LCI databases
- Sub-models developed for asphalt binder, HMA and cement to quantify impacts due to changing variables (i.e., crude source, mixing temperature, cement type, etc.)





A user-friendly standalone excel-based LCA tool



Detailed environmental impact categorization

IFSTTAR ès JULLIEN : agnes.jullien@ifsttar.fr
ch Unit EASE Department AME

ECORCE2 (2013) a Life Cycle Assessment tool for construction and maintenance of roads (45 materials/processes LCIs)

http://ecorce2.ifsttar.fr

OFRIR2 (2013) a data base on materials (new and recycled materials) and 20 documents written as state of the art LCIs for construction and maintenance of roads

http://ofrir2.ifsttar.fr

- Focus on the implementation of Life Cycle Assessment for pavements.
- Coordinated with activities of the FWHA Sustainable Pavement Technical Working Group.
- A follow up to the 2010 Pavement LCA workshop at UC Davis and the 2012 RILEM meeting on LCA for pavement materials in Nantes, France.
- Website: http://www.ucprc.ucdavis.edu/LCA2014
- Sponsors:

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ISAP TC APE Asphalt Pavements & Environment

International Society ISCP for Concrete Pavements

Road Directorate

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