



SUSTAINABILITY: TOWARD “GREEN” ROADS

**2014 International
& Western States In-Place
Recycling Conference, Denver, CO**

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TOPICS OF TODAY'S PRESENTATION

- Sustainability definition
- What it means to be “sustainable” road
- Drivers of sustainable roads initiatives
- Sustainable pavement programs worldwide
 - DuboCalc from Holland
- Focus on green recycling technologies
 - Recycling HIR, CIR, FDR
- Long-term pavement performance studies
- Comparative LCA studies
- Conclusions

SUSTAINABILITY

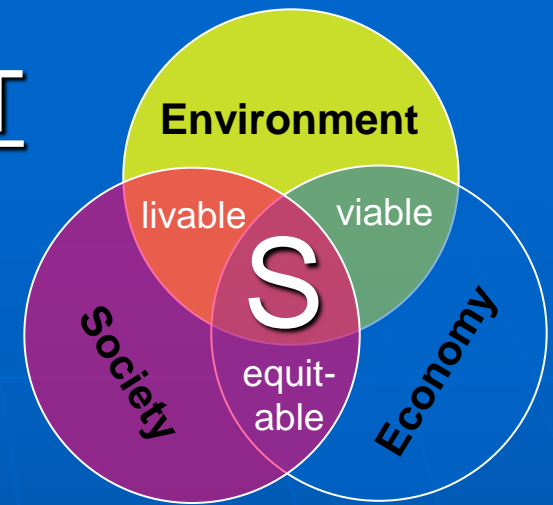


“development that meets the needs of the present without compromising the ability of future generations to meet their own needs.” (1)



(1) Brutland Report: “Our Common Future,” 1987, UN World Commission on Environment & Development.

SUSTAINABLE DEVELOPMENT



Economic
(GDP)
Growth

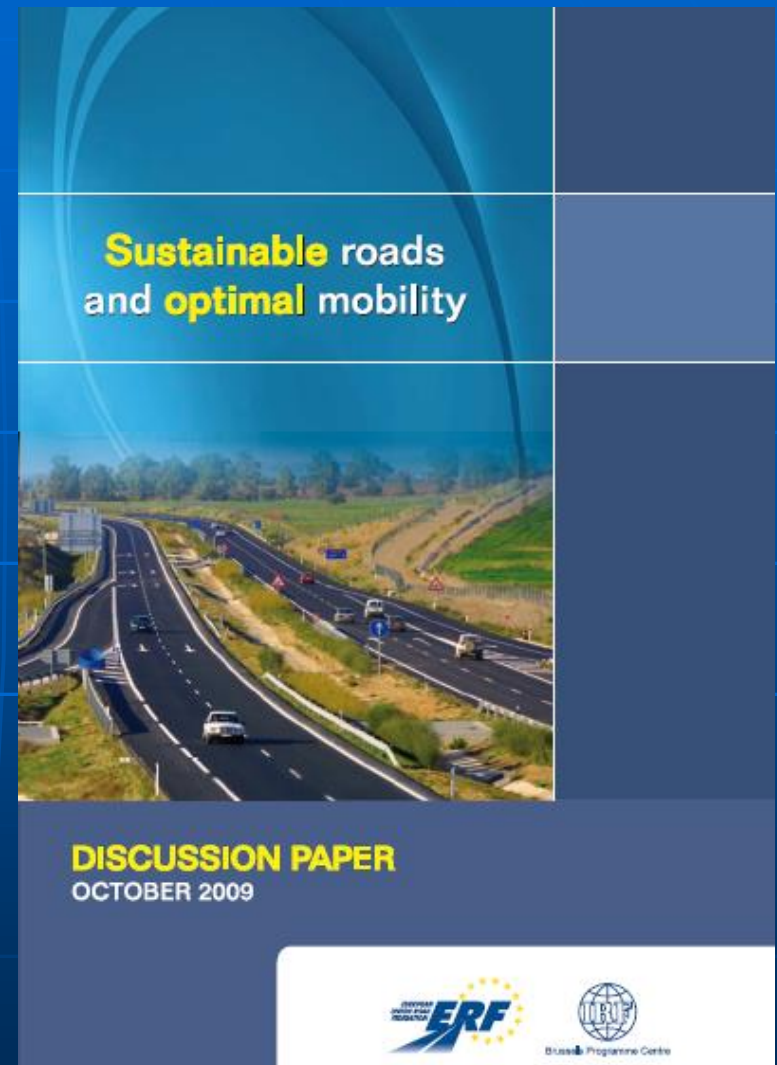
Neutral or positive
Environmental
Impact

Use of
land (natural resources) &
labor (manufacturing)
to meet current
demand levels for
goods & services

While conserving, reusing, &
renewing to prevent irreparable
resource depletion/damage
& / or waste accumulation

SUSTAINABLE ROADS: 2009

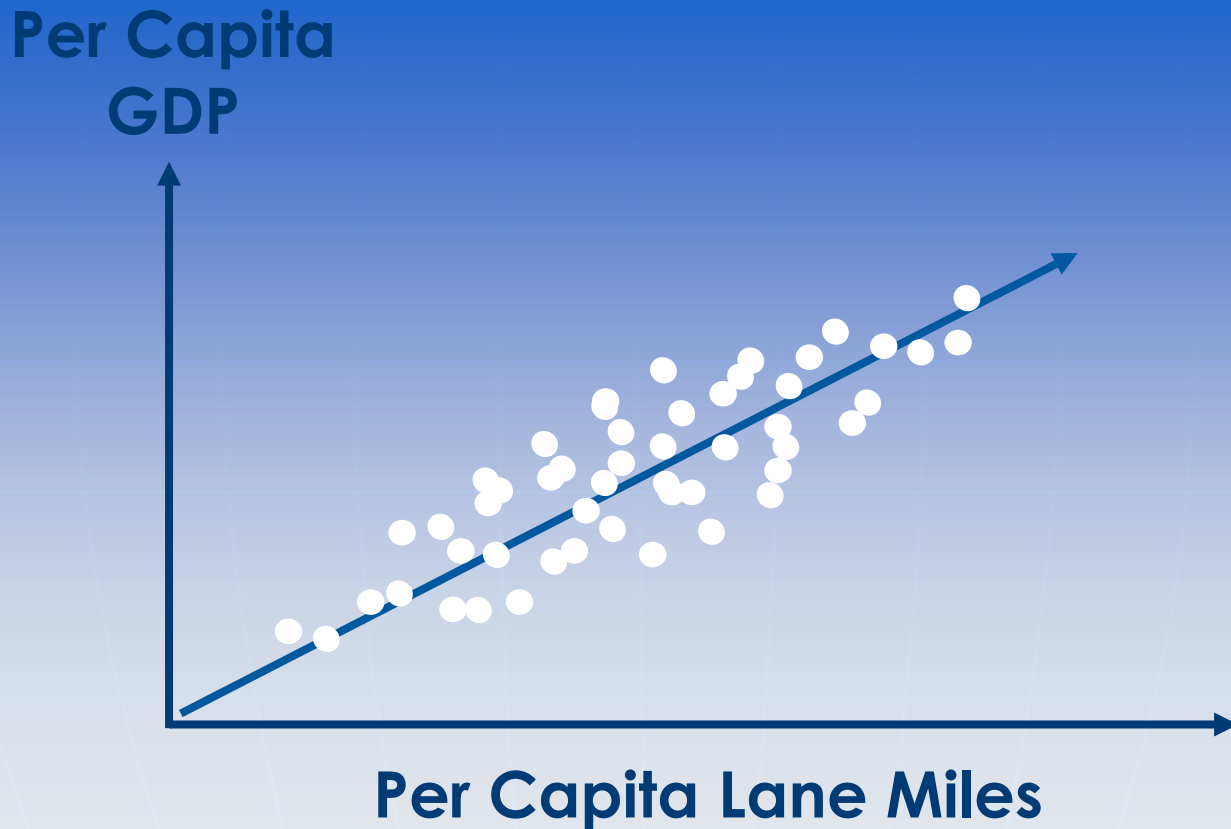
Roads that are “effectively & efficiently planned, designed, built, operated, upgraded, & preserved by means of integrated policies respecting the environment & providing the expected socio-economic services with optimal mobility & safety” (2) ensure sustainable economic growth.



(2) ERF & IRF BPC: “Sustainable Roads and Optimal Mobility,” October 2009.

WHY ASPHALT ROAD SUSTAINABILITY?

It is well-established that per-capita GDP growth is directly proportional to the length of the highway network.



SUSTAINABLE ROADS: TODAY

“ASPHALT
PAVEMENT
DURABILITY”

=

SUSTAINABILITY AND
ENVIRONMENTAL
LIFE CYCLE



SUSTAINABLE ROADS: 2014 IN THE EU

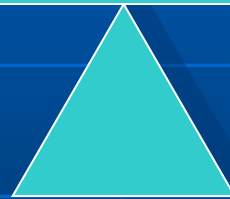
“ASPHALT
PAVEMENT
DURABILITY”

=

SUSTAINABILITY AND
ENVIRONMENTAL
LIFE CYCLE



**Pavement service life
and maintenance
treatments are
influenced by
durability**



SUSTAINABLE ROADS: 2014 IN THE EU

“...in a post fossil-fuel world...”

“...multiple recycling while maintaining long-term eco-stability...”

“...mitigating climate change...”



Conférence Européenne
des Directeurs des Routes
Conference of European
Directors of Roads

Mitigating climate change



February 2013

INCENTIVIZING GREEN ROADS

WRAP

DuboCalc

Highways Agency
Carbon Calculator
Tool

WLCO2T

JouleSAVE

CO₂

**Performance
Ladder**

CO2NSTRUCT

PaLATE

asPECT

ROAD-RES

AggRegain

LCI Model

Green
Roads

**AllBack2Pave
100% Recycling**

GHG
Calculator for
Infrastructure

SEVE

GreenDot

Ecologiciel

AMW

INCENTIVIZING GREEN ROADS: DuboCalc

Ministry of Transportation Netherlands

1. *The DuboCalc software*
2. *The Library: a reference database with basic information*
3. *The project document (or project data)*

Instructions for use of DuboCalc can be found at
<https://www.youtube.com/watch?v=LJY9QzxIW2w>

INCENTIVIZING GREEN ROADS: DuboCalc

- Calculate the environmental impact of material and energy use
- Judge the sustainability of a design relatively quickly and easily
- Achieve significant environmental results
- Based on the methodology of the Life-cycle Analysis (LCA)
- Takes into account all the relevant environmental effects during the entire course of a project
- Expresses the effects of the project on the environment
- Environmental effect categories
- These effects are then translated into shadow prices
- This result is expressed as the value in Euros of the ECI

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INCENTIVIZING: CO₂ Performance Ladder

Vendors qualify for five levels of demonstrable CO₂ management capabilities. With each level the owner (began with the rail agency in Holland) can offer **discounts off the tender bid**.

Level 5	10%
Level 4	7%
Level 3	4%
Level 2	2%
Level 1	1%

The screenshot shows the 'Supply Chain Initiatives Database' website. The header includes the logo and 'A PROJECT OF Institute for Industrial Productivity'. The main content area features a description of the database and a 'LEARN MORE' button. Below this, the 'Prorail's CO₂ Performance Ladder' is highlighted. The page includes a 'Share' and 'PDF' button, a 'BACK TO SEARCH' button, and a section for 'SCI Information' with details on activity types, purchasing approaches, the leading organization (Prorail), and the region (Europe, Netherlands).

Supply Chain Initiatives Database
A PROJECT OF Institute for Industrial Productivity

USING THE DATABASE
INSIGHTS

The Supply Chain Initiatives Database is an interactive and user-friendly database of case studies that describe supply chain initiatives for energy savings and GHG mitigation in industry.
[LEARN MORE](#)

Prorail's CO₂ Performance Ladder

Share PDF

The CO₂ Performance Ladder is a procurement tool whereby participating suppliers obtain external verification of their carbon management approach, scored on a 1-5 scale against a number of set criteria. A score of 5 is awarded an advantage equivalent to a 10% discount on the price of their bid in the tender evaluation process. Lesser scores receive smaller virtual discounts.
[BACK TO SEARCH](#)

SCI Information

Activity types: Purchasing Approaches
Organisation leading the initiative: Prorail
Region from which the initiative is led: Europe, Netherlands

INCENTIVIZING: CO₂ Emissions Calculators



United States Environmental Protection Agency

European Environment Agency



Carbon footprint
asphalt:

60 g CO₂ equiv/kg

INCENTIVIZING: CO₂ Emissions Calculators



United States Environmental Protection Agency

European Environment Agency



Carbon footprint
asphalt:

60 g CO₂ equiv/kg

Carbon footprint
orange juice:

1600 g CO₂ equiv/kg

Carbon footprint
cheese burger:

6000 g CO₂ equiv/kg



INCENTIVIZING: CO₂ Emissions Calculators



United States Environmental Protection Agency

European Environment Agency



Carbon footprint
milk:

2500 g CO₂ equiv/kg (17.6 lb CO₂ equiv/gallon)



INCENTIVIZING: asPECT in the UK

asPECT Version 3.0.0.4



About

This tool is an execution of the protocol for the calculation of life cycle greenhouse gas emissions generated by asphalt used in highways. It will calculate CO2 equivalent figures for each of the life cycle stages as per the criteria laid out in the above protocol and accompanying guidance document.

Online

Visit the Sustainability of Highways website for up to date information and the latest versions of the Protocol and Guidance documents and the asPECT software and users guide. <http://www.sustainabilityofhighways.org.uk>

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4 components of asPECT

- Protocol – a defined set of “rules” for footprinting asphalt products and applications
- Guidance – explains the decision making process behind the Protocol and provides worked examples
- Software – facilitates the calculation for those that choose to use it (calculations can alternatively be embedded into other company systems)
- Software User Guide

INCENTIVIZING GREEN: AllBack2Pave

Sponsor: Conference of EU Directors of Roads (CEDR)

Funding: \$620,000

Goals: evaluate feasibility of moving to **100% recycled roads**

Currently relying on WMA technologies

INCENTIVIZING GREEN: CoRePaSol

Advanced **C**old **R**ecycled Bitumen Stabilized **P**avement **S**olutions

Sponsor: Conference of EU Directors of Roads (CEDR)

Funding: \$480,000

Goals: evaluate feasibility of moving to 100% recycled base and binder layers

- Tasks:
- establish new mix evaluation procedures and pavement design protocol
 - establish long-term **ecostability**

INCENTIVIZING GREEN ROADS: USA



501(c)(3)

Project Requirements

- PR-1 Environmental Review Process
- PR-2 Lifecycle Cost Analysis
- PR-3 Lifecycle Inventory
- PR-4 Quality Control Plan
- PR-5 Noise Mitigation Plan
- PR-6 Waste Management Plan
- PR-7 Pollution Prevention Plan
- PR-8 Low Impact Development
- PR-9 Pavement Management System
- PR-10 Site Maintenance Plan
- PR-11 Educational Outreach

Environment & Water

Access & Equity

Construction Activities

Materials & Resources

Pavement Technologies

Custom Credit

2015 Pavement Test Track Conference

March 3-5, 2015

The Hotel at Auburn University
and Dixon Conference Center
Auburn, Alabama

- ▶ WMA & High RAP/RAS/GTR Mixes
- ▶ Optimized Structural Design
- ▶ Pavement Preservation
- ▶ Implementation

Official registration information will soon be available at www.ncat.us



INCENTIVIZING GREEN ROADS

SUSTAINABLE HIGHWAYS INITIATIVE

Use the
INVEST 1.0
Self-Evaluation Tool

[Home](#) / [Overview](#) / [FHWA Initiatives](#) / [Resources](#) / [Contact](#)

The Sustainable Highways Initiative supports programs and activities conducted across the Federal Highway Administration to facilitate balanced decisionmaking among environmental, economic, and social values — the triple bottom line of sustainability.



INVEST 1.0 supports roadway sustainability

[ACCESS THE TOOL >](#)



INVEST
ECONOMIC • SOCIAL • ENVIRONMENTAL

INCENTIVIZING GREEN ROADS: FHWA

 U.S. Department of Transportation
Federal Highway Administration

SUSTAINABLE HIGHWAYS INITIATIVE

Use the
INVEST 1.0
Self-Evaluation Tool

INVEST (Infrastructure Voluntary Evaluation Sustainability Tool) was developed by FHWA as a practical, web-based, collection of voluntary best practices, called criteria, designed to help transportation agencies integrate sustainability into their programs (policies, processes, procedures and practices) and projects.



INVEST
ECONOMIC • SOCIAL • ENVIRONMENTAL

INCENTIVIZING GREEN ROADS: INVEST

Project Development by Criteria Scorecard						
	Paving	Urban Basic	Urban Extended	Rural Basic	Rural Extended	Custom Core Criteria ¹
PD-17 Energy Efficiency		✓	✓	✓	✓	✓
PD-18 Site Vegetation		✓	✓	✓	✓	✓
PD-19 Reduce and Reuse Materials	✓	✓	✓	✓	✓	✓
PD-20 Recycle Materials	✓	✓	✓	✓	✓	✓
PD-21 Earthwork Balance			✓		✓	
PD-22 Long Life Pavement Design	✓	✓	✓	✓	✓	✓
PD-23 Reduced Energy and Emissions in Pavement Materials	✓	✓	✓	✓	✓	✓
PD-24 Contractor Warranty	✓	✓	✓	✓	✓	✓
PD-25 Construction Environmental Training		✓	✓	✓	✓	✓
PD-26 Construction Equipment Emission Reduction	✓	✓	✓	✓	✓	✓
PD-27 Construction Noise Mitigation		✓	✓			
PD-28 Construction Quality Control Plan	✓	✓	✓	✓	✓	✓
PD-29 Construction Waste Management	✓	✓	✓	✓	✓	✓
Total Number of Criteria in Scorecard	12	24	29	21	25	19

1 – Indicates the core criteria that must be included in the custom scorecard. The user may choose as many additional criteria as desired.

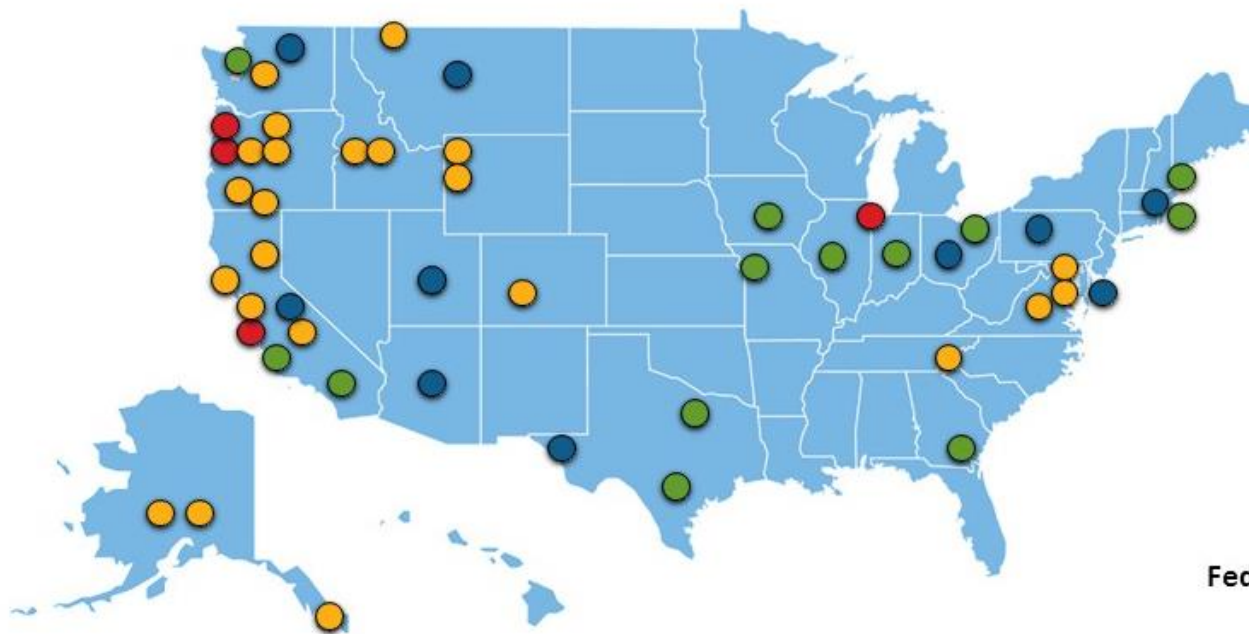
INCENTIVIZING GREEN ROADS: INVEST

INVEST Implementation Sites



By the Numbers

- 55 INVEST implementation projects
- In 25 states and DC
- By 29 agencies, including:
 - 10 state DOTs
 - 13 MPOs
 - Federal Lands Highway Divisions (all 3 divisions)
 - 4 other transportation agencies



- State DOT ●
- MPO ●
- Federal Lands Highway ●
- Other ●

INCENTIVIZING GREEN ROADS: INVEST

TABLE 1: POINTS FOR AVERAGE RECYCLED CONTENT (PERCENT BY WEIGHT OR VOLUME OF MATERIALS)

Recycling Method Used	Points Earned				
	1	2	3	4	5
Percent average recycled material (ARC) required for recycling in pavements	10%	20%	30%	40%	50% or more
Percent average recycled material (ARC) required for granular base course or embankments	20%	30%	40%	50%	60% or more

2-6 points. In-Place Pavement Recycling

TABLE 2: POINTS AWARDED FOR IN PLACE RECYCLING

Percentage Pavement Area Recycled	Points Awarded by Method of Recycling		
	HIR	CIR	FDR
50–74%	2	3	4
75–99%	3	4	5
100%	4	5	6

SUSTAINABILITY/DURABILITY STUDIES

Cold Insitu Recycling Evaluation

A Report of Research by

**R. Gordon McKeen, P. E.
Director, Materials Research Center
Alliance for Transportation Research
1001 University Boulevard SE, Suite 103
Albuquerque, New Mexico 87106-4342**

Under Contract for the

**New Mexico State Highway and Transportation Department
Research Bureau
P. O. Box 1149
Santa Fe, New Mexico 87504-1149**

Over 130 CIPR projects studied.

Service lives exceeded the 10-year design life.

Compared to mill and overlay, the CIPR projects saved

\$12,109 / lane-mile

SUSTAINABILITY/DURABILITY STUDIES

COLD IN-PLACE RECYCLING (CIR) TECHNIQUE IN NEVADA: FIELD PERFORMANCE EVALUATION FOR A DECADE OF IN-SERVICE PERIOD

By

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SUSTAINABILITY/DURABILITY STUDIES

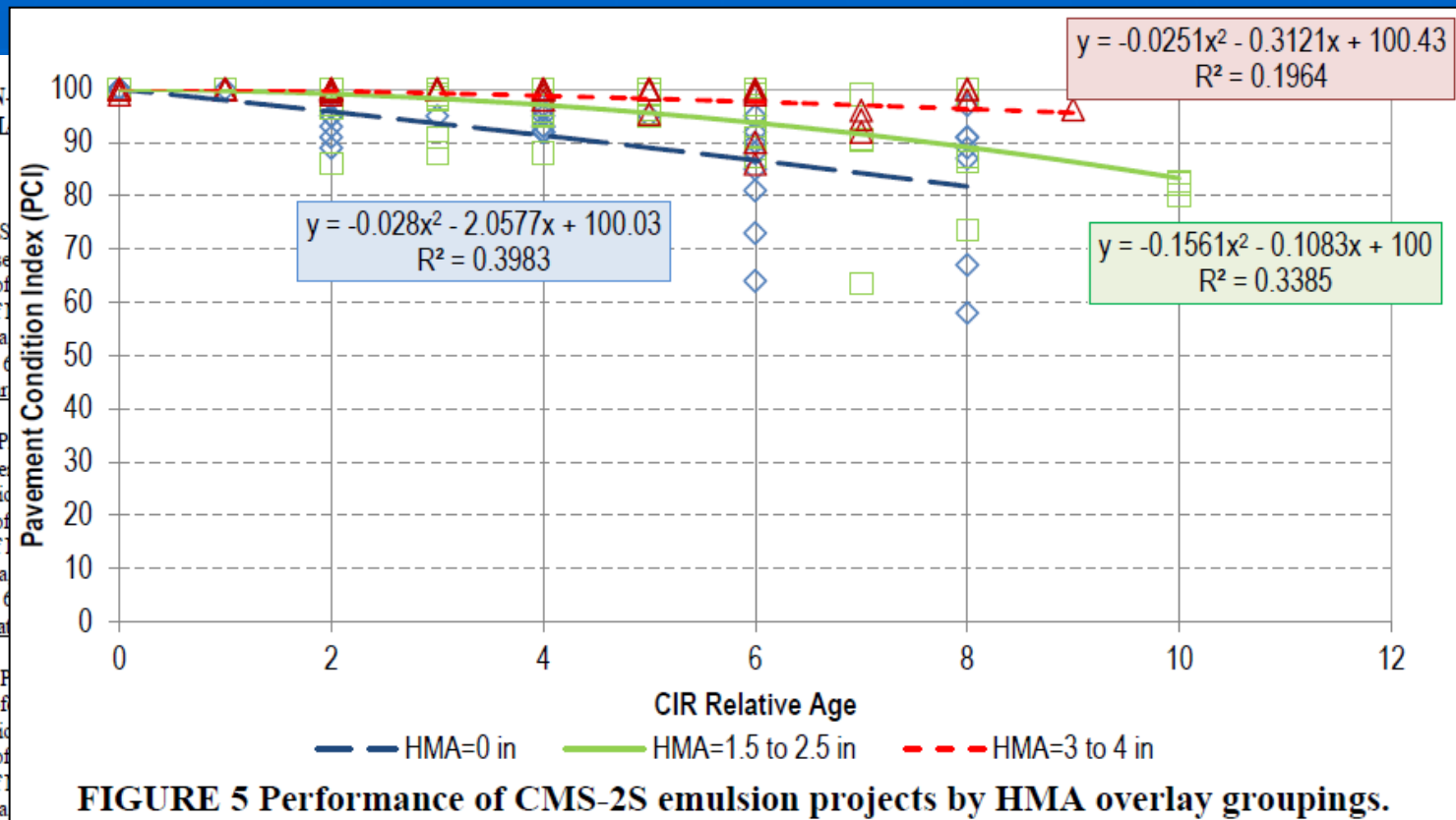


FIGURE 5 Performance of CMS-2S emulsion projects by HMA overlay groupings.

**Service life extensions
projected to 20 years
before rehab required.**

COLD IN
PERFORM

By

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COLD RECYCLING ECO-STABILITY

Two Life Cycle Assessment studies (5a & 5b) have been published recently, showing the relative environmental impact (fuel consumption most notably) of different asphalt application (paving) technologies.

Energy consumption (MJ/t)

Product	Binders	Aggregates	Manufacture	Transport	Laying	Total (MJ/t)
Bituminous concrete	279	38	275	79	9	680
Road base asphalt concrete	196	36	275	75	9	591
High modulus asphalt concrete	284	38	289	79	9	699
Warm mix asphalt concrete	294	38	234	80	9	654
Emulsion bound aggregate	227	37	14	81	6	365
Cold mix asphalt	314	36	14	86	6	457
Road base asphalt concrete with 20% RAP	157	33	275	64	9	538
Road base asphalt concrete with 30% RAP	137	30	275	58	9	510
Road base asphalt concrete with 50% RAP	98	25	275	47	9	454
Emulsion in-situ recycling	105	4	-	15	15	139

(5a) Chappat, M. & Bilal, J. "Environmental Roads of the Future," 2003.

(5b) Epps, J. & Robinette, C. 2010 TRB 10-2679.

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80% Reduction

(5a) Chappat, M. & Bilal, J. "Environmental Roads of the Future," 2003.

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CONCLUSIONS

Sustainable recycling technologies are proven across the globe to extend pavement service life in an economical and eco-stable manner.

- Long-term pavement studies bear this out.
- Eco-analysis and LCA prove the eco-stability of recycling.

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- CO₂ Performance Ladder are seminal developments.

Trends toward greater implementation of sustainability programs are clear. Given demonstrable pavement durability & long-term performance data, we must ask ourselves what does our industry need to do to expand sustainable pavement construction technologies like recycling?

**GREEN RECYCLING TECHNOLOGIES
ARE MARKET-READY.**

THANK YOU.