Asphalt Pavement Association of Michigan



Paving the Future: Perspectives on Sustainability from the Asphalt Binder Industry

February 26, 2025 Mt. Pleasant, MI







• Some Background Information:

- Regime Change for the Asphalt Institute
- Where AI Fits in the Bigger Picture
- Asphalt Update for the United States

Perspectives from the World of Sustainability:

- Regime Change for the United States
- Where Sustainability Fits in Our Bigger Picture
 - Research From Yesterday
 - Innovations For Today
 - Outlook Because Tomorrow Matters

• Final Thought:

° 2% of 100%

2025 Member Leadership for the Asphalt Institute







2025 Chair Charles Boan Flint Hills Resources LP 2025 Vice Chair Seth Hankowski All States Materials Group

Al Organizational Chart



2/28/2025

Al Organizational Chart – Technical Staff



asphalt institute

Asphalt Supply-Chain



SUPPLY CHAIN

UPSTREAM

ASPHALT BINDER

DOWNSTREAM











ASPHALT ROOFING









🔥 AEMA





Changing Refinery Landscape in the United States



2001:

150 "Operable" Refineries in US48 Produced Asphalt (Approximately)

2024:

132 "Operable" Refineries in US43 Producing Asphalt (Approximately)

- The Asphalt Institute is the international association of petroleum asphalt producers, manufacturers, and affiliated businesses
 - Members represent 90% of the liquid asphalt produced in North America.



Source: Energy Information Agency, Oil & Gas Journal

- **Production Factors...**
- Refinery economics
- Demand from end users
- Funding from federal, state, commercial activity
- Specifications
 - Recycling of RAP/RAS
 - Use of modifiers such as REOB/VTAE
- Public agencies still the largest market
- Lots of capacity in the system; not a supply issue





Tonnage History 2000 - 2023

asphalt institute



.....

Asphalt Materials for Paving (US)





2023 Data Highlights



- 38.7 MM tons production capacity (US)
- 3.5 MM tons production capacity (Canada)
- 24.2 MM tons produced (US) (all types) (EIA)
- 23.8 MM tons reported by AI members (US) (all types)
- 2.4 MM Tons reported by AI members (Canada) (all types)
- 5.4 MM Tons imported into US (4.9 MM Tons from Canada)
- 89% paving, 11% non-paving uses in U.S.





- Modified asphalt: 3.8 MM tons (US) in 2023, 16% of all use 3.3 MM tons (US) in 2022, 14% of all use
- Emulsified asphalt: 2.3 MM tons (US) in 2023, 10% of all use
- 0.6 % decrease in <u>paving</u> tons (2022-2023; US)
- 1.0 % decrease in <u>paving</u> tons (2022-2023; Canada)
- 11.2% increase in <u>non-paving</u> tons (2022-2023; US)
- 9.0 % decrease in <u>non-paving</u> tons (2022-2023; Canada)

AI members receive the full report annually as part of their Asphalt Institute member benefit.

Perspectives from the World of Sustainability

ENVIRONMEN

PERFORMANC

SOCIAL

ECONOMIC

• Performance

Achieve the engineering goals for which it was constructed

Environment

Preserve and (ideally) restore surrounding ecosystems

Economy

Use financial, human, and environmental resources economically

Social

Meet basic human needs such as health, safety, equity, employment, comfort, and happiness.

Regime Change in the United States

.........





Some Perspective . . .





• Fair Question:

- Why should we care now?
- But, Ask Yourself:
- When did this all start?
- Understand:
- Relationship between good stewardship and politics.
- Realize:
- Sustainability is all around us we just call it by different names – this is a good thing!

Behold the Laboratories for Democracy!



Sustainability by Any Other Name: Our Big Picture





Research from Yesterday

- CARE Group Formation
 - In 2020, two publications generated a significant media impact both in the US and Europe
 - FSU claimed that exposure of paving asphalt to sunshine generated water pollutants
 - Yale claimed that paving and roofing asphalts when exposed to sunshine generated air pollutants
 - Given the high level of media attention to the above publications, the asphalt-related associations from the US and Europe collaborated to review and respond to the two publications and that is how the CARE group formed

Third Party Expert Reviews





Dr. Bernhard Hofko

Professor, Civil Engineering, TU Wien, Austria Head of the Laboratory of the Research Department of Roads **Dr. Charles Glover**

> Retired Professor - Artie McFerrin Department of Chem. Engineering

Texas A&M University

• Reviewed by Dr. Glover and Dr. Hofko

- $^{\rm o}$ Both raised technical issues with the Yale methodology and findings
- Both stated the potential for significant over-estimation of emissions from asphalt
- However, neither expert has determined that there are "no emissions" from asphalt



Heritage Research Group (HRG) Study



HRG conducted a lab-scale project to replicate the Yale study – published Nov. '22

HRG was unable to duplicate the high levels of emissions reported by Yale – some emissions are <u>10,000 lower</u> <u>that those reported from the Yale</u> <u>Study</u>

HRG has submitted a letter to the editor – if journal agrees that Yale's work is not reproducible – the paper can be opened for review



FAQ Document and Executive Summary







Coalition for Research on Asphalt Emissions Summary

Introduction

In September 2020 the Asphalt Institute (AI) identified two peer-reviewed publications related to air and water pollutant generation caused by sunlight photooxidation of emissions from asphalt* products. Khare et al. from Yale University performed both laboratory and field research on paving and laboratory research on roofing asphalt products demonstrating the generation of precursors to atmospheric particulate matter emissions (PM2.s). Niles et al. from Florida State University also performed laboratory research on paving asphalt binder that demonstrated the generation of water pollutants. Prior to these publications, AI was unaware of any earlier research demonstrating similar results.

The Khare et al. publication was quickly referenced in multiple mainstream sources including the New York Times, USA Today, and several European publications. It continues to be referenced. To date, it has been cited 65 times. The Khare et al. publication has also generated inquiries to AI and the National Asphalt Pavement Association (NAPA) related to the potential pollution from the use of asphalt-based products. After initial interest, the Niles et al. publication has only been minimally cited. Internal industry and third-party experts' reviews of these publications determined that, while the Florida state results were questionable, the photooxidation mechanism in the Khare et al. paper was misunderstood but real. What is unknown is the actual quantity and a review of the emissions referenced in the Khare et al. paper show that they may be overestimated by a factor of 5-10.

Currently, the asphalt industry is increasing its focus on developing data and tools to be used for its sustainability and product stewardship programs. Asphalt product manufacturers and users are more often required to quantify and disclose emissions from products to compete for sales. Khare et al. have referenced 1000s of tons of asphalt-related emissions just in the South Coast Air Basin. If projected to the rest of the United States, the emissions quantities referenced in the Khare et al. could conceivably affect the public perception of asphalt products. It could also affect asphalt facility permitting activities. The asphalt industry currently does not have data to evaluate and correct the Khare et al. results. Valid emissions data is critical to future Asphalt Institute sustainability efforts. The asphalt industry CARE Directors Group was formed to respond to this need.

* For the purposes of this paper "asphalt" is used to describe the bituminous binder, rather than a combination of binder and apprepates.

January 13, 2023

FAQ Document

Executive Summary

An Industry Sponsored Asphalt Testing Project



The CARE Group met with several professors from leading academic institutions to explore the possibility of field studies to develop alternative emissions factors to those published by Khare et al. (Yale)

The group ultimately decided to partner with Professor David Cocker from the University of Riverside, a CE-CERT laboratory.



Sample Selection & Compacted Hot Mix Asphalt Specimens

3x PG 64-22 asphalt binders:

All Samples Will Be Blinded

A. Canadian Crude

Β.

Gulf Coast Crude

East Coast Crude



Constant Gradation: Superpave 9.5 surface mix



Laboratory Compacted:

Superpave 9.5 surface compacted to 6 % air voids



Shipping

Sealed in Teflon and shipped to UC Riverside, CA using Dry Ice

FedEx

Express



Heritage Research Group has performed sample collection, property testing, and preparation

Asphalt Pavement Puck Sample Preparation at HRG





One Field-Aged Pavement Site is Also Being Tested

- Site selection is based on an asphalt pavement with a known source (PG 64-22) and composition, positioned adjacent to a non-asphalt pavement (control), both of which were placed simultaneously under identical traffic conditions.
- Six-inch cores will be extracted from both pavements and analyzed for emissions after 30 years of use.
- The control pavement will be utilized to eliminate any atmospheric and trafficrelated deposition that could introduce variability under similar conditions.





Sample Location at UCR & Task 1 Setup



Sustainability by Any Other Name: Our Big Picture



Innovations for Today

- Highly modified asphalt can be successfully constructed even with a 2+ hour haul time
- 7.5" of HiMod compacted down to 6 inches"
- High densities were easily achieved
- The full depth density was 97 percent and has not budged with 3 years of truck traffic
- Unquestioned exceptional early performance
- Approximately 4 million commercial trucks over three years of service
- NO DISCERNABLE MOVEMENT
- NO CRACKING
- NO BLEEDING
- ZERO DISTRESS



- Port of Entry on I-80 Near Wendover, UT
- High Truck Volume (51%), AADT 7,900
- 2-2.5 Million ESALs/year
- Very Hot in the Summer
- LTPPBind = PG64-28 (98% reliability)
- Mill and Inlay 6.0 Inches of PCC
- ~330 Ton Project
- Highly Modified Binder
- Dense-Graded Mixture
- Construct in a Single Lift
- ~2-Hour One-Way Haul



Core	Total Thickness	Top Half Density	Bottom Half Density
1	6.27 inches	97.9%	98.0%
2	6.27 inches	97.8%	94.4%
3	6.1 Inches	97.2%	92.8%
4	6.1 Inches	97.3%	97.6%



Pictures From 2023 & 2024





Mixture Specimer		Air Voids (%)	Strain (με)	Flexural Modulus at 50 cycles, MPa	Cycles to Failure (N,) Cycles*Modulus (AASHTO T321)
				Test Data	Test Data
PG 64- 34 - Typical Mix	1	7.7	300	7,491	1,199,504
	2	7.1	400	7,879	162,013
	3	6.9	475	7,542	171,958
	4	6.8	525	7,482	23,894
	5	7.4	600	7,360	12,162
PG 76- 34 - HiMod Mix	1	4.2	475	6,104	7,817,272
	2	3.8	525	6,320	1,200,843
	3	3.9	600	5,882	913,716
	4	4.0	675	5,655	276,589
	5	4.3	750	5,030	20,180



Projects Since the Port of Entry ~24,400 T

Facility	Project Description	Design Thickness	Observed Density	Construction Year	Tonnage
Wendover	Port of Entry off I-80	6 Inches	+97%	2021	450
I-15 north of SLC	Overlay of PCC	3 Inches	+96.5% 2022 and 2023		2,216 NB 1,258 SB
SR 196	13-mile Overlay of AC	1.5 Inches	+96%	2023	15,506
SR 173 near Bangerter Highway	Overlay of Asphalt	1.5 Inches	+96%	2023	5,001
Bridge Decks	Overlay	3-4 Inches	+96%	2023	unknown

Project Description	Pavement Description	Design Thickness	Construction Year	HiMod Tonnage	Has Thick Lift?
US 6 Interchange	High Traffic Interchange	5 inches	2024	4,123	Yes, 5 inch
F-0006(230)174					
I-80 MP 41 to 50	9-mile Overlay	1.5 inches	2024	38,932	No
F-I80-2(82)41					
I-215 Ramps; State, Fashion F-R299(458)	Overlay of Concrete	3 inches	2024	1,673	No
US 40 East of Duchesne	10-mile Overlay	2 inches	2024	18,000 (estimate)	No
US 6 Tucker to Soldier Summit F-0006(245)204	7-mile mill and Overlay truck lane Overlay entire road	4 inches – truck lane Plus 2-inch to Truck lane and rest of road	2024	52,666	Yes, 4 inch
I-80: Near Airport Entrance Bridge Preservation F-R299(270)	Overlay of 19 bridge decks	3 inches	2024	4,603	No
SR-276 and SR-95 F-R499(457)	45 -Mile Overlay	2 Inches	2024	84,764	No
SR-261 and SR-276 Near Bluff	Overlay	2 inches	2024-2025	204,728	Yes, 7 inch
US-191: Dry Valley to Hatch Wash F-0191(206)89	Overlay	2 inches	2024	16,969	No
SR-171; 700 W. to State Street F-0171(72)9	Overlay	1.5 inches	2024	4,752	No
SR-190; Pavement Preservation F-0190(29)2	Overlay	1.5 inches	2024	11,105	No
US-89: Passing Lanes near Buckskin Wash S-0089(572)35	Overlay	2 inches	2024	17,906	Yes, 5 inch
US-89, SR-204 to SR-134	SMA changing to HiMod	2 inches	2024	11,500	No
SR 35 F-0035(13)0	Overlay	1.5 inch	2024	14,000 (estimate)	No
I-215 Reconstruction	Rubblize PCC Pavement and Overlay	5.5 inches	2025	In design	Yes, 4 inch
			Total:	+500,000	

Future Project Spotlights

I-215 Reconstruction – Beltway in the Heart of Metro SLC

- Originally slated for remove and replace with PCC
- Because of HiMod performance, reevaluated option for asphalt
 - Rubbilize existing PCC
 - Overlay with highly modified, low air void mixture @ 5.5 total inches!
 - 1.5" leveling course
 - 4" overlay
- \$40 million dollar savings over the PCC option
 - These savings will be used to extend the project 17 miles for ramp reconstructions

SR 261 & 276

Mostly overlays @ 2" – New Construction will be 7" in one lift

■Total tonnage = ~205,000





We Are Still Learning – Together An Experiment & Illustration from UDOT

- Twenty-fold increase in use in 2024 from all previous years combined
- Bid prices are ranging from ~\$113 \$130/T
- Starting in 2025 90% of asphalt tonnage in Region 2 of UDOT will be HiMod (with low air voids)
- UDOT's strongest advocate for more PCC is now flipping slated PCC projects
- Continued exceptional performance on all current installations
- Density of 97% is common w/no rutting
- Regular rolling equipment & procedures
- Feeding the paver with such a large volume is possible
- Mix is stable & workable
- Thin lift projects are becoming common
- Bridge decks are an excellent application
- It hasn't been all been sunshine, rainbows and unicorn farts – we are STILL learning - TOGETHER



Do you have a feel for 1 kPa pressure?

- 1 pa = 1 Newton per square meter
- 1 pa = 0.000145 psi
- 1 kPa = 0.145 psior about 11 dimes





VWR

TIMER



Outlook – Because Tomorrow Matters

- Environmental Sustainability Vision
 - Tactical Industry Initiatives
 - Strategic Industry Initiatives



AI and AIF Sustainability Vision





Tactical Industry Initiatives

EPDs for Asphalt Binders: Reference LCA

- Existing Cradle-to-Gate Industry Average LCA for Asphalt Binders:
 - Started in 2016 / Published in 2019
 - Contracted with Thinkstep, now Sphera
 - Collected "Foreground" (process) data from 12 refineries and 10 terminals
 - Used Sphera's "Gabi" for background data
 - Declared Unit: 1 kg of Asphalt Binder
 - Without Additives
 - SBS Modified
 - GTR Modified
 - PPA Modified
- Feeds into NAPA's Mixture EPD Tool



Al's EPD Taskforce: Mid 2022 to April 2023

Recommended Path Forward

- > To meet CDOT's (and others) requirements for EPDs on asphalt by early 2025
- SmartEPD hired as Program Operator (PO)
 - o Oversee PCR development in an unbiased manner
- Sphera hired as LCA consultant
 - $\,\circ\,$ Leverage AI's existing LCA study (published 2019) and methodology
 - Update Al's existing LCA in accordance with the PCR
 - Develop EPD software tool for asphalt utilizing "LCA Calculator"
 - Refinery template and terminal template

Path Forward



- Promote Holistic (Entire-Life Cycle) Sustainability Approach
- What's Needed?

A systematic analysis of the potential sustainability impacts (Four Pillars) of products during their entire life cycle.

- Holistic Sustainability
 - Key is entire "Life-Cycle"



Example: Influence of Durability on Pavement Life Cycle Emissions



Influence of performance and extended service life on cradleto-grave emissions intensity



Source: AIF – Wood Mackenzie Study

Parameters used in cradle-to-grave emissions examples

The 3 examples show the emissions impact of changing a single variable in the asphalt mixture or use phase treatment





Strategic Industry Initiatives



Wood Mackenzie



Analyzing the Petroleum Asphalt Binder Supply Chain under Energy Transition Scenarios

by Wood Mackenzie Consulting on behalf of the Asphalt Institute Foundation



January 2025

Strategic Project with Wood Mackenzie



"Analyzing the Petroleum Asphalt Binder Supply-Chain in a Net Zero World"

• Objective:

- Wood Mackenzie's Projected Energy Transition Scenarios
- Relationship Between Energy Transition and Asphalt Binder Supply-Chain Carbon Emissions
- Relationship Between Energy Transition and Potential Asphalt Binder Supply/Demand
- Feedback to Help Strengthen the Asphalt Supply Chain for the Future



Global Energy Transition Targets and Emissions Outlook

Source: Wood Mackenzie Energy Outlook, Net-Zero Targets

Status of net zero pledges by country



Announced pledges

Country	2030 target vs baseline	Net Zero year
UK	68% decline vs 1990	2050
EU27	55% decline vs 1990	2050
US	50-52% decline vs 2005	2050
Japan	46% decline vs 2013	2050
South Korea	40% decline vs 2017	2050
China	Peak emissions before 2030	2060
India	45% drop in intensity by 2030	2070

Energy Transition and Oil Demand

Source: Wood Mackenzie Energy Outlook

Global oil demand by scenario



2050 demand by sector and by scenario



■Road transport ■Aviation ■Shipping ■Industry ■RCA ■Power

Note: the 'Pledges' and 'Net Zero' scenarios are deterministic, i.e. they show the level of oil demand necessary for the world to reach net zero. Forecasts are subject to uncertainties around policy, technology development, consumer behaviour and other factors

Energy Transition Fundamentals



Base case outlook: Steady advancement of current and nascent technologies largely driven by affordability and supply security concerns.

Key 2050 metrics





Scenario: coordinated policy responses to the current energy crisis and geopolitical challenges facing the global economy, building momentum in the 2030s.

Key 2050 metrics





Scenario: immediate peak energy, rapid deployment of negative emissions technologies, nuclear, long-duration storage and geothermal.

Key 2050 metrics



Asphalt Binder Demand Constant to 2050

Base case

Global bitumen demand

Source: AIF – Wood Mackenzie Study



Bitumen demand vs. all other oil product demand



WEBINAR

Thursday, March 20th, 2025 • 12:00 - 1:00 p.m. E.T.

Analyzing the Petroleum Asphalt Binder Supply Chain under Energy Transition Scenarios





Chait Bhat Asphalt Institute



John Brownie Imperial Oil **Reed Ryan** Asphalt Institute Foundation

Conclusions

Energy Transition Analysis Insights

- Base case is the most likely scenario (limited change in overall oil demand)
- Asphalt binder demand and supply stable under Base Case North American crude runs peak in 2030
- Refineries could shift productions to meet stable asphalt binder demand under Pledges and Net-Zero Scenarios – Decrease in global refinery supply is <10% versus today
- Asphalt binder supply looks stable
- Reduction of Carbon Emissions
 - Durability and project management plan play a critical role
 - Reductions up to 24% in Base Case scenario and 58% in Net-Zero scenario
 - Proactive steps from all stakeholders across the asphalt binder value chain required



Sustainability is not an either/or proposition

- It is all around us yesterday, today, and tomorrow
- It is more than just politics it goes by many names and actions from research, to innovations, to industry outlooks
- This is not a greenwashing; It is a realization the march continues

• Although we are only 2% of what constitutes a barrel of oil, we are all in this together 100% of the time

- 2% has built our world
 - 2% makes the other 98% possible roads for cars to drive on, runways to land planes on, highways for trucks to move on, etc.
- $^\circ$ 2% likely brought you here today
- $^\circ$ 2% will shape 100% of our collective future moving forward