The Environmental Benefits of Smokeless Asphalt

NJ Asphalt Pavement Association
Paving Conference

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AGENDA

1. Utilizing Smokeless Asphalt to Reduce Fugitive Emissions
2. Data from 2021-2022 Smokeless Asphalt Demonstrations
3. Fugitive Emissions Data
4. Fuel Usage and CO_2 Data
5. The proof is in the pictures
6. Smokeless asphalt = longer lasting pavements
7. Sample Specifications and Regulations
8. Questions?

Utilizing Smokeless Asphalt to Reduce Fugitive Emissions

Chemical Warm Mix + Lower Production Temperatures = Smokeless Asphalt

- Reduce energy consumption
- Limit air pollution
- Longer-lasting asphalt pavements

- Reduce GHG emissions
- Improve health and safety of crews

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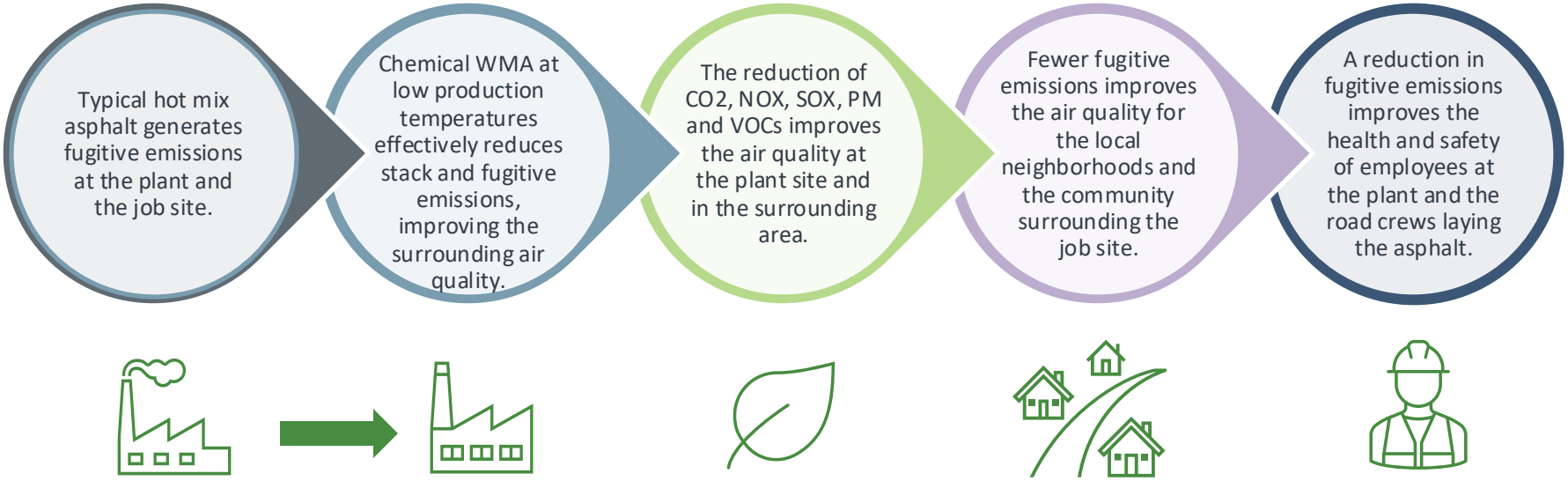
Using Smokeless Asphalt to Reduce Stack and Fugitive Emissions



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Data from 2021-2022 Smokeless Asphalt Demonstrations

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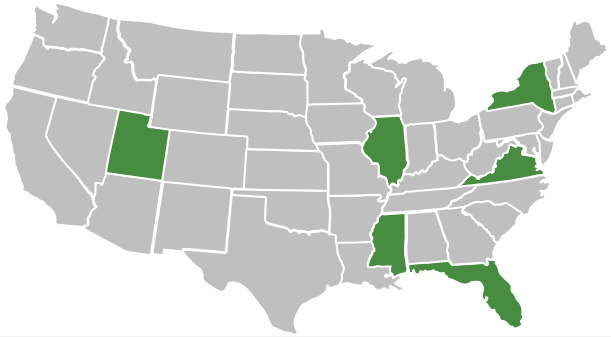
Data Summary:
WMA at Low Production Temperatures



Six Projects in Six States: Reductions By The Numbers

Temperature

48°F

Fuel

18%

CO_2

23%

Fugitive Emissions*

91%

*Fugitive emissions are measured at the top of silos.

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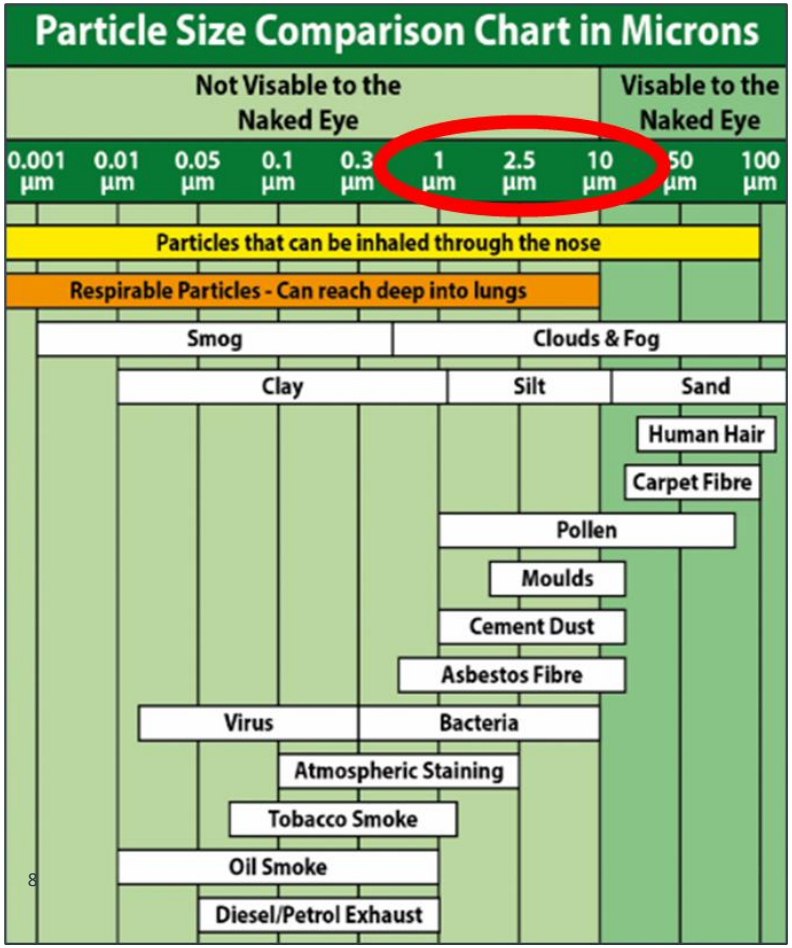
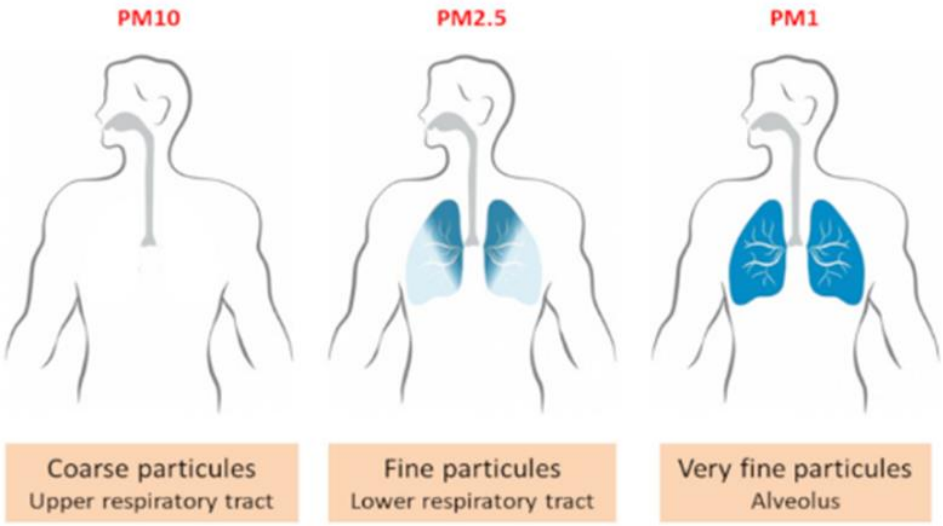
How is Particulate Matter Classified?





- Airborne particulate matter is a mixture of solids and aerosols that vary in shape, size and chemical composition.
- Particulate matter particles are classified by their aerodynamic diameter
  - PM10 →Coarse particles that are less than 10 microns in diameter
  - PM2.5 → Fine particles that are less than 2.5 microns in diameter
  - PM1.0 →Very fine particles that are less than 1 micron in diameter
- Particle size is important for classification because particles less than 10 microns are inhalable into the lungs with fine particles penetrating deep into the lungs, which may induce adverse health effects.

Particulate Emissions Devices at the Plant

One particulate analyzer placed at the load out

APT Device

One particulate analyzer placed at the top of the silo

One particulate analyzer placed over the chute

Fuel Usage Measurements

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CO_2 - Stack Testing

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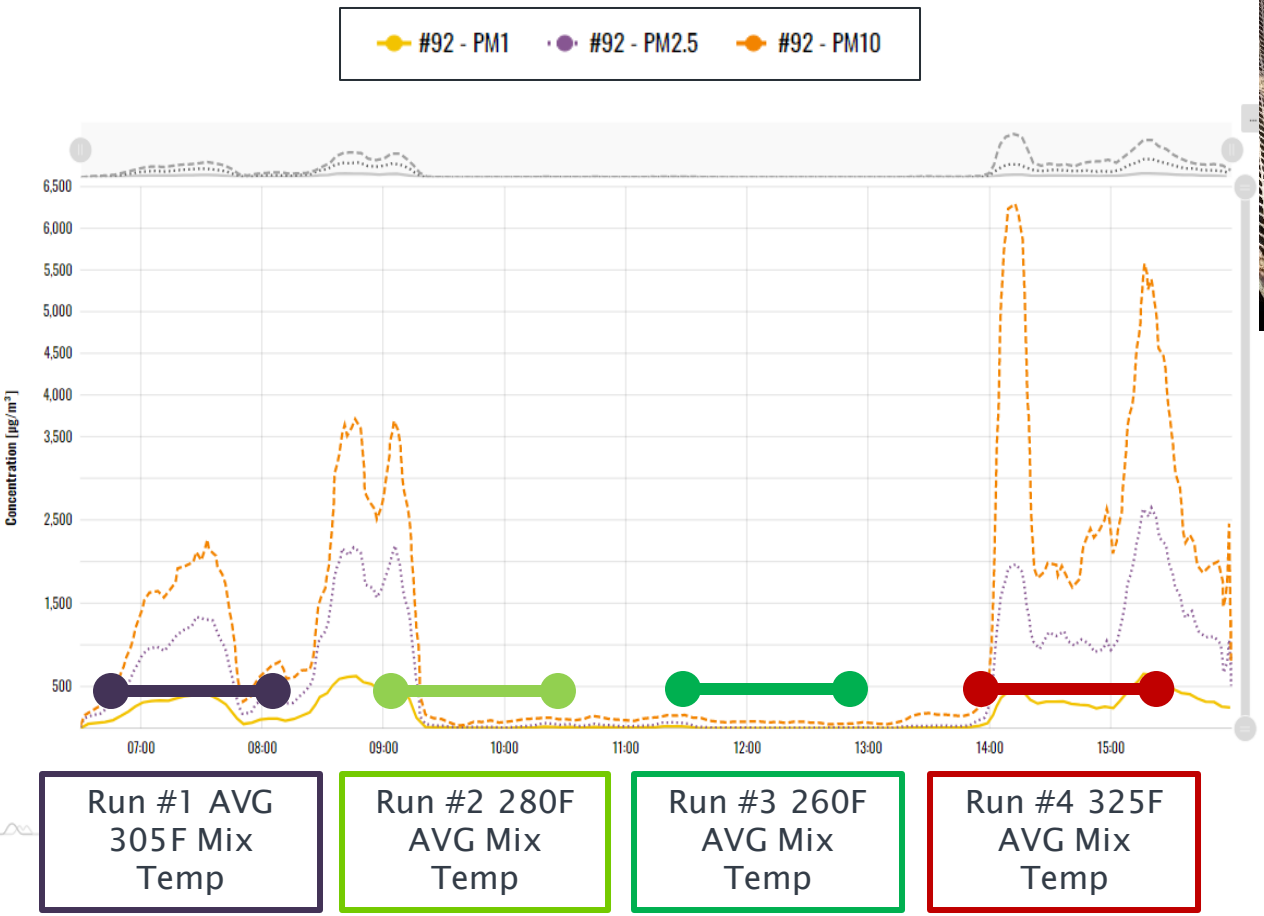
Emissions Reductions Benefits with True WMA

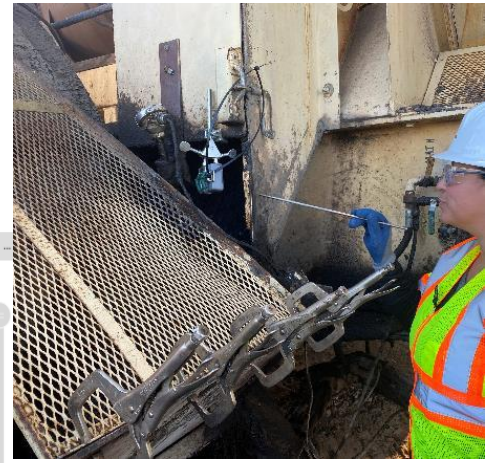


Run #1 AVG 305F Mix Temp

Run #2 280F AVG Mix Temp

Run #3 260F AVG Mix Temp

Run #4 325F AVG Mix Temp



APT Device

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Mix Design Variables

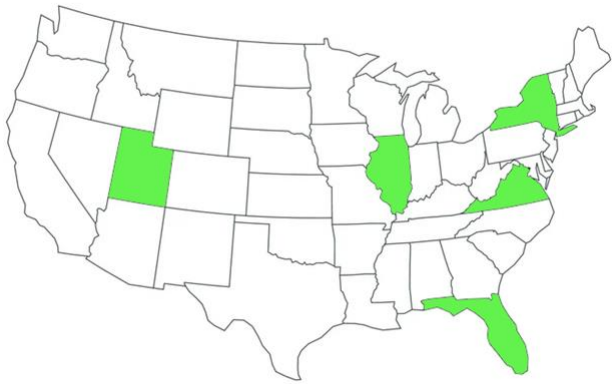

Table 1- Mix Design Characteristics and Aggregate Mineralogy

Location	RAP Content (%)	Total Binder Content (%)	Virgin Binder Content (%)	Virgin Binder Grade	N Max Aggregate Size (mm)	Aggregate Minerology
Florida	40	5.9	3.6	PG 52-28	9.5	Nova Scotia Granite River-bottom Sand
Illinois	40 (3% RAS)	5.4	3.4	PG 58-28	19.0	Dolomitic Limestone
New York	20	6.0	4.7	PG 64V-22	9.5	Limestone (78%) Graywacke (sandstone) (22%)
Utah	15	5.1	4.4	PG 64-28	12.5	Quartzite
Virginia	30	5.6	3.9	PG 64S-22	9.5	Diabase Traprock
Mississippi	20%	6.1	5.2	PG 67-22	9.5	Crushed Gravel (36%) Limestone (33%) Sand (10%)

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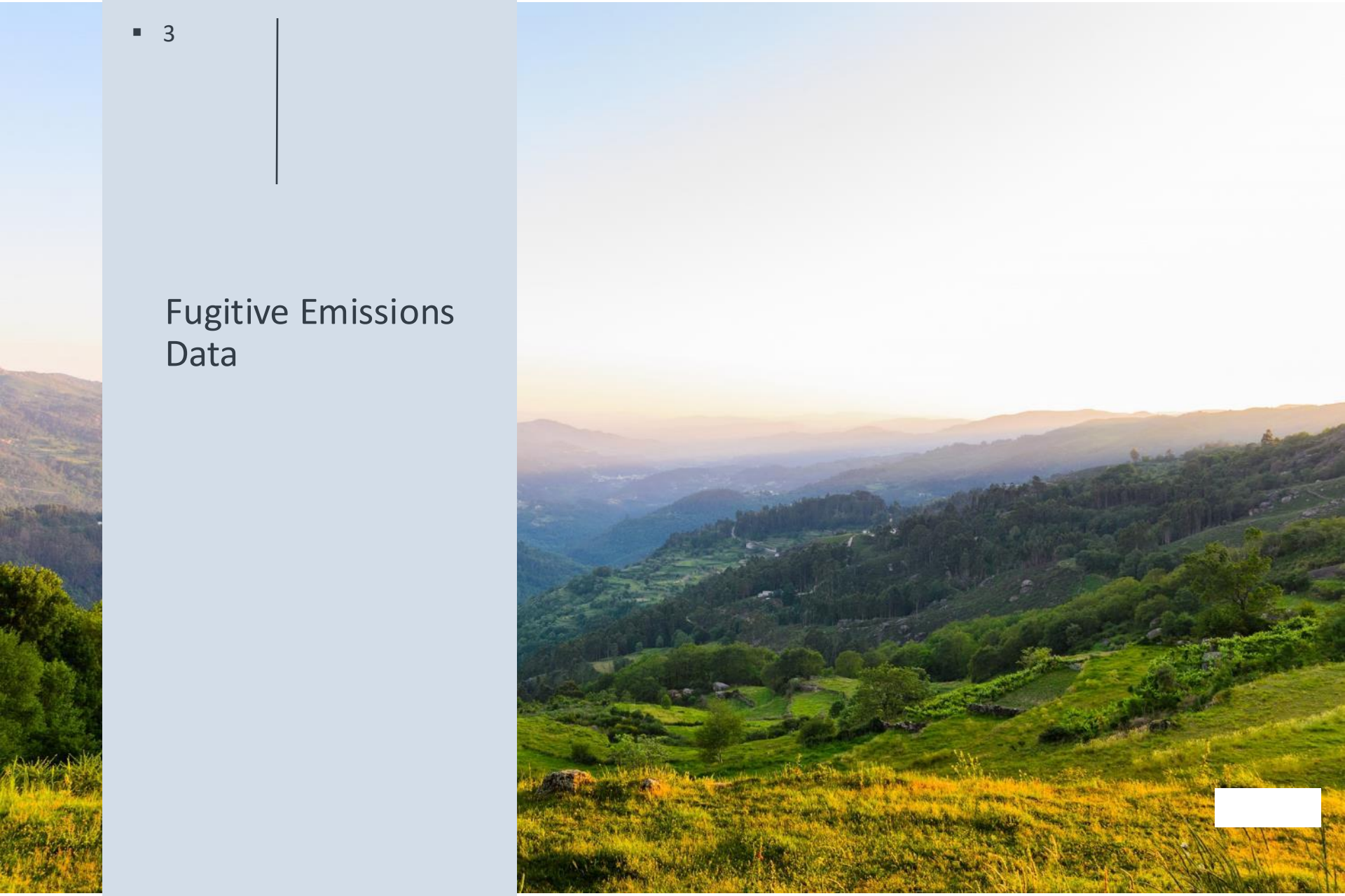
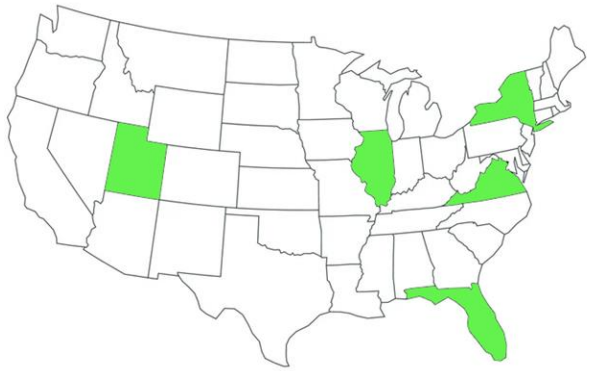
Fugitive Emissions Data



2022 Low Temperature WMA Data



Fugitive Emissions Reductions by Location (PM10)

Note: Average Temp Reduction 51°F-55°F

Top of Silo

92%

Silo Loadout

80%

Screed Operator

88%

Center of Screed

92%

Note: Average Reduction across the projects

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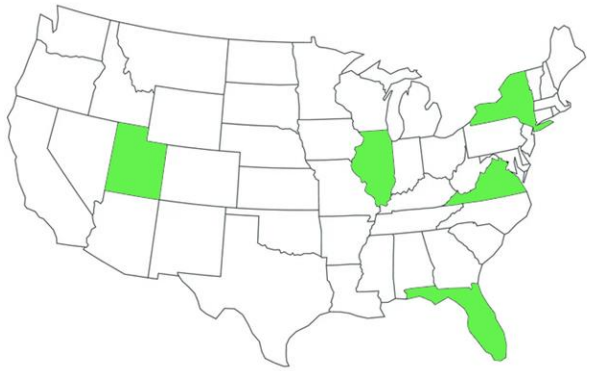
2022 Low Temperature WMA Data



Fugitive Emissions Reductions by Location (PM2.5)

Note: Average Temp Reduction 51°F-55°F

Top of Silo

75%

Silo Loadout

67%

Screed Operator

90%

Center of Screed

87%

Note: Average Reduction across the projects

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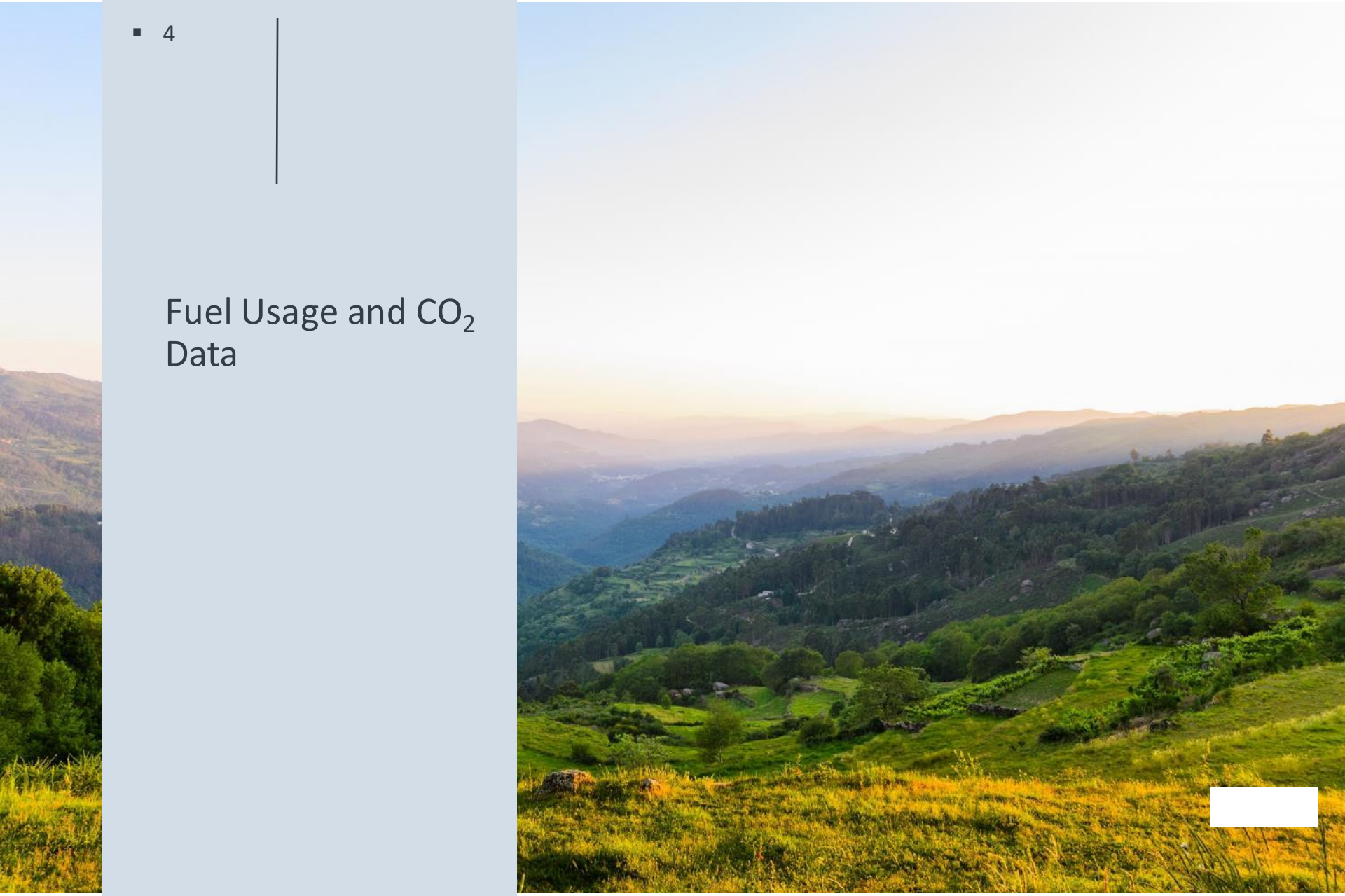
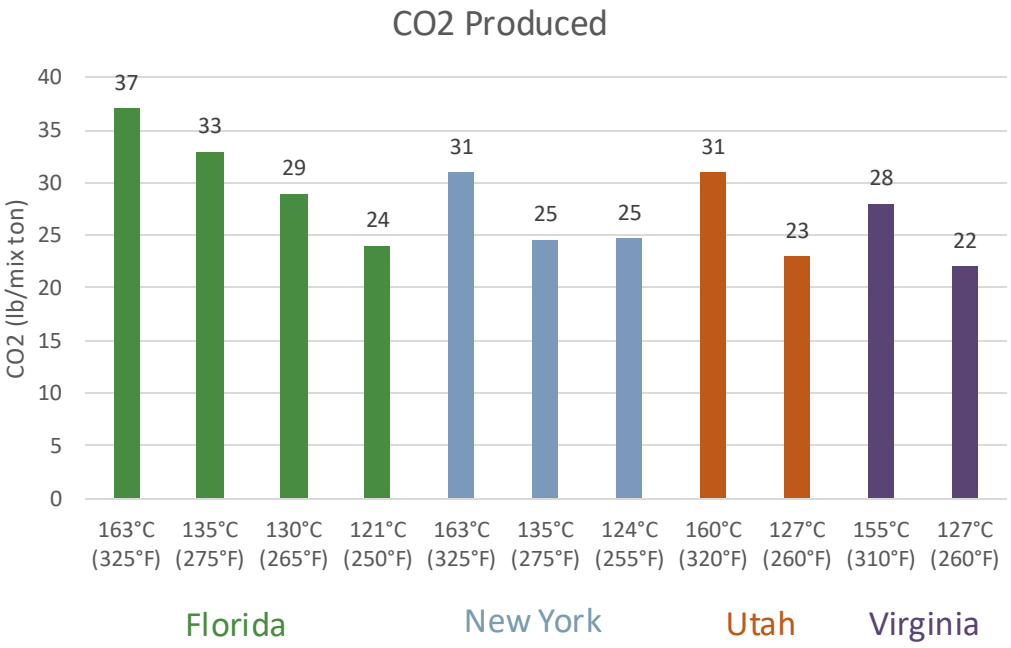
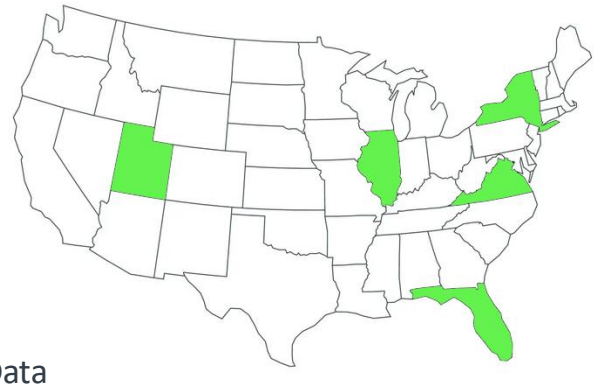
Fuel Usage and CO_2 Data



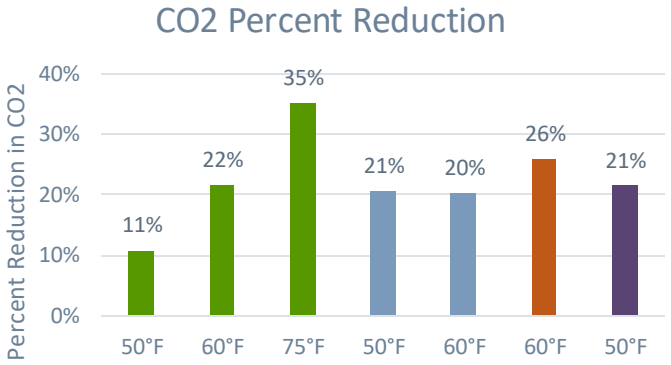
CO_2 Emissions – Stack Data





Average Data

57.8°F Temperature Reduction
22.3% Reduction in CO_2



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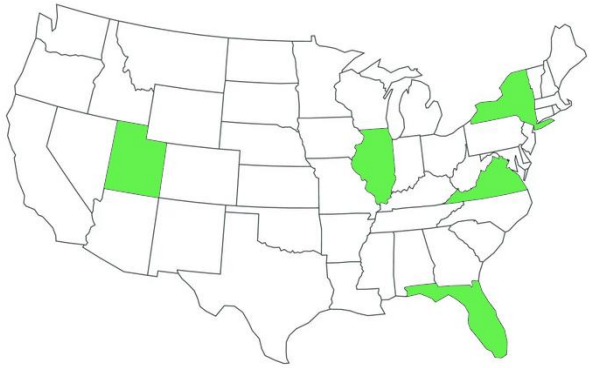
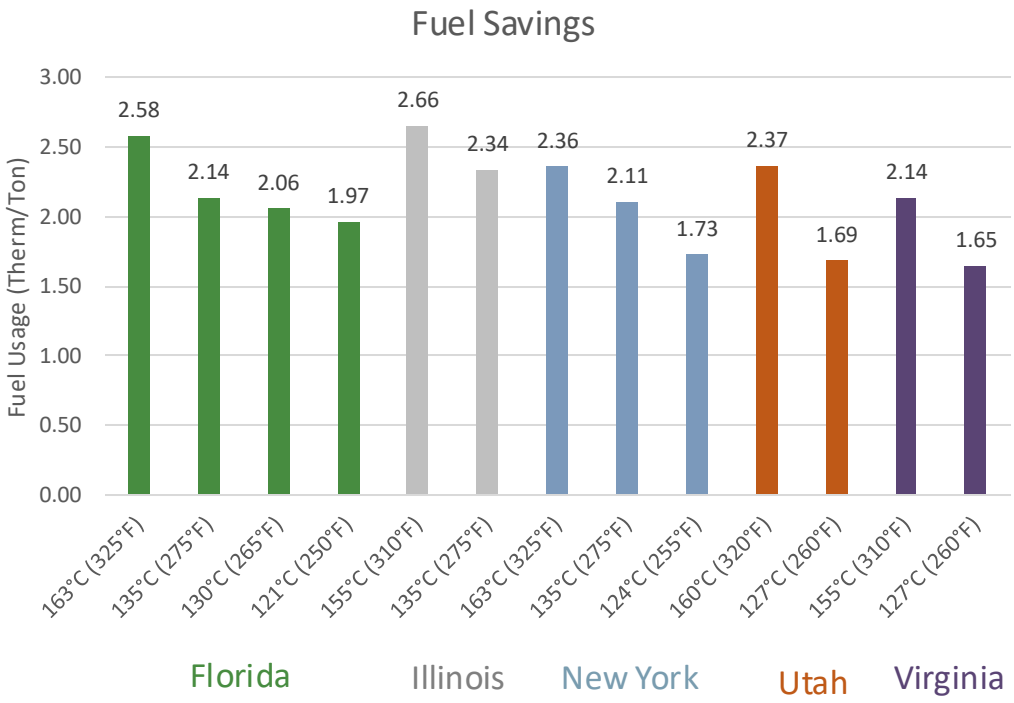
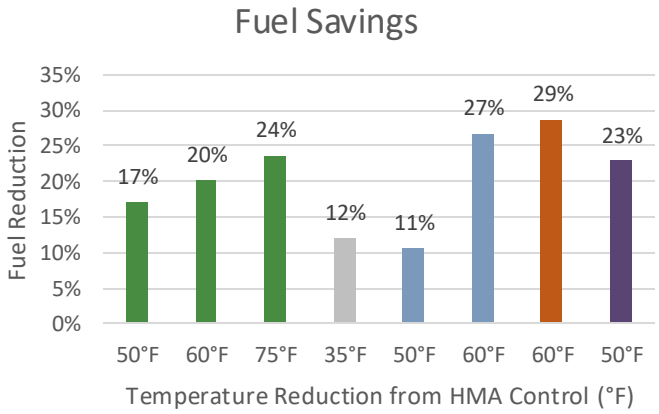
Fuel Usage Reduction





Average Data

55.0°F Temperature Reduction
20.4% Reduction in natural gas consumed



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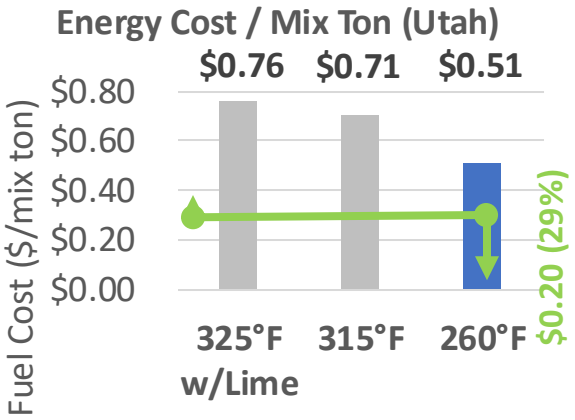
WMA Plant Fuel Consumption 2022

Note: Natural gas fuel $3.00/MMBtu assumption

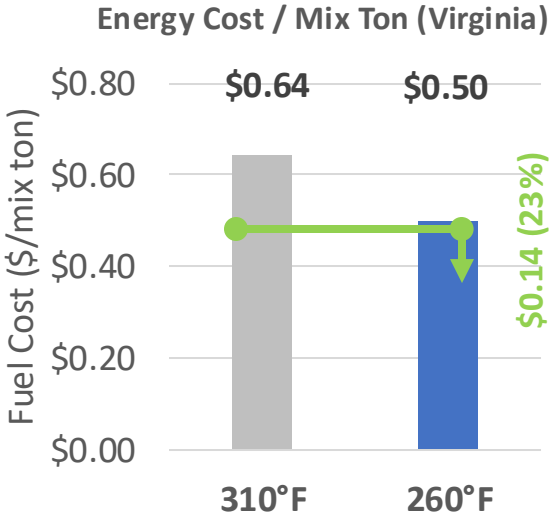
Utah Contractor
- 360 Tons/hr
- Gencor Counter Flow
- 15% RAP
- 250k Mix Tons/yr
- $50k Savings (single plant at 260°F)

CO_2 Reduction 26.0%



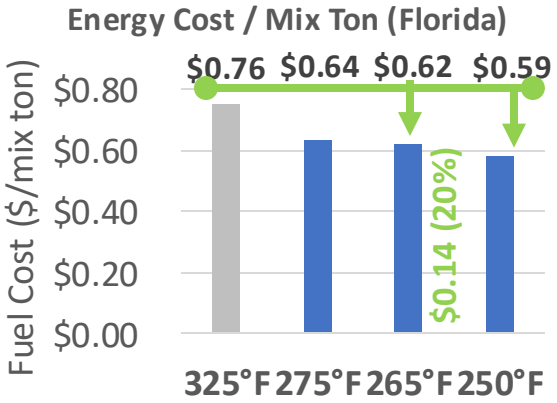
Virginia Contractor
- 290 Tons/hr
- Astec Double Barrel
- 30% RAP Content
- 250k Mix Tons/yr
- $35k Savings (single plant at 260°F)

CO_2 Reduction 21.8%



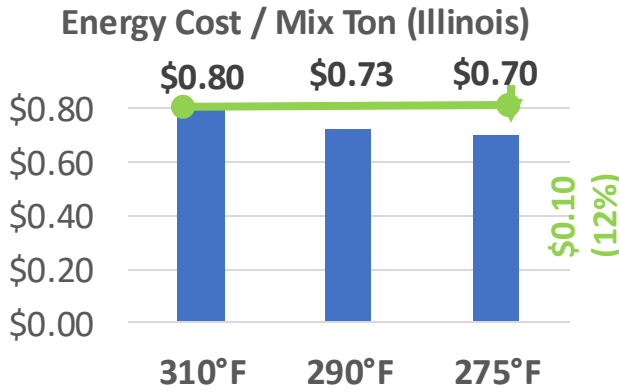
Florida Contractor
- 200 Tons/hr
- Astec Double Barrel
- 40% RAP
- 150k Mix Tons/yr
- $21k Savings (single plant at 265°F)

CO_2 Reduction 25.1%



Illinois Contractor
- 300 Tons/hr
- Gencor Counter Flow
- 40% RAP Content
- 350k Mix Tons/yr
- $35k Savings (single plant at 275°F)

CO_2 Reduction 14.0%



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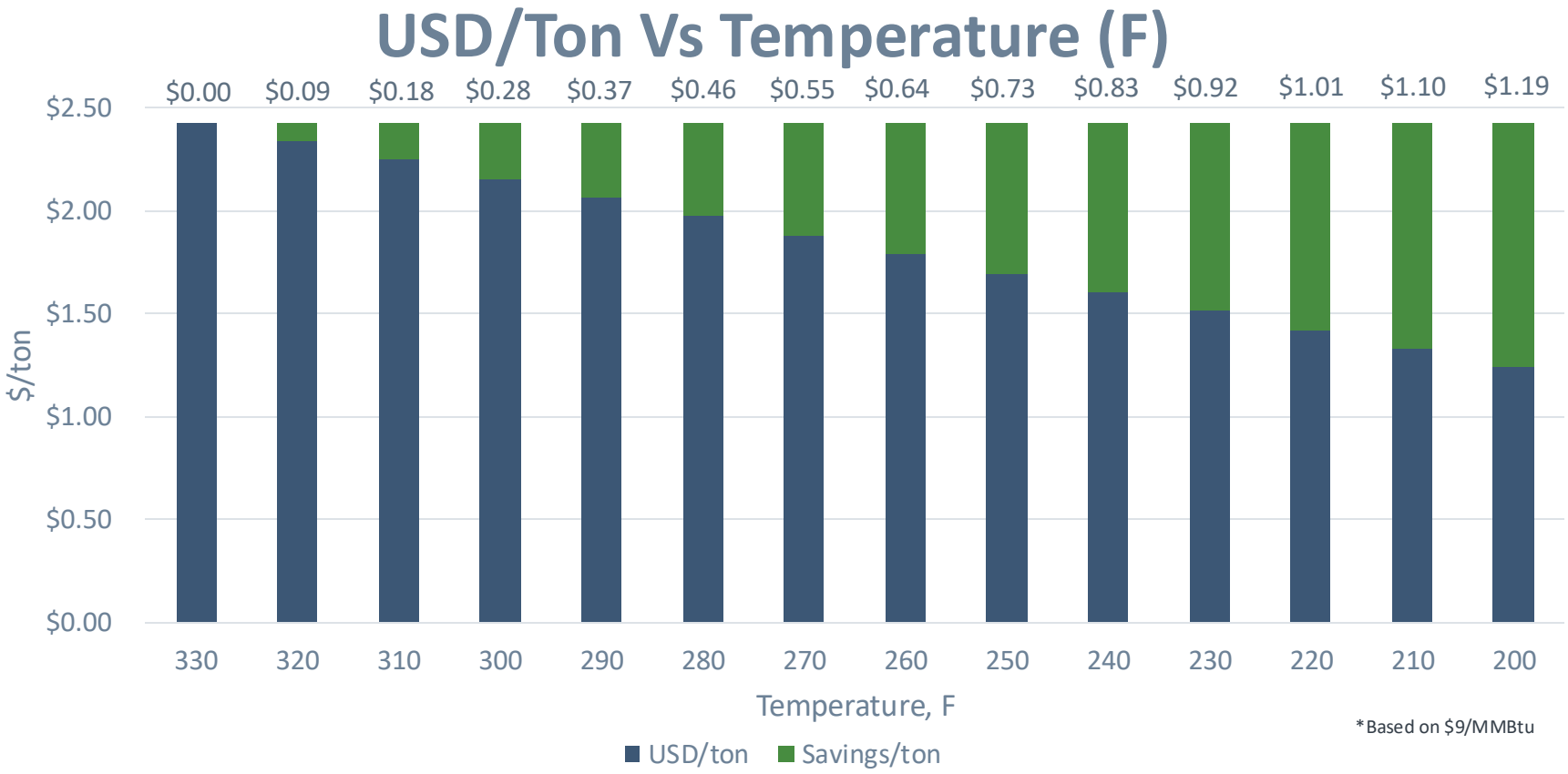
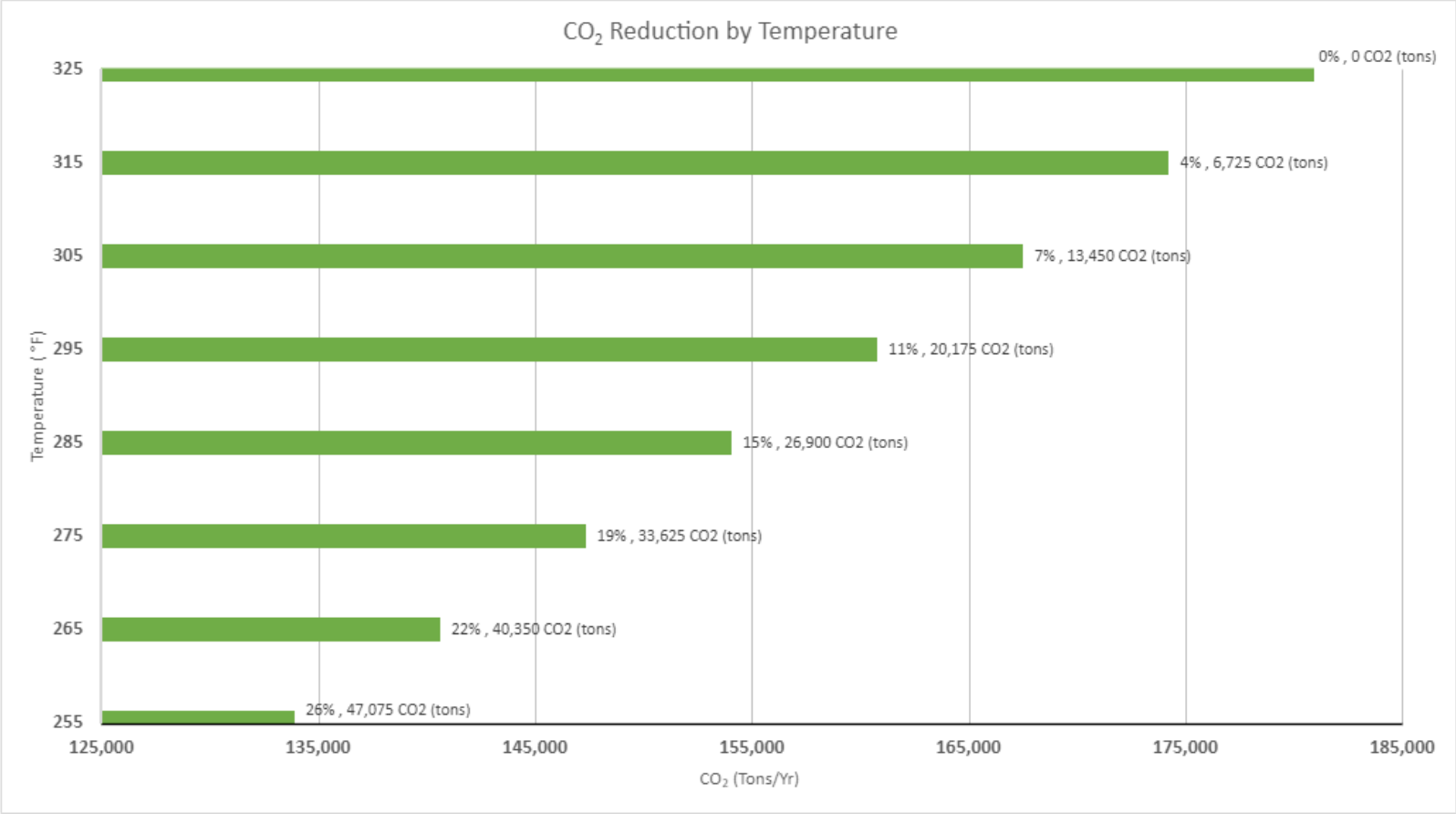
Fuel Savings from Model



The Benefits of Chemical WMA at Low Production Temperatures - CO2 Reduction



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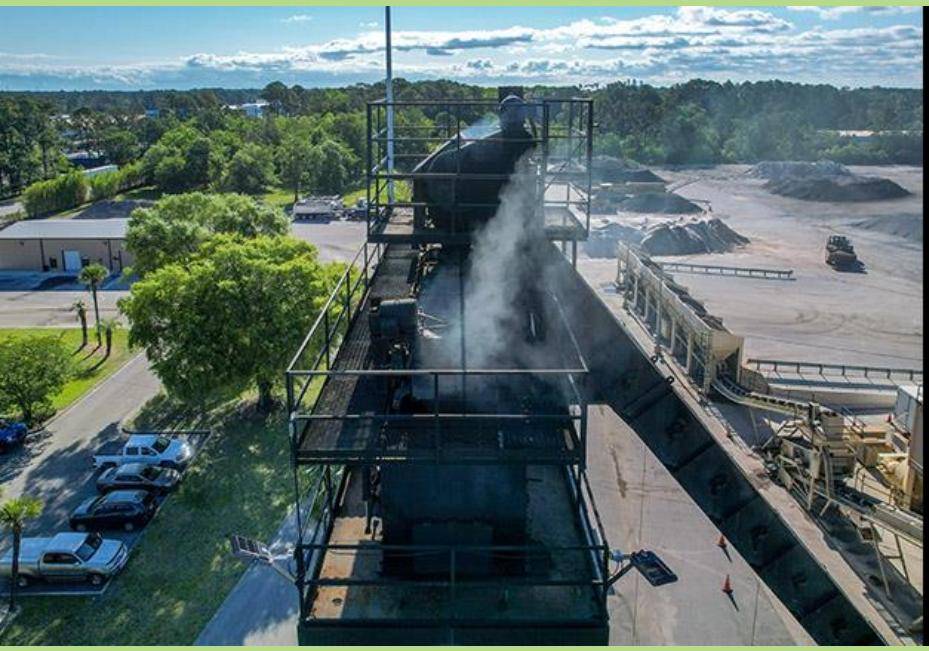
The Proof is in the Pictures

Reducing Visible Emissions with Low Production Temperatures



Standard Asphalt Mix

Mix with Chemical WMA at 50F Reduction

Reducing Visible Emissions with Low Production Temperatures

Smoke – Standard Hot Mix Asphalt at 315F

No Smoke – Mix with Chemical WMA at 260F

Reducing Visible Emissions with Low Production Temperatures

325F production temperature

275F production temperature

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Smokeless asphalt= longer lasting pavements

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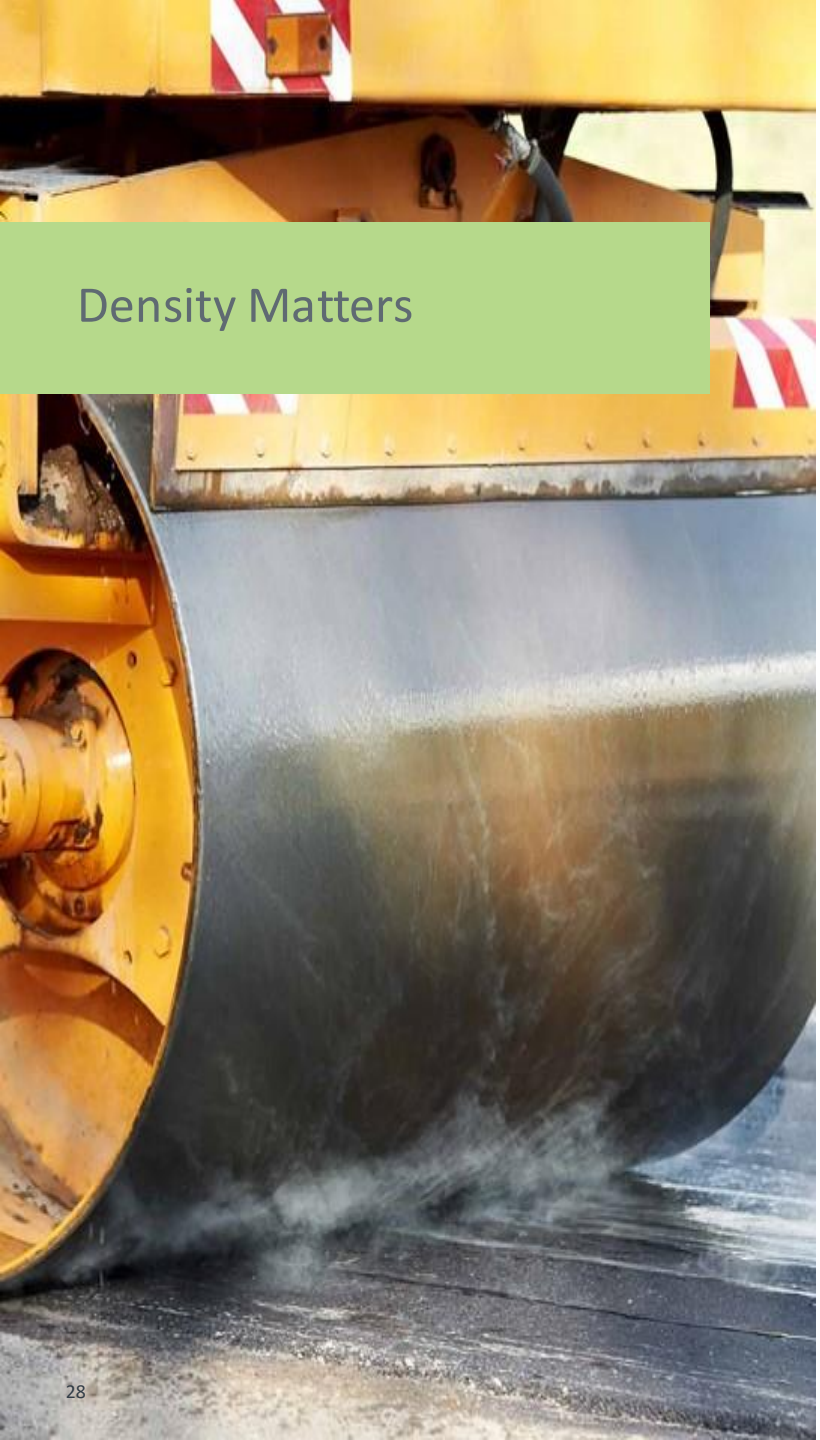

Density Matters

- 1% increase in field density increases pavement service life up to 10+%
- Annual Savings of $1.75 to $8.75 billion with a “B”
- FHWA Demonstration Project for Enhanced Durability of Asphalt Pavements through Increased In-place Pavement Density showcased that chemical WMA improved in place density or reduced effort needed to achieve required density

Aschenbrener, T., ETG Presentation, April 27, 2016
FHWA Demonstration Project for Enhanced Durability of Asphalt Pavements through Increased In-place Pavement Density, Phase 3 FHWA-HIF-20-003

Smokeless Asphalt can lead to longer lasting roads

- Heat ages the binder in the mix production process = oxidation of the material and shortens service life
- Smokeless asphalt enables contractors to achieve workability and improve compaction, all while avoiding aging of the binder
- This effect can enhance the life of the pavement and extend road life by 20-30%
- NJ DOT produces approximately 14M tons of asphalt per year at $70 per mix ton.
- NJ DOT spends roughly $980M per year on asphalt
- Assuming asphalt overlays last 10 years on average.
  - A 10% life extension saves NJ ~ $98Million/yr
  - A 20% life extension saves NJ ~$196 Million/yr
  - A 30% life extension saves NJ ~$294 Million/yr

Smokeless asphalt presents an opportunity for NJ to realize $98-$294 Million per year in life cycle cost savings!

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Sample Specifications and Regulations utilizing WMA

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Sample Specifications/Regulations

1. MN DOT Incentive Spec
2. TX DOT Draft Incentive Spec
3. NY DEC Part 220 Regulation
4. Utah DEQ R-313

MN DOT WMA Incentive Specification

S-1.1 Delete and replace MnDOT 2360.2C.4 with the following:

C.4 Warm Mix Asphalt (WMA) Option with Incentive Payment

WMA is an approved alternative to HMA. Any mix that is produced with a non-wax based warm mix chemical additive with a temperature less than or equal to 275°F as measured exiting the drum and recorded on the plant recordation system will be considered as WMA. Provide documentation the discharge temperature measuring device (sensor) has been calibrated for the current construction season. The Department will pay an incentive based on the HMA contract unit price for WMA produced in accordance with Table 2360.2-1A. An incentive will not be paid if the temperature sensor or the 20 minute recordation export is not functioning properly.

Plant mixing temperatures greater than 275°F will be allowed for the first 100 tons of daily production to allow for plant warm-up. That tonnage will be included in the incentive payment. Incentive payment for each mix type will be based on the day's average plant mixing temperature as determined from the 20 minute plant recordation. Excluding the first 100 tons of daily production, there will be no incentive payment for each mix type if more than 10 percent of the daily discharge mix temperature readings are above 275°F. Provide plant and laboratory mixing and compaction temperatures for temperature and dosage rates as determined by the manufacturer of the additive to the Engineer. The Department will not pay any WMA Incentive if greater than 25 percent of all density lots for the Project fail to meet the minimum density requirements in accordance with 2360, "Plant Mixed Asphalt Pavement." Use the composite pay factor for mainline density lots with longitudinal joint density.

Table 2360.2-1A
Warm Mix Asphalt Incentive Payment

Plant Mixing Temperature	Incentive Payment, percent
≥ 275°F	0
250°F - 275°F	2
< 250°F	4

S-1.2 Add the following to the list in MnDOT 2360.2G.8.c:

(9) Additive (percent)

S-1.3 Add the following to the list in MnDOT 2360.2G.8.d:

(7) Additive (percent)

TX DOT Incentive Summary (under industry review/piloted projects 2023 and 2024)

Requirements:
Thermal Imaging at Plant Discharge (procedure attached)
Thermal Imaging Behind the Paver Screed
A full dosage of an approved Chemical Warm Mix Additive

HMA Maximum Temps
PG 76 345F
PG 70 335F
PG 64 325F

WMA Maximum Temps
PG76 295F
PG 70 285F
PG 64 275F

Producer has the option to produce HMA or WMA (but still have to use thermal imaging and full dosage of chemical WMA additive regardless).

To be eligible for WMA bonus:

- Must not exceed WMA Maximum temperatures (producer will need to set target production temperature lower than maximum temperature to account for temperature variance throughout the day).
- Must achieve density.
- Average temperature must be within 10F+/- of target temperature.
- Must control temperature variance.

Bonus Structure:
WMA with less than 20 degree temperature variance throughout the day – 3% bonus
WMA with less than 30 degree temperature variance throughout the day – 2% bonus
WMA with less than 40 degree temperature variance throughout the day – 1% bonus

Utah DEQ R307-313—WMA option for controlling VOC emissions at asphalt plants

R307. Environmental Quality, Air Quality.
R307-313. VOC and Blue Smoke Controls for Hot Mix Asphalt Plants.
R307-313-1. Purpose.

Rule R307-313 establishes emission controls and work practice standards for the emissions of blue smoke and volatile organic compounds (VOC) from hot mix asphalt plants and associated oil storage tanks.

R307-313-2. Applicability.

Rule R307-313 applies to stationary hot mix asphalt plants and their associated oil storage tanks located in Salt Lake, Davis, Weber, Utah, and Tooele counties with an annual production level greater than or equal to 250,000 tons of hot mix asphalt per rolling 12-month period. Warm mix asphalt production shall not be included in the applicable annual production level in Rule R307-313.

R307-313-3. Definitions.

Terms defined in Section R307-312-3 also apply to this rule.

"Blue smoke" means a mixture of visible emissions and VOC emissions from HMA plants that results from the process of mixing hot oil with aggregate.

"Dryer" means a piece of machinery where aggregate is dried and heated during the asphalt manufacturing process, usually drum or cylinder shaped.

"Load out" means an area used for the loading of material from a silo or a batch tower into a truck or train or other means of transport, often located under a silo.

"Silo" means a tower used to store material.

"Storage tank" means any storage vessel where oils are heated and stored before mixing with aggregate.

"Warm mix asphalt" means asphalt produced at a temperature at or below 275 degrees F (135 degrees C).

NY Part 220-3.6(b)—WMA option for controlling blue smoke emissions at asphalt mix plants

§ 220-3.6 Emissions from asphalt storage silos, drag conveyors, and pug mills

(a) The owner or operator of an existing asphalt mixture processing unit shall control emissions associated with the drag conveyor, and/or hot screens, pug mill and asphalt storage silo filling operations. These emissions must be captured and can either be returned to the drum mixer, controlled with coalescing filters or controlled with any other method acceptable to the department, approved in writing, according to the following schedule:

(1) Existing asphalt mixture processing units that have a calculated annual production level equal to or greater than 500,000 tons per year of asphalt mixture, must comply within one year of the effective date of this Subpart.

(2) Existing asphalt mixture processing units that, have a calculated annual production level equal to or greater that 250,000 tons per year but less than 500,000 tons per year of asphalt mixture, must comply within three years of the effective date of this Subpart.

(3) Existing asphalt mixture processing units that have a calculated annual production level equal to or greater than 75,000 tons per year but less than 250,000 tons per year of asphalt mixture, must comply within five years of the effective date of this Subpart.

(4) New asphalt mixture processing units or reconstructed asphalt mixture processing units, regardless of annual production levels, must comply upon start-up.

(5) Provided that the operator has ordered equipment and otherwise timely complied with this Subpart, any delays outside of the control of the operator, such as supply chain shortages, as determined by the department, shall not cause a violation of this section.

(b) Notwithstanding the methods of blue smoke capture and control set forth in subdivision (a) of this section, compliance with this section may also be achieved by demonstration to and written approval by the department that warm mix asphalt technology is being used that will control or eliminate blue smoke at the asphalt mixture processing unit, and can meet the requirements of 40 CFR Part 60, Appendix A-4, Method 9.

CONCLUSION: Smokeless asphalt can virtually eliminate smoke and emissions and improve mix performance.

- Temp reduction of 50°F or more will significantly reduce visible emissions and odors at the plant and paver versus merely capturing the smoke at the plant
- Temp reduction is a proven, economical approach to reducing/eliminating visible emissions and odors
- Smokeless asphalt has the added benefit of helping industry meet the climate goals by reducing GHG emissions by approximately 20% or more
- Smokeless asphalt can improve mix performance and make the roads last longer

Questions?

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