Energy Useage and GHG Emissions for Pavement Preservation Processes

Cold In-place Recycling Workshop

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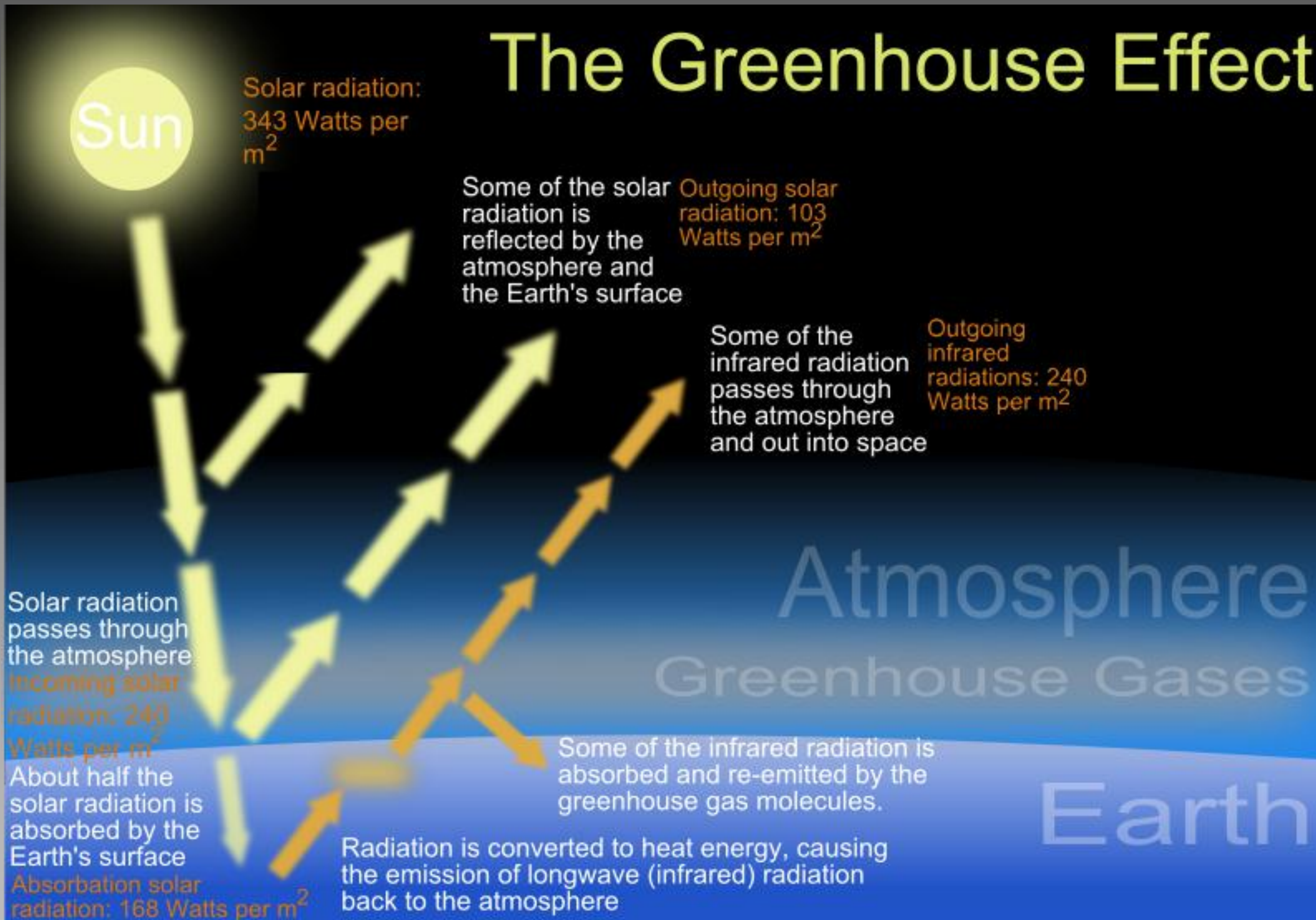
National Center for Pavement Preservation



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Background

- GHG in the atmosphere absorbs and emits radiation within the thermal infrared range.
- The primary greenhouse gases in the Earth's atmosphere are water vapor, carbon dioxide, methane, nitrous oxide, ozone and gases containing fluorine.
- Greenhouse gases greatly affect the temperature of the Earth

Energy Use Components

- Raw Materials - extract, transport, process
- Mixing/Heating/Production
- Jobsite Transport
- Jobsite Installation

Energy and GHG Equivalencies

1 Gallon Diesel Fuel

- 140,000 BTUs
- 22 lb CO_2

1 Kilowatt Electrical Power

- 3,412 BTUs
- 0.5 lb CO_2

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Energy and GHG Determinations

Partial Process Comparisons

- Starts at a specific point in the process

From The Earth Concept Comparisons

- Includes total energy going back to raw materials extracted from the earth

Energy Use for Pavement Construction

The Environmental Road of the Future:
Life Cycle Analysis, Energy Consumption and Greenhouse Gas Emissions

Chappat & Bilal, Colas Group, 2003

- Analysis of energy use and GHG emissions for highway materials and processes
- Includes Binders, Aggregates, Manufacture, Transport and Laying

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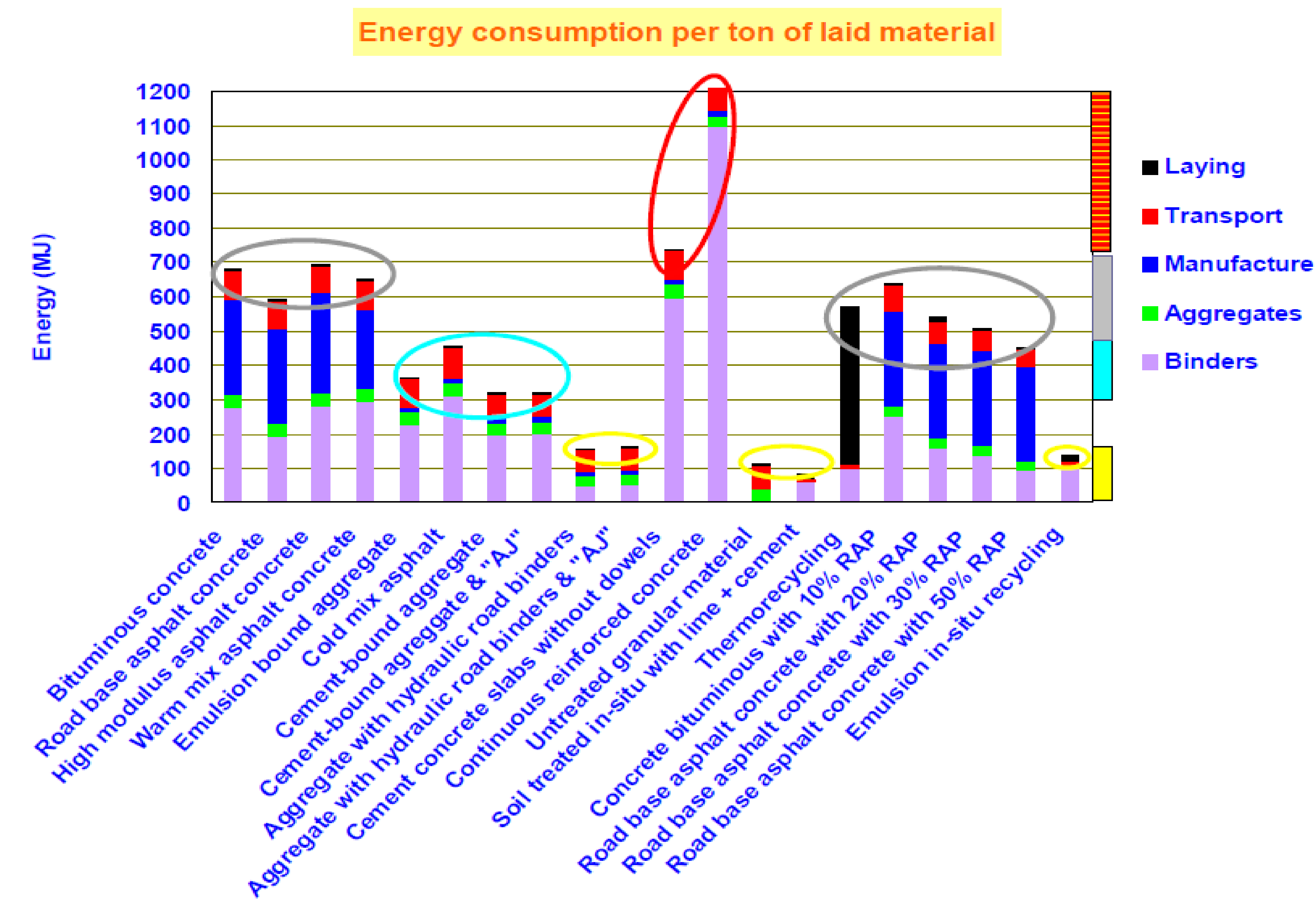

Energy consumption per ton of laid material
Energy (MJ)
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
Laying
Transport
Manufacture
Aggregates
Binders
Bituminous concrete
Road base asphalt concrete
High modulus asphalt concrete
Warm mix asphalt concrete
Emulsion bound aggregate
Cold mix asphalt
Cement-bound aggregate
Cement-bound agreggate & "AJ"
Aggregate with hydraulic road binders
Aggregate with hydraulic road binders & "AJ"
Cement concrete slabs without dowels
Continuous reinforced concrete
Untreated granular material
Soil treated in-situ with lime + cement
Thermorecycling
Concrete bituminous with 10% RAP
Road base asphalt concrete with 20% RAP
Road base asphalt concrete with 30% RAP
Road base asphalt concrete with 50% RAP
Emulsion in-situ recycling

Energy Use Amounts

Product	BTU/ Ton	lb CO_2/ Ton
Steel	21,600 m	7,080
Plastic	6,800 m	2,200
Portland Cement	4,300 m	1,960
Asphalt Cement	4,200 m	570
Hot Mix Prod	236 m	44
Aggregate	30 m	12
Transport/mile	1.2 m	0.2

Total Energy and GHG Emissions for Product Types

Product Type	BTU/ Ton	lb CO_2/ Ton
Hot Mix AC	586 m	108
Warm Mix AC	563 m	106
Plain PCC	635 m	268
CRCP	1,055 m	400
HIR	490 m	84
CIR	90 m	20

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Preservation Energy and GHG Emissions Determinations

- Ton comparisons not applicable
- Determine Energy and GHG by square yard (area) for typical installations
- Annualize by determining energy and GHG per year of life extension provided

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Preservation Process Designs

Treatment	Quantities	Life Ext.
Hot Mix AC	1.5 inch	5-10 yr
HIR	1.5 inch	5-10 yr
Chip Seal	.44 gal - 38 lb/ yd^2	3-6 yr
Type II Slurry	16 lb/ yd^2	3-5 yr
Crack Seal	1 lin ft/ yd^2	1-3 yr
Crack Fill	2 lin ft/ yd^2	1-2 yr
Fog Seal	0.10 gal/ yd^2	1 yr

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Construction and Rehabilitation Process Designs

Process	Quantities	Life
New Construction	4”AC/6” base	20 yr
Hot Mix Rehab	4”AC	15 yr
Warm Mix Rehab	4”AC	15 yr

Energy and GHG Determinations

Energy and GHG emissions for preservation processes are calculated for the entire process including raw materials, quantities used in the process, product manufacturing, transportation, and installation.

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Energy and GHG Emissions per Yard^2

Process	BTU/ yd^2	lb CO_2/ yd^2
Hot Mix AC	46,300	9.0
HIR	38,700	7.0
Chip Seal	7,030	0.90
Slurry Seal	3,870	0.40
Crack Seal	870	0.14
Crack Fill	1,860	0.25
Fog Seal	500	0.07

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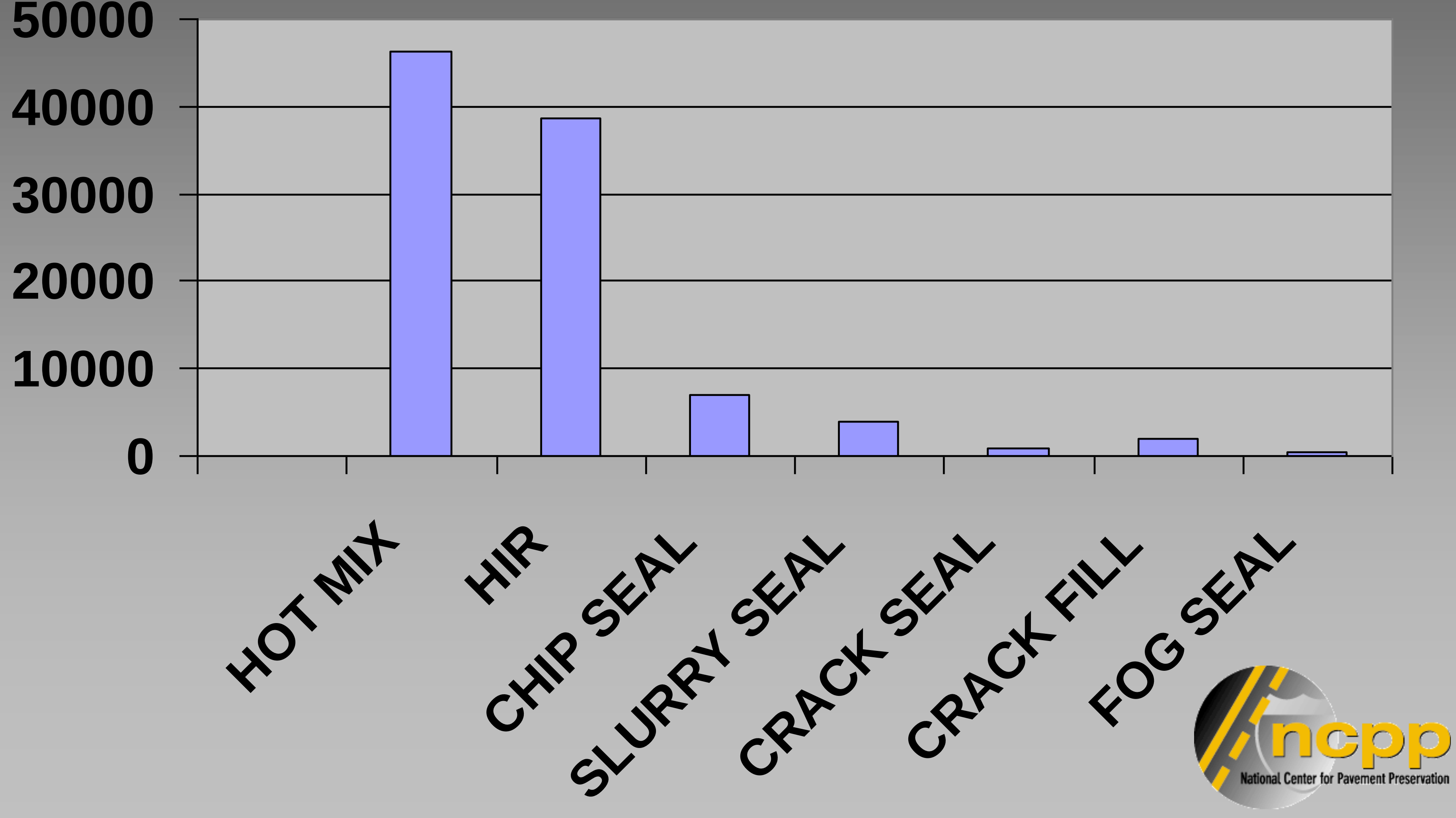
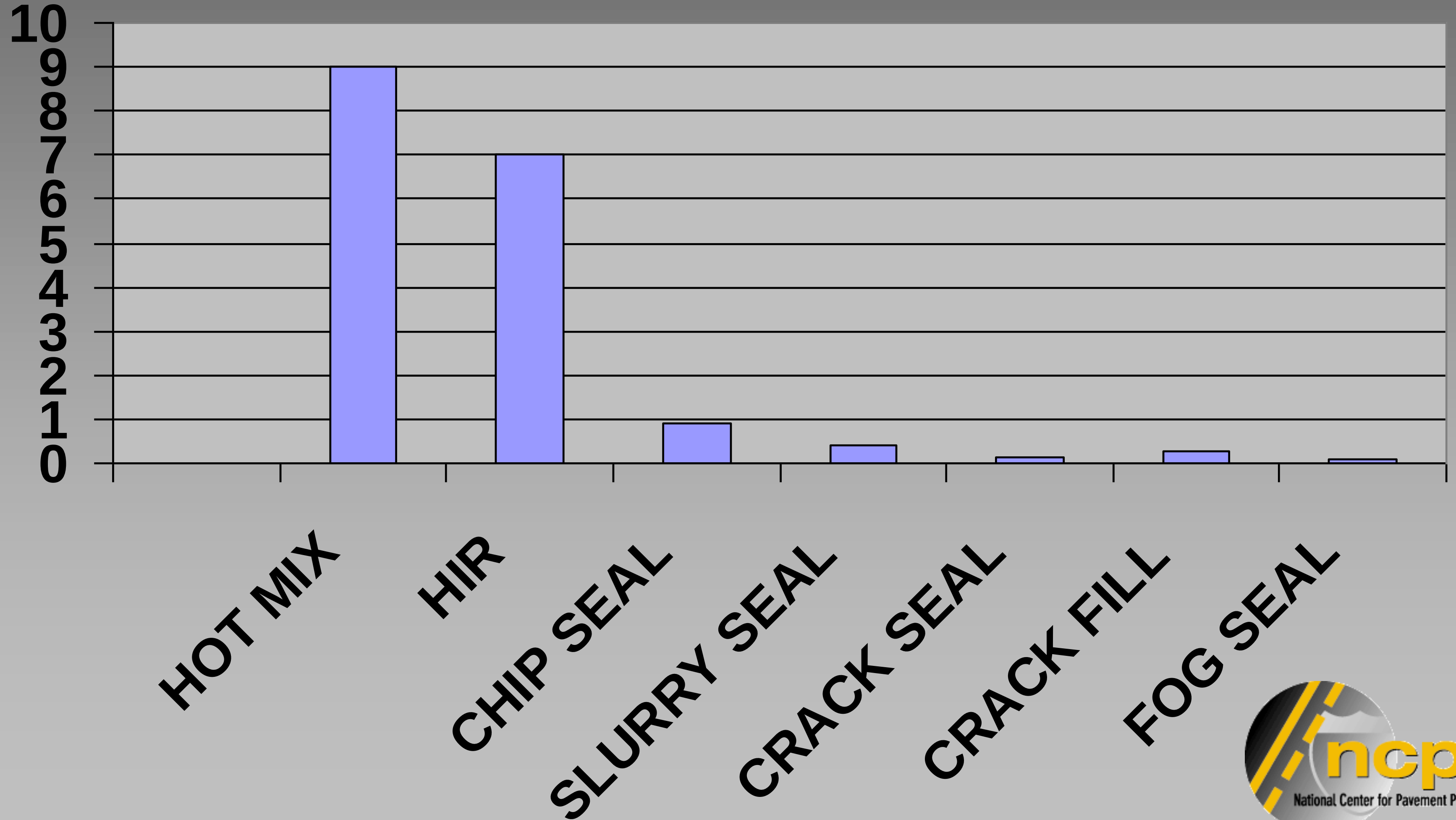
Energy Use for Preservation Processes (BTU/ yd^2)



GHG Emissions For Preservation Processes (lb CO_2/ yd^2)



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Construction and Rehabilitation Energy and GHG Emissions

Process	BTU/ yd^2	lb/ CO_2/ yd^2
New Construction (4"AC/6" base)	156,820	24.1
4 inch Hot Mix	112,800	20.9
4 inch Warm Mix	108,500	20.5

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Annualized Energy and GHG

Process	BTU/ yd^2/ yr	lb CO_2/ yd^2/ yr
Hot Mix	4,660 – 9,320	0.9 - 1.8
HIR	3,870 – 7,740	0.7 - 1.4
Chip Seal	1,170 – 2,340	.15 - .30
Slurry Seal	968 – 1,935	.10 - .20
Crack Seal	290 - 870	.05 - .14
Crack Fill	930 – 1,860	.13 - .25
Fog Seal	500	.07

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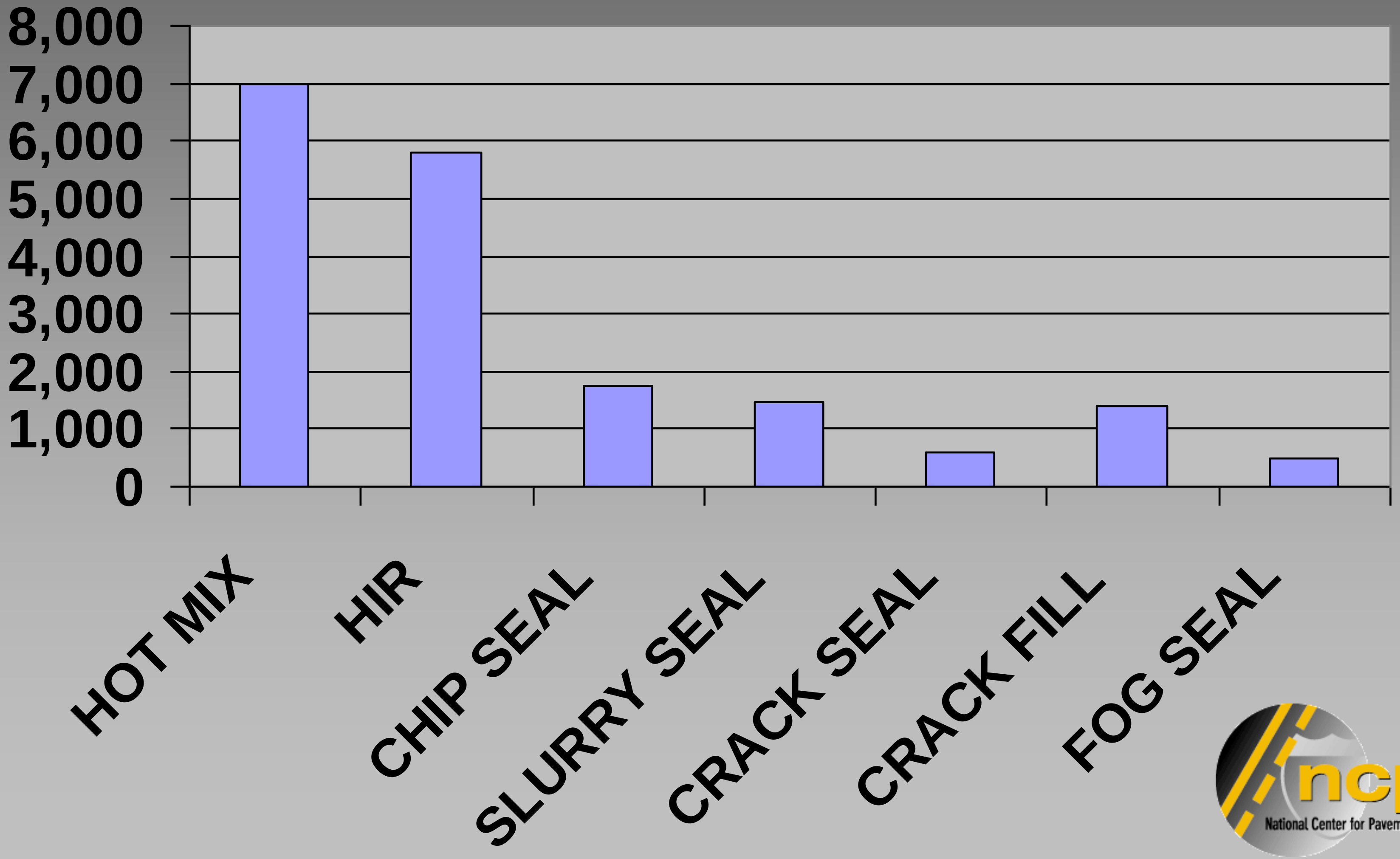
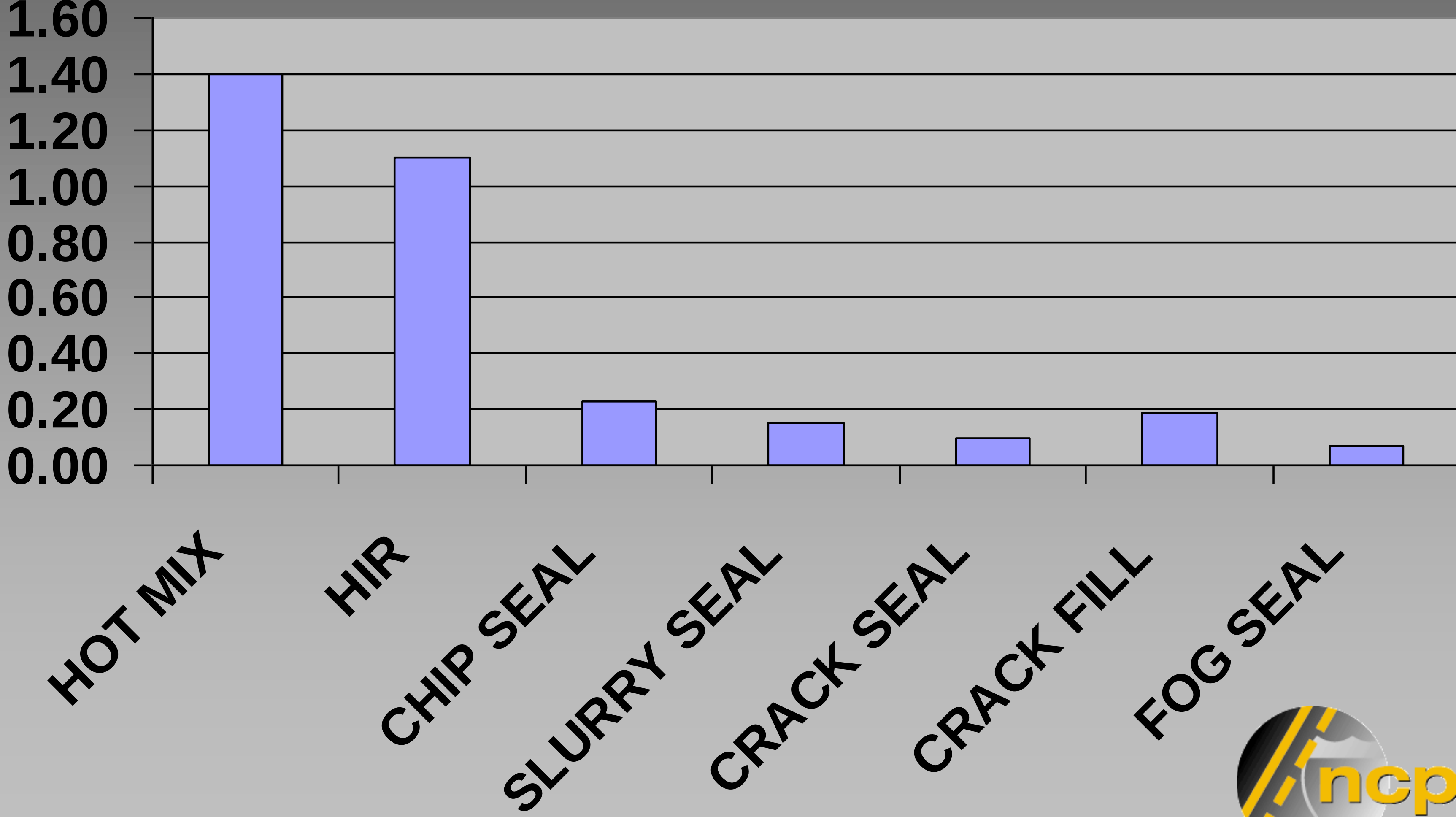
Annual Energy Use (BTU/ yd^2/ yr)



Annual GHG (lb CO_2/ yd^2/ yr)



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Annualized Energy and GHG for Construction and Rehabilitation

Process	Life	BTU/ yd^2/ yr	lb /CO_2/ yd^2/ yr
New Const.	20	7,840	1.2
4” Hot Mix	15	7,500	1.3
4” Warm Mix	15	7,210	1.3

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Comparison of Annualized Energy Use Results

Lowest Energy (<1000 Btu/ yd^2/ yr)

- Crack Seal and Fog Seal

Medium Energy (1000-3000 Btu/ yd^2/ yr)

- Crack Fill, Slurry Seal, and Chip Seal

Highest Energy (3,000-10,000 Btu/ yd^2/ yr)

- Thin Hot Mix Overlay, HIR, New Construction, Hot Mix Rehabilitation, and Warm Mix Rehabilitation

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Comparison of Annualized GHG Emission Results

Lowest Emission (<0.15 lb /CO_2/ yd^2/ yr)

- Crack Seal, Fog Seal

Medium Emission (0.1-0.3 lb /CO_2/ yd^2/ yr)

- Crack Fill, Slurry Seal, Chip Seal

Highest Emission (0.7-1.8 lb /CO_2/ yd^2/ yr)

- Thin Hot Mix Overlay, HIR, New Construction, Hot Mix Rehabilitation, and Warm Mix Rehabilitation

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Lane Mile Energy and GHG Savings compared with New Construction

Process	Life Ext	Fuel (gal)	GHG (ton)
Fog Seal	1yr	370	4.1
Chip Seal	4½ yr	315	3.5
Slurry Seal	4 yr	345	3.8
Crack Fill	1½ yr	330	3.6
Crack Seal	2 yr	370	4.1
AC Overlay	7½ yr	85	0.9
HIR	7½ yr	140	1.5

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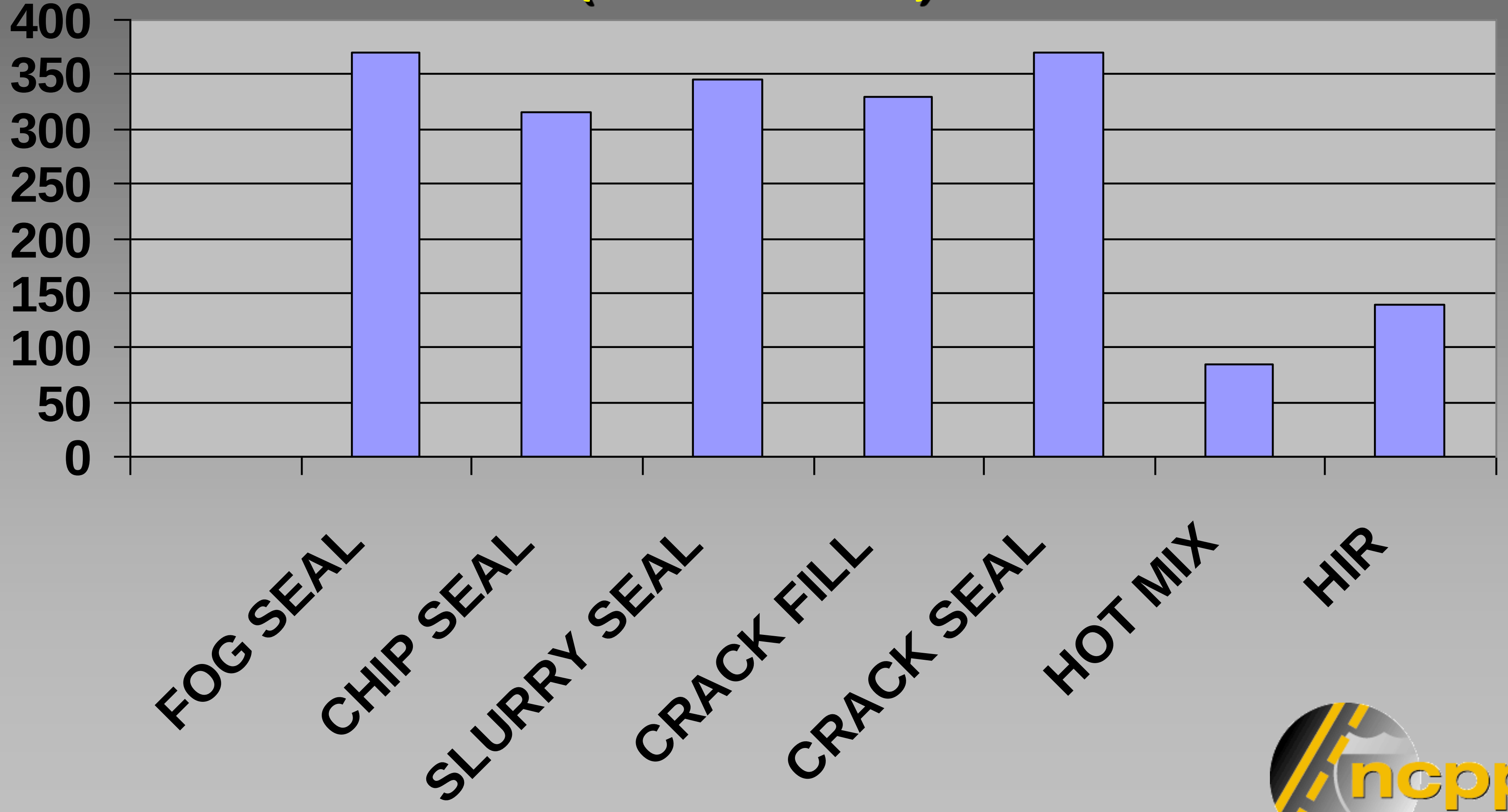
Lane Mile Energy Savings compared with New Construction (Gal Fuel)



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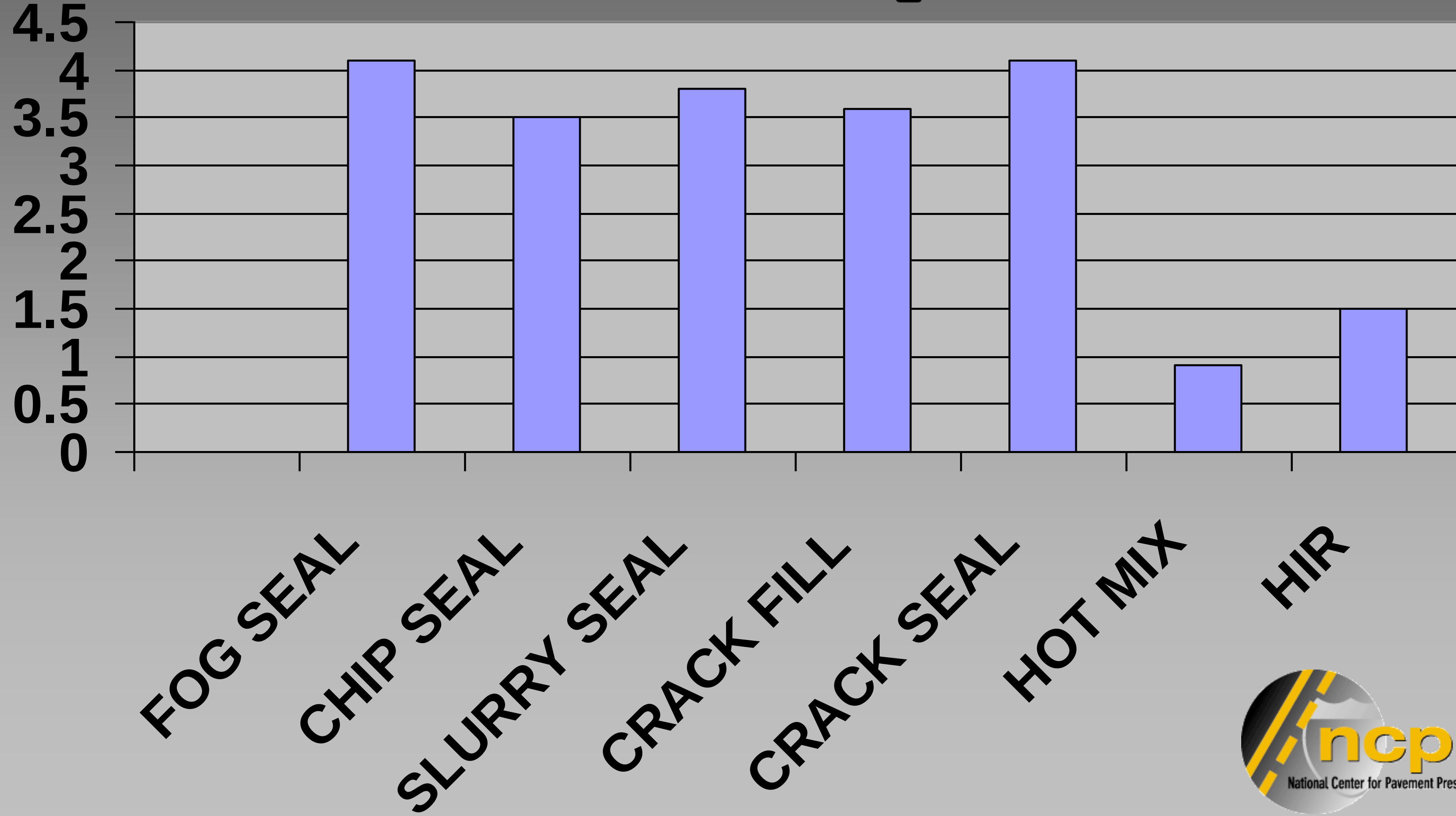
Lane Mile GHG Reductions compared with New Construction (Tons CO_2)



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Conclusions

1. Pavement Preservation Processes use significantly less energy and have reduced GHG emissions per year of pavement life than Hot Mix and Warm Mix rehabilitation overlays, and New Construction

Conclusions

2. Preservation processes require less energy and generate less GHG emissions due to use of strategic installations of specific materials in greatly reduced quantities than with new construction or rehabilitation.

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Conclusions

3. To minimize energy use and GHG emissions of pavement systems, Pavement Preservation Processes should be utilized to the maximum extent feasible considering pavement conditions

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Thank You !