West Coast Climate
& Materials Management Forum

Reducing Carbon Emissions From Concrete and Asphalt

- West Coast Climate Forum: westcoastclimateforum.com
- Webinar archive: westcoastclimateforum.com/annualwebinar

West Coast Climate Forum Webinar Series Disclaimer

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Reducing Carbon Emissions From Concrete and Asphalt

Speakers:

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StopWaste
Alameda County

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City of Eugene

Stacy Ludington
Oregon DEQ

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Good
Company

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We value your feedback!

3-5 minute evaluation will be sent out in the follow-up email

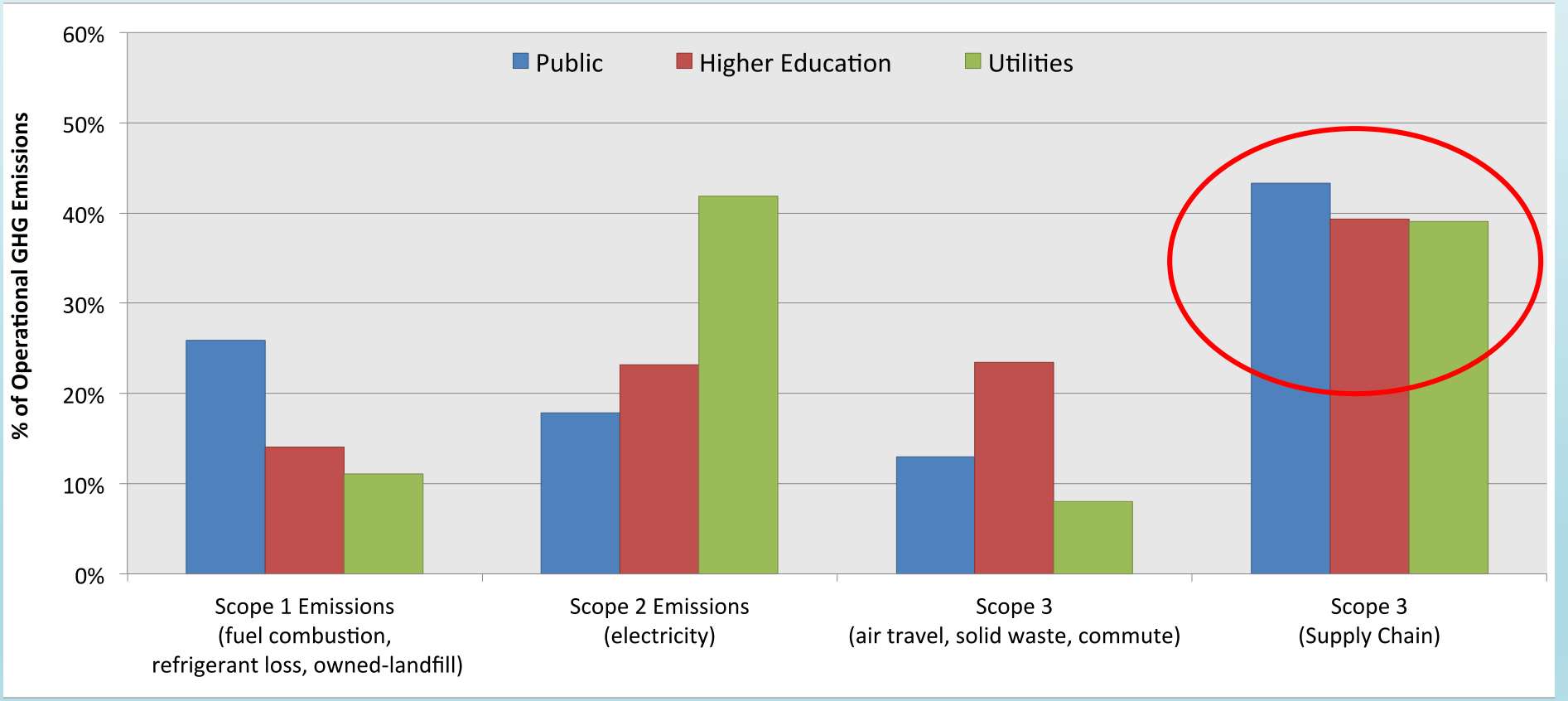
westcoastclimateforum.com

Good Company

- sustainability research and consulting firm
- mission-driven, for-profit
- clients: government, higher ed, private sector

Scopes 1&2 (Required)	Public	Private	Capital Projects	TOTAL
Electricity use (generated and purchased)	45	30	14	89
Stationary fuel use (natural gas, etc.)	45	30	14	89
Fugitive emissions of refrigerant use	45	30	N/A	75
Fleet fuel use (diesel, gasoline, CNG, LNG, etc.)	45	30	14	89
Scope 3 (Optional but Recommended)	**Public**	**Private**	**Capital Projects**	**TOTAL**
Solid waste management	45	23	11	79
Employee commute	45	24	8	77
Business travel (air, car, train, etc.)	45	23	8	76
Supply chain purchases from operations	30	24	14	68
Supply chain purchases from capital projects	30	24	14	68
Transit access trips	1	1	N/A	2
Benefits of mode shift to transit, congestion relief and land use multiplier	0	1	6	7
Benefits of onsite renewable energy generation	1	4	6	11

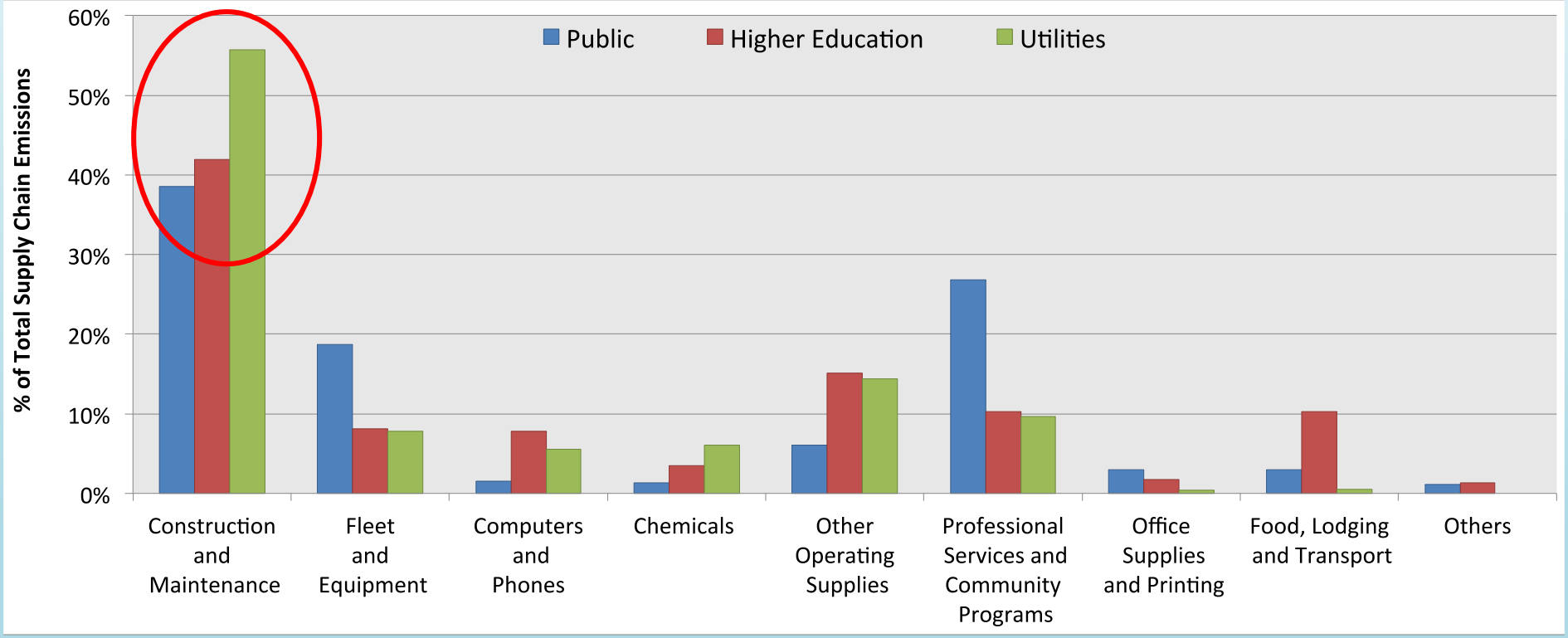
Significance of Supply Chain GHG Emissions



Source (slides 2-3): Good Company on behalf of Alameda County, CA (2015). *Supply Chain Greenhouse Gas Inventory Meta-Analysis*.

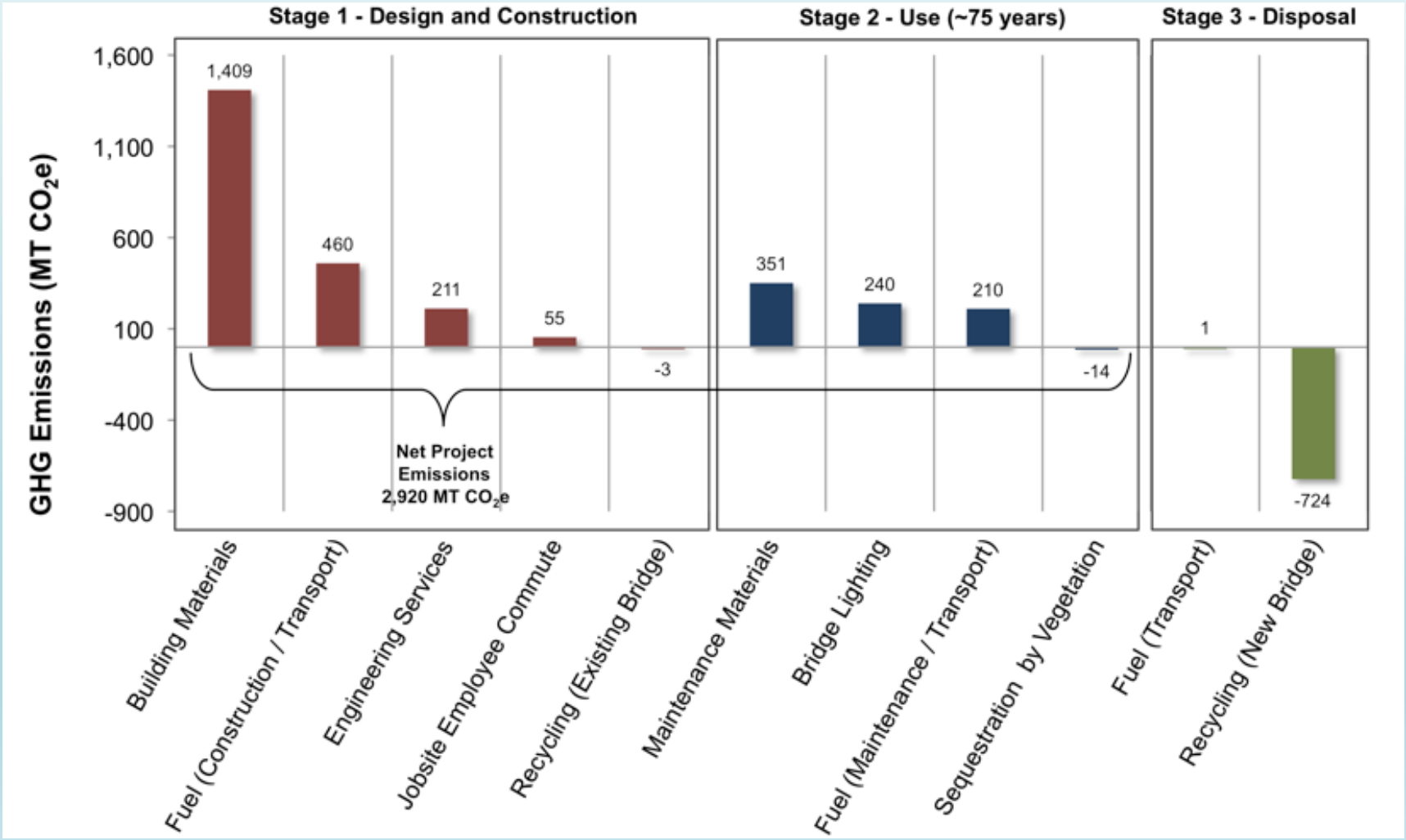
Results of Supply Chain Meta Analysis

Significance of Construction GHG Emissions



Case Study: North Vancouver Bridge

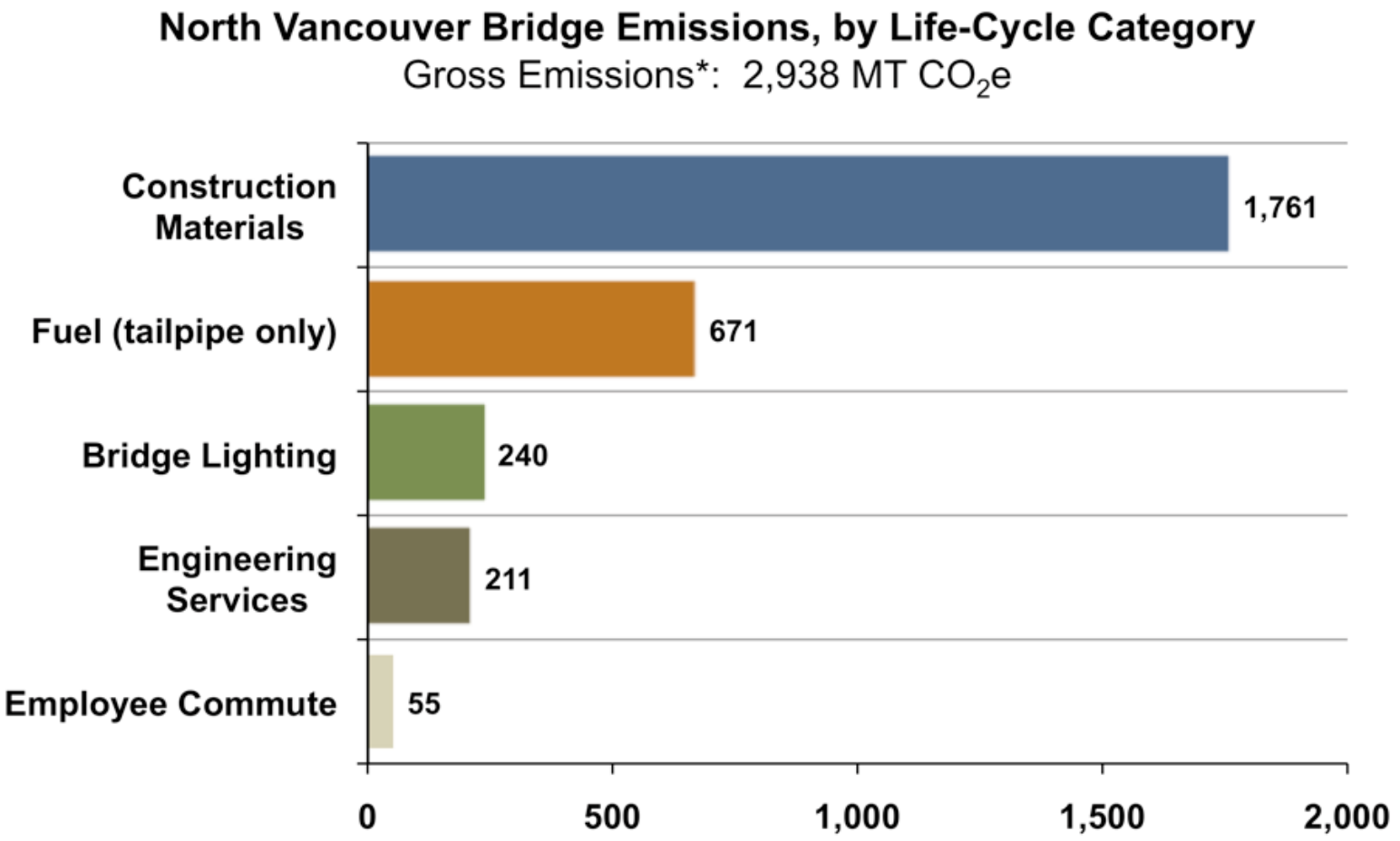
lifecycle emissions, by stage and source



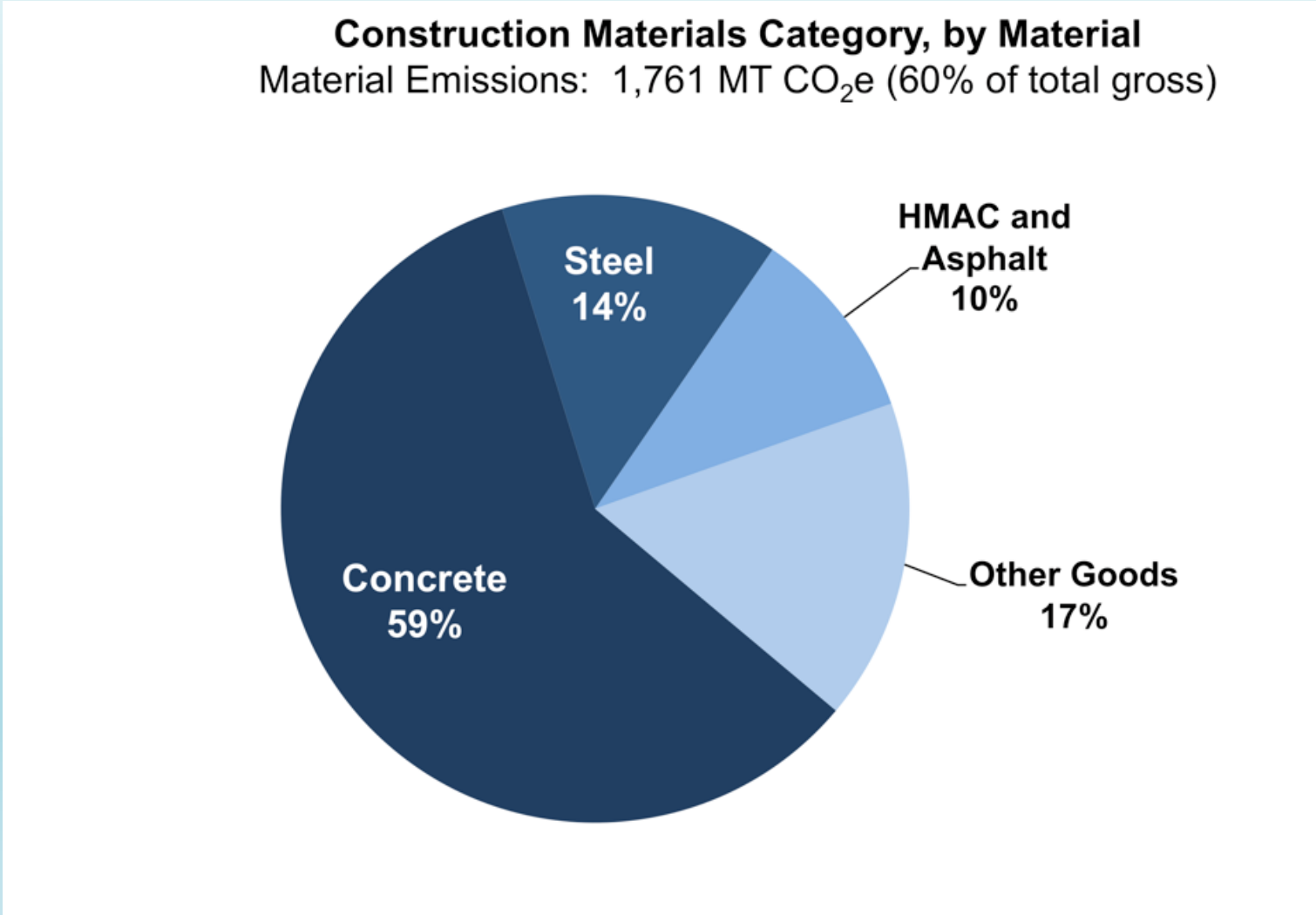
Source (slides 3-6): Good Company on behalf of Portland Bureau of Transportation (2009). *Vancouver Bridge Lifecycle GHG Assessment.*

Case Study: North Vancouver Bridge

gross lifecycle emissions



construction material emissions details



Case Study: North Vancouver Bridge

GHG reduction opportunities

Emissions Reduction Strategies	Maximum Potential Reductions MT CO_2e
1. Deconstructed Materials Management	**-1,774**
a. Existing Bridge	
i. Wood	*-1,031*
ii. Steel	*-11*
iii. Concrete	*-8*
b. New Bridge (~75 years from now)	
i. Steel	*-628*
ii. Concrete	*-96*
2. Increase Recycled Content	**-695**
a. Concrete - Fly Ash Substitution	
i. Deck Concrete	-657
ii. Pre-Cast Beams	-30
a. Steel	
i. Pedestrian Railing	-8
3. Low-Carbon Fuels and Fuel Efficiency	**-161**
a. Low-Carbon Fuels	
i. B20 in Construction Equipment	*-122*
b. Fuel Efficiency	
i. Anti-Idling Policy	*-17*
ii. Equipment Efficiency	*-22*
MAXIMUM POTENTIAL REDUCTION:	**-2,630**

Thank You!

Feel free to contact me:

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Construction Reduction:

Reducing Greenhouse Gas Emissions and Costs for Concrete, Asphalt, and Aggregate

Stacy Ludington | Oregon DEQ

May 12, 2015

Project Intent

Compile available information on **GHG reductions** and **cost savings** of concrete and asphalt substitute materials compared to traditional materials.

Explore benefits and concerns.

Project Measures

Asphalt

- Warm Mix Asphalt Concrete
- WMAC w/ 30% Reclaimed Asphalt Pavement
- Hot Mix Asphalt Concrete w/30% RAP

Concrete

- Fly Ash
- Slag

Aggregate

- Recycled aggregate

Asphalt

Hot-Mix Asphalt Concrete

Facts

- 95% aggregate, 5% binder
- Heated to 300 - 350°F
- High heat volatizes chemical fumes

- 0.067 MT CO_2e / short ton

Warm-Mix Asphalt Concrete

Facts
• Change in process •Chemical additives lower mixing temp. by 50-100°F

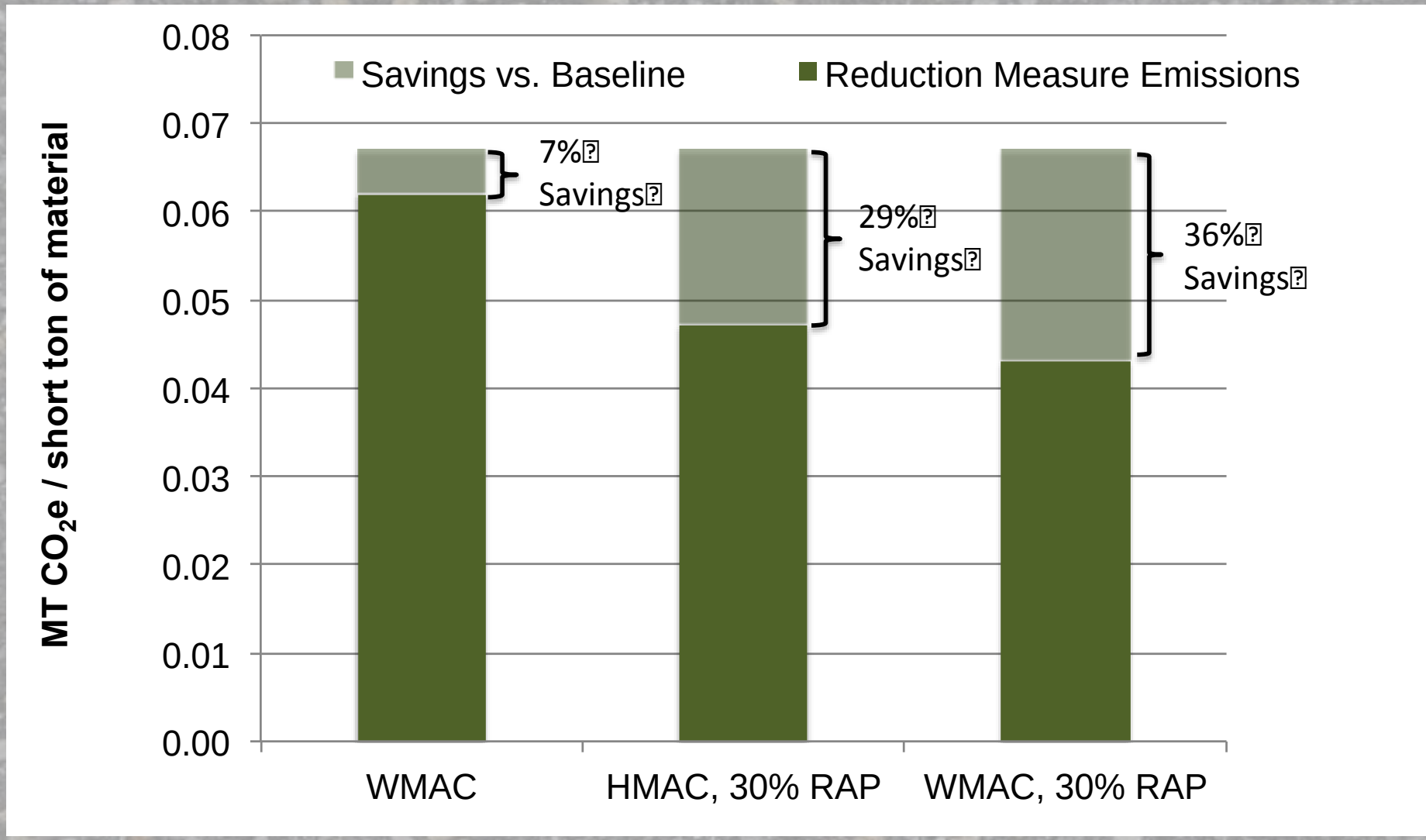
Benefits	Concerns
• Reduced energy use and GHG emissions • Cost savings from lower energy use • Healthier/safer working conditions • Easier to work with	• Questions about long-term performance • Risk of moisture damage • New equipment investment by asphalt plants

MT CO2e/ton	$ / Ton
0.062	-$1.29

Reclaimed Asphalt Pavement

Facts		
• Substitute for binder (material change) • 80 million tons recycled / year		
Benefits		**Concerns**
• Widely used and proven technique. • Reduces costs, energy use and GHGs. • Can be used in a variety of asphalt mixes.		• RAP can be stiff and difficult to apply. • Variability among RAP stockpiles have prevented national mix standards.
MT CO2e/ton		**$ / Ton**
HMA	0.047	-$8.00
WMA	0.043	-$9.29

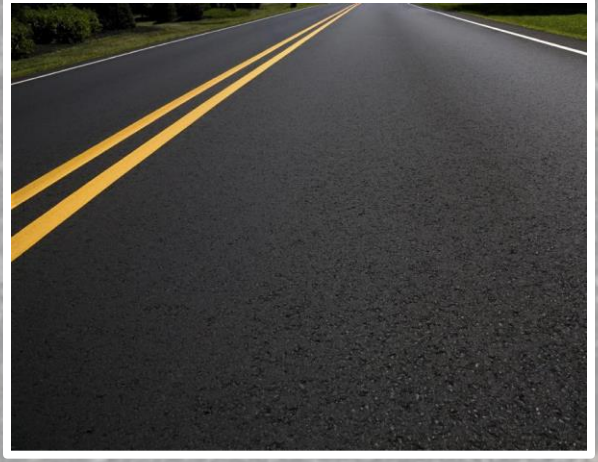
Asphalt GHG Measures vs. Baseline



Baseline = 1 short ton of HMAC with 5% binder

Asphalt Summary

Material/Process	MT CO2e / ton	Change from Baseline MT CO2e / ton	Change $/ton
WMAC	0.062	-0.005	-$1.29
HMAC, 30% RAP	0.047	-0.020	-$8.00
WMAC, 30% RAP	0.043	-0.024	-$9.29



Concrete

Concrete

Facts

- 41% rough aggregate, 26% fine aggregate, 16% water, 11% cement, 6% air
- Crushed limestone + 2,7000°F = Lime & CO_2

- 0.120 MT CO_2e / short ton

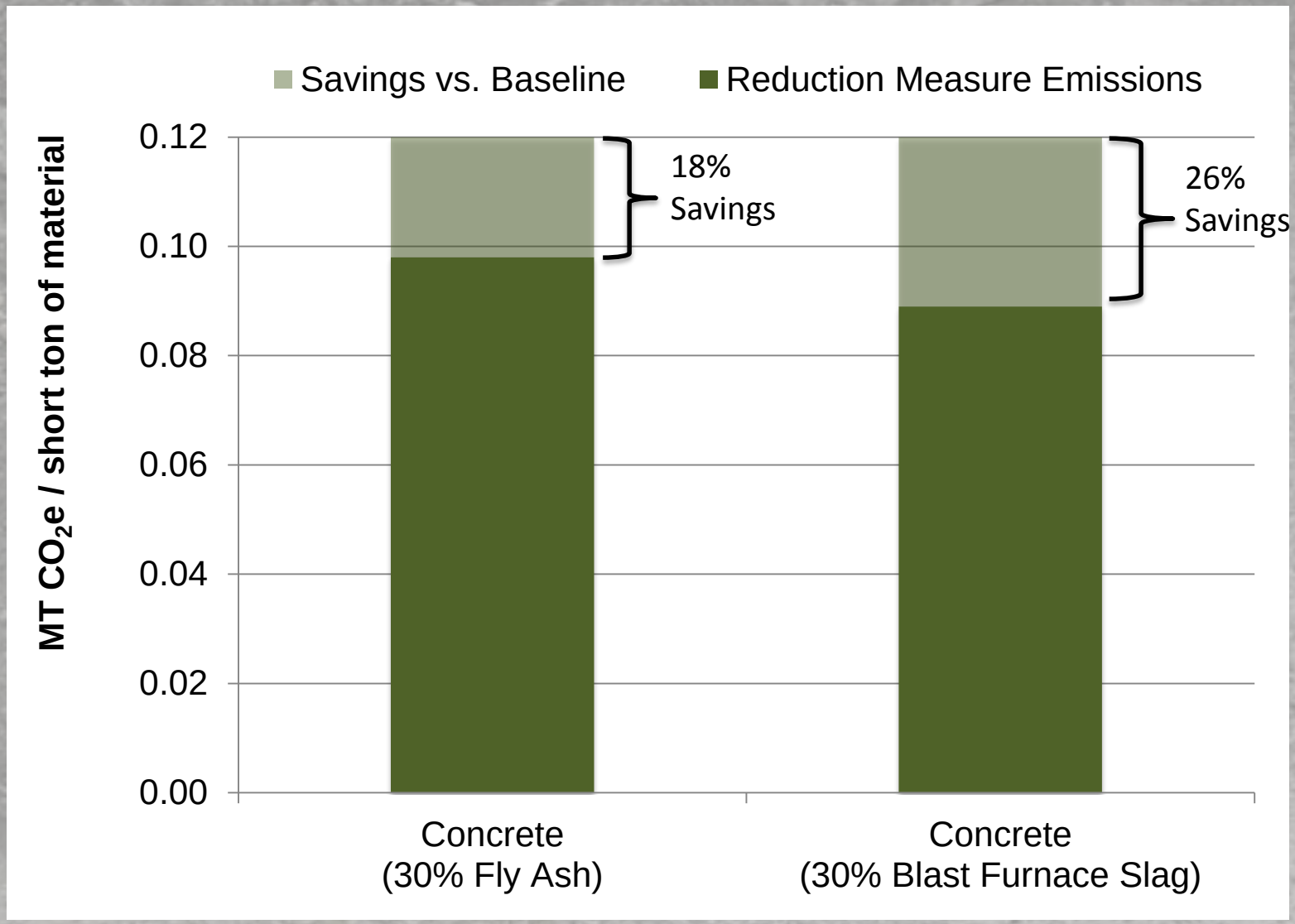
Fly Ash

Facts	
• Waste by-product from coal • Generally replace 0-30% of cement • “Class C Fly Ash”	
Benefits	**Concerns**
• Stronger, denser, more durable • Protects steel better • Increased workability • Less water • Produces white concrete	• Toxicity concerns • Longer set time • Reduced early strength • Transportation of material can be costly
MT CO2e/ton	**$ / Ton**
0.098	-$9.98

Slag

Facts	
• Waste by-product from iron and steal manufacturing • Typically replace 20-80% of cement	
Benefits	**Concerns**
• Stronger, denser, more durable • Increased workability • Less water • Produces white concrete	• Health & safety concerns • Longer set time • Reduced early strength • Increased risk of salt scaling
MT CO2e/ton	**$ / Ton**
0.089	-$6.32

Concrete GHG Measures vs. Baseline



Baseline = 1 short ton of 3,600 psi concrete

Concrete Summary

Material/Process	MT CO2e / ton	Change from Baseline MT CO2e / ton	Change $/ton
Concrete w/ 30% Fly Ash	0.098	-0.022	-$9.98
Concrete w/ 30% Slag	0.089	-0.031	-$6.32

Aggregate

Aggregate

Facts

- Wide, multiple uses
- Sand, gravel, rock, etc.

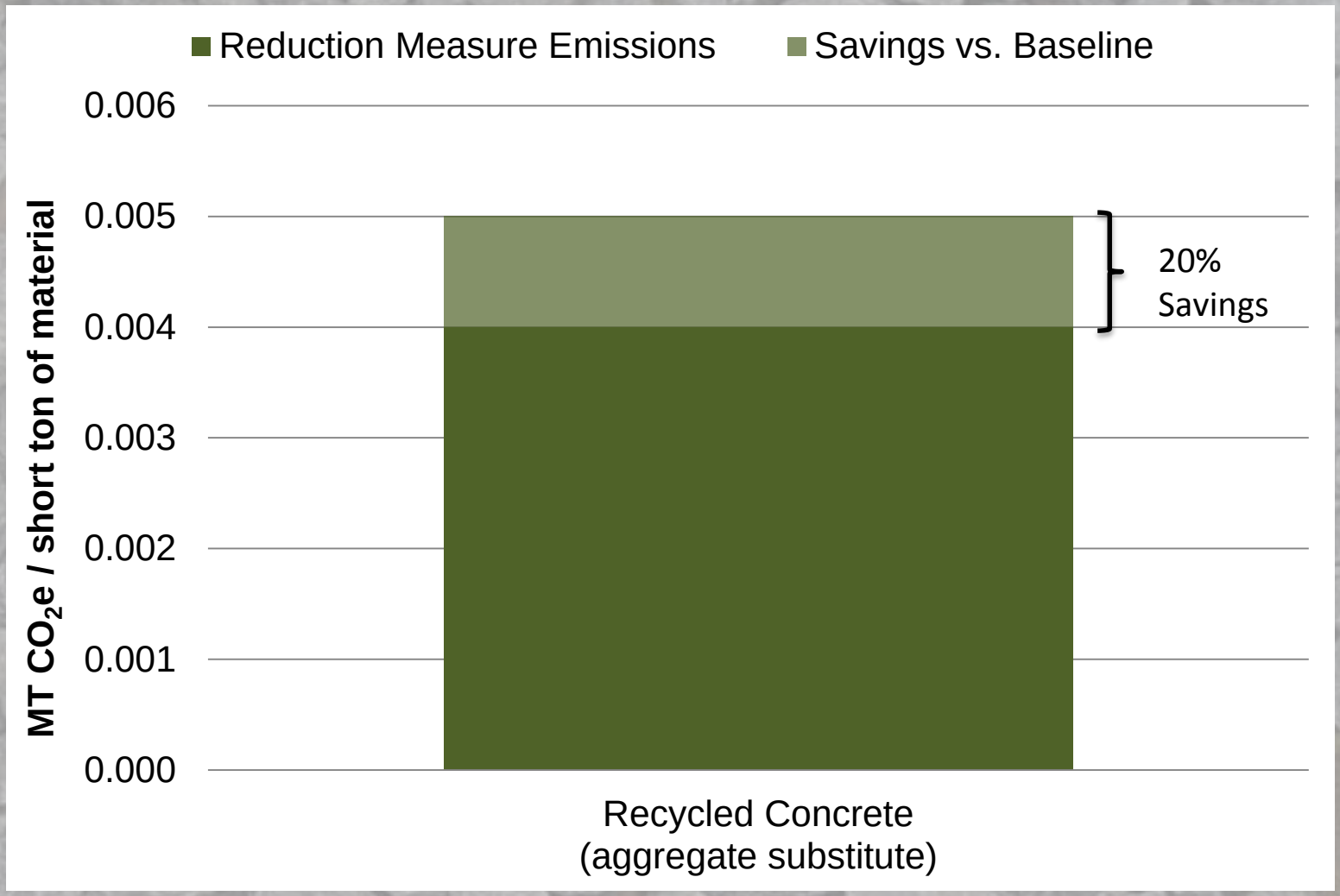
- Transportation GHG intensive

- 0.005 MT CO_2e / short ton

Recycled Aggregate

Facts	
• Crushed concrete	
Benefits	**Concerns**
• Lower cost • Reduced damage to roadways from aggregate transport	• Lack of contractor experience • Only for non-structural application • Human health & safety concerns
MT CO2e/ton	**$ / Ton**
0.004	-$0.45

Aggregate GHG Measures vs. Baseline



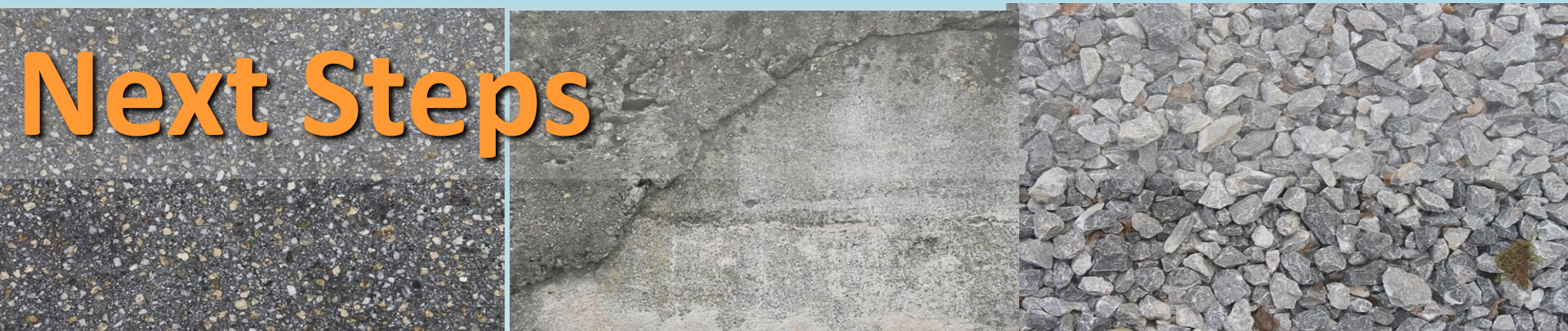
Baseline = 1 short ton of virgin aggregate

Aggregate Summary

Material/Process	MT CO2e / ton	Change from Baseline MT CO2e / ton	Change $/ton
Recycled Aggregate	0.004	-0.001	-$0.45

Next Steps

- Develop **Cost of Carbon Reduction** Measure
- Expand boundaries to capture **lifecycle costs**
- Conduct a **sensitivity analysis** to determine the effect of transportation distances
- **Expand material selection**
- Provide the **calculator** with the toolkit



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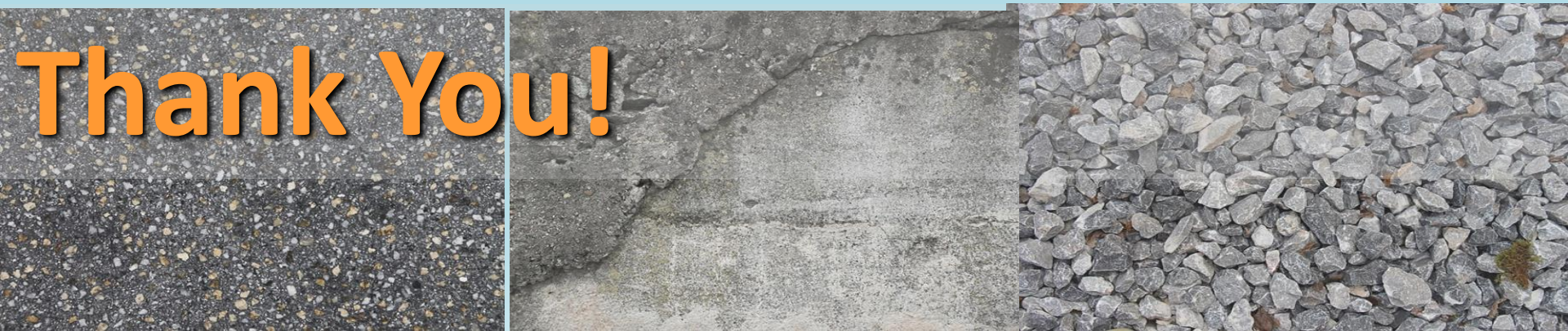
Thank You!



Case Study: Warm Mix Asphalt Pavement

West Coast Climate and Materials Management Forum

May 12, 2015

About the City of Eugene

- Located in the Willamette Valley in the I-5 corridor in Oregon, about 110 miles south of Portland.
- Population of more than 140,000 and Oregon's second largest City.
- Eugene covers about 41.5 square miles.
- Public Works manages about 1,260 lane miles of improved streets.

Eugene's Pavement Preservation Program

- Implementing City-wide focus on sustainability.
- 2014 projects rehabilitated 23.8 lanes miles on 19 streets.
- Methods used include:
  - Warm Mix Asphalt Pavement
  - Reclaimed Binder in Asphalt Pavement
  - In-Place Reclamation

"A Sustainable Community is one that meets its present environmental, economic and social needs without compromising the ability of future generations to meet their own needs."

– City of Eugene 'Sustainable Community' web

Eugene and Warm Mix Asphalt Pavement

- Introduced at an Asphalt Pavement Association of Oregon annual conference.
- Three pilot projects in 2009.
- Standard specification in 2010.
- Standard to combine with 30% reclaimed asphalt pavement.

Eugene and Warm Mix Asphalt Pavement

- City of Eugene Greenhouse Gas calculator “G4C” created by Good Company.
- ~34% reduction in greenhouse gases by using warm mix combined with 30% RAP.
- From 2009 – 2014, placed approx. 361,000 tons of warm mix asphalt pavement = reduction of 8,700 Metric Tons of CO_2e.

What is Warm Mix Asphalt Pavement?

- Used in Europe in the 1990's.
- Used in the US since 2004.
- FHWA "Everyday Counts Initiative"
- Asphalt pavement is produced and placed at 50 to 100°F lower than conventional hot mix asphalt.
- Produced by a variety of technologies, primarily using a "foaming process" or additives.

Warm Mix Asphalt Pavement Benefits

- Reduced Fuel/Energy Consumption
- Reduced Emissions
- Extended Paving Season
- Improved Performance

Eugene

Warm Mix Asphalt Pavement Benefits
Improved Performance

- Reduces “aging” of the binder during production.
  - Temperatures are below the boiling point of “light oils”
  - Asphalt coating is thicker because light oils haven’t been burned off slowing the aging process
  - High temperatures oxidize the asphalt, like sunlight, making it brittle. By reducing the production temperature, the asphalt is not pre-oxidized in the manufacturing stage.

Warm Mix Asphalt Pavement Benefits
Improved Performance

- Allows for easier and better compaction of the pavement.
  - Density is a typical acceptance criteria
  - Higher Density = Less air voids
  - Less Air Voids = Less water and air intrusion

Warm Mix Asphalt Pavement
How Does it Work?

- Plant modifications or additives.
- Plant modification, known as “foaming process” is the most common.

Warm Mix Asphalt - Status in Oregon

- Eugene and Portland require warm mix asphalt pavement
- Oregon DOT has permitted warm mix by special provision
- As of 2015, Oregon DOT permits warm mix in the standard specifications
- Several other cities and counties require or permit warm mix asphalt pavement at this time.

What's next in Eugene?

- Increase reclaimed asphalt binder content in warm mix asphalt pavement.
- Pilot projects in 2013 and 2014 with 35% binder replacement.
- Good fit with warm mix asphalt pavements (less oxidization, better mixing).
- Need to adjust virgin asphalt binder properties to compensate for stiffer mix.

Questions & Contact Information

- Questions?

- Contact Information:

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