DUC 2024

TII ENVIRONMENTAL MANAGEMENT ANALYSIS

dTIMS BA Implementation

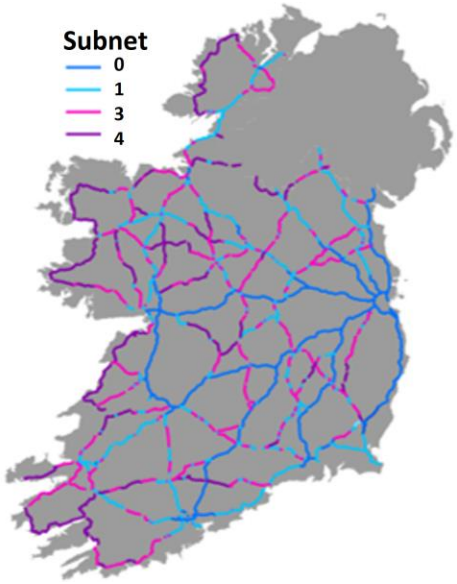
Stephen Smyth, TII, Senior Manager – Pavement Assets

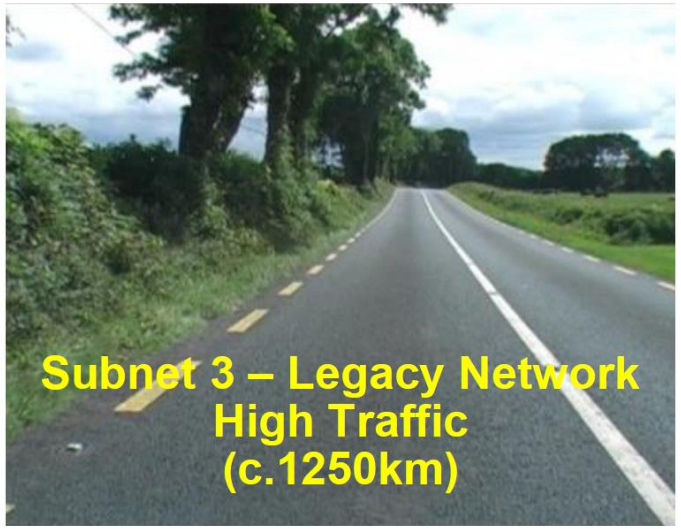
Jeff Zavitski, Deighton, Asset Management

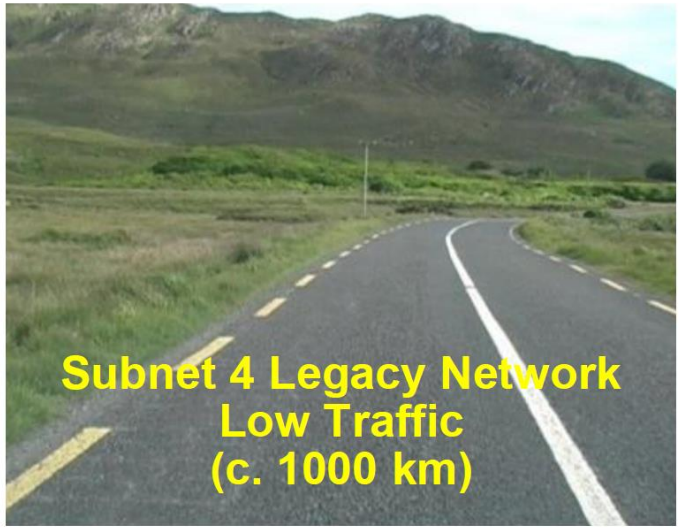
AGENDA

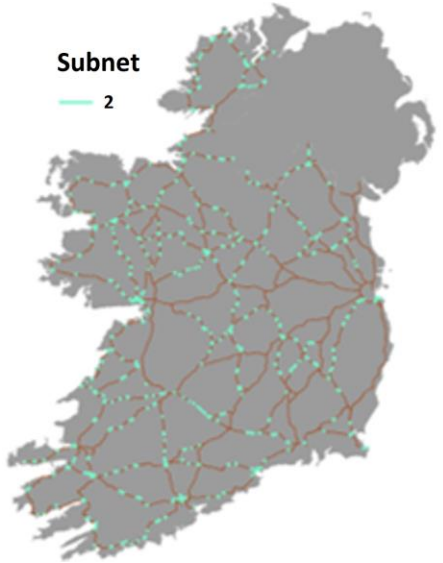
- Transportation Infrastructure Ireland Climate Targets
- TII Active Travel Initiative
- EMS Components In dTIMS BA
- EMS Analysis Initial Results
- EMS Implementation Project Progress

TRANSPORT INFRASTRUCTURE IRELAND: NATIONAL ROADS



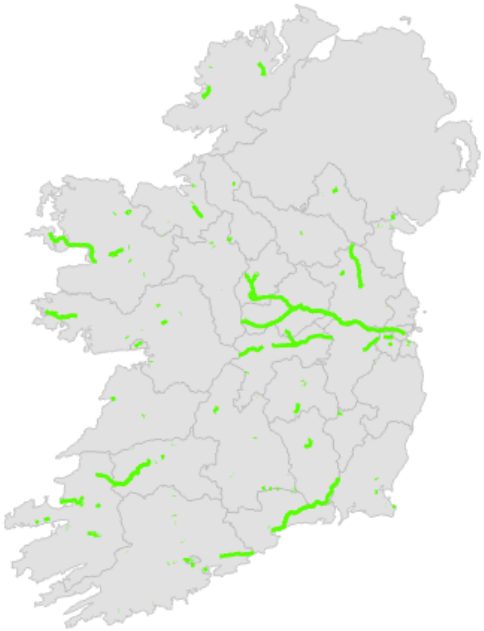






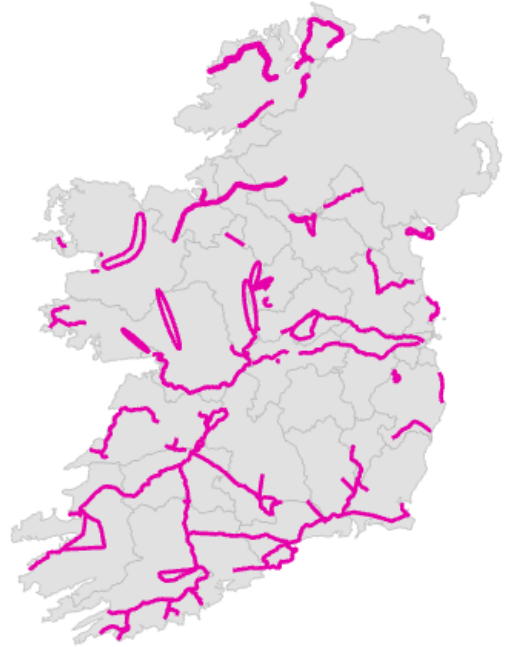
TRANSPORT INFRASTRUCTURE IRELAND: ACTIVE TRAVEL

Existing



c.900 km Cycleways/Greenways

Planned



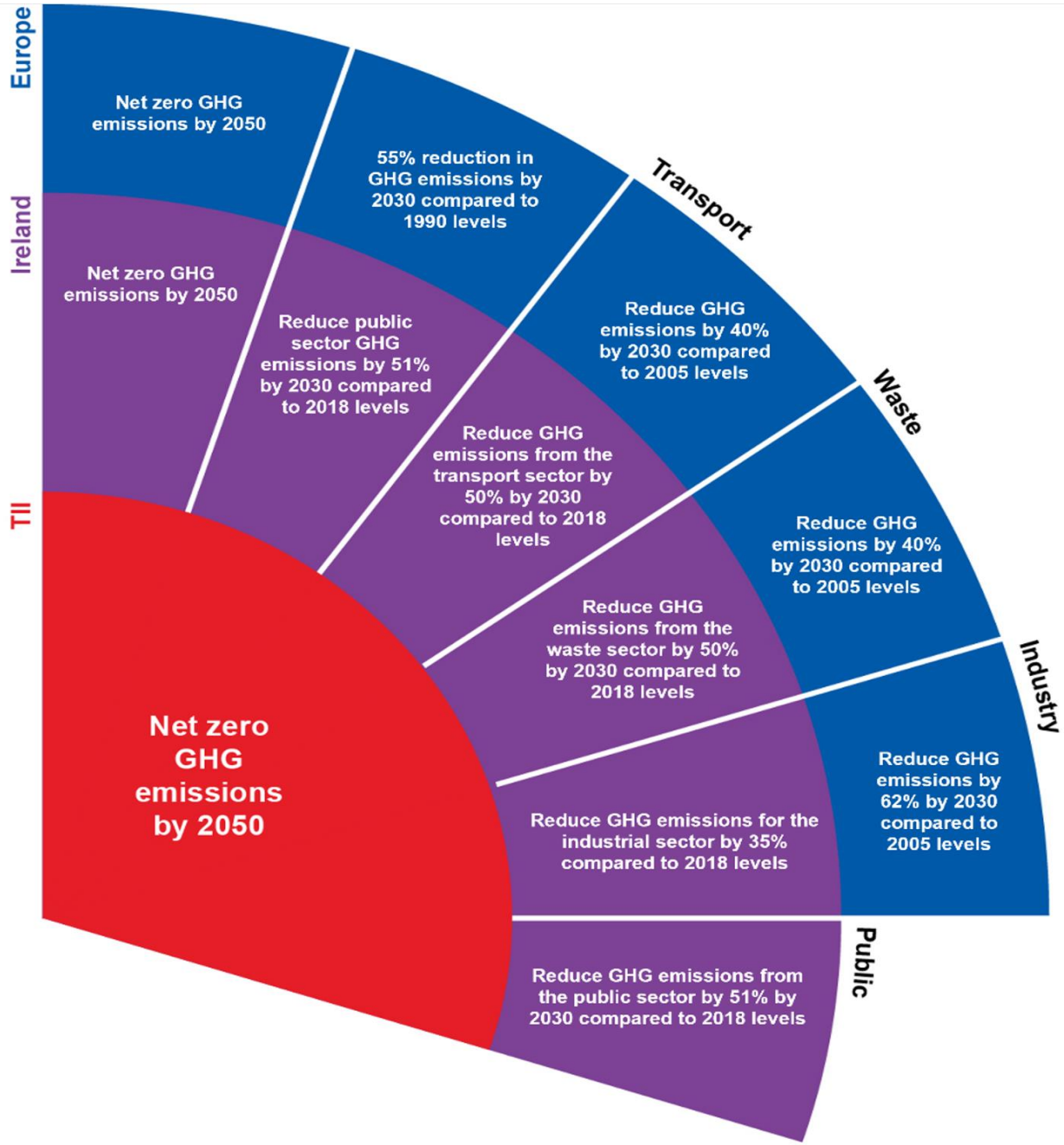
National Cycle Network c.3500km

Greenways c. 2500km

CLIMATE TARGETS

TII Commitments

- Reduce GHG emissions by 50% by 2030.
- Net zero GHG emissions by 2050.
- Current focus on scope 1 and 2.
- Developing our scope 3 programme.



CLIMATE COMMITMENTS

Policy, Legislation, Targets

European Landscape: Climate/Carbon Legislation and Policy

Paris Agreement

European Green Deal & European Climate Law

EU Sustainable and Smart Mobility Strategy

Fit for 55

Effort Sharing Regulation

Construction-Specific Strategies and Legislation

Irish landscape: Climate/Carbon Legislation and Policy

Project Ireland 2040

National Sustainable Mobility Policy: Action Plan 2022-2025

Programme for Government – Our Shared Future

Climate Action and Low Carbon Development (Amendment) Act 2021

Carbon budgets & Sectoral emission ceiling

Public Sector Climate Action Mandate

Climate Action Plan 2023

Climate Action Plan 2024

TII commitments

TII Statement of Strategy 2021 to 2025

TII Sustainability Implementation Plan

TII Climate Action Roadmap 2022

National Roads 2040

TII Circular Economy Policy and Strategy 2023 – 2025

Overall Strategies & Framework

Monitoring Frameworks

Reporting Requirements

Complex body of law/requirements/information

- Strategic
- Tactical
- Operational

How?

ENVIRONMENTAL MANAGEMENT IN dTIMS BA

- Allows users to include Global Warming Potential (GWP) metrics in the dTIMS BA analysis strategic and tactical analysis.

- Allows for the comparison of GWP output from deteriorating pavement infrastructure vs improved pavement infrastructure allowing for offsets due to construction related GWP and construction delay related GWP.

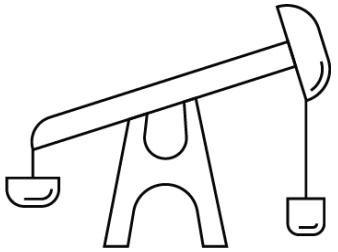
- Traffic related GWP output based upon fuel consumption at operating speed and condition of pavement.

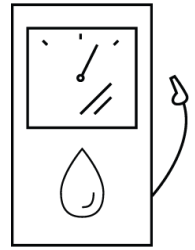
"Pavement roughness is one of the key contributors to rolling resistance and thus vehicle fuel consumption. Roughness-induced fuel consumption is the result of energy dissipation in the suspension system of vehicles and therefore depends on both road surface characteristics and vehicle dynamic properties."

Botshekan, M., Tootkaboni, M. P., & Louhghalam, A. (2019). Global Sensitivity of Roughness-Induced Fuel Consumption to Road Surface Parameters and Car Dynamic Characteristics. Transportation Research Record, 2673(2), 183-193. https://doi.org/10.1177/0361198118821318

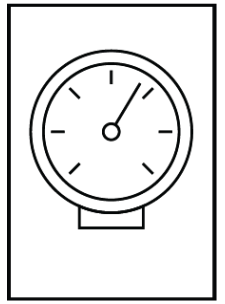
GLOBAL WARMING POTENTIAL FROM NORMAL OPERATIONS

- All vehicles use energy while traversing the pavement network.
  - Gasoline and Diesel Fuel Vehicles
  - Battery Electric Vehicles (BEV)
  - Plug In Hybrid Vehicles (PIHV)
- Gasoline, Diesel fuel, and electricity are produced with a GWP cost.
  - Gasoline: 2.31 Kg / L
  - Diesel: 2.68 Kg / L
  - Electricity 0.33 Kg / KWh





- Under normal traffic operations (no construction):
  - AADT classified into passenger vehicles and commercial vehicles
  - Passenger Vehicles classified into Carbon, BEV, PIHV
  - Commercial Vehicles classified into Carbon and Electric
  - Fuel Consumption calculated (Distance, Speed, IRI Factor) for all vehicles and total GWP calculated for the analysis element each year.



GLOBAL WARMING POTENTIAL FROM NORMAL OPERATIONS

- Classifying Traffic to determine Carbon vs Electric vehicles

Vehicle Type	Fuel Source	Fleet %
Cars	Electric	30
	Carbon	70
LGV	Electric	25
	Carbon	75
OGV1	Electric	15
	Carbon	85
OGV2	Electric	10
	Carbon	90
PSV	Electric	20
	Carbon	80

TII Pavement Renewals Business Case
Pavement Renewals Programme 2023 - 2027
July 2023 (Issue 1)

GLOBAL WARMING POTENTIAL FROM NORMAL OPERATIONS

- Calculating Fuel Consumption - Equation Supplied by TII as follows:

Fuel Consumption Function	$L = a/v + b + c*v + d*v^2$ Where: L = consumption (litre/km) v = average speed (km/hr) a, b, c, and d = fuel consumption parameters

	a	b	c	D
Petrol Car	0.5155	0.06767	-0.0007362	0.000005619
Diesel Car	0.4229	0.06613	-0.0006266	0.000004798
Electric Car[3]		0.221		
Petrol LGV	0.2535	0.2081	-0.0033072	0.0000212
Diesel LGV	0.218	0.13917	-0.0023135	0.000018692
Electric LGV		0.259		
OGV1	2.5876	0.11176	-0.0006445	0.000009922
OGV2	5.0715	0.34664	-0.0027069	0.000014479

TII Project Appraisal Guidelines Unit 6.11 – National Parameters Values Sheet
PE-PAG-02030
December 2023

GLOBAL WARMING POTENTIAL FROM NORMAL OPERATIONS

- Determining Impact of Pavement Roughness (IRI in m/km) on Fuel Consumption:

Fuel Consumption Factor based on Increasing Roughness (IRI)					
	Cars		Trucks		
IRI	0-20 Km/h	20-140 Km/h	0-20 Km/h	20-60 Km/h	60-80 Km/h
1	1.00	1.00	1.00	1.00	1.00
2	1.02	1.02	1.03	1.05	1.04
3	1.04	1.04	1.06	1.10	1.08
4	1.06	1.05	1.09	1.15	1.12
5	1.08	1.07	1.12	1.20	1.16
6	1.10	1.09	1.15	1.25	1.20

National Academies of Sciences, Engineering, and Medicine. 2012. *Estimating the Effects of Pavement Condition on Vehicle Operating Costs*. Washington, DC: The National Academies Press. https://doi.org/10.17226/22808.

GLOBAL WARMING POTENTIAL FROM NORMAL OPERATIONS

GWP Do-Nothing Calculations					
Item	**Year 1**	**Year 2**	**Year 3**	**Calculation**	**Source**
Segment Length (km)	1.25	1.25	1.25	Pavement Segment Data	PMS
Operating Speed PV	80.00	80.00	80.00	Pavement Segment Data	PMs
Operating Speed CV	60.00	60.00	60.00	Pavement Segment Data	PMS
Total AADT	1800.00	1818.00	1836.18	Pavement Segment Data - with annual growth rate	PMS
Passenger Vehicle AADT	1584.00	1599.84	1615.84	Calculated by subtracting CV from total AADT	PMS
Passenger Vehicle AADT - Carbon	1108.80	1123.45	1138.26	Calculated by subtracting BEV, and PIHV from PV AADT	PMS
Passenger Vehicle AADT - BEV	380.16	381.11	382.06	80 % of 30% passenger traffic and increases at 0.25% each year	TII Pavement Renewals Business Case July 2023, Table 5.8
Passenger Vehicle AADT - PIHV	95.04	95.28	95.52	20 % of 30% passenger traffic and increases at 0.25% each year	TII Pavement Renewals Business Case July 2023, Table 5.8
Commercial Vehicle AADT	216.00	218.16	220.34	Pavement Segment Data - with annual growth rate	PMS
Large Good Vehicle - Carbon	85.86	86.72	87.59	53 percent of total truck traffic and 75 percent carbon	TII Pavement Renewals Business Case July 2023, Table 5.4 and Table 5.8
Large Good Vehicle - Electric	28.62	28.91	29.20	53 percent of total truck traffic and 25 percent electric	TII Pavement Renewals Business Case July 2023, Table 5.4 and Table 5.8
Other Goods Vehicles - Carbon	34.56	34.91	35.25	20 percent of total truck traffic and 80 percent carbon	TII Pavement Renewals Business Case July 2023, Table 5.4 and Table 5.8
Other Goods Vehicles - Electric	8.64	8.73	8.81	20 percent of total truck traffic and 20 percent electric	TII Pavement Renewals Business Case July 2023, Table 5.4 and Table 5.8
Other Goods Vehicles 2 - Carbon	38.88	39.2688	39.66149	20 percent of total truck traffic and 90 percent carbon	TII Pavement Renewals Business Case July 2023, Table 5.4 and Table 5.8
Other Goods Vehicles 2 - Electric	4.32	4.3632	4.406832	20 percent of total truck traffic and 10 percent electric	TII Pavement Renewals Business Case July 2023, Table 5.4 and Table 5.8
Public Service Vehicles - Carbon	12.096	12.21696	12.33913	7 percent of total truck traffic and 80 percent carbon	TII Pavement Renewals Business Case July 2023, Table 5.4 and Table 5.8
Public Service Vehicles - Electric	3.024	3.05424	3.084782	7 percent of total truck traffic and 20 percent electric	TII Pavement Renewals Business Case July 2023, Table 5.4 and Table 5.8
Fuel Consumption - PV Carbon	5.12	5.12	5.12	L/100km - Using Speed and TII Fuel Consumption Equation	Project Appraisal Guidelines Unit 6.11 - National Parameters Values Sheet, PE-PAG-02030, December 2023
Fuel Consumption - PV BEV	22.10	22.10	22.10	KWh/100Km - Using Speed and TII Fuel Consumption Equation	Project Appraisal Guidelines Unit 6.11 - National Parameters Values Sheet, PE-PAG-02030, December 2023
Fuel Consumption - PV PIHV	22.10	22.10	22.10	KWh/100km - Using Speed and TII Fuel Consumption Equation	Project Appraisal Guidelines Unit 6.11 - National Parameters Values Sheet, PE-PAG-02030, December 2023
Fuel Consumption - LGV - Carbon	7.13	7.13	7.13	L/100km - Using Speed and TII Fuel Consumption Equation	Project Appraisal Guidelines Unit 6.11 - National Parameters Values Sheet, PE-PAG-02030, December 2023
Fuel Consumption - LGV - Electric	25.90	25.90	25.90	KWh/100km - Using Speed and TII Fuel Consumption Equation	Project Appraisal Guidelines Unit 6.11 - National Parameters Values Sheet, PE-PAG-02030, December 2023
Fuel Consumption - OGV1 - Carbon	15.19	15.19	15.19	L/100km - Using Speed and TII Fuel Consumption Equation	Project Appraisal Guidelines Unit 6.11 - National Parameters Values Sheet, PE-PAG-02030, December 2023
Fuel Consumption - OGV1 - Electric	25.90	25.90	25.90	KWh/100km - Using Speed and TII Fuel Consumption Equation	Project Appraisal Guidelines Unit 6.11 - National Parameters Values Sheet, PE-PAG-02030, December 2023
Fuel Consumption - OGV2 - Carbon	32.09	32.09	32.09	L/100km - Using Speed and TII Fuel Consumption Equation	Project Appraisal Guidelines Unit 6.11 - National Parameters Values Sheet, PE-PAG-02030, December 2023
Fuel Consumption - OGV2 - Electric	25.90	25.90	25.90	KWh/100km - Using Speed and TII Fuel Consumption Equation	Project Appraisal Guidelines Unit 6.11 - National Parameters Values Sheet, PE-PAG-02030, December 2023
Fuel Consumption - PSV - Carbon	28.61	28.61	28.61	L/100km - Using Speed and TII Fuel Consumption Equation	Calculated using OVG2 parameters but speed limit of PV
Fuel Consumption - PSV - Electric	100.00	100.00	100.00	KWh/100km - Using Speed and TII Fuel Consumption Equation	Default value from Internet, no TII source for PSV EV fuel consumption
GWP (Kg) per liter of Gasoline	2.31	2.31	2.31	Kg	https://www.seai.ie/data-and-insights/seai-statistics/conversion-factors/
GWP (Kg) per liter of Diesel	2.68	2.68	2.68	Kg	https://www.seai.ie/data-and-insights/seai-statistics/conversion-factors/
GWP (Kg) per KWh	0.33	0.33	0.33	Kg	https://www.seai.ie/data-and-insights/seai-statistics/conversion-factors/
IRI	2.00	2.27	2.54	Pavement Segment Data	PMS
Fuel Consumption Factor - PV	1.00	1.02	1.02	Calculated using IRI and lookup table SYS_LOOKUP_FUEL_IRI_FACTOR	NCHRP Report 720: Estimating the Effects of Pavement Condition on Vehicle Operating Costs
Fuel Consumption Factor - CV	1.00	1.05	1.05	Calculated using IRI and lookup table SYS_LOOKUP_FUEL_IRI_FACTOR	NCHRP Report 720: Estimating the Effects of Pavement Condition on Vehicle Operating Costs
GWP - PV Carbon	163.93	169.42	171.65	Kg Calculated based on segment length, count, Fuel Consumption, GWP	Calculated
GWP - PV BEV	34.87	35.65	35.74	Kg Calculated based on segment length, count, Fuel Consumption, GWP	Calculated
GWP - PV PIHV	8.72	8.91	8.94	Kg Calculated based on segment length, count, Fuel Consumption, GWP	Calculated
GWP - LGV - Carbon	20.53	21.77	21.99	Kg Calculated based on segment length, count, Fuel Consumption, GWP	Calculated
GWP - LGV - Electric	3.08	3.26	3.29	Kg Calculated based on segment length, count, Fuel Consumption, GWP	Calculated
GWP - OGV1 - Carbon	17.61	18.68	18.86	Kg Calculated based on segment length, count, Fuel Consumption, GWP	Calculated
GWP - OGV1 - Electric	0.93	0.98	0.99	Kg Calculated based on segment length, count, Fuel Consumption, GWP	Calculated
GWP - OGV2 - Carbon	41.84	44.37	44.82	Kg Calculated based on segment length, count, Fuel Consumption, GWP	Calculated
GWP - OGV2 - Electric	0.46	0.49	0.50	Kg Calculated based on segment length, count, Fuel Consumption, GWP	Calculated
GWP - PSV - Carbon	11.61	12.31	12.43	Kg Calculated based on segment length, count, Fuel Consumption, GWP	Calculated
GWP - PSV - Electric	1.25	1.33	1.34	Kg Calculated based on segment length, count, Fuel Consumption, GWP	Calculated
GWP Total	304.82	317.18	320.56	Summation of GWP for each vehicle type / fuel	Calculated

GLOBAL WARMING POTENTIAL FROM CONSTRUCTION

- Pavement projects completed on the pavement segment incur a GWP cost from the various stages of a construction project:
  - Material Production (kg/m2)
  - Manufacturing and Mixture (kg/m2)
  - Transportation of material to site (kg/m2)
  - Placement (kg/m2)
  - Demolition (kg/m2)
  - Recycling credit (kg/m3)

- TII has supplied the following GWP costs (Kg) for square meter for each treatment:

Carbon Emissions for $1m^2$ - $kgCO_2eq$		Resurfacing					Overlay					Strengthening					Reconstruction				
		Subnet 0	Subnet 1	Subnet 2	Subnet 3	Subnet 4	Subnet 0	Subnet 1	Subnet 2	Subnet 3	Subnet 4	Subnet 0	Subnet 1	Subnet 2	Subnet 3	Subnet 4	Subnet 0	Subnet 1	Subnet 2	Subnet 3	Subnet 4
Pavement with a...	SMA Surface Course	13.93364	13.93364	13.93364	13.93364	13.93364	27.74456	27.74456	27.74456	27.74456	27.74456	50.85667	48.93687	47.01706	45.09726	39.33785	93.97719	93.97719	88.21777	82.45836	72.85934
	HRA Surface Course	15.47996	15.47996	15.47996	15.47996	15.47996	29.29088	29.29088	29.29088	29.29088	29.29088	52.40299	50.48319	48.56338	46.64358	40.88417	95.5235	95.5235	89.76409	84.00468	74.40566
	Surface Dressing Surface Course				9.958215	9.958215															

GLOBAL WARMING POTENTIAL FROM CONSTRUCTION RELATED DELAYS

- While construction is taking place, traffic is delayed. TII has two major traffic control practices for construction and limits the work zones to 500m at a time.
  - Signals
  - Pilot Vehicles
- TII has provided the following table for use in calculating traffic delay where figures indicate minutes of delay for each vehicle between the hours indicated. Since the work zones are so short, Deighton has calculated the GWP delay assuming the vehicles are at Idle for the time indicated.

	AM	AM	AM Peak	Interpeak	Interpeak	PM Peak	PM	PM
Subnet	**12am to 3am**	**3am to 6am**	**6am to 9am**	**9am to 12 pm**	**12pm to 3pm**	**3pm to 6 pm**	**6pm to 9pm**	**9pm to 12am**
1&2	0.3	0.3	9.1	4.7	4.7	9.1	4.7	0.3
3&4	0.3	0.3	9.1	4.1	4.1	7.1	4.7	0.3
	Min	Min	Max	Average	Average	Max	Average	Min

- For subnetwork 0 (Motorways) diversions or detours with given lengths are used to calculate additional GWP over the diversion distance (work in progress).

GLOBAL WARMING POTENTIAL FROM CONSTRUCTION RELATED DELAYS

- Delay time in minutes considered to be time where vehicle is idling and these fuel consumption figures for idling will be used.

Vehicle Class	Engine	Gallons at Idle / Hour	Liters at Idle / Hour	Liters at Idle / Minute
Passenger Vehicle AADT - Carbon	Gasoline	0.16	0.61	0.01
Passenger Vehicle AADT - BEV	Battery	0.00	0.00	0.00
Passenger Vehicle AADT - PIHV	Hybrid	0.00	0.00	0.00
Large Good Vehicle - Carbon	Diesel	0.64	2.42	0.04
Large Good Vehicle - Electric	Battery	0.00	0.00	0.00
Other Goods Vehicles - Carbon	Diesel	0.84	3.18	0.05
Other Goods Vehicles - Electric	Battery	0.00	0.00	0.00
Other Goods Vehicles 2 - Carbon	Diesel	0.84	3.18	0.05
Other Goods Vehicles 2 - Electric	Battery	0.00	0.00	0.00
Public Service Vehicles - Carbon	Diesel	0.97	3.67	0.06
Public Service Vehicles - Electric	Battery	0.00	0.00	0.00

Argonne National Library
Idle Reduction Savings Calculator
https://www.anl.gov/taps/reference/vehicle-idle-reduction-savings-worksheet-pdf

GLOBAL WARMING POTENTIAL FROM CONSTRUCTION RELATED DELAYS

- To calculate the GWP delay cost during construction, the following methodology is used:
  - Traffic Volume in each vehicle class (PV / CV / Carbon / Electric) is split into 8 time periods of 3 hours each using an hourly traffic volume distribution.
  - Minutes of delay per vehicle is assigned based upon traffic control type (Diversion / Signals / Pilot Vehicle)
  - Fuel Consumption per vehicle class is assigned
  - Project Duration is calculated
  - Total delay calculated as Volume * Minutes * Fuel Consumption * GWP/L * Duration for each vehicle class and each 3-hour period

Traffic Calculations	0 to 3am	3 to 6 am	6 to 9 am	9 to 12 pm	12 to 3pm	3 to 6 pm	6 to 9pm	9 to 12am
Percent Per Hour	0.33	4.00	8.00	5.00	5.00	7.00	3.00	1.00
Number of Hours in Period	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Percent of Total AADT	1.00	12.00	24.00	15.00	15.00	21.00	9.00	3.00
Number of Hours in Period	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
GWP (Kg) per liter of Gasoline	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31
GWP (Kg) per liter of Diesel	2.68	2.68	2.68	2.68	2.68	2.68	2.68	2.68
GWP (Kg) per KWh	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33
Passenger Vehicle AADT - Carbon	393.76	4725.15	9450.31	5906.44	5906.44	8269.02	3543.86	1181.29
Passenger Vehicle AADT - BEV	9.74	116.91	233.82	146.14	146.14	204.59	87.68	29.23
Passenger Vehicle AADT - PIHV	2.44	29.23	58.46	36.53	36.53	51.15	21.92	7.31
Large Good Vehicle - Carbon	8.55	102.64	205.27	128.29	128.29	179.61	76.98	25.66
Large Good Vehicle - Electric	2.85	34.21	68.42	42.76	42.76	59.87	25.66	8.55
Other Goods Vehicles - Carbon	3.44	41.31	82.62	51.64	51.64	72.30	30.98	10.33
Other Goods Vehicles - Electric	0.86	10.33	20.66	12.91	12.91	18.07	7.75	2.58
Other Goods Vehicles 2 - Carbon	3.87	46.48	92.95	58.10	58.10	81.33	34.86	11.62
Other Goods Vehicles 2 - Electric	0.43	5.16	10.33	6.46	6.46	9.04	3.87	1.29
Public Service Vehicles - Carbon	1.20	14.46	28.92	18.07	18.07	25.30	10.84	3.61
Public Service Vehicles - Electric	0.30	3.61	7.23	4.52	4.52	6.33	2.71	0.90
Subnetwork	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Construction Type	Signals	Signals	Signals	Signals	Signals	Signals	Signals	Signals
Minutes of Delay / Vehicle / Day	0.28	0.28	9.08	4.06	4.06	7.06	4.68	0.28
Treatment Duration	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00
Passenger Vehicle Carbon - L/min	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Passenger Vehicle BEV - L / Min	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Passenger Vehicle - PIHV L/Min	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Large Good Vehicle - Carbon - L/Min	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
Large Good Vehicle - Electric - KWh/Min	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Other Goods Vehicles - Carbon - L/Min	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Other Goods Vehicles - Electric - KWh/Min	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Other Goods Vehicles 2 - Carbon - L/Min	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Other Goods Vehicles 2 - Electric - KWh/Min	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Public Service Vehicles - Carbon - L/Min	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
Public Service Vehicles - Electric - KWh/Min	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Passenger Vehicle Carbon - Delay GWP Kg	45.47	545.64	36036.75	10060.16	10060.16	24500.90	6961.50	136.41
Passenger Vehicle BEV - Delay GWP Kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Passenger Vehicle PIHV - Delay GWP Kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Large Good Vehicle - Carbon - Delay GWP Kg	4.59	55.04	3635.02	1014.77	1014.77	2471.40	702.21	13.76
Large Good Vehicle - Electric - Delay GWP Kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Other Goods Vehicles - Carbon - Delay GWP Kg	2.42	29.08	1920.39	536.10	536.10	1305.64	370.98	7.27
Other Goods Vehicles - Electric - Delay GWP Kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Other Goods Vehicles 2 - Carbon - Delay GWP Kg	2.73	32.71	2160.43	603.12	603.12	1468.85	417.35	8.18
Other Goods Vehicles 2 - Electric - Delay GWP Kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Public Service Vehicles - Carbon - Delay GWP Kg	0.98	11.75	776.16	216.67	216.67	527.70	149.94	2.94
Public Service Vehicles - Electric - Delay GWP Kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Delay Cost GWP kg	**109,165.79**							

Percentages and GWP Costs

Traffic Volume Distribution

Minutes of Delay and Traffic Control Type

GWP Per Period Per Vehicle Class

GWP IN THE PAVEMENT ANALYSIS

- GWP in the PMS Analysis :
  - Do Nothing GWP calculated based on increasing traffic and deteriorating pavement condition
  - Then for each treatment within a strategy:
    - GWP Treatment Cost added to GWP variable to account for GWP output from construction
    - GWP Delay Cost added to GWP variable to account for GWP output from construction delay
    - Pavement Conditions are reset (IRI is reduced)
    - GWP after treatment calculated based on reset IRI

- GWP variable can be included in the benefit model or can be output to use in scenario comparisons and project comparisons.

slido

GWP Results
Which would you prefer?

ⓘ Start presenting to display the poll results on this slide.

GWP RESULTS – GOOD NEWS FIRST OR BAD NEWS FIRST?

- Bad News:
  - Addressing pavement conditions and reducing road roughness does not lead to a net savings in GWP output. dTIMS BA can demonstrate the effects on GWP of all alternative scenarios though to help balance investment to maintain and improve network condition vs GWP output.

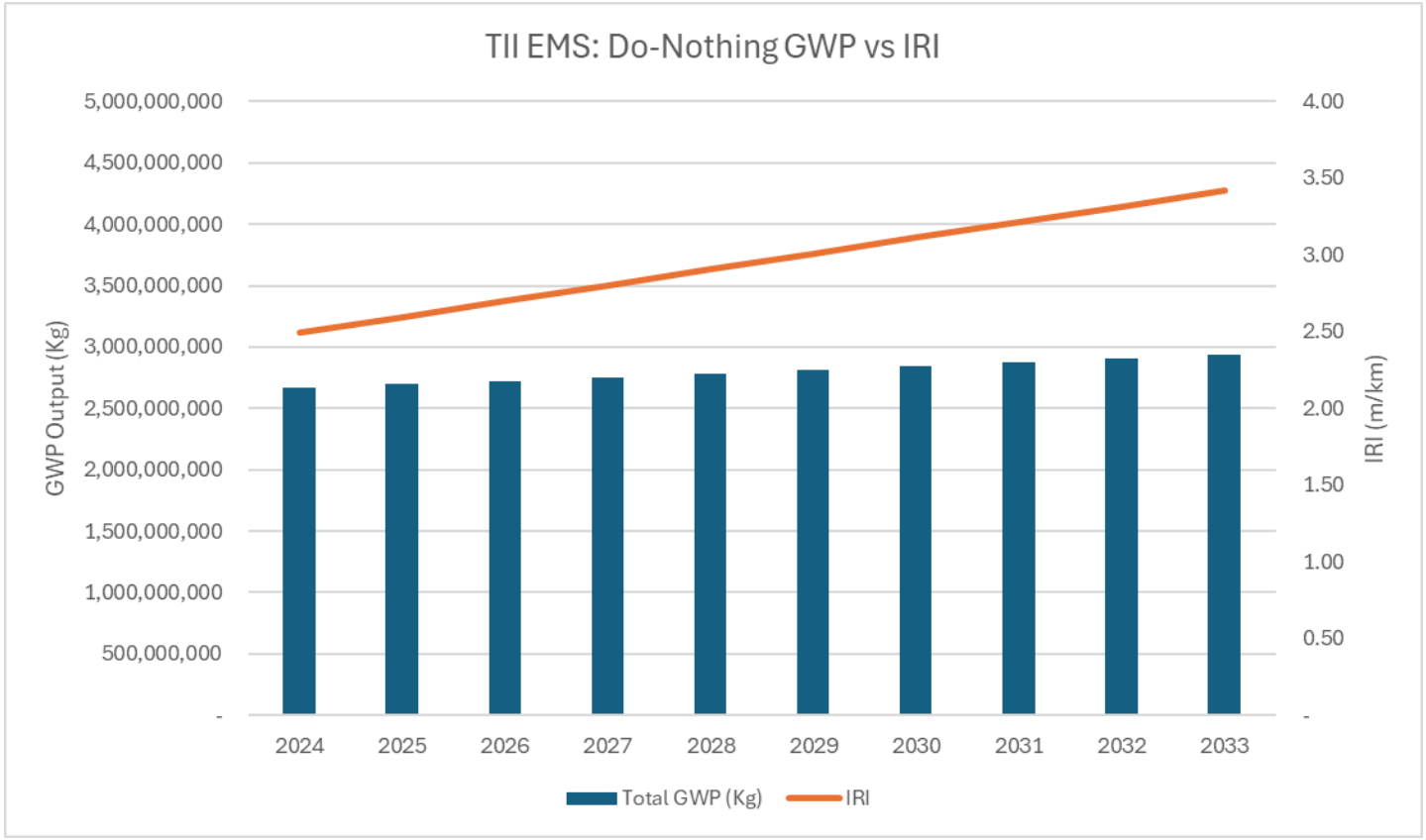
  - Improvements in passenger vehicle and commercial vehicle GWP output due to smoother pavement does not offset the GWP cost of pavement treatments and construction related delays.

GWP RESULTS – GOOD NEWS FIRST OR BAD NEWS FIRST?

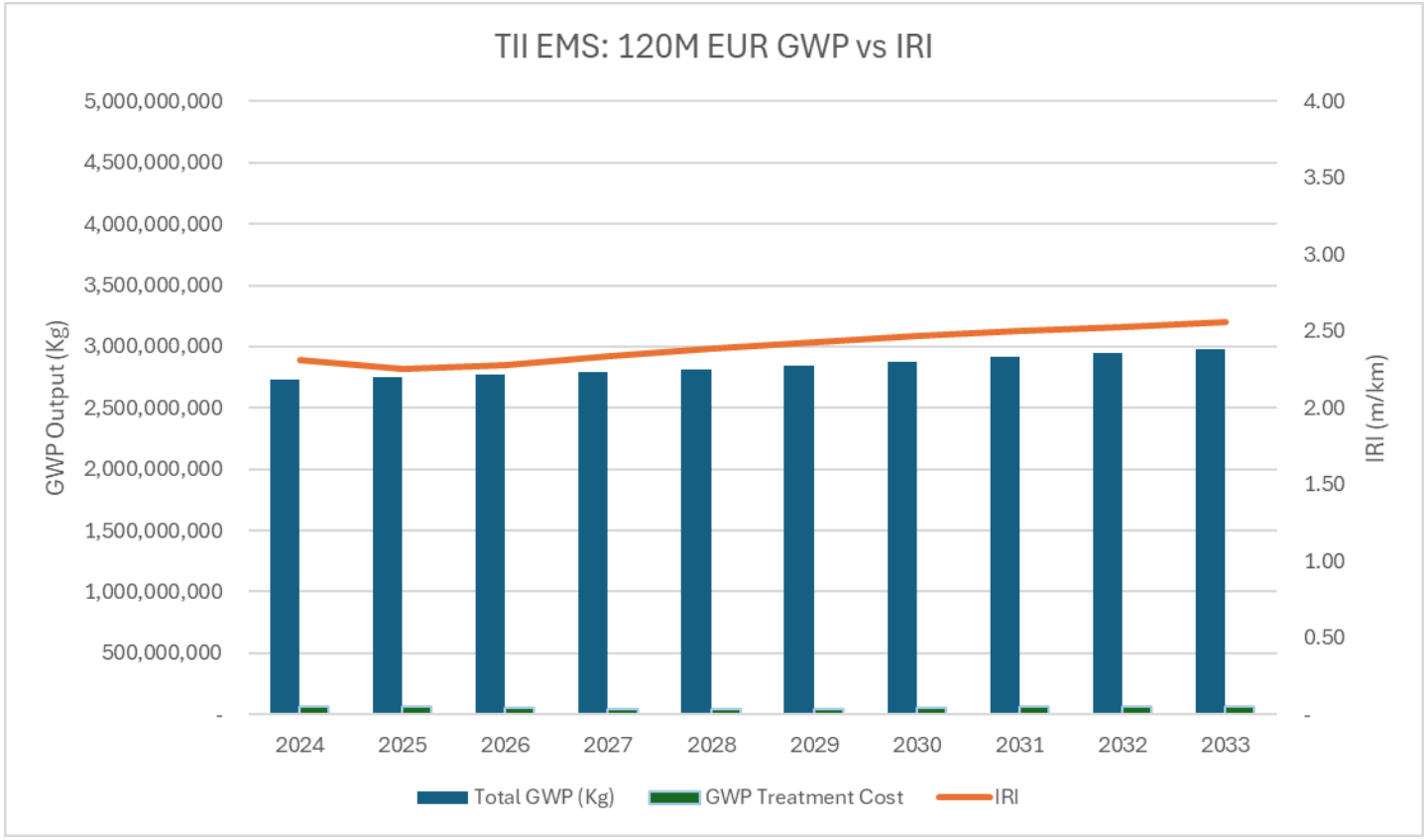
- ~~Good~~ Great News:
  - EMS analysis in dTIMS BA allows for the comparisons of GWP output for
    - alternative treatment strategies
    - different material types
    - alternative budget scenarios
    - different electric vehicle uptake rates.

  - EMS analysis in dTIMS BA allows you to weigh the impacts of environmental measures against overall asset condition and network performance.

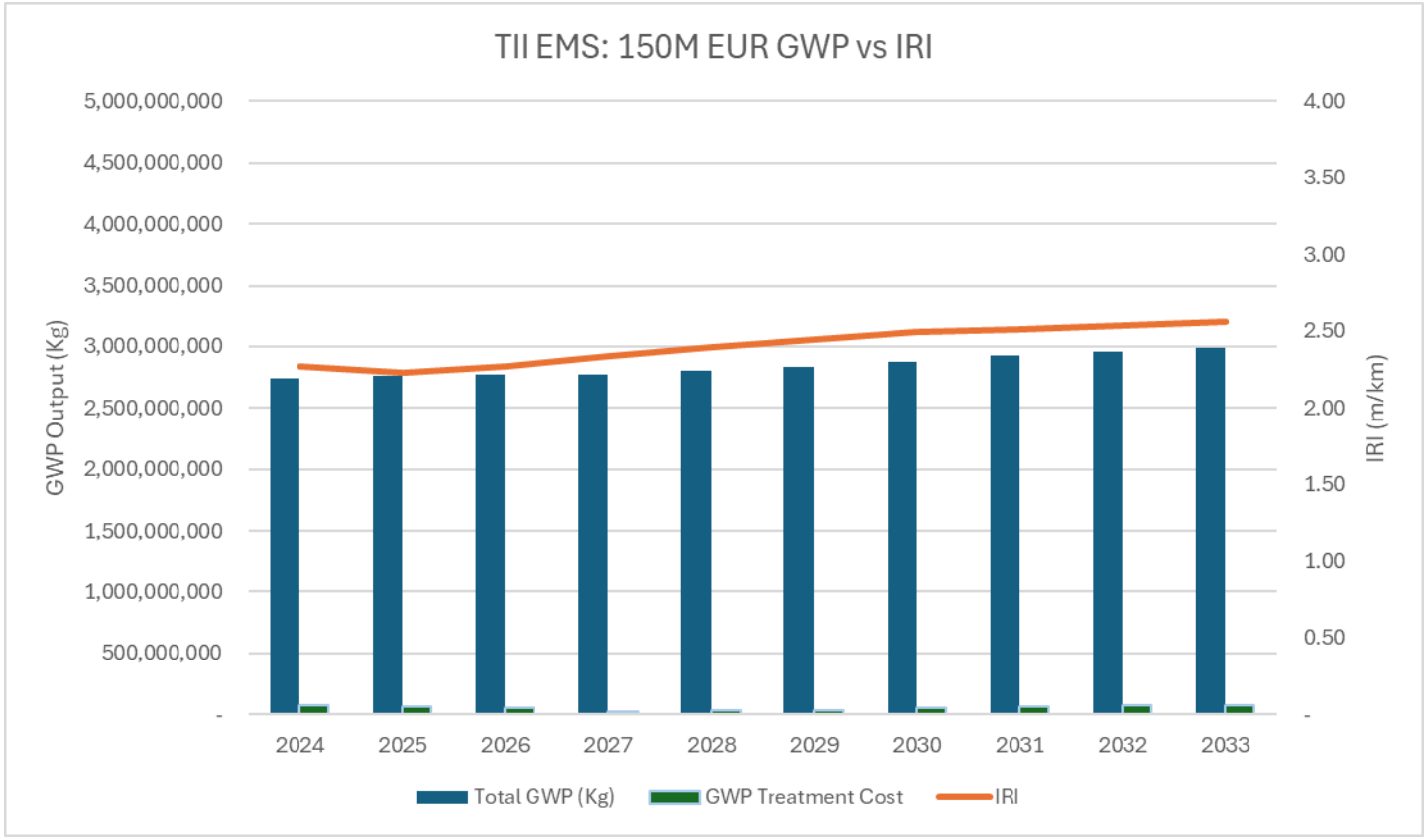
GWP RESULTS – DO-NOTHING SCENARIO - DRAFT RESULTS



GWP RESULTS – 120M EUR SCENARIO: DRAFT RESULTS



GWP RESULTS – 150M EUR SCENARIO: DRAFT RESULTS



GWP RESULTS – COMPARISON: DRAFT RESULTS

Budget Sencario	GWP PV (Kg)	GWP CV (Kg)	TREATMENT GWP COST (Kg)	IRI (m/Km)
Do-Nothing	10,593,654,482.33	3,025,406,210.24	-	2.70
120M EUR	10,574,424,212.57	3,015,295,262.41	263,438,854.67	2.31
150M EUR	10,572,869,149.26	3,014,397,799.59	259,247,565.27	2.30

NEXT STEPS

- Finalize delay costs (diversion lengths for motorways)
- Verify Analysis Results
- Finalize Documentation
- Solution Delivery and Training

QUESTIONS TO THE PRESENTERS?

DUC 2024

deighton

THANK YOU