CI5313 Transporte Sustentable y Tecnologías Disruptivas

Clase 5

31 de agosto de 2021

Tema:

Contaminación como externalidad del tráfico

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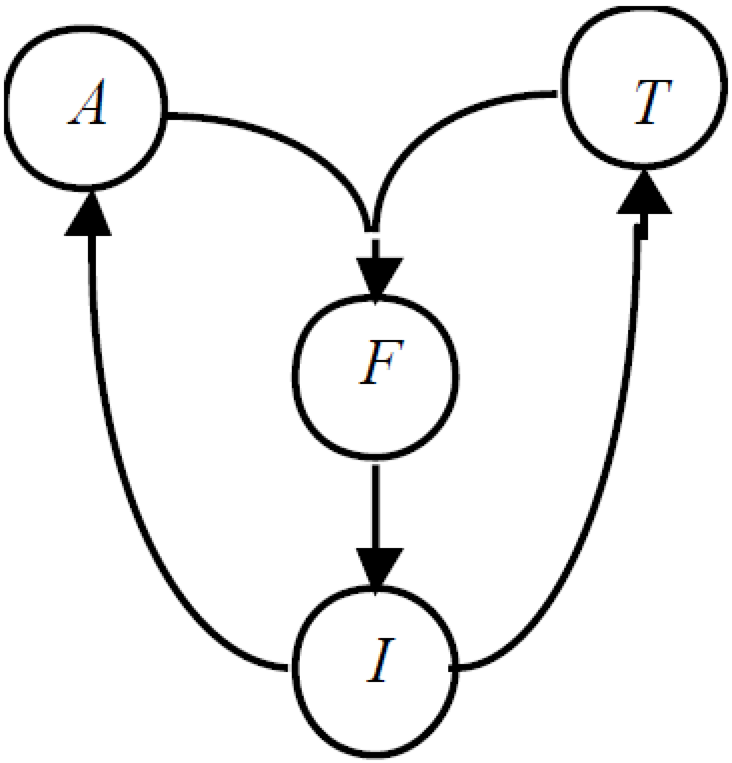
Universidad de Chile

(Clase 3)

Dinámica del transporte

Esquema de Manheim



- A: Sistema de actividades
  - Residencia, trabajo, estudio, servicios, etc.
- T: Sistema de transporte
  - Vías, vehículos, estacionamientos, paraderos, formas de operación
- F: Flujos
  - Patrón de viajes: elección de modo, ruta, destino, período.
- I: Impactos del flujo
  - Congestión, contaminación, ruido, siniestros, segregación, intimidación y otros.

Externalidades de transporte


IF THESE IDIOTS WOULD JUST TAKE THE BUS, I COULD BE HOME BY NOW
IF THESE IDIOTS WOULD JUST TAKE THE BUS, I COULD BE HOME BY NOW
KIRK
PIONEER PRESS

Externalidades del tráfico vehicular

1. Siniestros de tránsito
2. Contaminación

Daños a la salud humana por contaminación del aire

Neurology > Dementia

Dementia Incidence Tied to Air Pollution

— London study finds 40% increased risk among adults living with poorer air quality

by Judy George, Contributing Writer, MedPage Today
September 18, 2018

Older people living in areas with higher air pollution were more likely to be diagnosed with dementia in subsequent years, an observational study in England found.

Adults living in areas of London with the highest levels of nitrogen dioxide (NO_2) had a

https://www.medpagetoday.com/neurology/dementia/75170

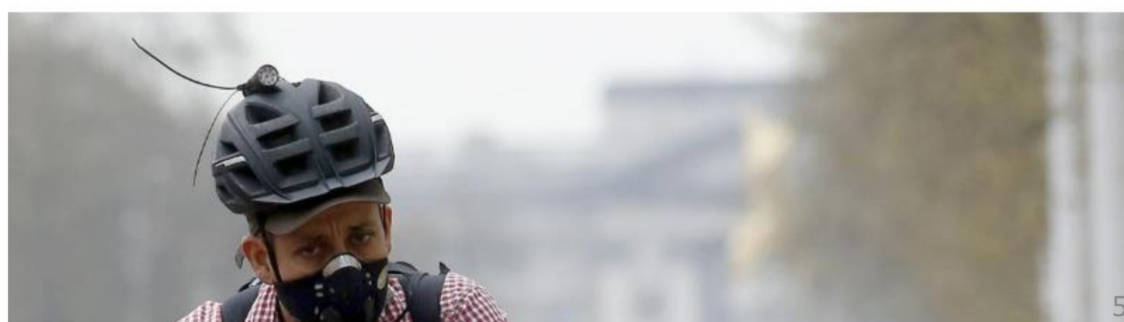
HEALTH NEWS SEPTEMBER 14, 2018 / 6:18 PM / 12 DAYS AGO

Even low levels of traffic pollution tied to heart damage

Lisa Rapaport 4 MIN READ

(Reuters Health) - People exposed to even low levels of air pollution are more likely to develop structural changes in the heart that can be a precursor to heart failure, a UK study suggests.

https://www.reuters.com/article/us-health-heart-pollution/even-low-levels-of-traffic-pollution-tied-to-heart-damage-idUSKCN1LU2PW



The health effect of air pollution from traffic

Date: June 4, 2018

Source: Lund University

Summary: What would happen if all petrol and diesel-powered vehicles were removed from a smaller European city? Up to 4% of all premature deaths could be prevented, according to a new study. The researchers used Malmö, Sweden, as a case study to calculate the health costs of inner city traffic.

Share:

RELATED TOPICS

Health & Medicine

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Earth & Climate

FULL STORY

What would happen if all petrol and diesel-powered vehicles were removed from a smaller European city? Up to 4% of all premature deaths could be prevented, according to a new study from Lund University in Sweden. The researchers used Malmö, Sweden, as a case study to calculate the health costs of inner city traffic.

https://www.sciencedaily.com/releases/2018/06/180604112505.htm

Contaminación de océanos

How your car sheds microplastics into the ocean thousands of miles away

July 14, 2020 11.16am EDT

Nirmal Rajendharkumar/Unsplash, CC BY-SA

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The impact of car travel on the environment is well known. Exhaust emissions pollute the atmosphere with gases that raise global temperatures and make the air less safe to breathe. Sadly, the problems don't end there. Scientists have been studying another problem – and one that connects your daily commute to the most remote stretches of the world's oceans.

A new study has revealed that microplastics released from car tires and brake systems are a major source of marine plastic pollution – much more than previously thought. Every year, 100,000 metric tonnes of microplastics are shed from tires, transported through the air and dumped in the ocean. Another 40,000 tonnes comes from brakes. To put that in perspective, if the average scrapped car tire is around nine kilograms, then the total weight of microplastics reaching the sea each year equates to just under 11 million tires.

Microplastics are polymers smaller than 5mm, and they are hazardous to the health of animals that are exposed to them. The different shapes and densities of microplastics cause them to disperse throughout habitats, making them available for different species to eat. In the ocean, microplastics can accumulate in an

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Disclosure statement

Claire Gwinnett does not work for, consult, own shares in or receive funding from any company or organization that would benefit from this article, and has disclosed no relevant affiliations beyond their academic appointment.

Partners

STAFFORDSHIRE UNIVERSITY

Staffordshire University provides funding as a member of The Conversation UK.

https://theconversation.com/how-your-car-sheds-microplastics-into-the-ocean-thousands-of-miles-away-142614

- Demencia
- Daños al corazón
- Muerte prematura
- Contaminación de océanos
- …

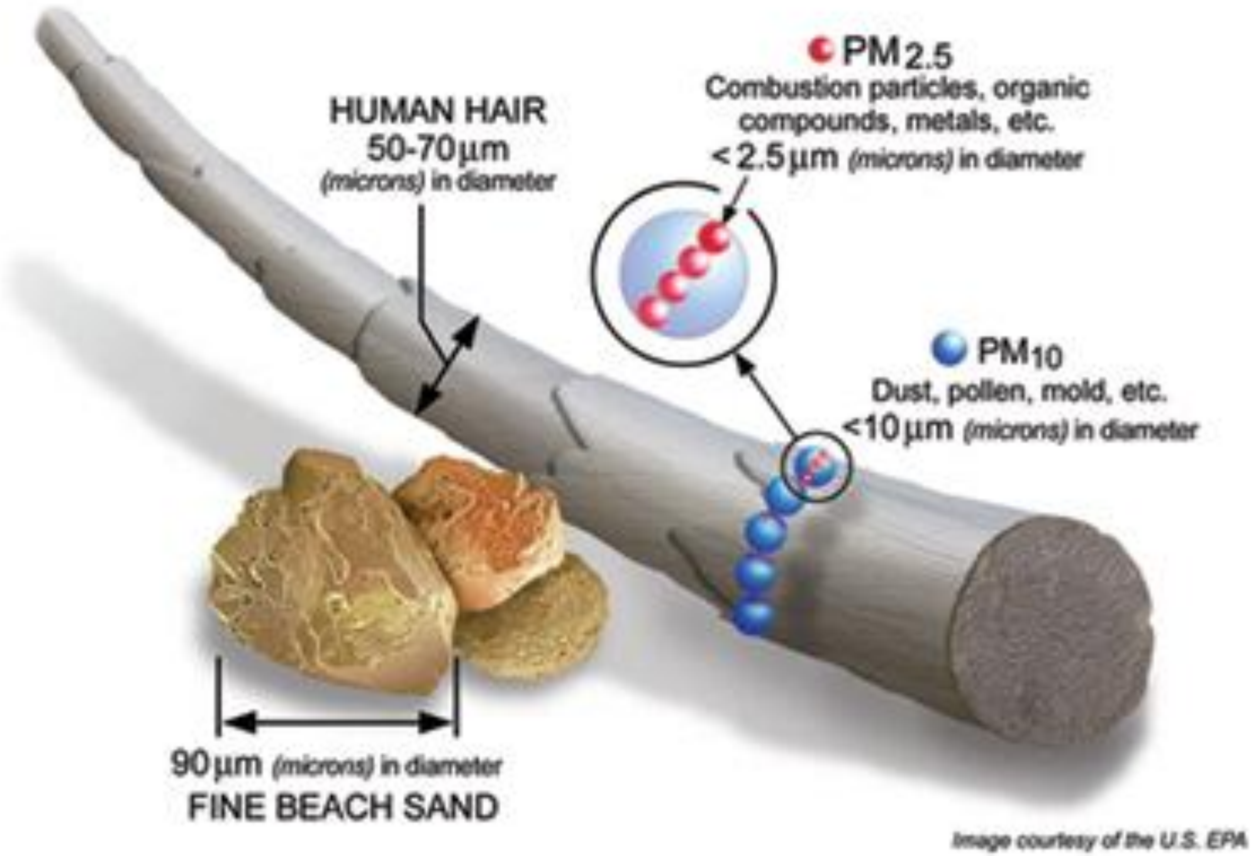
Emisiones: Contaminación local y global

- Contaminación local
  - Produce daños a la salud localmente
  - Principalmente Material Particulado (MP):
    - Nombre genérico para mezcla de partículas sólidas y pequeñas gotas de líquidos en el aire.
    - Daños salud: dificultad respirar, agrava asma, bronquitis crónica, irritación, etc.
    - MP fino (MP2.5) y grueso (MP10)
  - Otros: Ozono, dióxido de azufre, monóxido de carbono, compuestos orgánicos volátiles

- Contaminación global
  - Gases efecto invernadero, calentamiento global
  - Principalmente CO_2

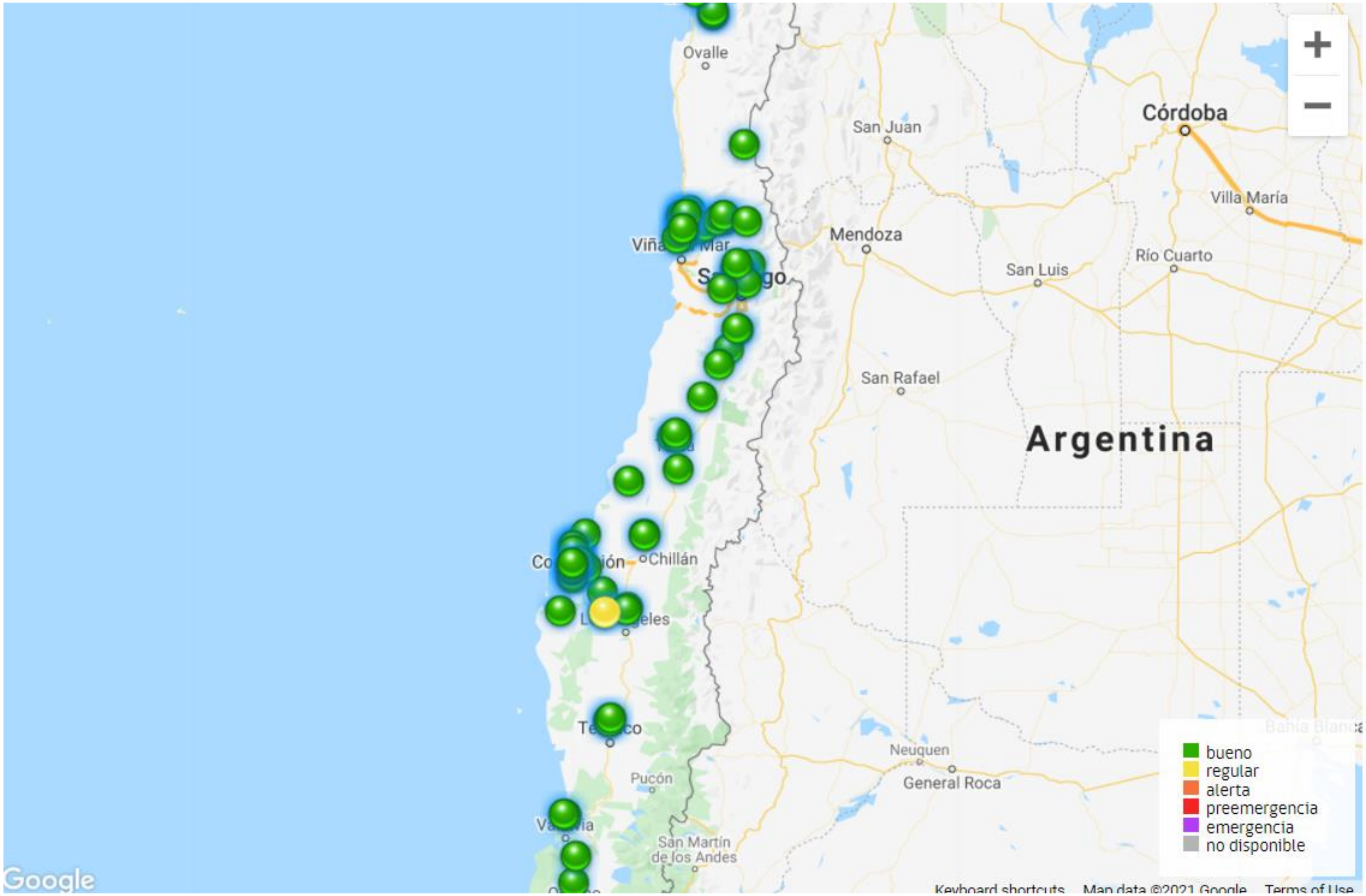
- Info sobre contaminantes:
  http://sinca.mma.gob.cl/index.php/pagina/index/id/glosario

Material particulado



https://www3.epa.gov/pm/

Sistema de Información Nacional de Calidad del Aire



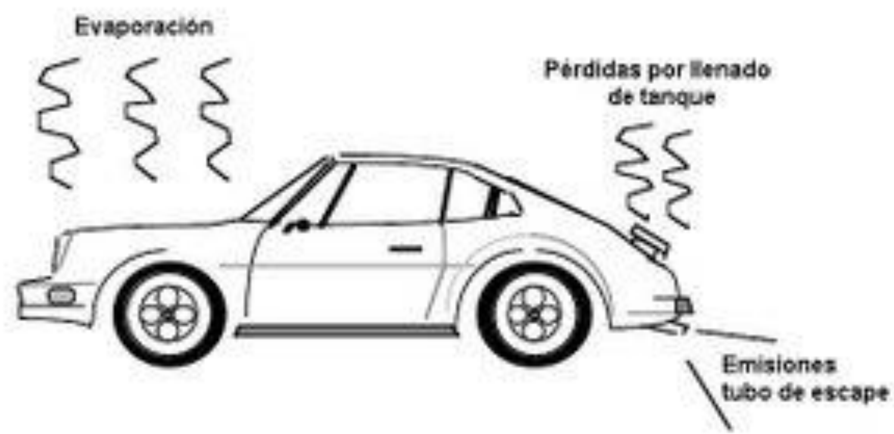
https://sinca.mma.gob.cl/

31 de agosto de 2021

Costo contaminación local

Costo contaminación local depende de 4 elementos (Parry y Strand, 2012):

1. Tasas de emisión vehicular
2. Cómo emisiones se acumulan en atmósfera
3. Impactos en la salud humana
4. Disposición a pagar por reducir impactos en salud



Parry, I. and J. Strand, 2012. International fuel tax assessment: an application to Chile. Environment and Development Economics 17(02): 127-144.

Costo contaminación local

- Small and Verhoef (2007): costo contaminación local es 3.8 $/km promedio en EEUU (valor crece en ciudades respecto a sectores rurales)
- 75% valor EEUU incremento mortalidad: muerte prematura para adultos y personas con condiciones de salud pre-existentes.
- Enfoque "Valor de la Vida Estadística": Disposición a pagar por reducir riesgo de muerte:
  - EEUU: $2179 millones (Small y Verhoef, 2007)
  - Chile: $616-1183 millones (Parry y Strand, 2012), $150-380 millones (Rizzi y Ortúzar, 2006)

Small, K. A. and E. T. Verhoef, 2007. The Economics of Urban Transportation, Routledge, Taylor & Francis Group.
Parry, I. and J. Strand, 2012. International fuel tax assessment: an application to Chile. Environment and Development Economics 17(02): 127-144.

El enfoque “valor de la vida estadística”

- Estimación de disposición a pagar por reducciones pequeñas del riesgo de morir en determinadas situaciones.

- Valor de la vida estadística: “Valoración monetaria que la sociedad atribuye a esfuerzos en la disminución de probabilidad de muerte de las personas y en ningún caso se trata de ponerle un precio a la vida humana, la cual es incuantificable” (MDS, 2017)

Environmental Protection Agency, EEUU: https://www.epa.gov/environmental-economics/mortality-risk-valuation

MDS, Chile: http://sni.ministeriodesarrollosocial.gob.cl/download/estimacion-estadistica-de-la-vida-por-capital-humano-3/?wpdmdl=2520

Table 1. Typical card from the Route 68 Stated Choice game

Choice situation number	Route 1	Route 2
Travel time	1 h 30 min	2 h
Fatal crashes	12	20
Toll (US$)	8	5
	I choose Route 1	I choose Route 2

VRR: Valor de reducción del riesgo, cantidad de dinero que personas están dispuestas a pagar por reducir riesgo de muerte prematura.

Rizzi y Ortúzar (2006)
http://intrawww.ing.puc.cl/siding/datos/public_files/profes/jos_HCHIVSFIWJPJXHD/Rizzi-JOS-TReviews-06.pdf

Costo contaminación local

- Otros efectos contaminación local:
  - Visibilidad reducida
  - Daños a ecosistemas y agricultura
  - Corrosión de edificios.

Estimación de emisiones por transporte

SECTRA
Ministerio de Transportes y Telecomunicaciones
Gobierno de Chile

Preguntas frecuentes

Secretaría de Planificación de Transporte

Buscar | BIBLIOTECA | SINTIA | CONTACTO | QUÉ ES SECTRA

Inicio / Metodologias y Herramientas de Transporte / MODEM

- Indicadores de Movilidad
- Planes de Transporte Urbano + ciudad
- Planes de Gestión de Tránsito + Región
- Datos e Información Espacial + ciudad
- Modelaciones de Transporte + ciudad
- Metodologías y Herramientas de Transporte
- Transporte Interurbano + Areas

DIRTP | DIVA | EISTU | MESPE | MESPIVU
MODEC | MODEM | MUSSA | REDEVU | Nuevos Desarrollos

METODOLOGÍA PARA EL CÁLCULO DE EMISIONES VEHICULARES (MODEM)

Actualización año 2010 disponible.

MODEM
Modelo de Cálculo de Emisiones Vehiculares

La creciente importancia de los fenómenos medioambientales, producidos por la actividad humana, exige la incorporación y cuantificación de este tipo de externalidades en las metodologías de planificación urbana. Debido al alto grado de responsabilidad del sector transporte en el nivel de emisiones de contaminantes atmosféricos existentes en ciudades como Santiago, se ha hecho imperativo contar con una metodología que cuantifique el nivel de emisiones asociadas a la actividad vehicular.

En el año 2001, en el marco del estudio "Análisis de Evaluaciones y Reevaluaciones Ex-Post, VI Etapa" se desarrolló la metodología para realizar las estimaciones de niveles de emisiones

http://www.sectra.gob.cl/metodologias/modem.htm

MODEM: estimación emisiones fuentes móviles

Emisiones fuentes móviles:

1. Emisiones por tubo de escape (*hot exhaust emissions*)
2. Emisiones en frío (*cold start emissions*)
3. Emisiones evaporativas (*evaporative emissions*)
4. Emisiones de polvo resuspendidas
5. Emisiones por desgaste de frenos y neumáticos

Desagregación de las emisiones totales:

$$E_{total} = E_{caliente} + E_{partidas\ en\ frío} + E_{evaporativas} + E_{polvo} + E_{desgaste} \qquad \text{Ecuación 3-2}$$

E_{total}	: Emisiones totales del contaminante considerado [gramos]
$E_{caliente}$	: Emisiones en caliente, fase estabilizada del motor [gramos]
$E_{partidas\ en\ frío}$	: Emisiones por partidas en frío [gramos]
$E_{evaporativas}$	: Emisiones por evaporación[3] [gramos]
E_{polvo}	: Emisiones provenientes del polvo resuspendido por la circulación de vehículos sobre calles pavimentadas.
$E_{desgaste}$	: Emisiones provenientes del desgaste de frenos y neumáticos [gramos]

Factores de emisión: ejemplo autos

Tabla 4-26. Factores de emisión para vehículos de pasajeros, propuestos dentro del estudio CONAMA RM 2008.

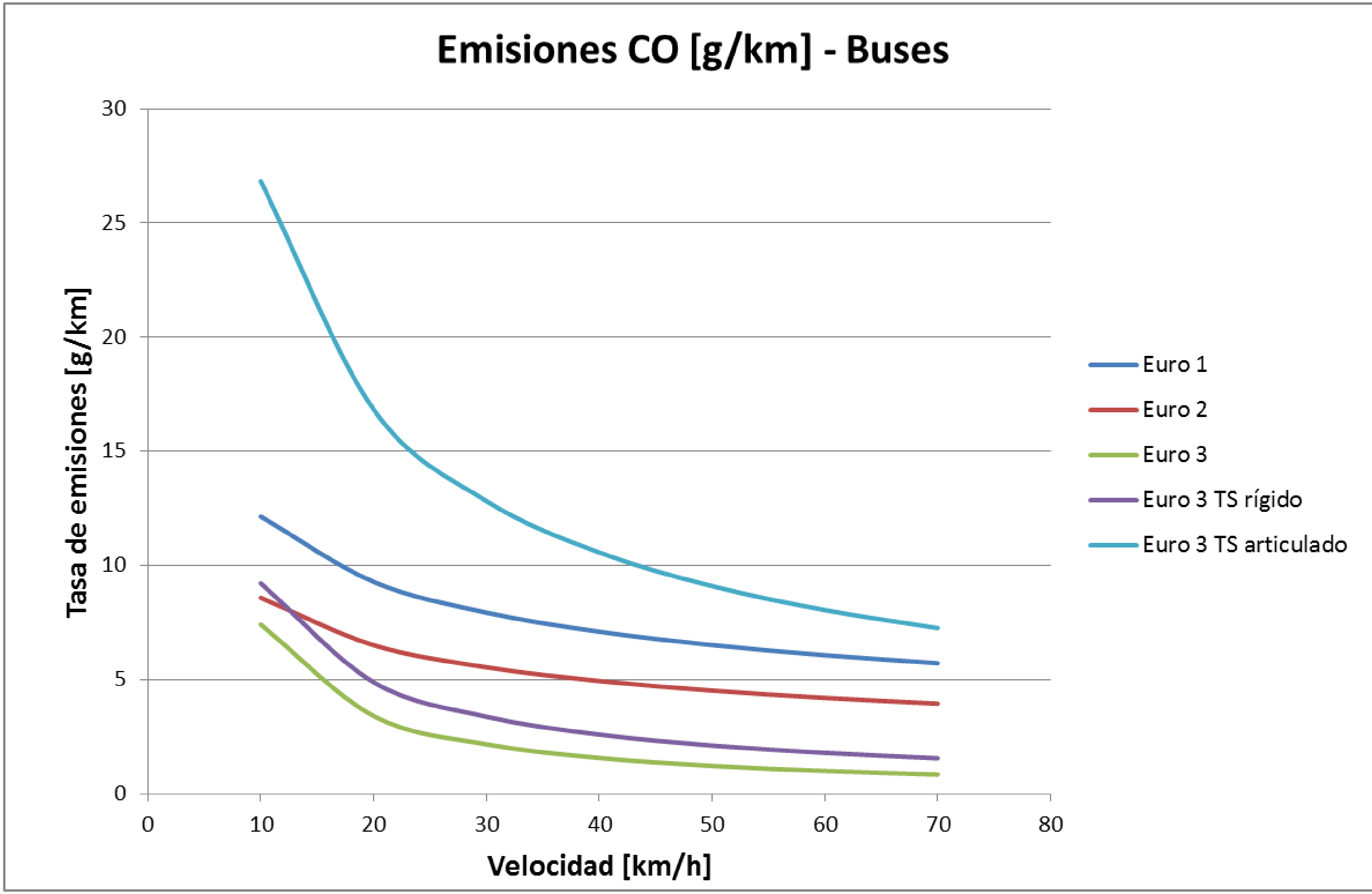
Sub-Categoría	Norma	Respaldo Estadístico		Cont.	Recomendación	Expresión
		COPERT IV	DIMEC			
Pasajeros Gasolina	S/Catalítico	A	B (10)	CO	COPERT IV	E = 281· V ^-0.63
				HC		E = 30.34 · V ^-0.693
				NOx		E = - 0.00014·V^2 + 0.0225·V + 1.173
				MP		N/A
	Euro I	A	B (17)	CO	DIMEC	E = 188,3 · V ^ -0,64
				HC		E = 17,64 · V ^ -0,78
				NOx		E = 4,07 · V ^ -0,41
				MP		N/A
	Euro III	D	B (12)	CO	DIMEC	E = 5.97· V ^-0.45
				HC		E = 2.323 · V ^-0.82
				NOx		E = -1.00E-06· V^3 + 0.000258·V^2-0.013084·V + 0.522927
				MP		N/A

Actualización Metodológica MODEM- MODEC para el Gran Santiago, Informe Final. Mideplan-Sectra, 2010

Factores de emisión: ejemplo buses

Sub-Categoría	Norma	Contaminante	Expresión	Constantes				
				a	b	c	d	e
Pre-Transantiago	Euro I	CO	$E=a \cdot V^b$	29,603	-0,387	N/A	N/A	N/A
		HC	$E=a \cdot V^b$	2,847	-0,552	N/A	N/A	N/A
		NOx	$E=a \cdot V^b$	32,467	-0,395	N/A	N/A	N/A
		MP	$E=(1/(((c \cdot (V^2))+(b \cdot V))+a)) \cdot 1{,}83$	0,412	0,071	0,000	N/A	N/A
	Euro II	CO	$E=a \cdot V^b$	21,523	-0,399	N/A	N/A	N/A
		HC	$E=a \cdot V^b$	8,707	-0,872	N/A	N/A	N/A
		NOx	$E=a \cdot V^b$	44,099	-0,502	N/A	N/A	N/A
		MP	$E=(c+(a \cdot \exp(b \cdot V))) \cdot 2{,}76$	0,517	-0,063	0,114	N/A	N/A
	Euro III	CO	$E=a \cdot V^b$	97,718	-1,120	N/A	N/A	N/A
		HC	$E=a \cdot V^b$	26,091	-1,435	N/A	N/A	N/A
		NOx	$E=a \cdot V^b$	40,890	-0,572	N/A	N/A	N/A
		MP	$E=((e+(a \cdot \exp(((-1) \cdot b) \cdot V)))+(c \cdot \exp(((-1) \cdot d) \cdot V))) \cdot 1{,}12$	0,453	0,056	1250,735	1,743	0,094
Transantiago	Rig.-Euro III	CO	$E=a \cdot V^b$	75,810	-0,915	N/A	N/A	N/A
		HC	$E=a \cdot V^b$	0,689	-0,684	N/A	N/A	N/A
		NOx	$E=a \cdot V^b$	74,629	-0,591	N/A	N/A	N/A
		MP	$E=((e+(a \cdot \exp(((-1) \cdot b) \cdot V)))+(c \cdot \exp(((-1) \cdot d) \cdot V))) \cdot 1{,}13$	0,453	0,056	1250,735	1,743	0,094
	Art.-Euro III	CO	$E=a \cdot V^b$	126,094	-0,672	N/A	N/A	N/A
		HC	$E=a \cdot V^b$	1,390	-0,565	N/A	N/A	N/A
		NOx	$E=a \cdot V^b$	65,325	-0,555	N/A	N/A	N/A
		MP	$E=(c+(a \cdot \exp(b \cdot V))) \cdot 2{,}31$	0,536	-0,056	0,112	N/A	N/A

Actualización Metodológica MODEM- MODEC para el Gran Santiago, Informe Final. Mideplan-Sectra, 2010



Fuente: MODEM

European Environment Agency

Topics | Countries | Data and maps | Indicators | Publications | Me

Data and maps > Datasets > External datasets catalogue > Copert 4

Copert 4

External Data Spec — Published 15 Jan 2016

The popular, straightforward and simple to use emissions calculator. COPERT 4 is a software tool used world-wide to calculate air pollutant and greenhouse gas emissions from road transport. The development of COPERT is coordinated by the European Environment Agency (EEA) , in the framework of the activities of the European Topic Centre for Air Pollution and Climate Change Mitigation . The European Commission's Joint Research Centre manages the scientific development of the model. COPERT has been developed for official road transport emission inventory preparation in EEA member countries . However, it is applicable to all relevant research, scientific and academic applications.

Provider:

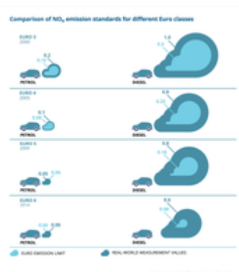
EMISIA

Dataset URL:

http://emisia.com/products/copert-4

Related content

Infographics produced



Comparison of NOx emission standards for different Euro classes

https://www.eea.europa.eu/data-and-maps/data/external/copert-4

COPERT (Europa)

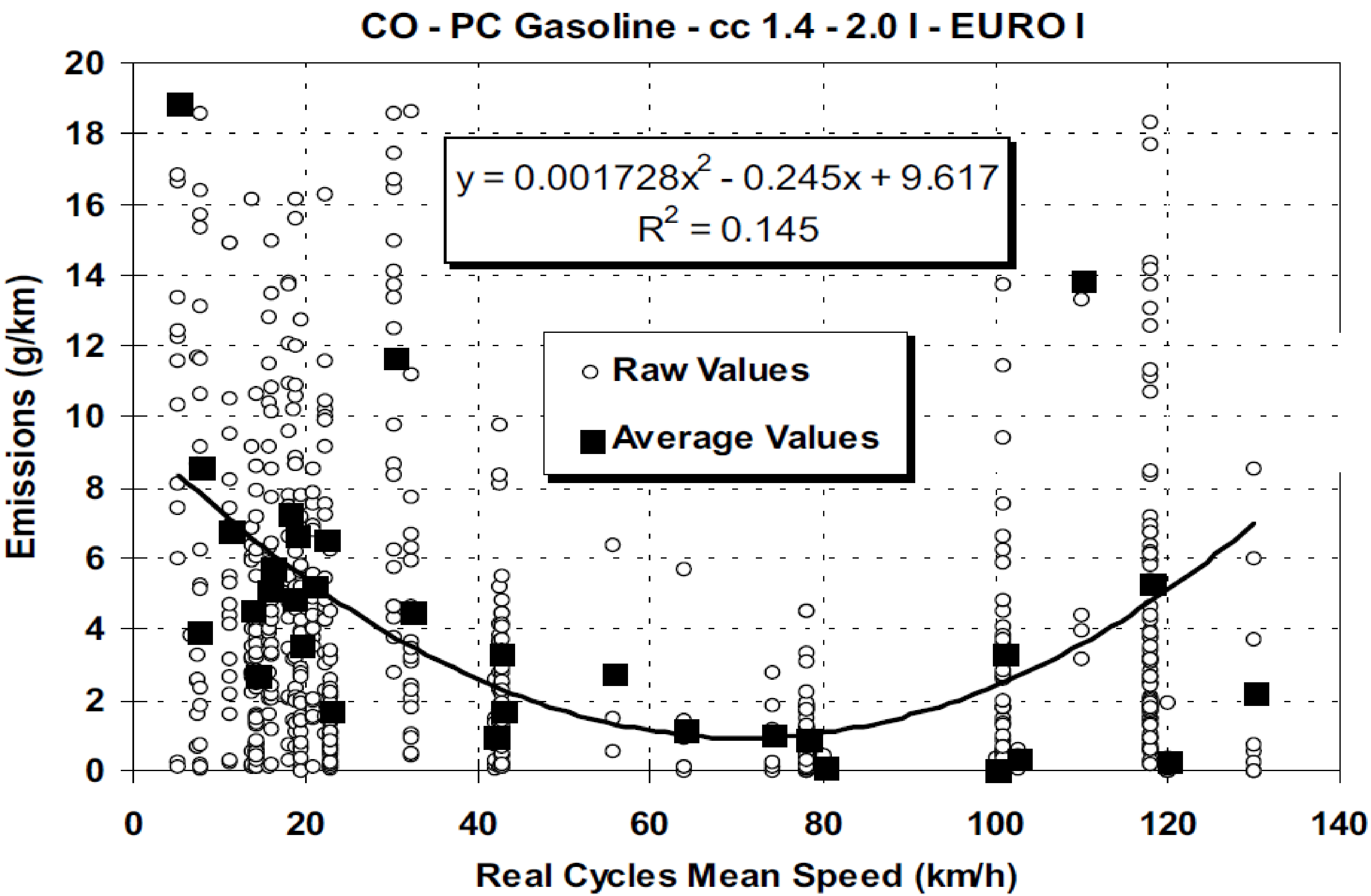
ID	Function Name	Form of function	Excel Function
0	Hoerl model	$y = a.b^x.x^c$	((a*(b^x))*(x^c))
1	Two power fits model	$y = a.x^b + c.x^d$	((a*(x^b))+(c*(x^d)))
2	Bleasdale model	$y = (a + b.x)^{-c}$	((a+(b*x))^((-1)/c))
4	Two-phase exponential decay	$y = e + a.exp(-b.x) + c.\exp(-d.x)$	((e+(a*exp(((-1)*b)*x)))+(c*exp(((-1)*d)*x)))
5	Reciprocal quadratic model	$y = 1/(c.x^2 + b.x + a)$	(1/(((c*(x^2))+(b*x))+a))
6	Harris model	$y = 1/(a + b.x^c)$	(1/(a+(b*(x^c))))
8	Sigmoidal	$y = a - b.\exp(-c.x^d)$	(a-(b*exp(((-1)*c)*(x^d))))
10	Reciprocal exponential model	$y = a + \{b/[1 + \exp(-c + d.\ln(x) + e.x)]\}$	(a+(b/(1+exp((((-1)*c)+(d*ln(x)))+(e*x)))))
11	One-phase exponential decay model	$y = c + a.\exp(-b.x)$	(c+(a*exp(((-1)*b)*x)))
13	Vapour Pressure model	$y = exp[(a + b/x) + c.\ln(x)]$	exp((a+(b/x))+(c*ln(x)))
14	Cubic model	$y = a.x^3 + b.x^2 + c.x + d$	(((a*(x^3))+(b*(x^2)))+(c*x))+d)
15	Quadratic model	$y = a.x^2 + b.x + c$	(((a*(x^2))+(b*x))+c)
16	-	$y = (a + b*x + c*x^2 + d/x) / (e + f*x + g*x^2)$	(a+b*x+c*x^2+d/x)/(e+f*x+g*x^2)

COPERT (Europa)

2	Subsector	Technology	Slope	Load	Pollutant	a	b	c	d	e	f	g
13483	Urban Buses Standard 15 - 18 t	HD Euro VI	-0.02	50	PM	0.000983	-0.000048	0.000000	0.077489	1.000000	-0.009199	-0.000012
13484	Urban Buses Standard 15 - 18 t	HD Euro VI	-0.02	100	CO	-113.468780	23.137994	-0.106322	118.736716	0.000000	-17.217186	4.820846
13485	Urban Buses Standard 15 - 18 t	HD Euro VI	-0.02	100	FC	617.762929	-8.268821	0.015541	110.429801	1.000000	0.069833	-0.000809
13486	Urban Buses Standard 15 - 18 t	HD Euro VI	-0.02	100	HC	0.019373	0.000314	0.000003	0.453715	1.000000	-0.006545	0.001342
13487	Urban Buses Standard 15 - 18 t	HD Euro VI	-0.02	100	NOx	-6.950486	0.471897	0.000959	29.897854	1.000000	-0.272228	0.023178
13488	Urban Buses Standard 15 - 18 t	HD Euro VI	-0.02	100	PM	-0.007609	0.000292	0.000000	0.081301	1.000000	-0.093853	0.003283
13489	Urban Buses Standard 15 - 18 t	HD Euro VI	0	0	CO	5.562629	-0.069217	0.000431	-5.321134	1.000000	0.813663	-0.007677
13490	Urban Buses Standard 15 - 18 t	HD Euro VI	0	0	FC	495.658241	-2.590105	-0.000865	607.714511	1.000000	0.039688	-0.000408
13491	Urban Buses Standard 15 - 18 t	HD Euro VI	0	0	HC	0.033017	-0.000707	0.000006	0.499691	1.000000	-0.003129	0.000045
13492	Urban Buses Standard 15 - 18 t	HD Euro VI	0	0	NOx	-7.421608	0.555948	-0.004124	37.866927	1.000000	-0.240733	0.023905
13493	Urban Buses Standard 15 - 18 t	HD Euro VI	0	0	PM	-0.000429	-0.000059	0.000001	0.084280	1.000000	-0.035169	0.000415
13494	Urban Buses Standard 15 - 18 t	HD Euro VI	0	50	CO	-224.385444	33.684785	0.329093	204.704884	0.000000	-35.335473	6.753178
13495	Urban Buses Standard 15 - 18 t	HD Euro VI	0	50	FC	592.408717	-1.614192	-0.034826	480.413910	1.000000	0.048402	-0.000567
13496	Urban Buses Standard 15 - 18 t	HD Euro VI	0	50	HC	0.037879	-0.000617	0.000003	0.510514	1.000000	0.006311	-0.000117
13497	Urban Buses Standard 15 - 18 t	HD Euro VI	0	50	NOx	-7.915663	0.550743	-0.003736	38.267182	1.000000	-0.262912	0.026590
13498	Urban Buses Standard 15 - 18 t	HD Euro VI	0	50	PM	-0.000973	-0.000058	0.000001	0.084930	1.000000	-0.040118	0.000485
13499	Urban Buses Standard 15 - 18 t	HD Euro VI	0	100	CO	526.865791	-8.463110	0.065528	-664.399823	0.000000	72.863555	-0.614173
13500	Urban Buses Standard 15 - 18 t	HD Euro VI	0	100	FC	-105.492465	53.355903	1.122451	148.638700	0.000000	0.032419	0.008172
13501	Urban Buses Standard 15 - 18 t	HD Euro VI	0	100	HC	0.037388	-0.000586	0.000003	0.520310	1.000000	0.006739	-0.000129
13502	Urban Buses Standard 15 - 18 t	HD Euro VI	0	100	NOx	-7.922108	0.533983	-0.002305	37.812788	1.000000	-0.286770	0.031750
13503	Urban Buses Standard 15 - 18 t	HD Euro VI	0	100	PM	-0.008245	0.000118	0.000006	0.087681	1.000000	-0.113731	0.003546
13504	Urban Buses Standard 15 - 18 t	HD Euro VI	0.02	0	CO	189.841098	-31.012688	0.014812	-148.106812	0.000000	22.399765	-4.286358
13505	Urban Buses Standard 15 - 18 t	HD Euro VI	0.02	0	FC	580.575988	6.647004	-0.077378	900.601184	1.000000	0.053667	-0.000499
13506	Urban Buses Standard 15 - 18 t	HD Euro VI	0.02	0	HC	0.033028	-0.000358	0.000005	0.586162	1.000000	0.000992	0.000112
13507	Urban Buses Standard 15 - 18 t	HD Euro VI	0.02	0	NOx	-7.195578	0.471730	0.000422	41.821693	1.000000	-0.281867	0.036201
13508	Urban Buses Standard 15 - 18 t	HD Euro VI	0.02	0	PM	-0.007341	0.000049	0.000007	0.093385	1.000000	-0.103734	0.003067
13509	Urban Buses Standard 15 - 18 t	HD Euro VI	0.02	50	CO	-12.970453	3.037391	-0.008397	11.542966	1.000000	-1.551036	0.399124

En cada caso se indica el ID de la función según tabla anterior

Emisiones



Fuente: Samaras, Z., Ntziachristos, L. (1998) Average hot emission factors for passenger cars and light duty trucks. Laboratory of Applied Thermodynamics (LAT), Aristotele University of Thessaloniki

UNIVERSIDAD DE CHILE
FACULTAD DE CIENCIAS FÍSICAS Y MATEMÁTICAS
DEPARTAMENTO DE INGENIERÍA MECÁNICA

DISTRIBUCIÓN ESPACIAL Y TEMPORAL DE EMISIONES CONTAMINANTES PRODUCIDAS POR BUSES DE TRANSPORTE PÚBLICO EN SANTIAGO

MEMORIA PARA OPTAR AL TÍTULO DE INGENIERO CIVIL MECÁNICO

ALBERTO ANDRÉS ARROYO MEJÍAS

PROFESORA GUÍA:
MARCELA MUNIZAGA MUÑOZ

MIEMBROS DE LA COMISIÓN:
MAURICIO OSSES ALVARADO
ROBERTO CORVALÁN PAIVA

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GPS buses + COPERT
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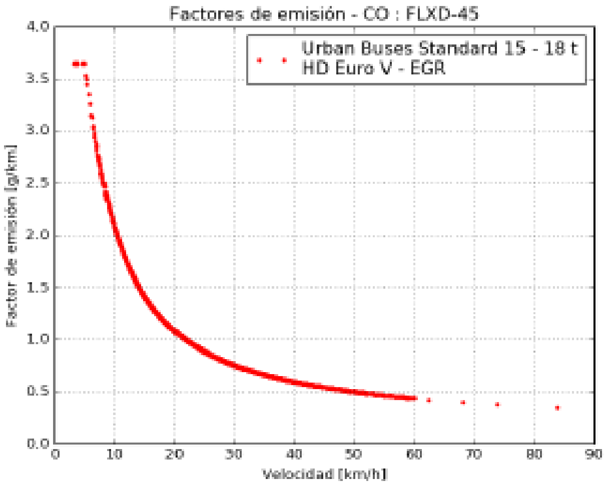
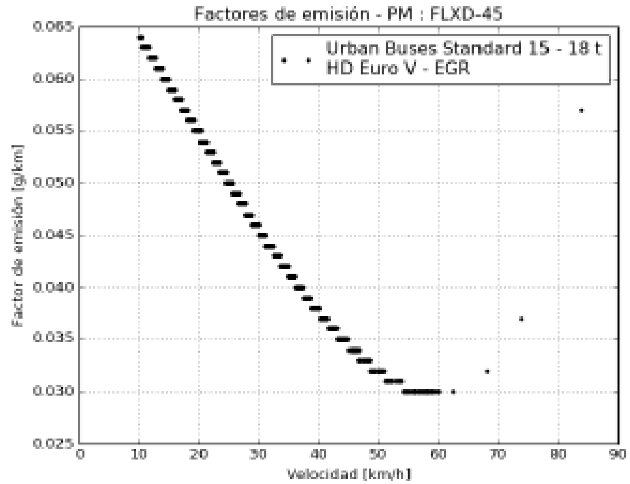
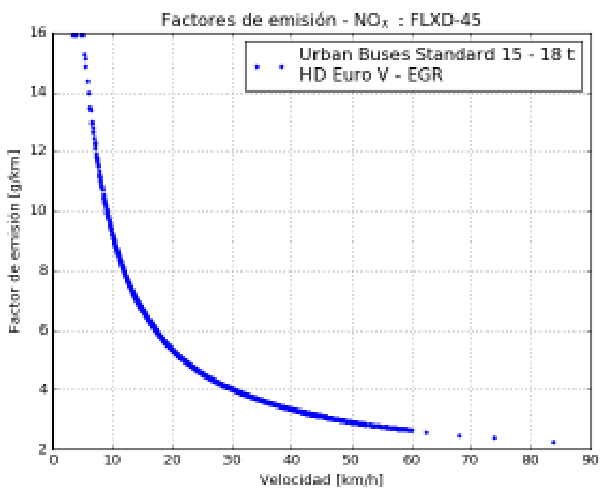


(a) CO

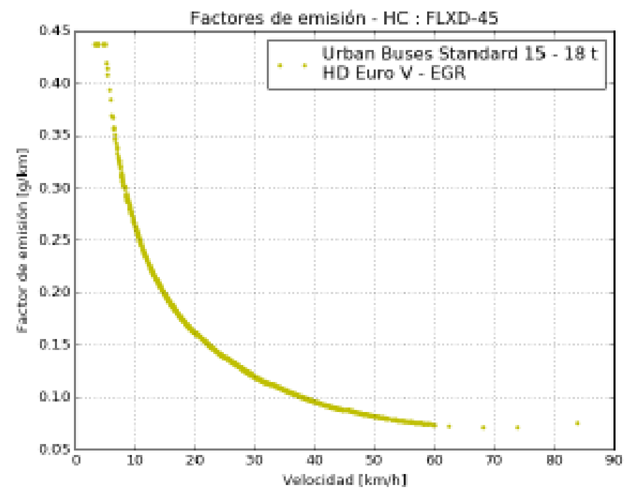


(b) MP



(c) NO_x

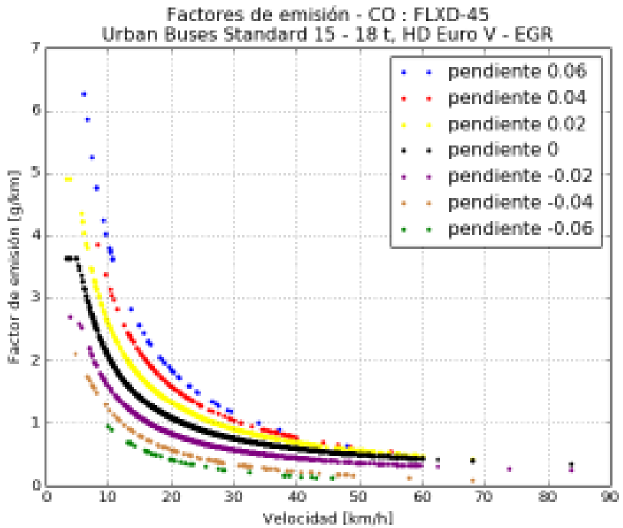
Óxidos de Nitrógeno



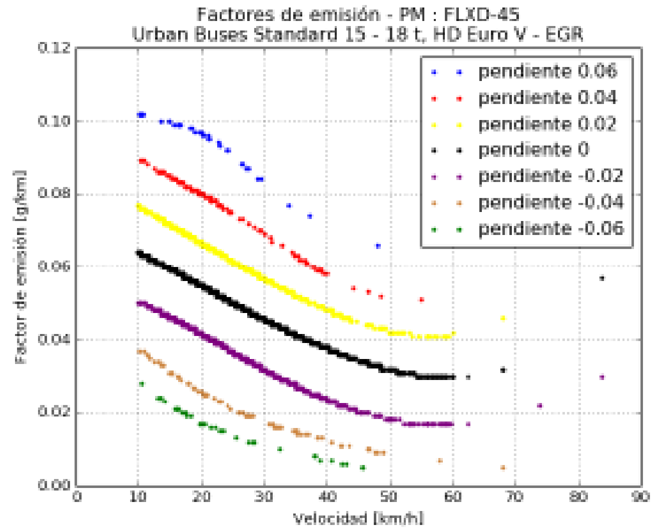
(d) HC

Hidrocarburos

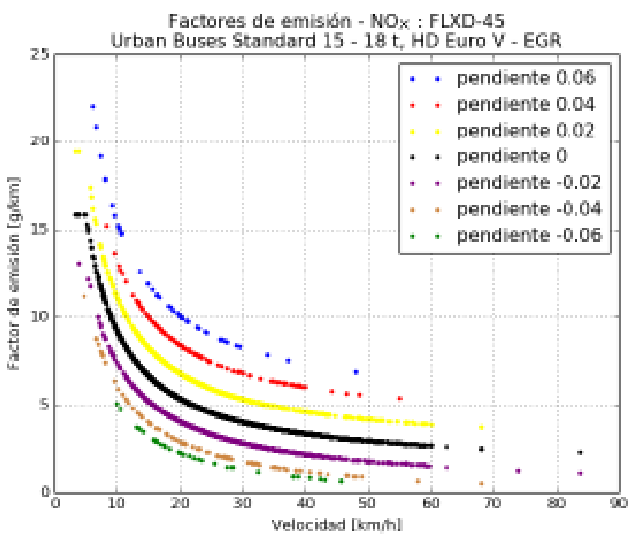
Efecto velocidad, pendiente cero



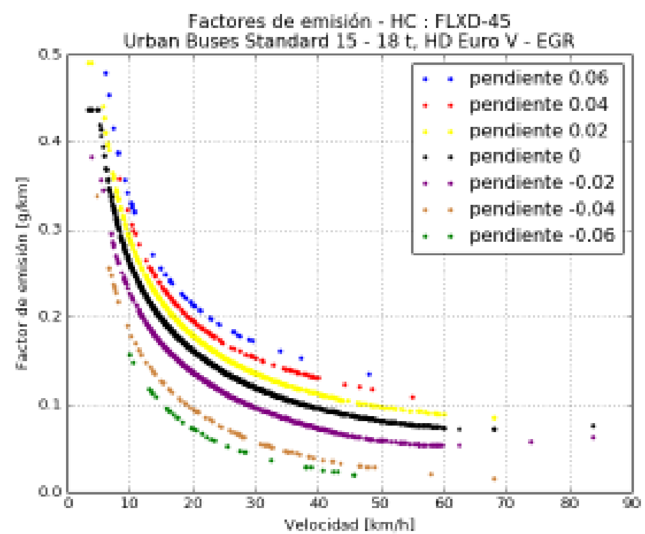
(a) CO



(b) MP



(c) NO_x



(d) HC

Efecto velocidad y pendiente

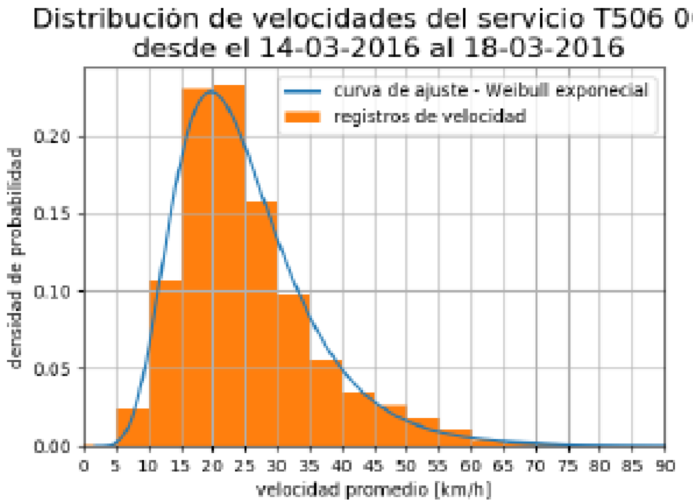


Figura 5.11: Distribución de velocidades del servicio 506I durante la semana en estudio.

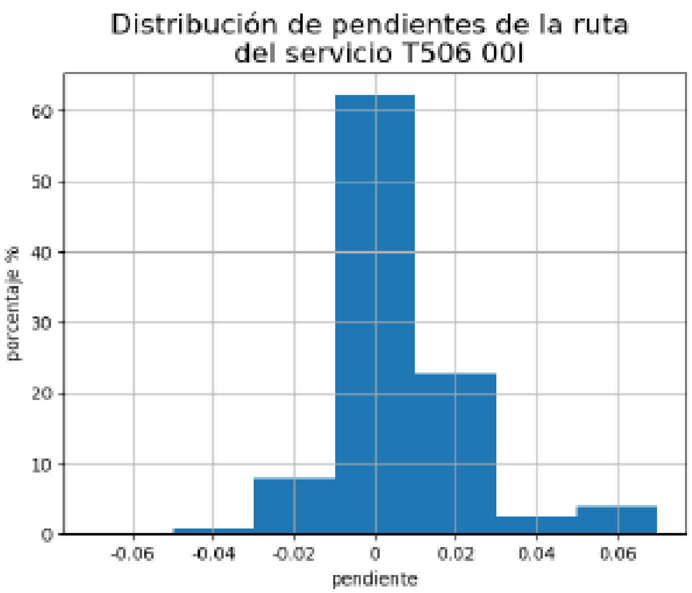


Figura 5.12: Distribución de pendientes de la ruta del servicio 506I.

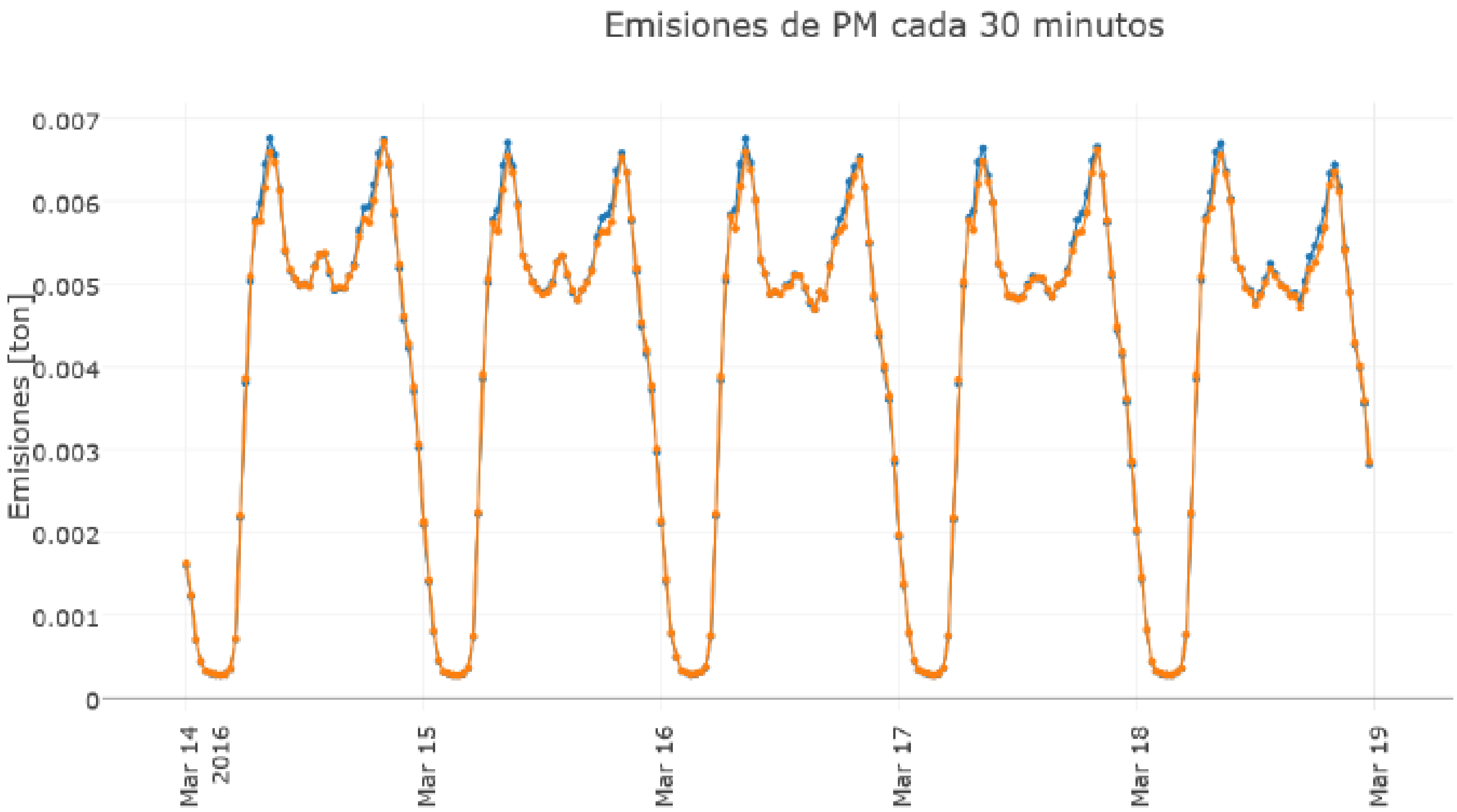
Ejemplo Línea 516

(b) MP

Figura 5.16: Ejemplo de emisiones en ruta de la patente FLXD-45 realizando un recorrido del servicio 506I, con horario de inicio 17:00 el día 18-03-2016.

Línea 506: Maipú - Peñalolén

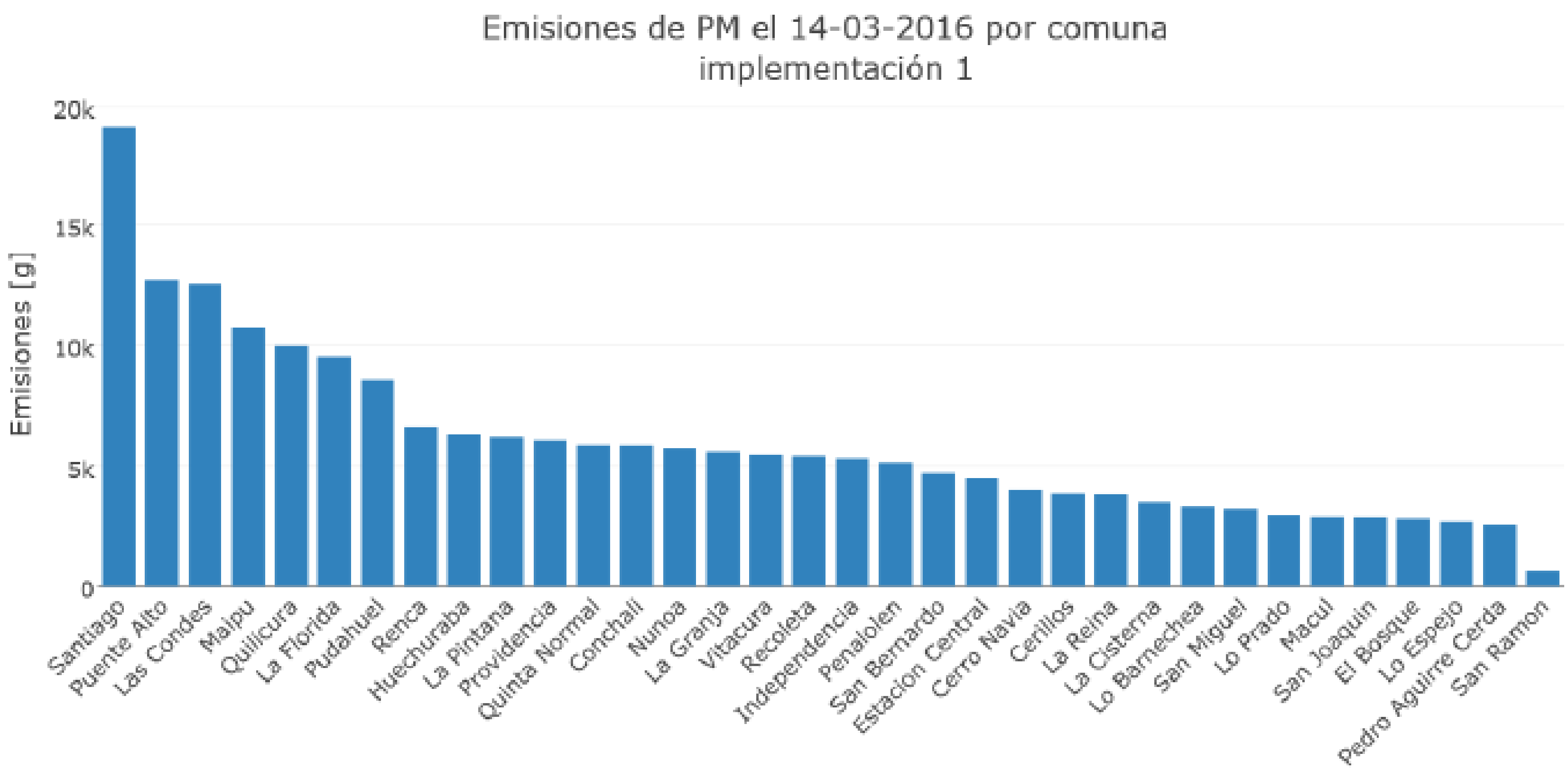
Resultado global Transantiago



(b) MP

Antes de entrada buses eléctricos

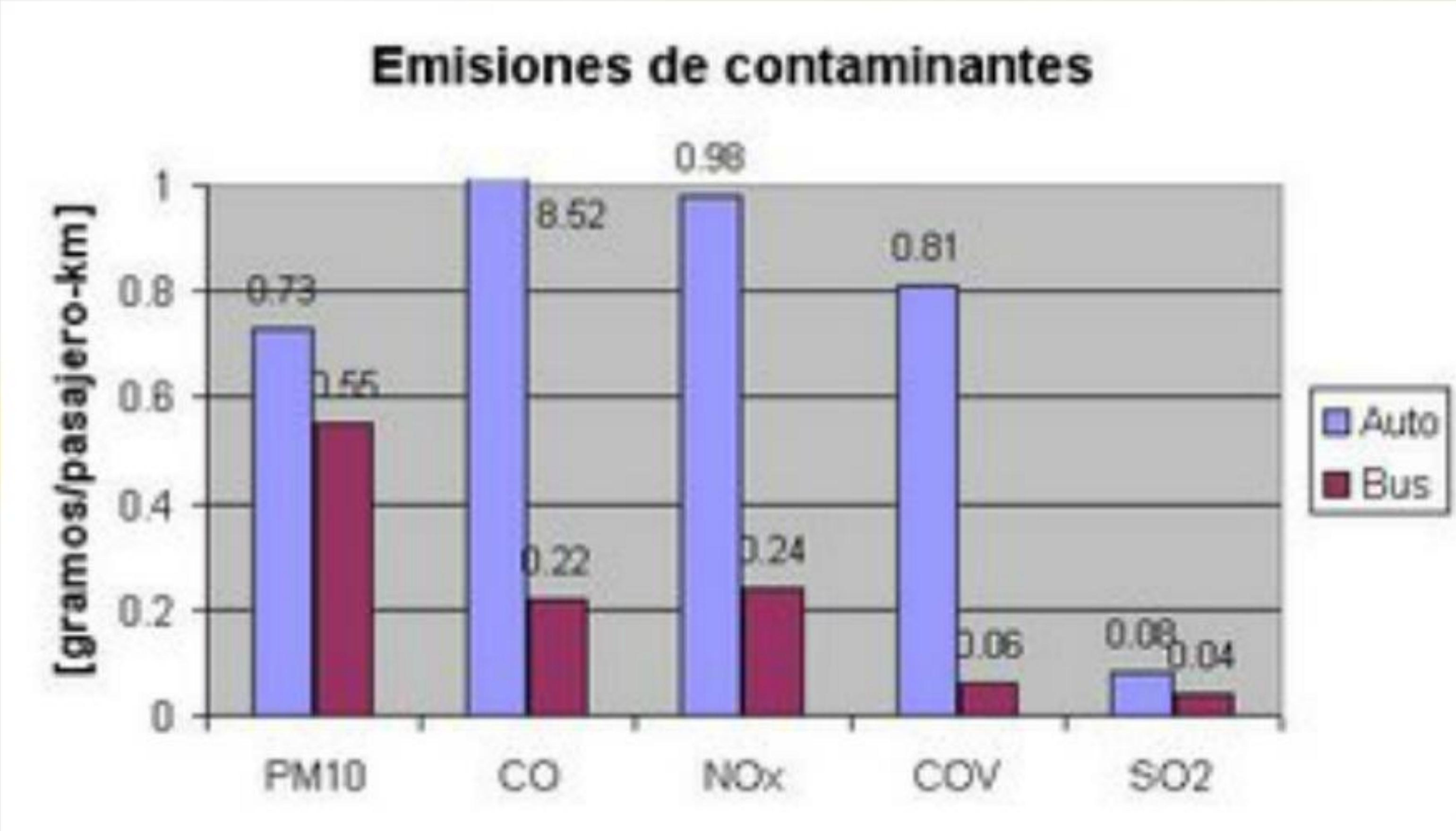
Resultado global Transantiago



(b) MP

¿y qué pasa con los autos?

¿viajero en auto contamina más o menos que viajero en bus?



(CONAMA)

- *Auto: 38 veces más monóxido de carbono (CO) que los buses por persona transportada.*
- *12.5 veces más compuestos orgánicos volátiles (COV) 3 veces más óxidos de nitrógeno (NOx),*
- *2 veces más dióxido de azufre (SO2)*
- *25% más de material particulado (PM10)*

Environmental assessment of passenger transportation should include infrastructure and supply chains

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Abstract
To appropriately mitigate environmental impacts from transportation, it is necessary for decision makers to consider the life-cycle energy use and emissions. Most current decision-making relies on analysis at the tailpipe, ignoring vehicle production, infrastructure provision, and fuel production required for support. We present results of a comprehensive life-cycle energy, greenhouse gas emissions, and selected criteria air pollutant emissions inventory for automobiles, buses, trains, and airplanes in the US, including vehicles, infrastructure, fuel production, and supply chains. We find that total life-cycle energy inputs and greenhouse gas emissions contribute an additional 63% for onroad, 155% for rail, and 31% for air systems over vehicle tailpipe operation. Inventorying criteria air pollutants shows that vehicle non-operational components often dominate total emissions. Life-cycle criteria air pollutant emissions are between 1.1 and 800 times larger than vehicle operation. Ranges in passenger occupancy can easily change the relative performance of modes.

Keywords: passenger transportation, life-cycle assessment, cars, autos, buses, trains, rail, aircraft, planes, energy, fuel, emissions, greenhouse gas, criteria air pollutants

S Supplementary data are available from stacks.iop.org/ERL/4/024008

http://iopscience.iop.org/article/10.1088/1748-9326/4/2/024008/meta;jsessionid=243815314BF86CB580AB21EFDF9AE49C.c1

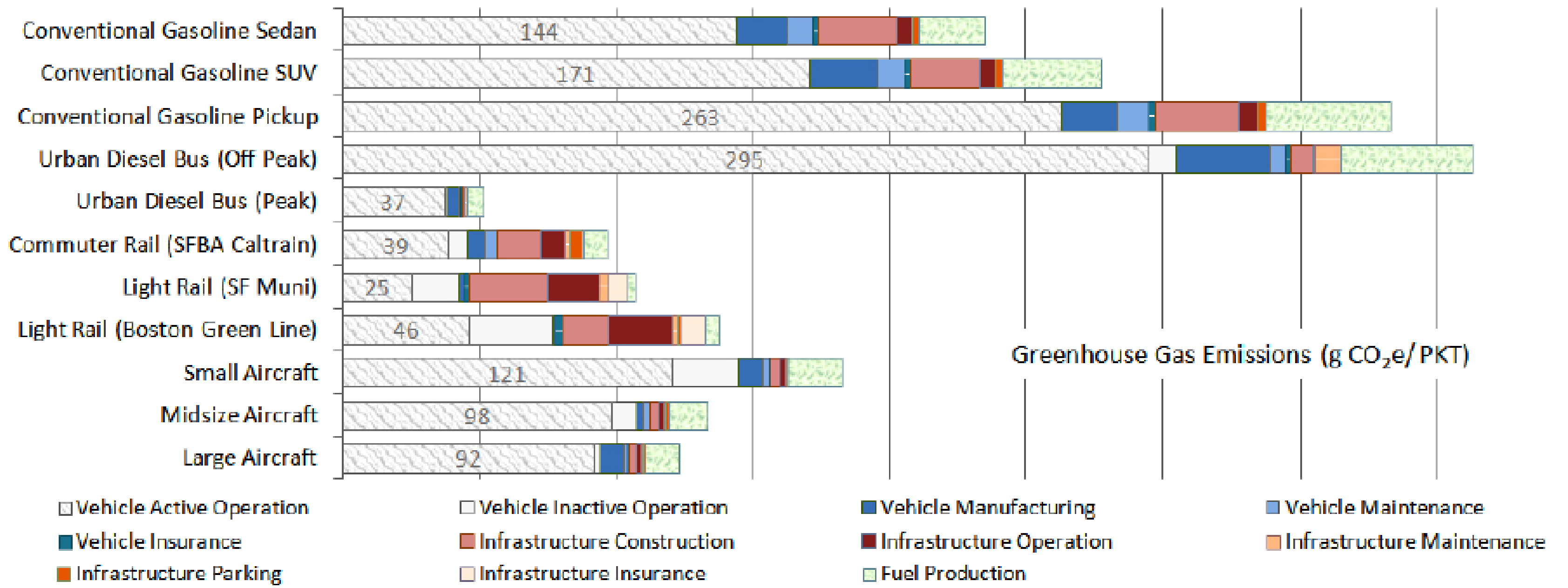

Figure 1. Energy consumption and GHG emissions per PKT (The vehicle operation components are shown with gray patterns. Other vehicle components are shown in shades of blue. Infrastructure components are shown in shades of red and orange. The fuel production component is shown in green. All components appear in the order they are shown in the legend.).

Chester, M. V. y A. Horvath (2009) Environmental assessment of passenger transportation should include infrastructure and supply chains. Environ. Res. Lett. 4 (2): 024008.