"ITF WORKSHOP 2 INFRASTRUCTURE" , Paris ,1rst october 2019

GWP assessment : lessons from case studies of road construction and maintenance Building LCA tools at national and European level (2001-2016)

Proposed as current research, national framework of the ANR TerDouest (national French project) and LCE4ROADS (FP7 project) and ville10D (national French project)

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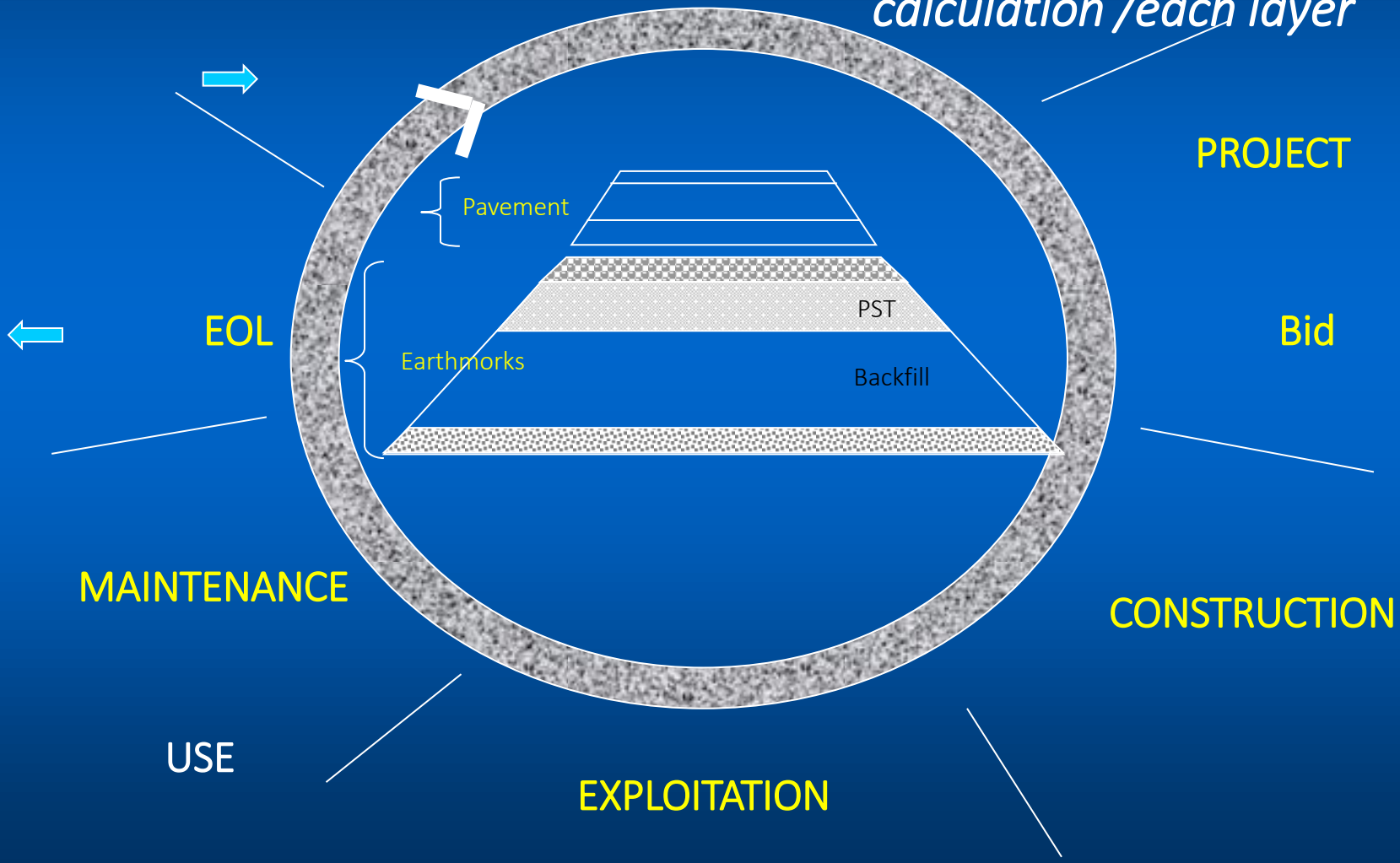
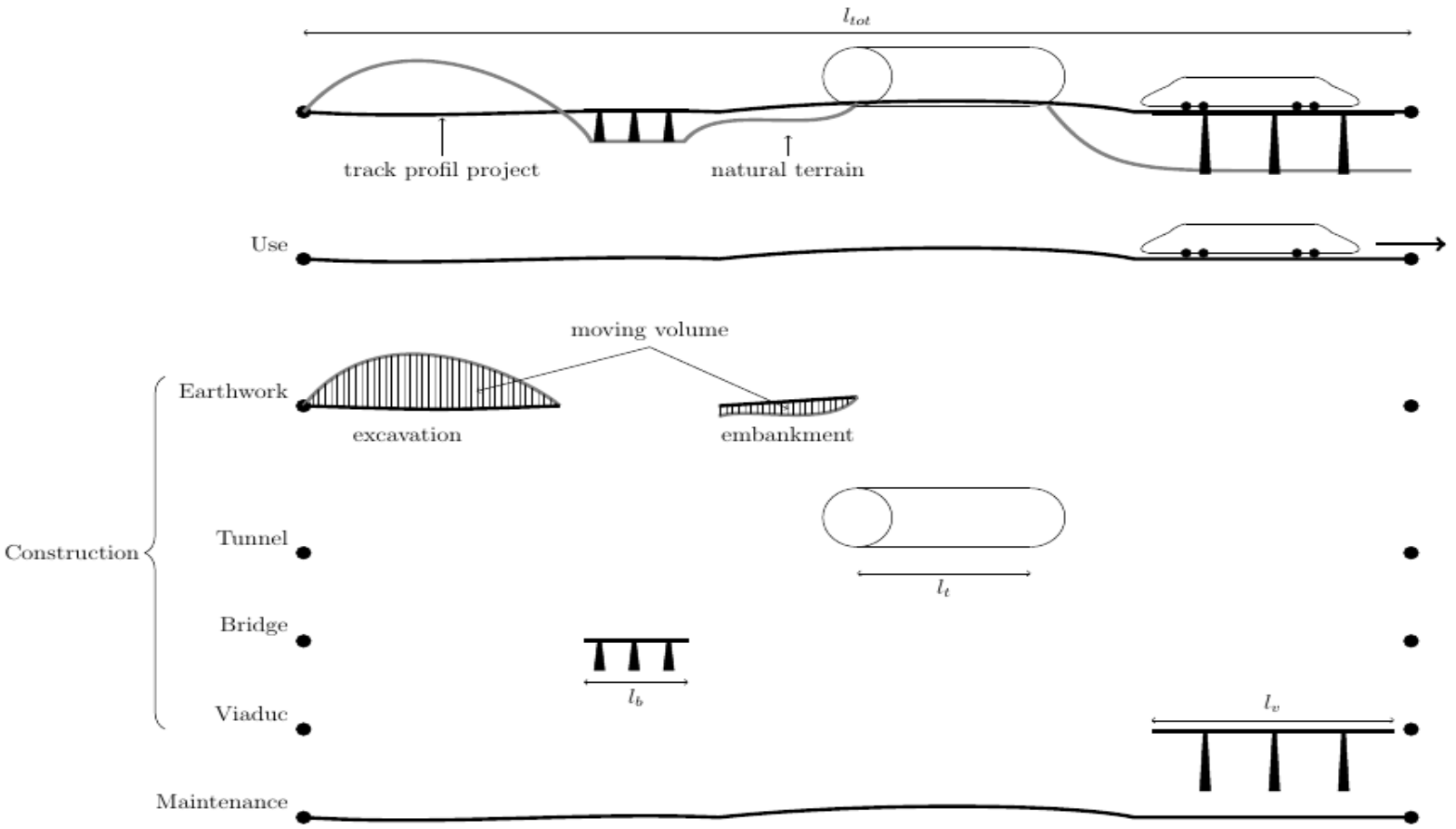
IFSTTAR

LCA and stage of infrastructure project : service FU

Which Structure ?description : mass calculation /each layer



PROJECT LEVEL : Which variant (itinerary)?

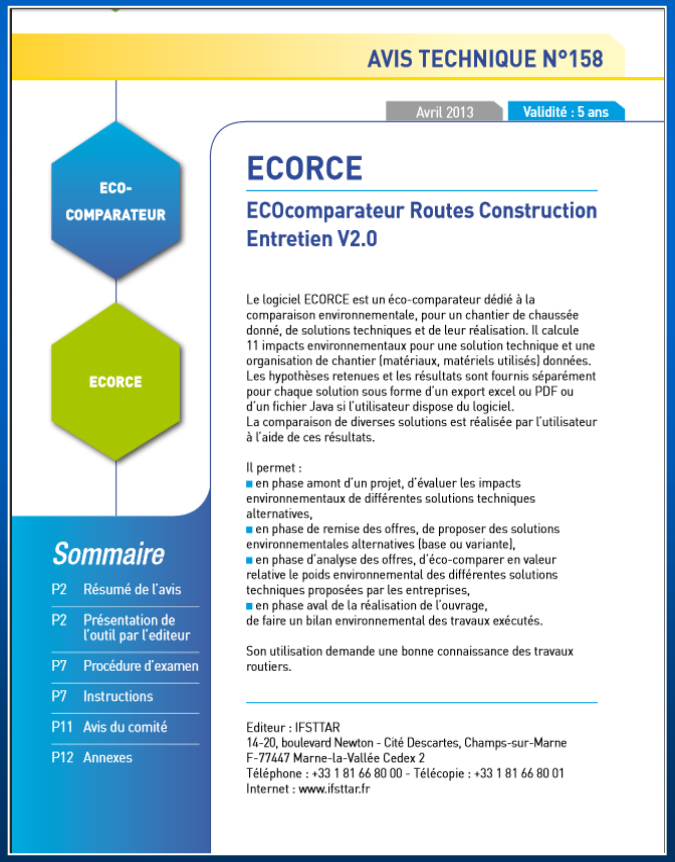


$$E = \sum = Use \cdot l_{tot} + Earthwork + e_t \cdot l_t + e_b \cdot l_b + e_v \cdot l_v + Maintenance \cdot l_{tot}$$

e_t, e_b, e_v : cout energie au km

France LEVEL- FRENCH EXPERTS GROUPS and TOOLS

2009 : creation of OEET (Observatoire Environnement Energie Transports) ,
2010 : sub-group on LCA
2011 : national methodology for infrastructures LCA
2013 : benchmarking for French LCA tools ECORCE-SEVE
2014 : technical notes : www.idrrim.com



AVIS TECHNIQUE N°158

Avril 2013 | Validité : 5 ans

ECO-COMPARATEUR

ECORCE

ECORCE

ECOcomparateur Routes Construction Entretien V2.0

Le logiciel ECORCE est un éco-comparateur dédié à la comparaison environnementale, pour un chantier de chaussée donné, de solutions techniques et de leur réalisation. Il calcule 11 impacts environnementaux pour une solution technique et une organisation de chantier (matériaux, matériels utilisés) données. Les hypothèses retenues et les résultats sont fournis séparément pour chaque solution sous forme d'un export excel ou PDF ou d'un fichier Java si l'utilisateur dispose du logiciel.
La comparaison de diverses solutions est réalisée par l'utilisateur à l'aide de ces résultats.

Il permet :
- en phase amont d'un projet, d'évaluer les impacts environnementaux de différentes solutions techniques alternatives,
- en phase de remise des offres, de proposer des solutions environnementales alternatives (base ou variante),
- en phase d'analyse des offres, d'éco-comparer en valeur relative le poids environnemental des différentes solutions techniques proposées par les entreprises,
- en phase aval de la réalisation de l'ouvrage, de faire un bilan environnemental des travaux exécutés.

Son utilisation demande une bonne connaissance des travaux routiers.

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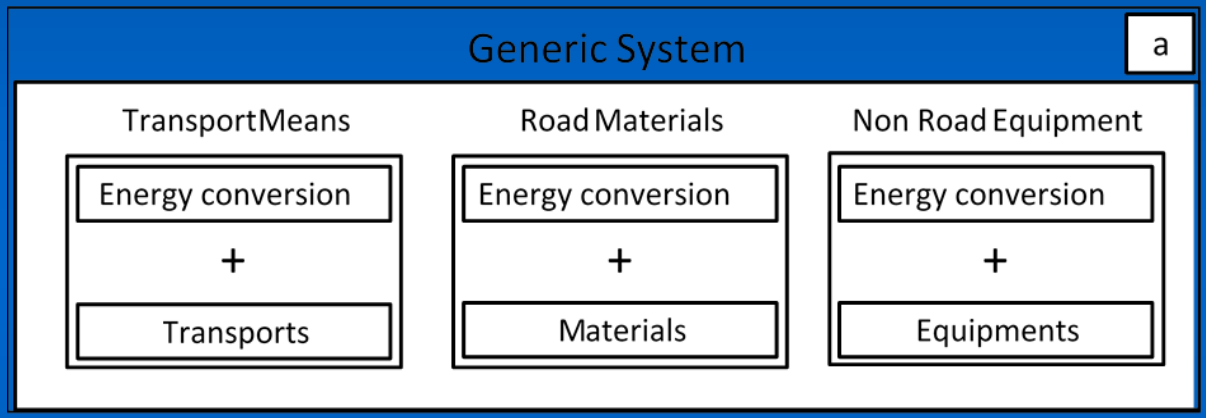


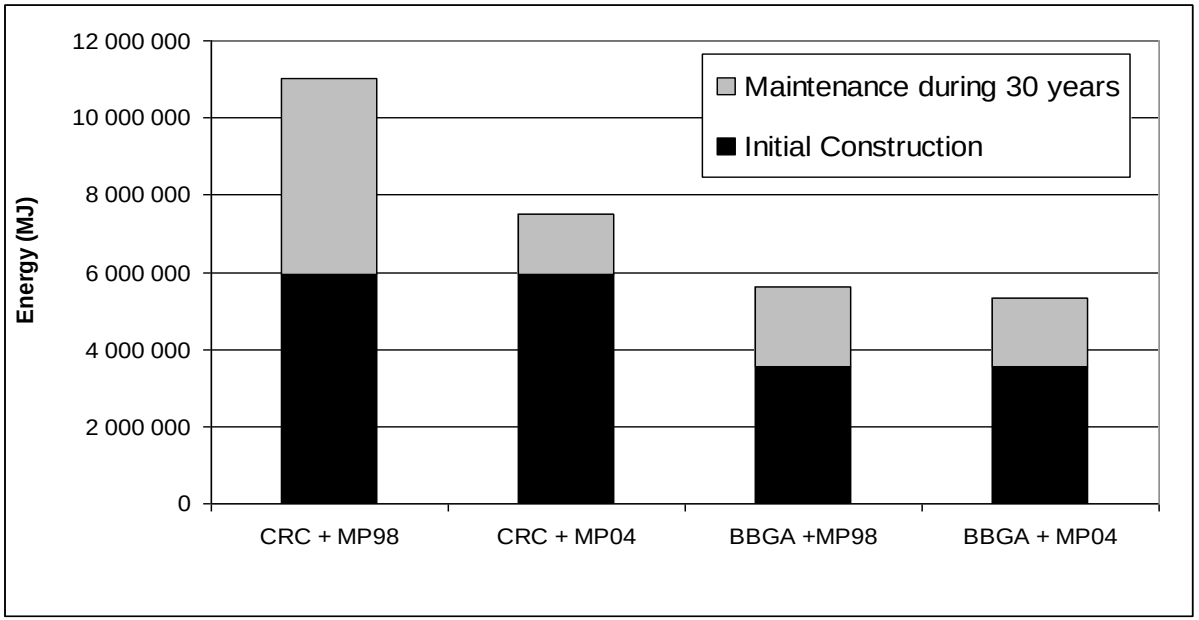
ECORCE2 (2013) a Life Cycle Assessment tool for construction and maintenance of roads (45 materials/processes LCIs)
http://ecorce2.ifsttar.fr (french version AND DATABASE,2013)
http://ecorcem.ifsttar.fr (english version 2014), multibase

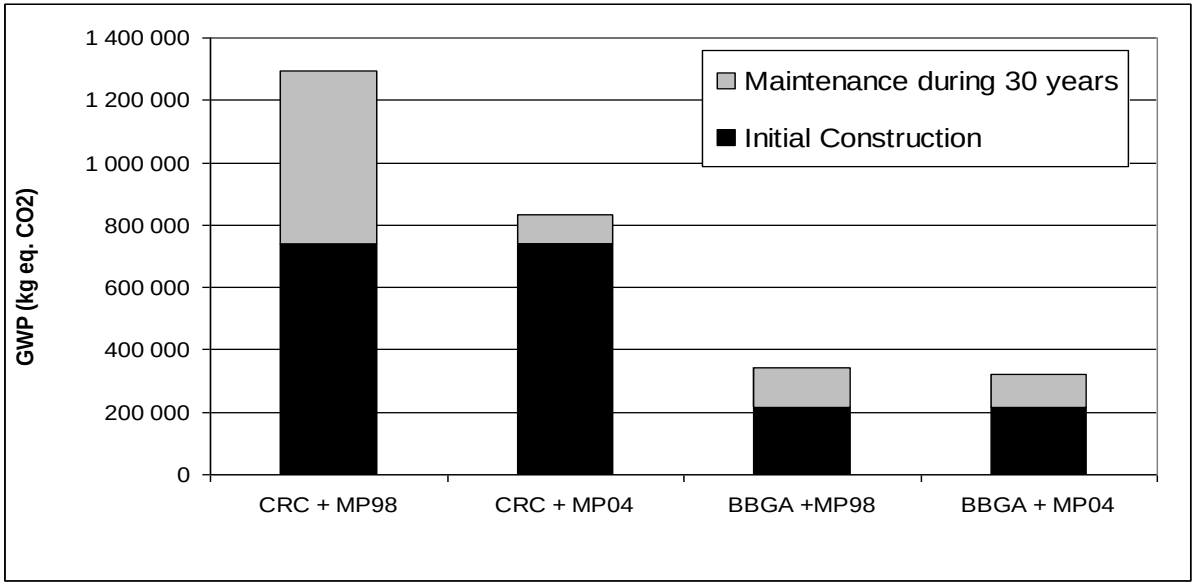
LCI of road materials : OFRIR2 (2013) a data base on materials
http://ofrir2.ifsttar.fr

CASE 1 : PAVEMENT CONSTRUCTION and MAINTENANCE POLICIES

Cement

(6000 GJ)





Bituminous

(3500 GJ)

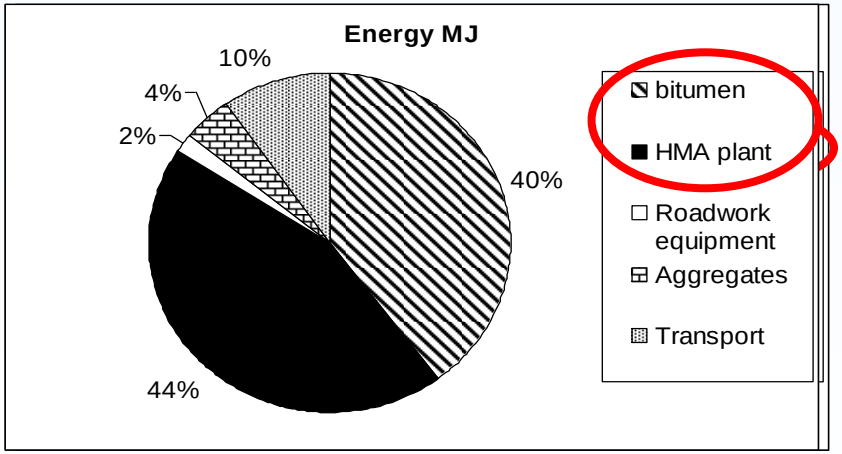
FU: 1 KM pavement, 2 lanes, 30 years Heavy traffic

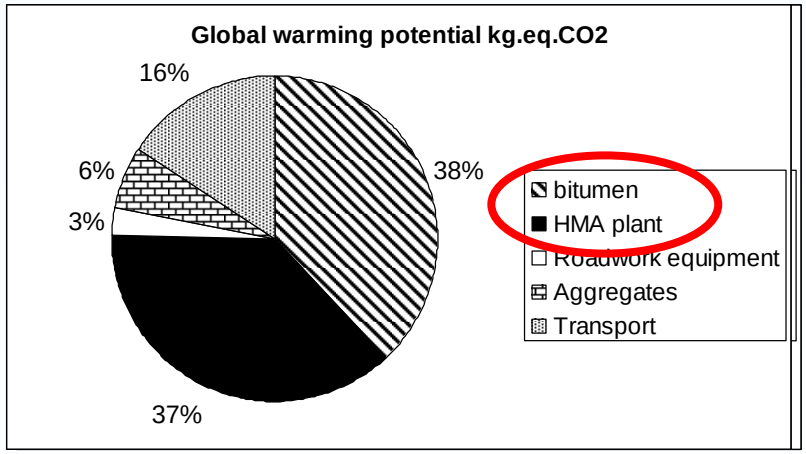
TC6 25 10^6 trucks/year/lane – 20% heavy vehicles and 80% passenger cars

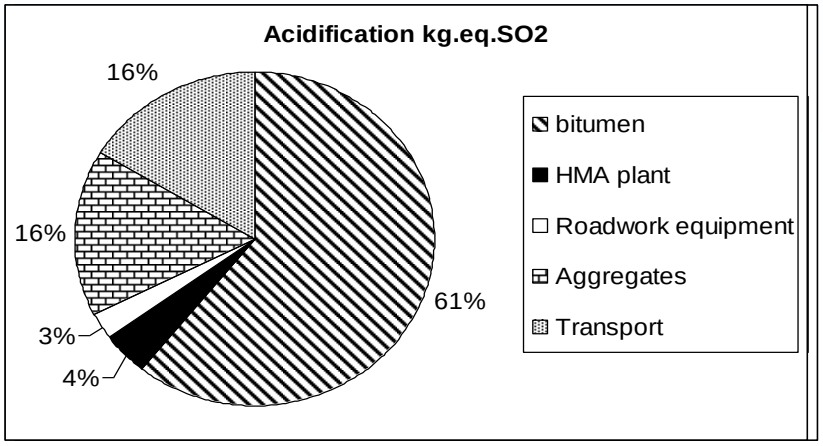
JULLIEN A, DAUVERGNE M., CEREZO V., Environmental assessment of road construction and maintenance policies using LCA., **Transportation Research Part D: Transport and Environment**, Vol. 29, p.56-65, *may 2014*..

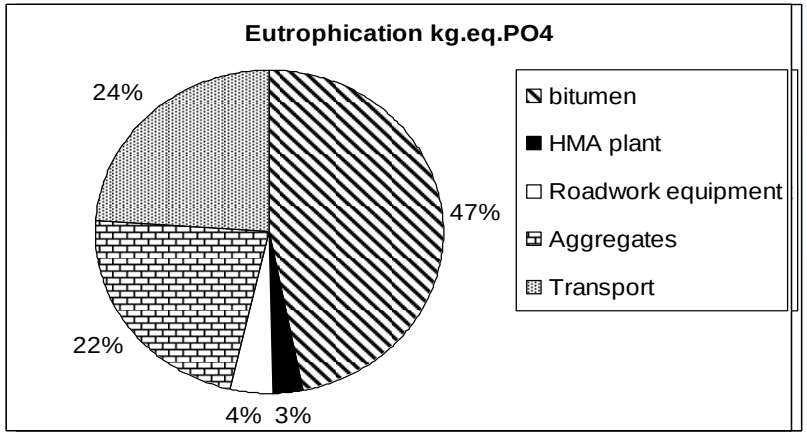
Classical HMA case study pavement construction

Layer	Thickness	HMA (plant)	Transport (km)
Wearing course (t)	6 cm	987	20
Subbase (t)	13 cm	2093	20
Surface (m2)	7000		







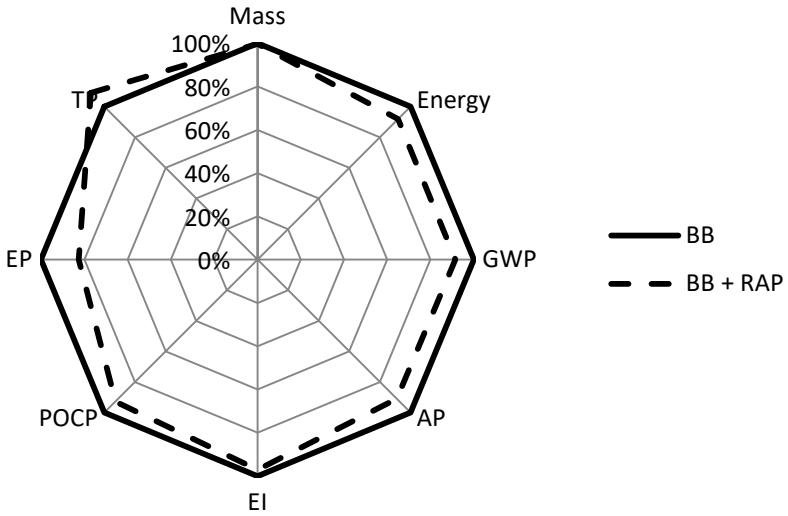


Pavement: recycling bituminous mixes

no RAP and 30% RAP solutions

FU: 1 km X 2 lanes X 30 years

with the defined operations at year 9, 17, 25, With *AC : Asphalt Concrete, STAC: TLAC : BBGA*



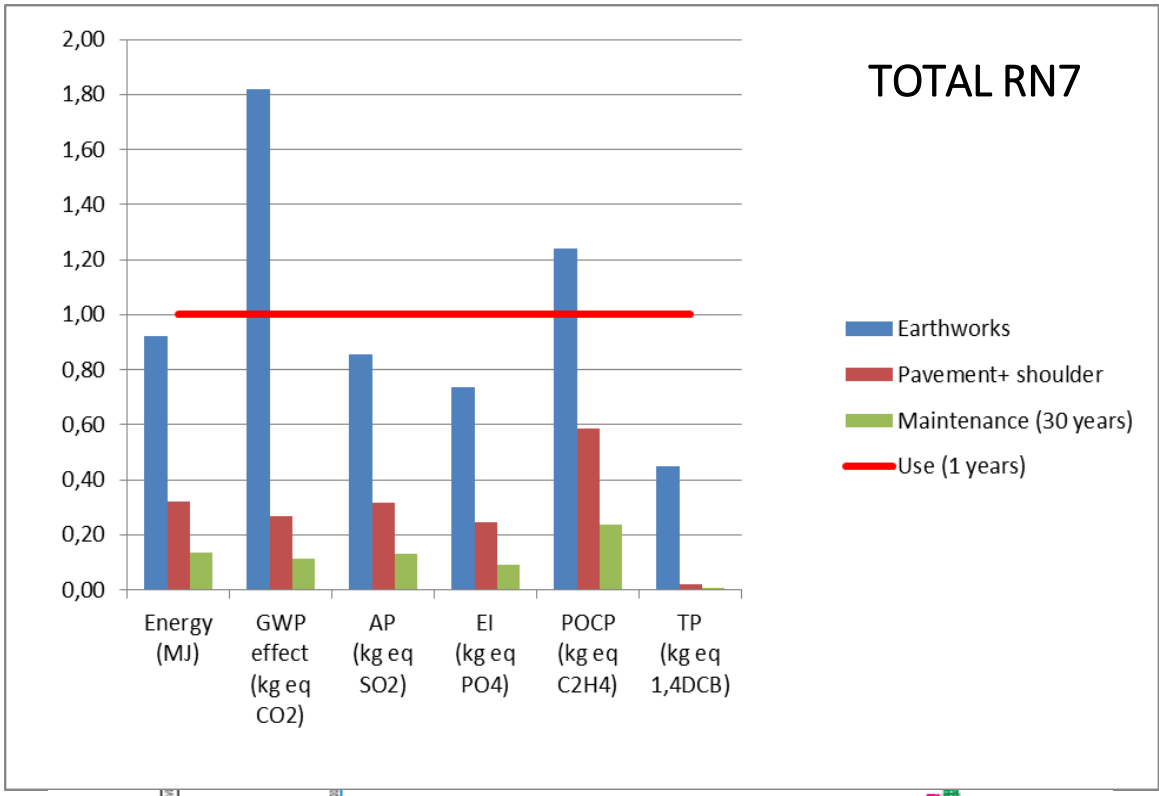
JULLIEN A., DAUVERGNE M., PROUST C., Road LCA: the dedicated ECORCE tool and database, **International Journal of Life Cycle Assessment**, Vol 20, N°5, pp 655-670, may *2015.*

CASE 2 : ROAD CONSTRUCTION and MAINTENANCE

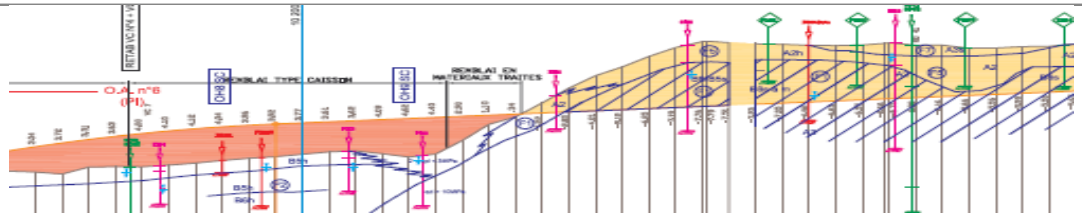
RN7 national road, LCE4ROADS French case study Deliverable 1.4
www.lce4roads.eu

FU: 1km, 30 years, 2 lanes heavy traffic

H	EE (GJ)	GES (t eq CO2)
earthwoks	22 000	3 100
Pavement+ shoulder	7 700	450
Total	29 700	3 550



Roadworks RN7 : 2 x2 lanes (25 km)



EARTHWORKS: CAPONY A, MURESAN B, DAUVERGNE M, AURIOL JC, FERBER V, JULLIEN A., Monitoring and environmental modelling of earthwork impacts – a case study, **Resources Conservation and Recycling**, Vol74, pp124-133, *may 2013.*

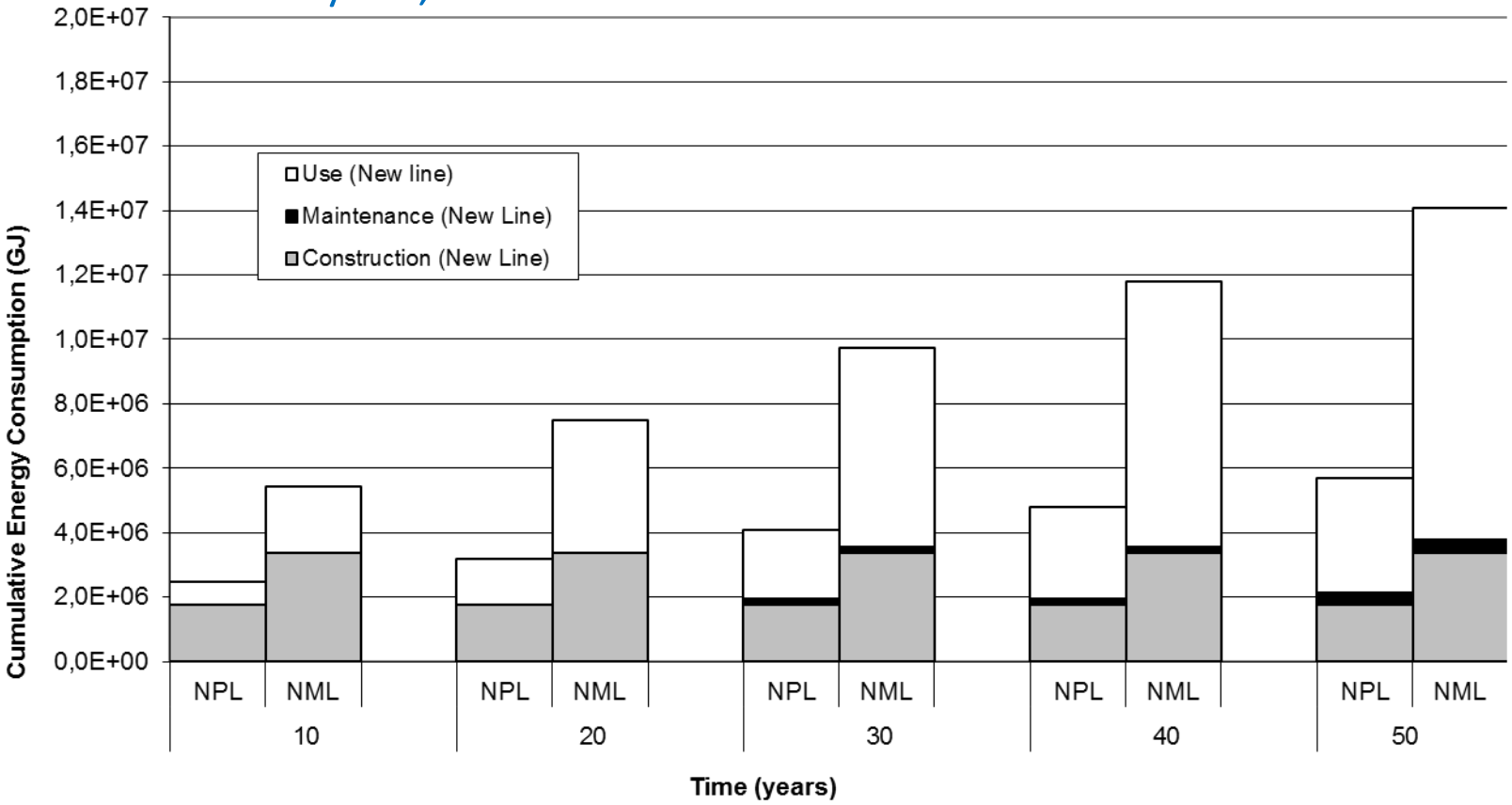
CASE 3 : RAILWAYS/ HSL ROAD CONSTRUCTION ,MAINTENANCE, USE

Variants :Passengers Line (NPL 23 km) Mix line (NML 25 km)

Montpellier-Perpignan/ Corbières

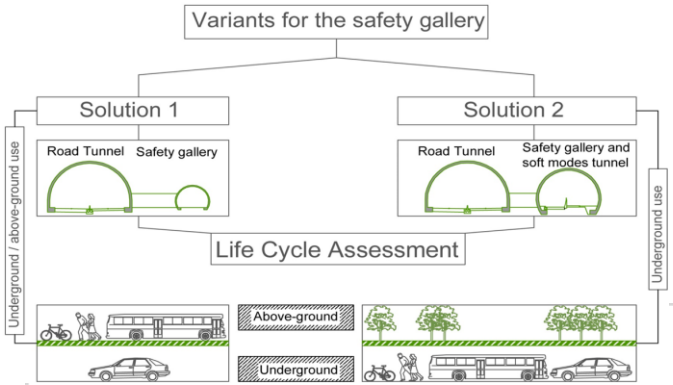
FU: 1km x 2 lanes

50 years, includes 40m of tunnel

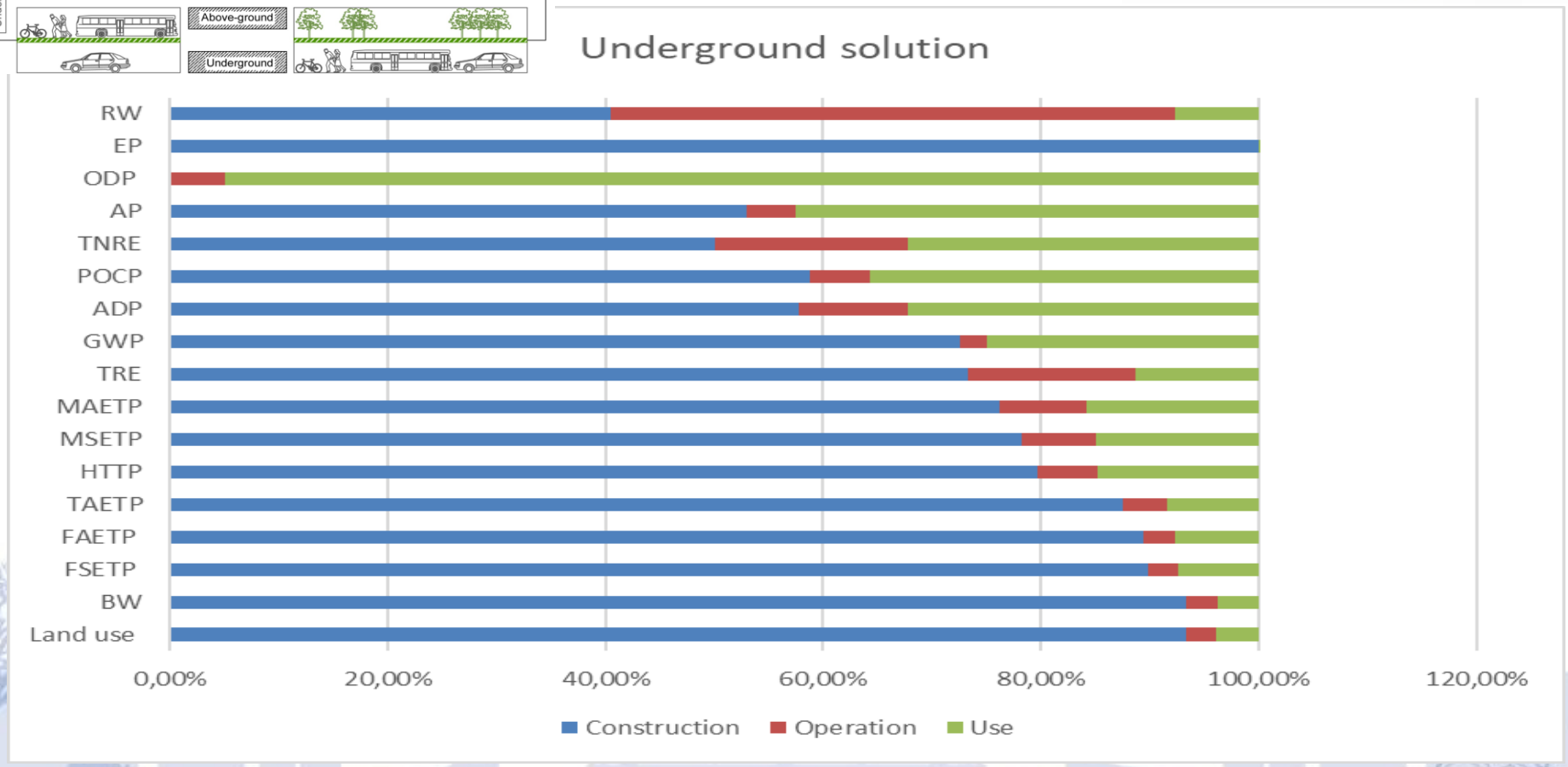


BOSQUET R., JULLIEN A. VANDANJON PO. SANCHEZ F., Eco-design model of a railway: A method for comparing the energy consumption of two project variants, **Transportation Research Part D: Transport and Environment**, 33, 111-124, 2014.

CASE 4 : URBAN TUNNEL –CONSTRUCTION, MAINTENANCE,USE



La croix Rousse Lyon



AUDI Y., JULLIEN A., M.DAUVERGNE, D'ALOIA-SCHWARTZENTRUBER L., FERAILLE A. « Life-Cycle Assessment For Underground Construction –Tunnel Case Study ». IN : SETAC Europ 26th annual meeting, 22-26 MAY 2016, Nantes –France.

European Projects : tools and data base

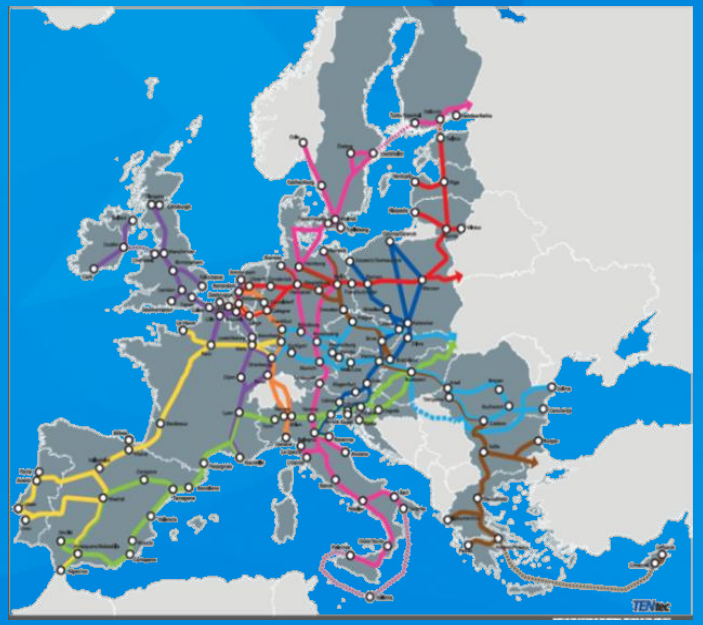
ECOLABEL PROJECT
LCE4ROADS (new name)

FINAL REPORT
https://cordis.europa.eu/project/rcn/110518/reporting/en

- ✓ Certification requirements (both qualitative and quantitative) defined. A support software tool created.
- ✓ Regional peculiarities (energy mix, regulations, etc), considered by the Project methodology

Project website (FP7)
www.lce4roads.eu

- ✓ Made for TENt network and similar roads
- ✓ Light certificate covering a minimum range of requirements.
- ✓ Complete certificate covering the whole range of requirements



validation on case studies 2016

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- ✓ Made for TENt network and similar roads
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LCE4 ROADS

Its ≈ 30 KPIs

LCE4ROADS CERTIFICATE (COMPLETE)

OPERATIONAL PHASE

CERTIFICATE NUMBER: 1

Date: 28.07.2015

ROAD IDENTIFICATION					
Road	Road Name : Gerede-Kızılcahamam Yolu		Traffic and Climate	Annual average daily traffic	4428
	Road Class	State Road		Percentage of heavy vehicle	59
	KKNo	750-06		Annual average frost days	119
	Kilometre	84+860-86+360		Annual average rainy days	104
	Number of traffic lane	2x2	Pavement Layer Thickness, cm	SMA	4
	Pavement width in one direction	11,3 m		Binder	12
	Year of opening to traffic	2011		CIPR Bituminous base	25
				Granular Base	20
				Subbase	20

SUSTAINIBILTY DOMAINS					
ENVIRONMENTAL			SOCIAL		
Material	Virgin aggregate consumption	20736	Safety	Skid resistance	SN_2
	Material suspected to be recycled	50		Traffic accident rate	-
	Low temperature asphalt, %	13951		Safety audits &safety inspections (Directive 2008/96EC)	No
	Energy demand	2,06E+00			
Impact	Global warming (climate change)	1,32E+06		Noise (habitant affection)	-
	Photochemical Ozone Creation (POCP)	3,96E+02		Noise (wild life affection)	-
	Acidification Potential (AP)	9,73E+03		Tire-road contact noise, dBA	96
	Eutrophication Potential (EP)	1,65E+03		IRI, m/km	1,05
	Abiotic Depletion Potential (ADP)	1,79E+04		Ruth depth, mm	4
	Abiotic Depletion – fossil fuel	9,73E+03	Traffic congestion mitigation plan		No
	Toxicity (T)	-	Dust mitigation plan		No
	Ecotoxicity (ET)	-			

TECHNICAL	
Analysis period / Life span, years	36
Number of rehabilitation	2
Maintenance and rehabilitation plan(M&R)	Yes
Pavement effective modulus, MPa	1005
Subgrade modulus, MPa	100
Maximum allowable IRI, m/km	3,5
Minimum allowable skid resistance	0,3
Maximum allowable rut depth, mm	30

ECONOMICAL		
Discount Rate, %		10
Annual Uniform Costs, (x100o €)	Initial Cost	68,6
	Maintenance cost	22,1
	Rehabilitation cost	65,1
	m^2 cost	0,04
	Salvage value	60,9
	User cost and Work zone cost	13076,9
	User cost (due to increase in IRI)	358,4

International cooperation

Sustainability of transport networks assessment : Needs for research considering international cooperation (LCA framework)

Discussed between EU and USA since 2010 (LCA congress)

Topics (topics proposed for H2020 WP18-20 by countries)

- International environmental and interoperable database (LCE, EPD)
- Sustainable assessment of complex infrastructures networks
- Development of solutions for production of renewable energy by transport infrastructures

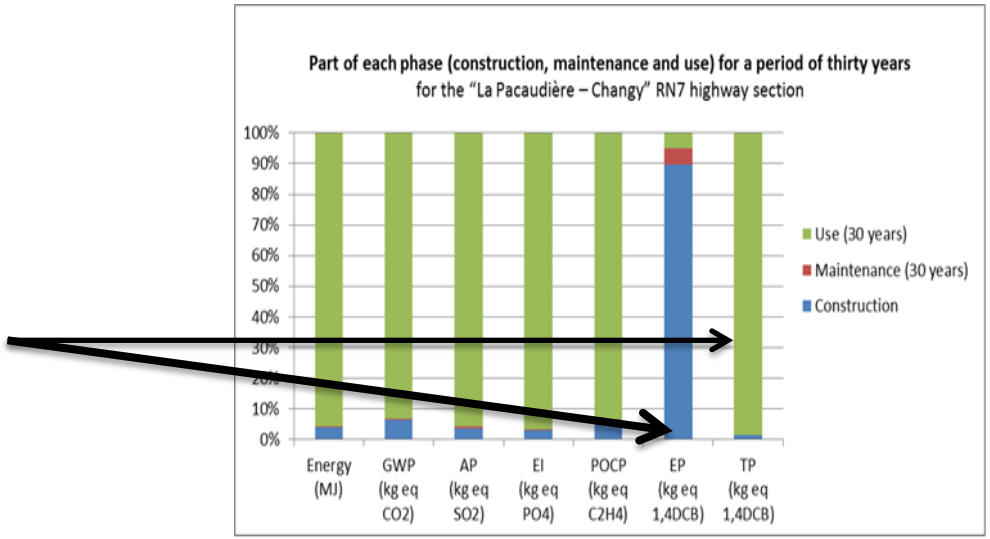
Horizon :The trends…

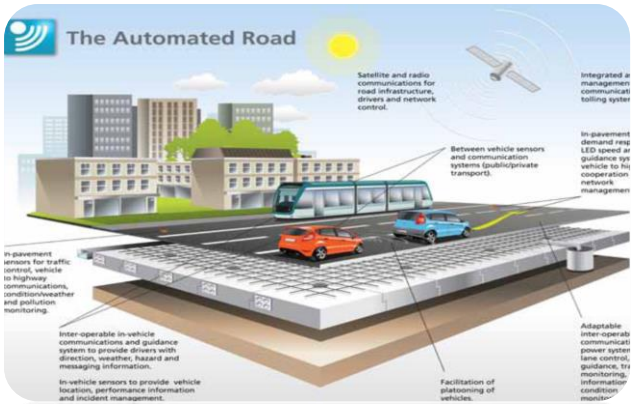
(D1.4 RN7 road, LCE4ROADS French case study)

Today: contribution phases

Use phase >>

Construction, Maintenance





Tomorrow : changes in the transport sub-system

LCA and certification of complex constructions?

Use phase with electric vehicles, autonomous vehicles ?

New roads equipement, materials incl. sensors, multifunctional pavements?