AV '17 KONFERENCE ASFALTOVÉ VOZOVKY 2017

Improved environmental footprint & road durability using hydrated lime in hot mix asphalt (HMA)

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Motto: Asfaltové vozovky – bezpečná cesta k prosperitě

SDRUŽENÍ PRO VÝSTAVBU SILNIC

ČESKÁ SILNIČNÍ SPOLEČNOST CZECH ROAD SOCIETY

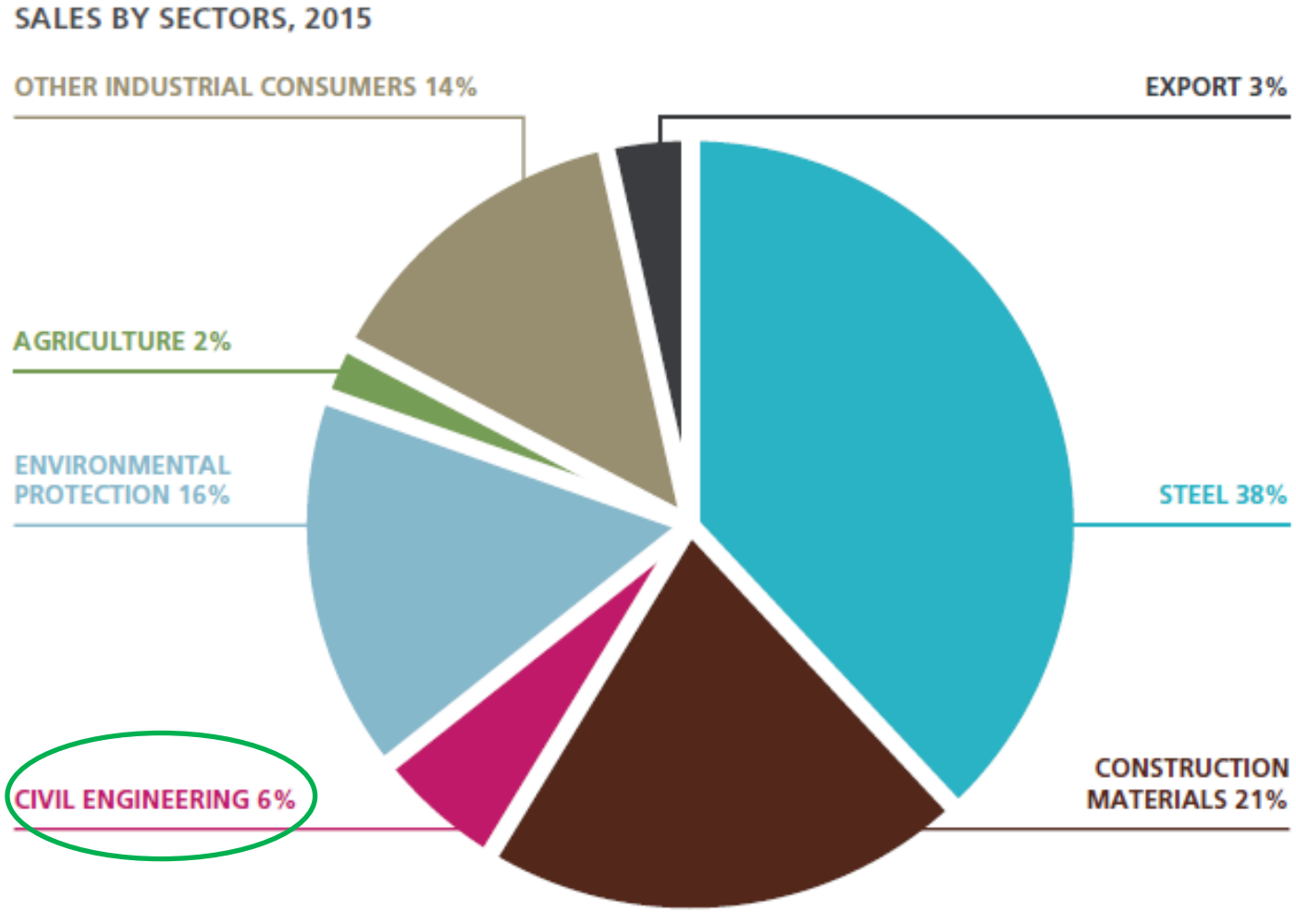
EAPA

PRAGOPROJEKT

Presentation Layout

- Lime uses/markets
- HMA LCA: Goal & Scope
- HMA LCA: System Boundaries
- HMA LCA: Functional unit
- HMA LCA: Assumptions
- HMA LCA: Results
- Conclusions
- Questions?

Lime main uses by market



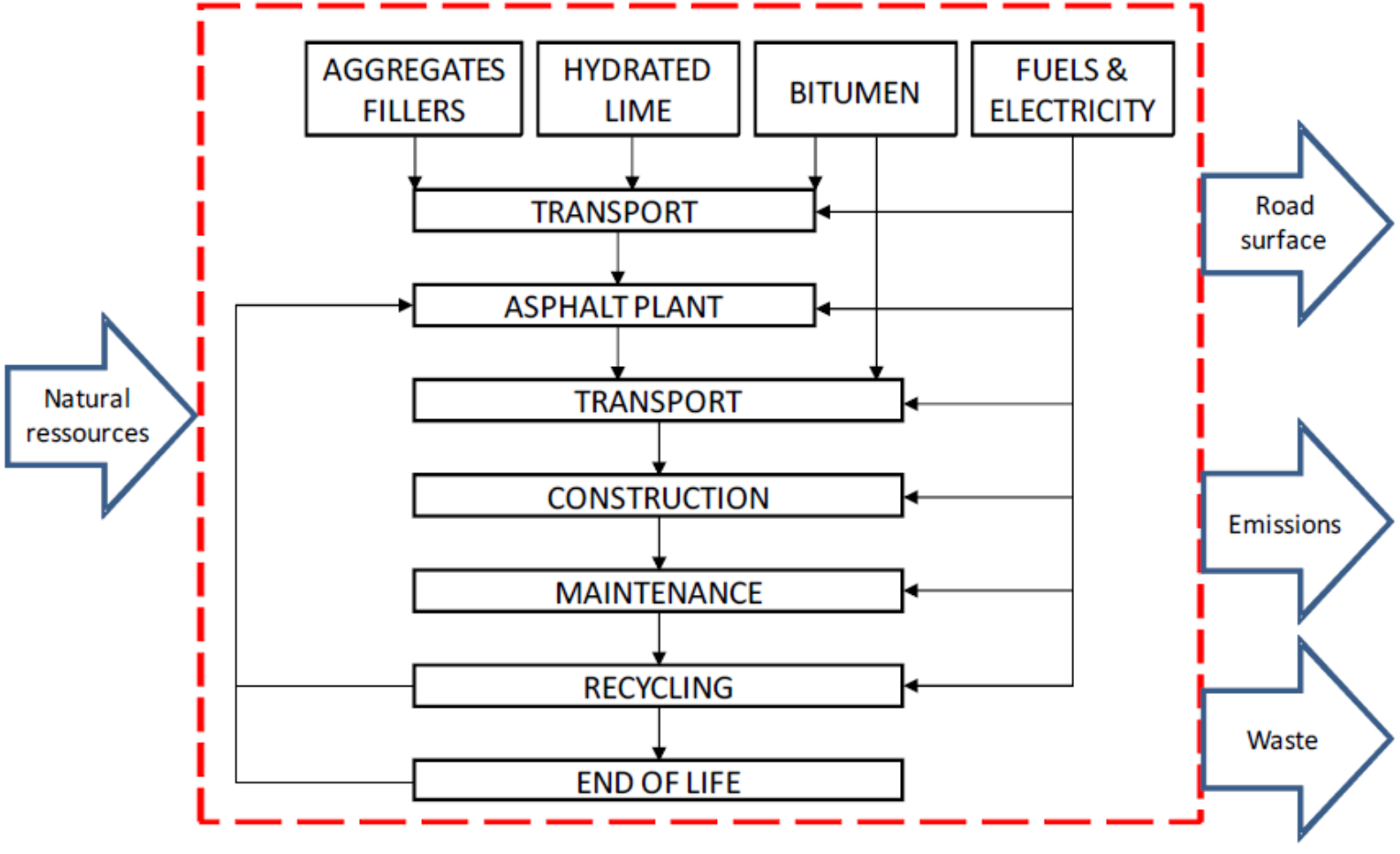
HMA LCA: Goal & Scope

To compare the environmental performances of Hot Mix Asphalt (HMA) used for the top asphalt layer with or without addition of hydrated lime The LCA study to be compliant with ISO 14040-14044 standard

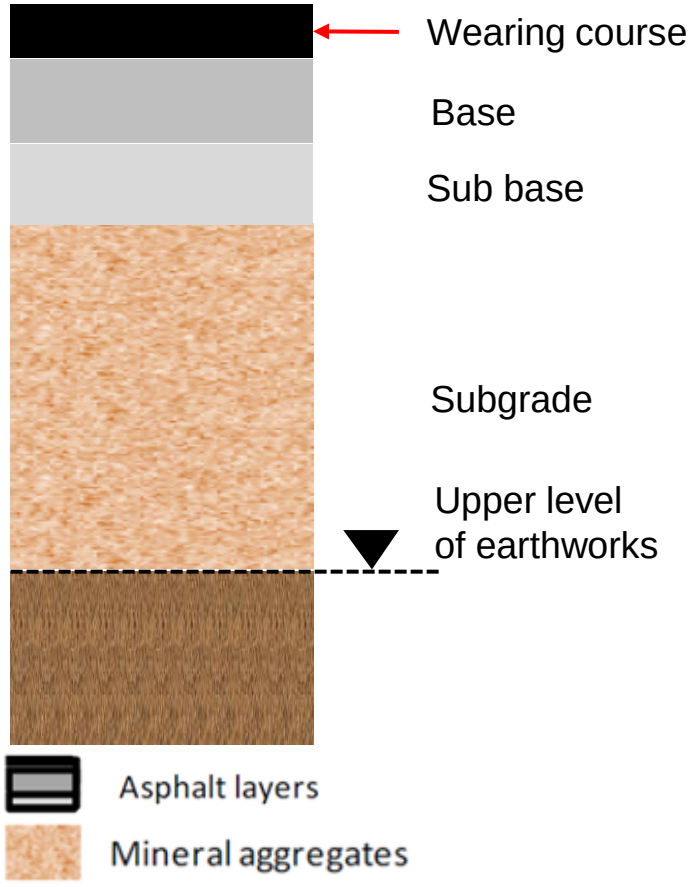
	Classical HMA (without lime addition)	Modified HMA (with lime addition)
Bitumen	5%	5%
Sand	38%	38%
Fine gravel	26%	26%
Coarse gravel	29%	29%
Filler	2%	0.5%
Hydrated lime	0%	1.5%

HMA LCA: System Boundaries

Cradle (extraction) to end of life (road)



HMA LCA: Functional unit

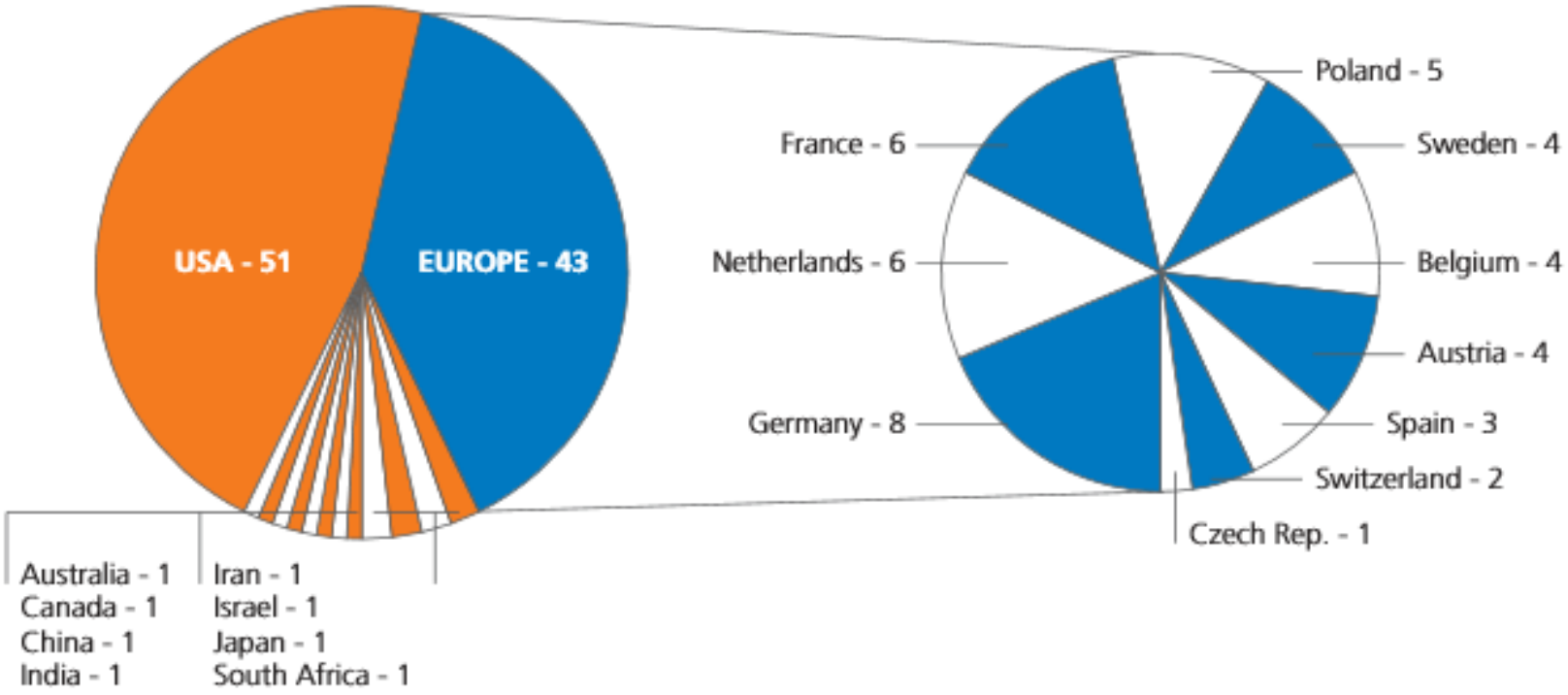


- HMA **Wearing course 8 cm**
- **One kilometre** French lane of road surface
- **Width of 3.5 meters** (representing a road surface of 3 500 m2)
- **Life span: 50 years** (corresponding for the whole road)
- **Construction practice & maintenance scenario** similar to published LCA study* (Bilal et al., 2009)

Ref: *Bilal, J., Grosshenny, V., Lecouls, H., Le Noan, C., Marcilloux, J., Quéro, J.-F., Verhée, F., 2009. Caractéristiques environnementales des matériaux routiers –Rectitatif – analyse de Cycle de Vie des enrobés bitumineux: vers un amendement Matériaux routiers à la norme NF P01 010, Union des Syndicats de l'Industrie Routière Française (USIRF) – French Trade Association of road contractors. Rev. Gén. Routes Aérodromes 872 (in French).

Hydrated lime in literature (1)

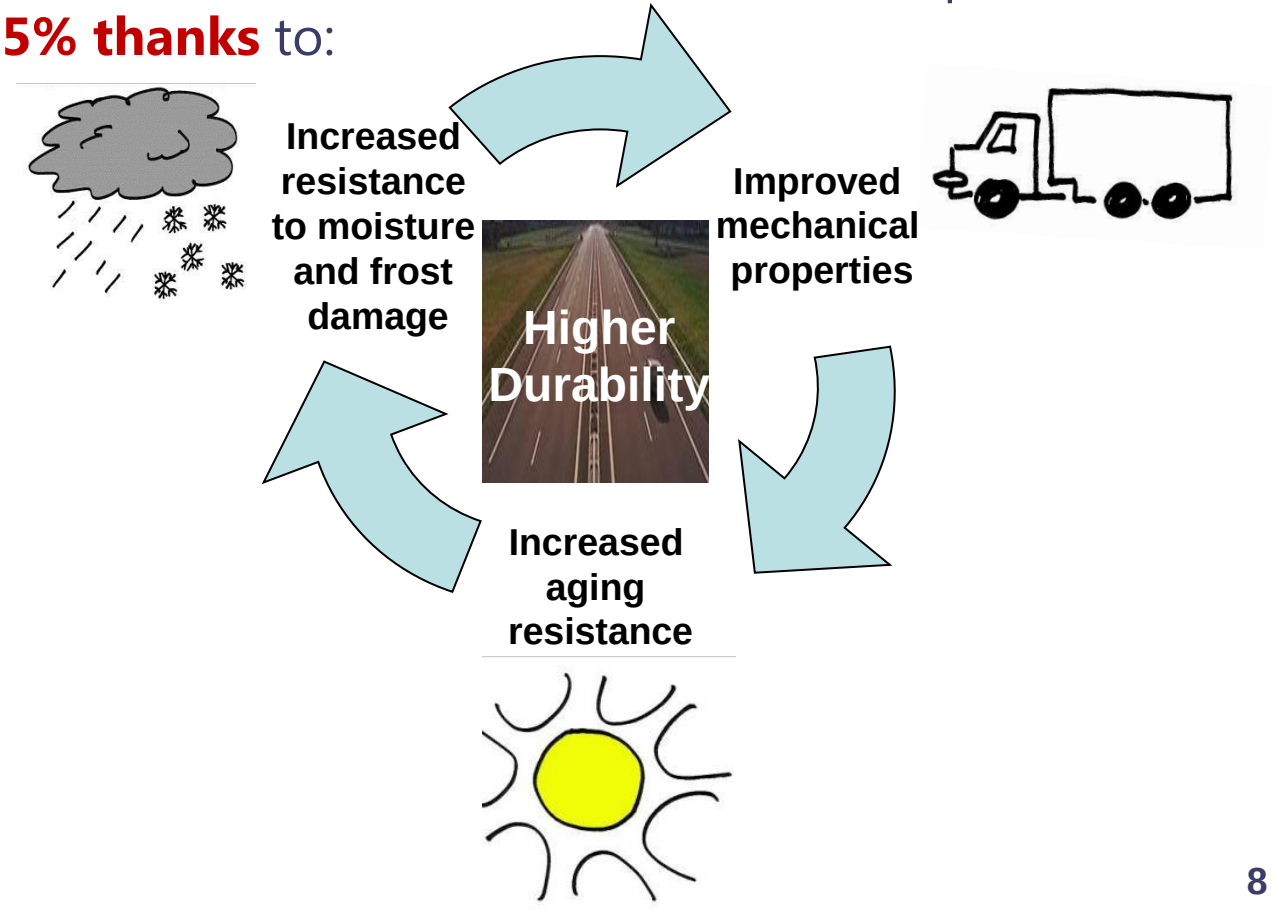
110 publications (reports, peer-review)*.
Origin of first author for the publications shown in the graph below



*Ref: *EuLA critical literature review: Hydrated lime, a proven additive for durable asphalt pavements; source: www.eula.eu*

Hydrated lime in literature (2)

More than 100 technical papers revised*. Based on science and testimonies from users Hydrated lime is a multifunctional additive that **increases** asphalt mixture **durability with 25% thanks** to:



*Ref: * EuLA critical literature review: Hydrated lime, a proven additive for durable asphalt pavements, source: www.eula.eu*

Hydrated lime use in EU

Country	Level of experience	Start	[Lime treated HMA] vs [total HMA] (estimate %)	% hydrate in HMA	Form	Objective	Applications
Austria	Voluntary	2003	1	1.5 to 3.5	Pure	Stripping, rutting	AC, SMA, PA
Belgium	From compulsory to voluntary	80's	< 1	1.5	Mixed filler	Stripping	SMA, PA (asphalt rubber)
Czech Republic	Tests	1996	< 1	1.5	Pure	Stripping, rutting	AC, PA (asphalt rubber)
Denmark	Voluntary	Mid 90's	< 1	1 to 1.5	Pure	Stripping	AC
Finland	Voluntary	?	< 1	1 to 2	Pure or MF	Stripping, aging, other	AC, SMA, CMA
France	Voluntary	? (> 1945)	1	1 to 1.5	Pure or MF	Stripping, aging, other	AC, CMA, PA, PA (asphalt rubber), BBTM
Germany	Voluntary	2000	< 1	1 to 3	Pure or MF	Stripping, aging	AC, SMA
Hungary	Tests	2009	< 1	2	To be defined	Stripping, rutting	AC
Ireland	Voluntary	2001	< 1	2	Pure	Stripping, rutting	PA
Italy	Voluntary	Mid 90's	< 1	1 to 2	MF	Stripping	SMA, PA
The Netherlands	Compulsory	Mid 90's	7	2	MF	Stripping, Aging, Durability	PA
Poland	Voluntary	1998	< 1	1 to 3	MF	Stripping	AC
Portugal	Voluntary	Beginning 2000's	< 1	1 to 2	Pure	Stripping	PA (asphalt rubber)
Sweden	Voluntary/ compulsory	1998	< 1	1	Pure	Stripping, aging	AC
Switzerland	Preferred	2006	1	1.5	Pure	Stripping, aging, durability	PA, AC, SMA,
Romania	Tests	2007	< 1	2	MF	Stripping, rutting	AC, SMA
Spain	Voluntary	2004	< 1	1 to 2	Pure	Stripping	SMA
Slovakia	Tests	2009	< 1	2	Pure or MF	Stripping	
UK	Voluntary	Early 00's	1	1 to 2	Pure	Stripping	AC

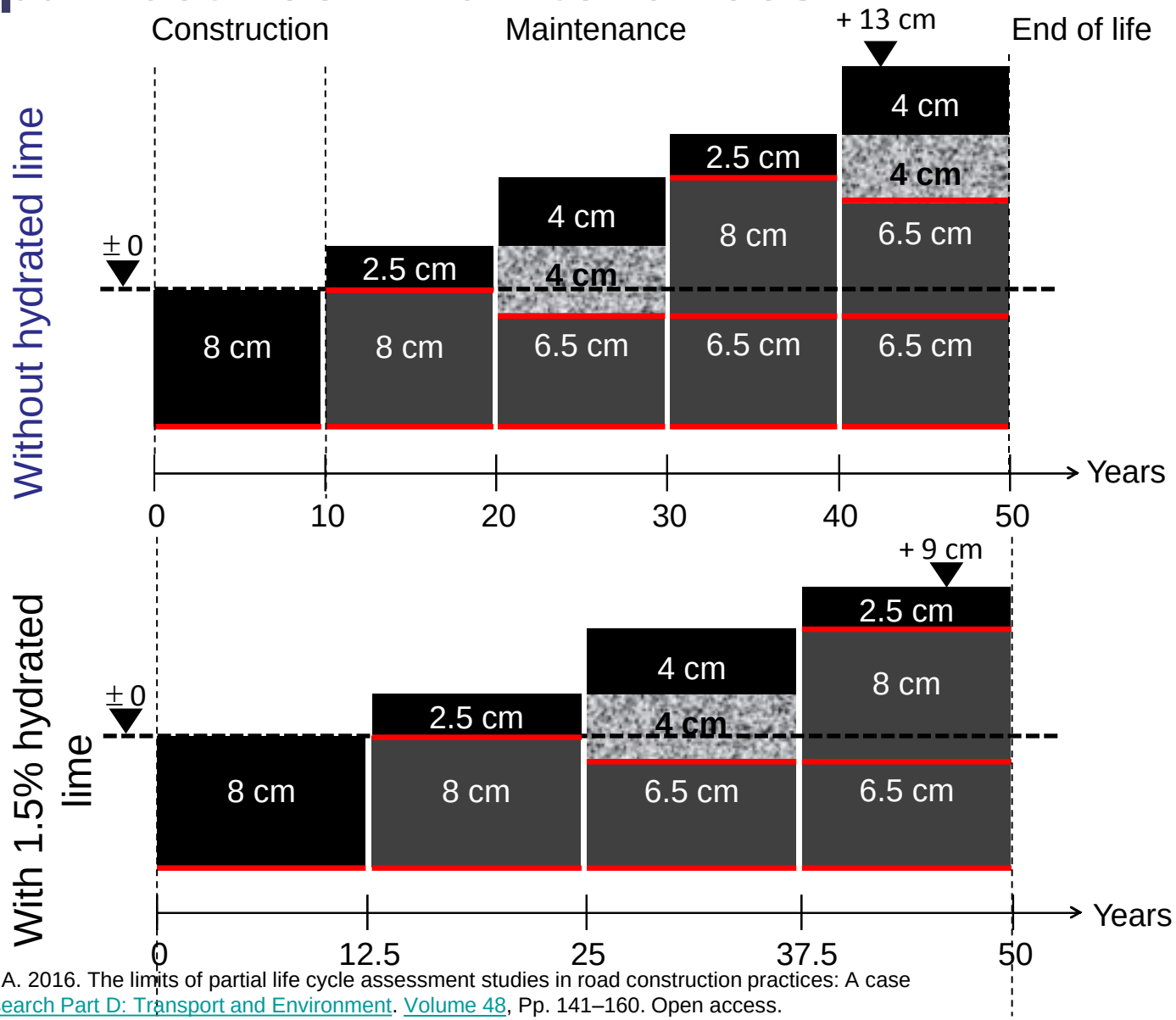
AC: Asphalt Concrete ; SMA: Stone Mastic Asphalt ; PA: Porous Ashaslt ; CMA: Cold Mix Asphalt ; BBTM: Very Thin Asphalt Layer ; MF: Mixed Filler

Ref: EuLA critical literature review: Hydrated lime, a proven additive for durable asphalt pavements, source: www.eula.eu*

HMA LCA: Life span between maintenances*

Classical HMA has a life span of the surface layer of **10y**

Modified HMA (+1.5% lime) has a life span of **12.5y** due to the increases the life span by 25%



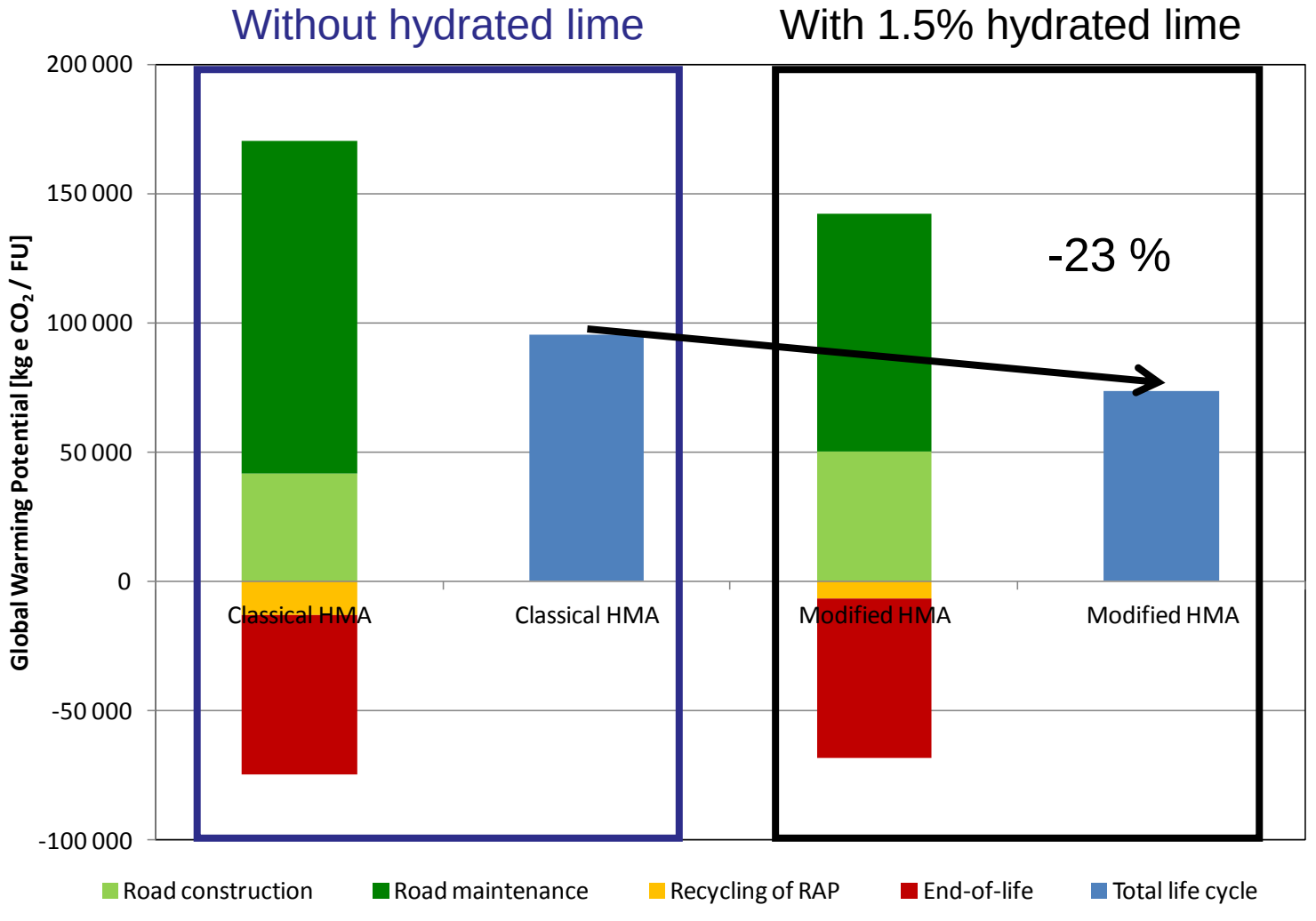
Ref: *Schlegel T., Puiatti D., Ritter H.-J., Lesueur D., Denayer C., Shtiza A. 2016. The limits of partial life cycle assessment studies in road construction practices: A case study on the use of hydrated lime in Hot Mix Asphalt. Transportation Research Part D: Transport and Environment. Volume 48, Pp. 141–160. Open access.

HMA LCA: Other assumptions

Following assumptions are made for the:

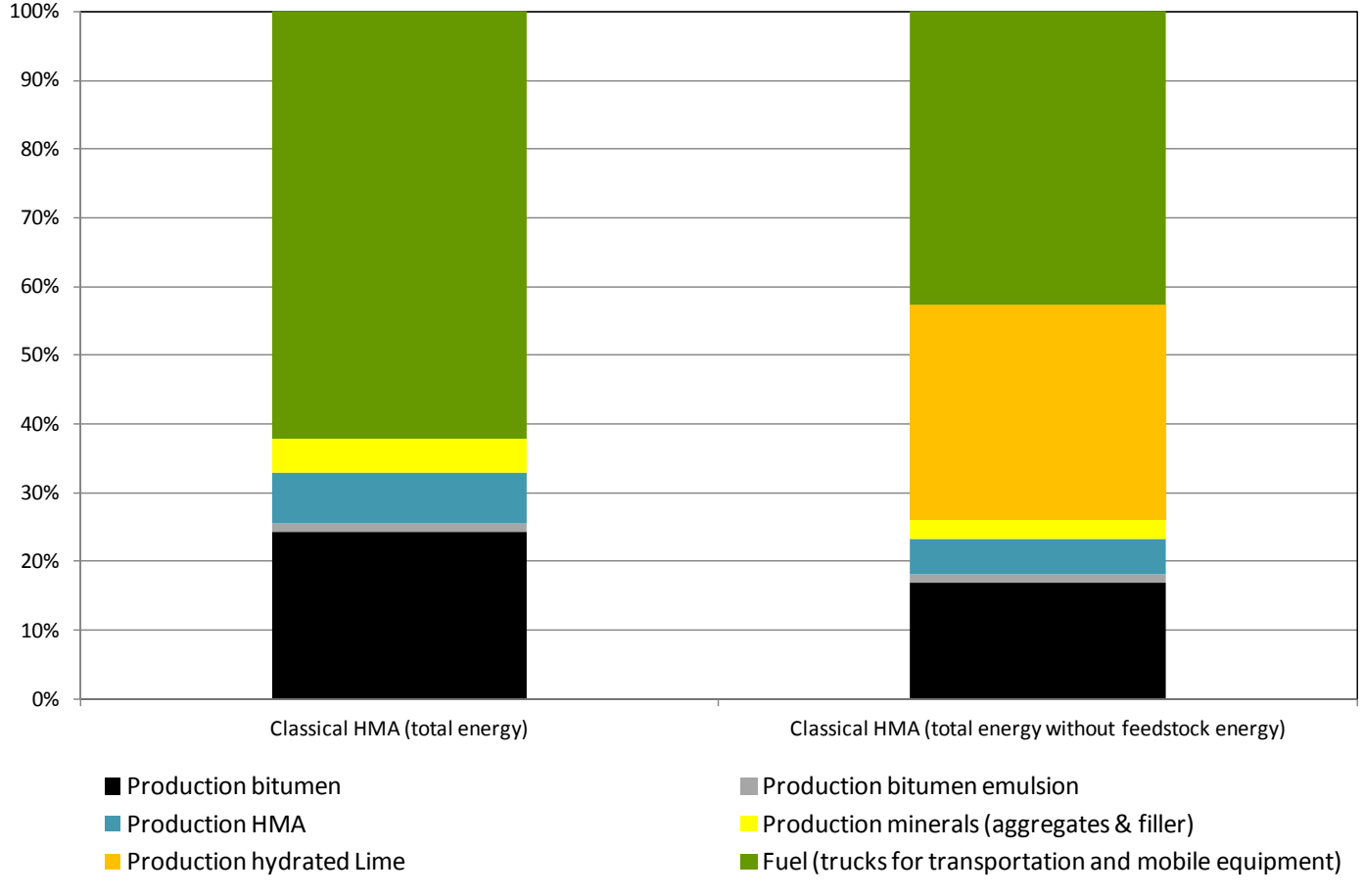
1. Recycling of the Reclaimed Asphalt Pavement (RAP):
   - 50% of the RAP reused for the production of new HMA (replacement of virgin bitumen, sand, gravel and filler)
   - 50% of the RAP reused as sand / gravel for external uses (substitute to sand / gravel)
2. End-of-life of the road (50 years):
   - The asphalt layers will not be removed
   - The surface layers do replace the sub base layer of the future new road.

HMA LCA: Results of Global Warming Potential (CO_2)



HMA LCA: Results of contribution analysis

Global Warming Potential



HMA LCA: Sensitivity Analysis

1. Use another LCI dataset for the production of bitumen in order to investigate the impact of lower energy consumptions

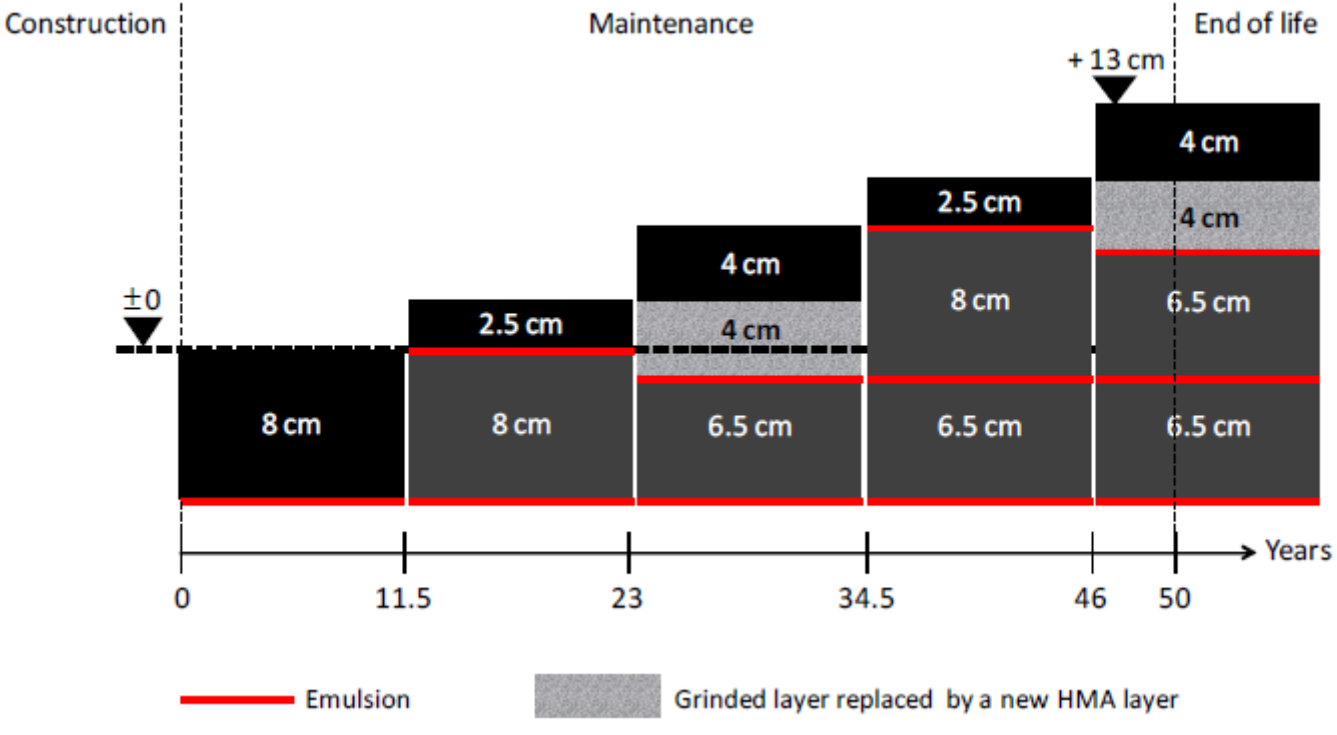
2. Change energy consumption and type of fuels used in the HMA plant as this process represents an important contributor

3. Modify transport distances of the aggregates & sands

4. Shorter or longer intervals for the maintenance of the modified HMA
   - Base case: 25%
   - Shorter: 15%
   - Longer: 35%

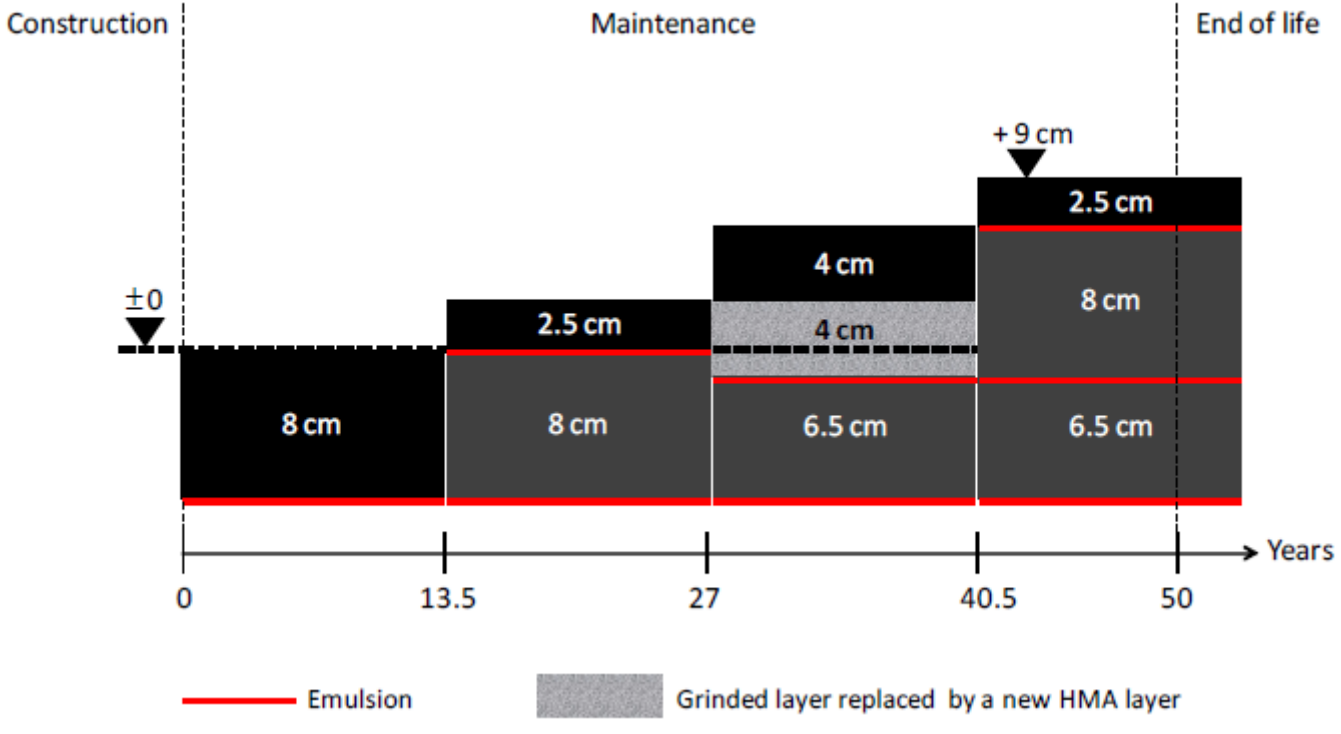
Sensitivity analysis: Maintenance scenario shorter

Maintenance scenario of wearing course of modified HMA with an increase in the life time **of 15% instead of 25%**



Sensitivity analysis: Maintenance scenario longer

Maintenance scenario of wearing course of modified HMA with an increase in the life time **of 35% instead of 25%**



HMA LCA: Conclusions

The key outcome of this LCA study is that for the full life cycle of a road (construction + maintenance stages) the use of modified HMA (i.e. with 1.5% lime) in the wearing course has clearly the lower **environmental footprint (-23%)** for the main environmental impact categories:

- energy consumption (with & without inclusion of the feedstock energy of bitumen);
- climate change;
- abiotic depletion;
- air acidification, photochemical oxidant formation;
- stratospheric ozone depletion & and
- eutrophication

Thanks to the **longer durability** of the modified HMA (hydrated lime), less maintenance operations will **result in less traffic jams**. This would **lower the energy consumption** and the emissions and should therefore give a **positive impact on the societal impacts** as well.

The LCA report and the associated data have undergone an **external critical review** by TNO that has **validated the methodology and the findings**.

Questions?

More information:

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References:

- Bilal, J., Grosshenny, V., Lecouls, H., Le Noan, C., Marcilloux, J., Quéro, J.-F., Verhée, F., 2009. Caractéristiques environnementales des matériaux routiers –Rectitatif – analyse de Cycle de Vie des enrobés bitumineux: vers un amendement Matériaux routiers à la norme NF P01 010, Union des Syndicats de l'Industrie Routière Française (USIRF) – French Trade Association of road contractors. Rev. Gén. Routes Aérodromes 872 (in French).

- Lesueur, D., 2011. Hydrated Lime: A Proven Additive for Durable Asphalt Pavements – Critical Literature Review. European Lime Association (EuLA) Ed., Brussels. Pp. 1–81. Available in EN, FR, DE and PL from http://www.eula.eu

- Schlegel T., Puiatti D., Ritter H.-J., Lesueur D., Denayer C., Shtiza A. 2016. The limits of partial life cycle assessment studies in road construction practices: A case study on the use of hydrated lime in Hot Mix Asphalt. Transportation Research Part D: Transport and Environment. Volume 48, Pp. 141–160. Open access.