CEDR Transnational Road Research Programme Call 2012: Recycling: Road construction in a post-fossil fuel society

funded by Denmark, Finland, Germany, Ireland, Netherlands and Norway





Towards a sustainable 100% recycling of reclaimed asphalt in road pavements

Dr. Davide Lo Presti

Senior Research Fellow

@ Nottingham Transportation Engineering Centre,
University of Nottingham









Introduction



Nottingham Transportation Engineering Centre (NTEC)

Application Sectors

Research Themes

Road Rail Air

Materials

Design & Performance

Asset Management

Operational Risk & Reliability

Sustainability & the Environment

Head: Prof. Gordon Airey

9 academics

5 Post-docs

about 35 PhD students

7 technicians

www.nottingham.ac.uk/ntec





Introduction



EXPERTISE

- Materials
- Design and Performance
- Sustainability and Asset management

Road Pavements
Railway tracks
Civil Engineering









RESEARCH PROJECTS AND GRANTS

- 2014 2015 HERMES fellowship €25k Rheology of complex fluids (PI)
- o 2013 2017 EU FP7 Marie Curie SUP&R ITN' €4M (main author, PM and CI)
- o 2013 2015 EU CEDR 'ALLBACK2PAVE' €460k (co-author and CI)
- 2013 2015 UK Knowledge Transfer Partnership £147k (PI)
- o 2012: UoN "Bridging the Gaps" £10k (PI)

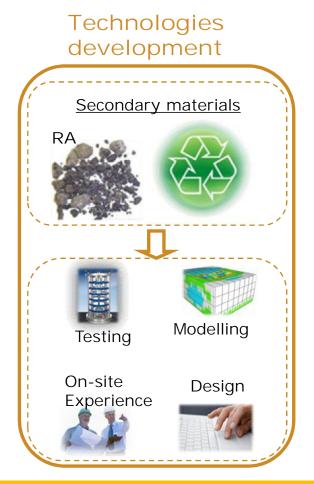




Vision



Sustainable development of transport infrastructures









- Sustainability metrics
- Performance based evaluation
- Life Cycle Assessment (LCA)
- Life Cycle Cost Analysis (LCCA)

Sustainability Assessment





Introduction















Partner 1 - Coordinator

Prof. Frohmut Wellner Anita Blasl

Technical University Dresden (TUD)

Institute of Urban and Pavement Engineering Faculty of Civil Engineering

Frohmut.Wellner@tu-dresden.de
Anita.BlasI@tu-dresden.de

Partner 2

Dr. Davide Lo Presti Prof. Gordon Airey Dr. Tony Parry

University of Nottingham (UNOTT)

Nottingham Transportation Engineering Centre Faculty of Engineering

Gordon.Airey @nottingham.ac.uk Davide.LoPresti @nottingham.ac.uk Tony.Parry @nottingham.ac.uk Partner 3

Dr. Gaetano Di Mino Maurizio Di Liberto Dr. Silvia Noto

University of Palermo (UNIPA)

Department of Civil Engineering Faculty of Engineering

Gaetano.Dimino@unipa.it











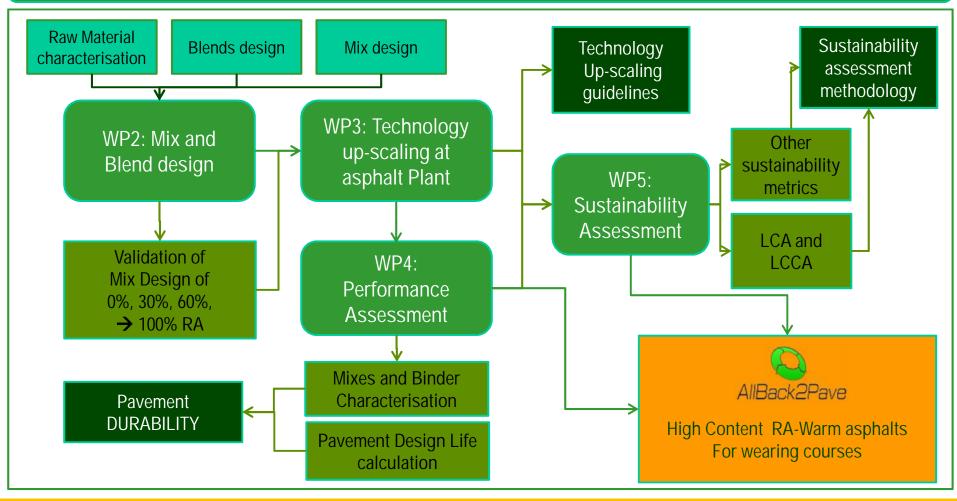




Introduction



WP1: Coordination, Management, Advisory board and Dissemination







Outline



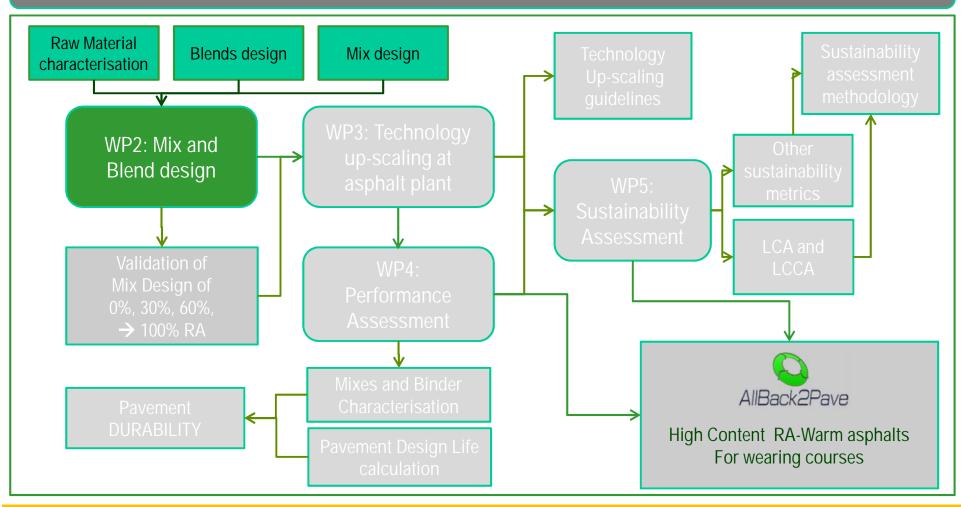
- Introduction
- WP2 High-content RA Warm asphalt mixes designs
- WP3 Technology Up-scaling at asphalt plant
- WP4 Performance assessment
- WP5 Sustainability assessment
- What's Now, What's Next







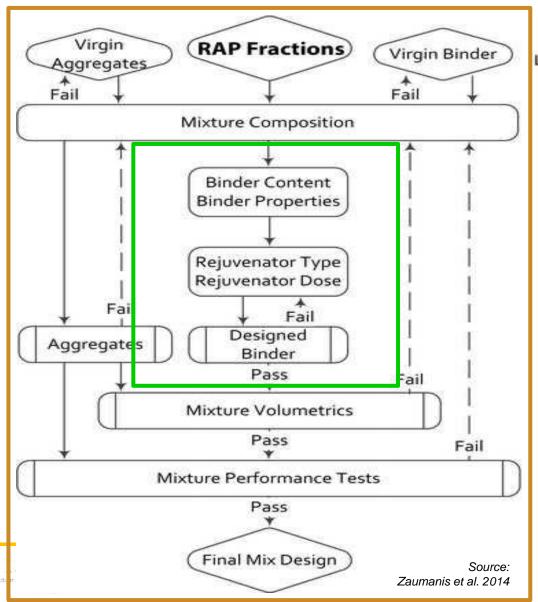
WP1: Coordination, Management, Advisory board and Dissemination



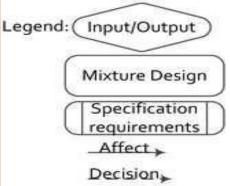








FIRM



BINDER'S DESIGN



Blending charts



Inputs for mix design

MIX DESIGN

2 asphalt wearing courses:

- German SMA
- Italian AC





- GERMAN asphalt wearing course
 - o Target asphalt mix: SMA 8S PmB 25/55-55
 - Grading curve -> 70 RA% maximum amount
 - 30% RA, 60% RA, 60% RA + Additives
- ITALIAN asphalt wearing course
 - Target asphalt mix: AC 16 Pen 50/70
 - Grading curve > 70-90 RA% maximum amount
 - 30% RA + Additives, 60% RA + Additives, 90% RA + Additives

GERMAN APPROACH:

- Use available RA (not so aged) and perform the design with and without rejuvenator
- Rejuvanatour:
 - o *virgin PmB 25/55-55*
 - partly rejuvenator + warm mix additive (mix)

ITALIAN APPROACH:

- Use available RA (very aged) and perform the design <u>with rejuvenator</u>
- Rejuvanatours:
 - o virgin bitumen 50/70
 - rejuvenator + warm mix additive (mix)





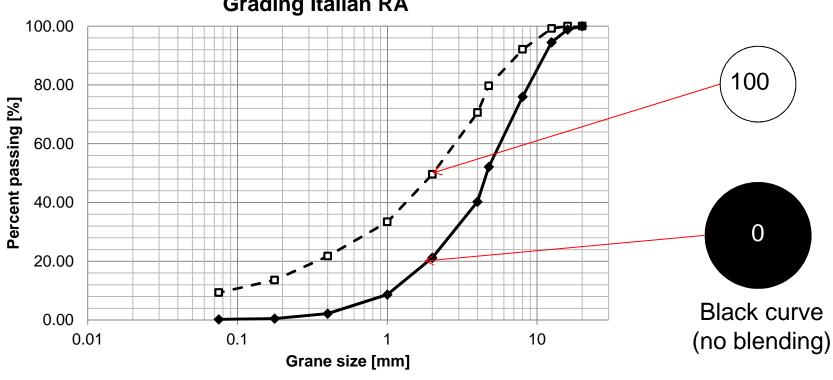


Partial blending concept

Grading Italian RA

- □ White curve

White curve (full blending)

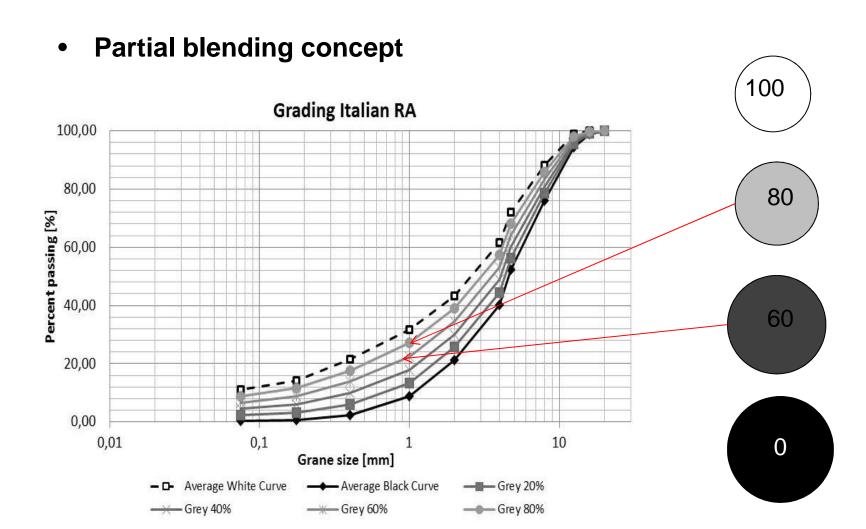






→ Black curve







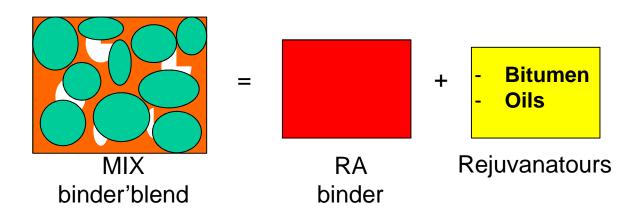




%RVB = Replaced Virgin Binder

This can be estimated by knowing the RA binder content, targeting the asphalt mix binder content and making an assumption on the extent of binder released from the RA during the asphalt mixing.

%RVB = %RAb mass */MIX binder mass





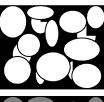




• %RVB = Replaced Virgin Binder

- Binder content X ± 0.2%
- Blending rate 100% 60%
- Rejuvanatours oils included in %RVB

%RA	Blending	%Binder	%RVB
30%	White 100%	7%	21.25
		7.20%	20,70
		7.40%	20.18
	Grey 80%	7%	17.00
		7.20%	16.56
		7.40%	16.14
	Grey 60%	7%	12.75
		7.20%	12.42
		7.40%	12.11











grey 60





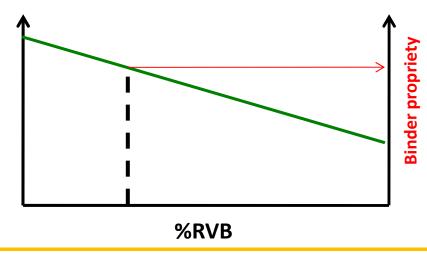


Blending charts

EU a log(pen_1) +b log(pen_2)=(a+b) *log(pen_mix)
$$T_{(SP mix)}=a T_{(SP 1)}+b T_{(SP 2)}$$

USA Tblend = TRAP*%RAP + TVB*%VB

Virgin binder property



(Rejuvanatued)
RA binders property







Binder's blend design

- Partial blending concept
- Replaced Virgin Binder concept
- EU blending charts
- USA blending charts



Inputs for mix design



Conventional properties blend design results for binder with RejA and RejB with limits indicating 100% and 60% blending

%RA in	Final properties of blend with RejA		Final properties of blend with RejB	
the	Penetration	Softening Point	Penetration	Softening Point
mixture	(25°C)	(^{0}C)	(25°C)	(°C)
	(d mm)		(d mm)	
30%RA	71.0	50.5	73.7	50.2
	73.9	53.3	79.5	52.6
60%RA	70.4	53.4	79.8	52.7
	80.3	59.0	92.9	57.5
70%RA	77.3	56.4	86.5	55.2
	87.2	64.7	108.7	62.5
target	50-70	<u>></u> 54	50-70	<u>></u> 54





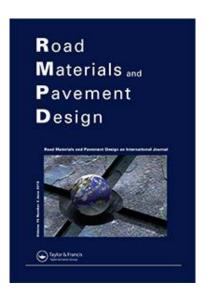




WP2 Deliverable

http://allback2pave.fehrl.org

D2.1 High-content RA Warm asphalt mixes designs (available)



Jiménez del Barco Carrión, D. Lo Presti & G.D. Airey "Binder design of high RAP content hot and warm asphalt mixture wearing courses"

50 free copies available from TODAY!!!!





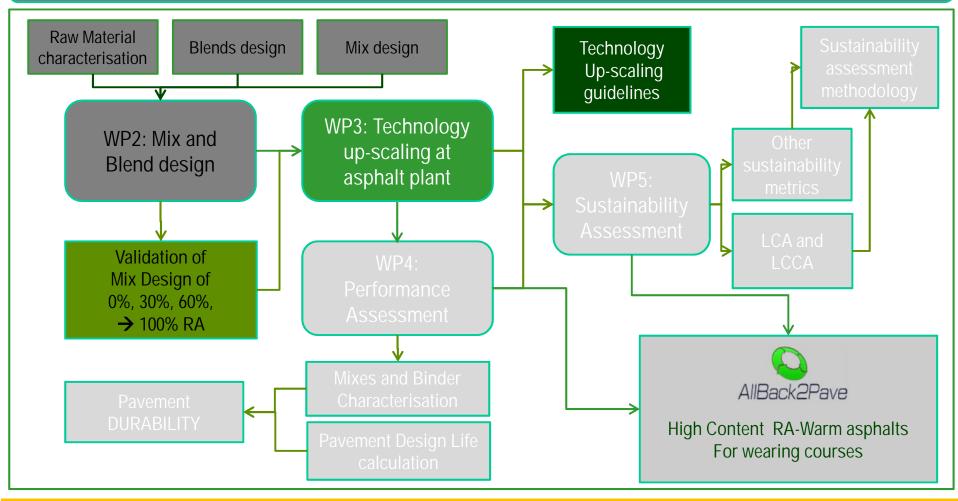




WP3 – Technology upsacling



WP1: Coordination, Management, Advisory board and Dissemination







WP3 – Technology upscaling



Laboratory mix design

Based on Marshall method (Germany) and to Super Pave method (Italy)

Plant manufacturing

Batch plants with parallel drum to preheat RA

8 mixes between Germany and Italy – up to 90% RA

Use of Rejuvenators and Warm Mix additives (mix) Cold virgin aggregates Cold RA Virgin Bitumen Additives Stockpiles of virgin aggregates Cold Feeders Aggregates heating drum Fibre silo Aggregate elevator Filler silo Screen / Fractioning Aggregate scale Parallel heating drum for RA Bitumen tank RA elevator 11 12 RA screen Stockpiles of RA Mixer Additive addition 16 Hot mix storage silo

WP3 – Technology upscaling





WP3 Deliverables

http://allback2pave.fehrl.org

D3.1 AllBack2Pave Technology Up-Scaling Guidelines (TUGs) (04/2015)

- a list of issues related to the plant manufacturing process
- a list of suggestions related to the compaction and laying of the asphalt mixtures on site
- network planning techniques will be used to optimise the implementation process in further full-scale trials
- Final mix-design procedures

The TUGs will also include:

Suggestions to drive the technician toward the most reliable production, so to minimize the gaps between laboratory mix-design and the full-scale production.

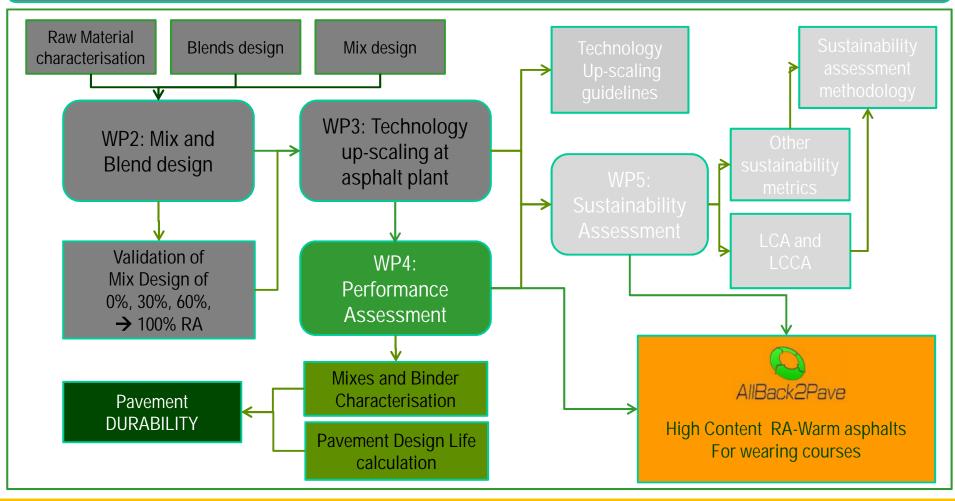




WP4 - Performance prediction



WP1: Coordination, Management, Advisory board and Dissemination







WP4 – Performance prediction





Stiffness behaviour

(indirect tensile test, four point bending beam test) EN 12697-26



Fatigue resistance

(indirect tensile test, four point bending beam test) EN 12697-24



Moisture damage resistance

(indirect tensile test) EN 12697-23/12



Rutting resistance

(wheel tracking test, cyclic compression tests) EN 12697-22/ EN 12697-25

• **Binders properties** characterisation (rutting related tests: Multiple Stress Creep recovery test; fatigue related tests: Time Sweep test)





WP4 – Performance prediction





WP4 Deliverables

http://allback2pave.fehrl.org

D4.1 - Mixes and Binders' properties charactersation (07/2015)

 To perform a wide mechanical characterisation of the designed mixtures in order to predict the performances of each asphalt mixtures

D4.2 - Pavement life prediction (07/2015)

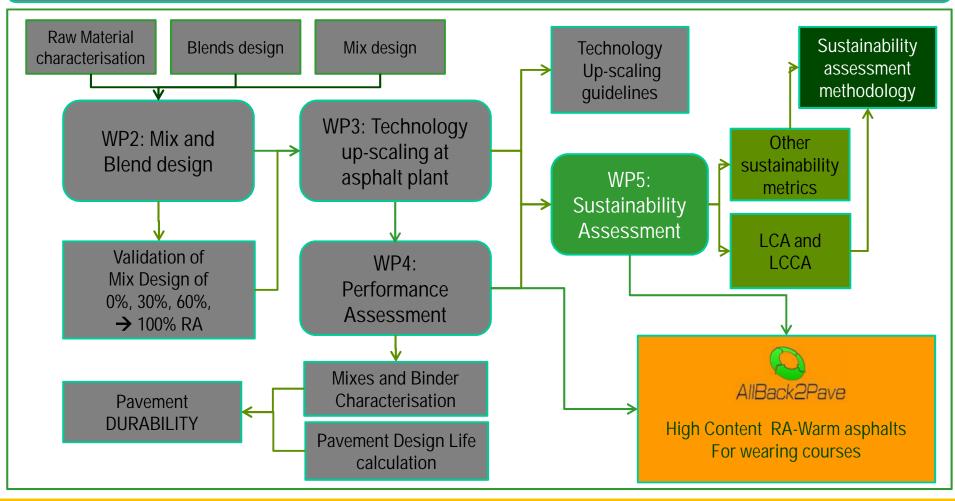
• To predict the fatigue and rutting susceptibility of typical German, British and Italian asphalt pavements with different amounts of RA used in wearing course – for low and high traffic conditions. (DURABILITY)







WP1: Coordination, Management, Advisory board and Dissemination

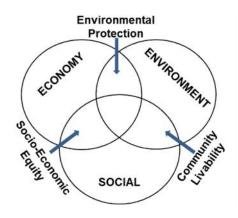








Measuring Sustainability of Road Pavements



- Mechanical Performance prediction WP4
- •The environmental performance of road pavement is generally assessed using life cycle assessment (LCA) tools
- •The economic aspect is conducted using life cycle cost analysis (LCCA) or Life Cycle Cost (LCC) tools
- The metrics to account for social aspect are typically conducted by involving many stakeholders or by ensuring long-term goals of the community. However, metrics to measure social impacts associated with pavement systems are still not widely accepted
- A sustainability rating system is essentially a list of sustainability best practices
 with an associated common metric which provides only a qualitative measurement of
 road pavement sustainability (i.e. INVEST, GREENPAVE, BE²ST)





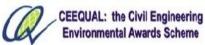




Sustainability assessment methodology

- Dedicated to Road Pavements (overlays, full-depth-reclamation, etc.)
- Flexible, User-friendly framework mainly based on quantitative measurements with suggested free tools
- Sustainability assessed through comparative assessment with one or more design alternatives (i.e. current local practice)
- Environmental impact with possibly full LCA/Carbon foot printing
- Economic impact with LCCA
- Other metrics such as noise and water management are under evaluation
- Development with training received from





- Validated with EU case studies (real projects) D5.2, D5.3
- Questionnaires sent to Road Authorities







Pavement Design:

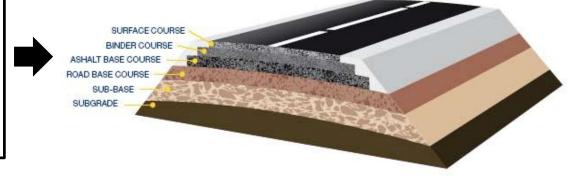
- Pavement structure
- Design Life
- M & R strategies



Sustainability Assessment

- Pavement Performance assessment
- Sustainability rating





Good



In collaboration with

www.superitn.eu









WP5 Deliverables

http://allback2pave.fehrl.org

D5.1 - A state of the art review of sustainability assessment tools (04/2015) of the impact of road pavement infrastructures. This will serve as a base for the development of the AllBAck2Pave sustainability assessment methodology

D5.2 - Evaluation of the environmental impact (LCA) and economical impact (LCCA) (07/2015) of the defined technology taking into account the European level of the project and adapted to real case studies

D5.3 - Sustainability assessment of the AllBack2Pave technologies (07/2015) adapted to real case studies at European level, through a methodology developed by this project and proposed in details for ease of use by CEDR members.





What's now?



•What is the expected outcome and impact of the project?

TRL 1 - 2 Basic research (towards 100% RA recycling in top layers):

- Fundamental understanding of mechanisms related to use of RA in asphalt (grade of blending, RA selection, rejuvenators type and dosage) – D2.1
- Sustainability assessment methodology D5.1

TRL 2 - 4 Feasibility study of AllBack2Pave technologies

- Laboratory study and Plant manufacturing D2.1, D3.1
- Performance prediction D4.1, D4.2
- Sustainability assessment D5.2; D5.3

TRL 3 - 4 Technology development

- Mix design for Italian and German wearing courses D2.1
- Technology Up-Scaling Guidelines D3.1





What's next? - Developments



- The status of progress of the project ?
 - Finalised on Sep 2015
- Where do the outputs of the project stand in terms of **Technology** readiness levels (TRLs)1?
- What work would still be necessary for the project to reach a TRL level of 9?
- What would still be necessary to implement the results of the project?



TRL 1 – 4

- Basic research
- Feasibility study
- Technology development

Needs validation and implementation



TRL 5 - 9

- Technology development
- Field trial
- Monitoring
- Deployment in EU



2015/16??





What's next? - Dissemination



- AllBack2Pave at ICONFBMP in Thessaloniki, Greece
 10-12th June 2015 http://iconfbmp.civil.auth.gr/en
- **EATA** 2015 in Stockholm, Schweden 15-17th June 2015 http://www.eata2015.org/
- CEDR Call 2012 Final Workshop of EARN, CoRePaSol and AllBack2Pave: "Road construction in a post-fossil fuel society" 24-25th September 2015 in Prague, Poland http://allback2pave.fehrl.org/events (details soon available)
- TRA 2016 (possibly)





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Questions?

http://allback2pave.fehrl.org/

Dr. Davide Lo Presti

www.davidelopresti.superitn.eu davide.lopresti@nottingham.ac.uk













