Life Cycle Assessment of Recycled Asphalt

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SEVENTH FRAMEWORK PROGRAMME

Overview

- Goal and scope
- Data (inventory analysis)
- Results
- Conclusions & recommendations for implementation

Goal & scope

Aim:

- To support decision making regarding the future use of RA in Europe

Goal:

- At the macro level – determine the most appropriate material management strategy for RA
- At the micro level – identify product level parameters that have a significant impact on the product's environmental performance

Goal & scope

Functional Unit was 1 m^2 of single lane highway over a 60 year service life

Life-cycle stage		Description
1	**Raw Material Acquisition**	Acquiring raw materials from the natural environment.
2	**Raw Material Transport**	Transport of raw materials to the point of use.
3	**Raw Material Storage**	Storage of materials in stockpiles/silos prior to use.
4	**Asphalt Production**	Production of bitumen bound materials.
5	**Material Transport to Site**	Delivery of materials to site.
6	**Installation**	Placing materials at the construction site.
7	**Use**	Utilisation of the pavement structure by road vehicles.
8	**Maintenance**	Interventions to maintain and refresh the pavement structure.
9	**End of Life**	Planing-off and material management, material movement off site.

CLOSED-LOOP RECYCLING

Data (inventory analysis)

Data was sourced from a range of sources:

- Elsewhere in the Re-Road project
  - Utilising the new “state of the art”
- Past published research
  - Peer reviewed articles provided much of the RA-specific emissions data
- Other FP7 completed research
  - Direct MAT project
  - ECRPD project

Scenario analysis

A number of key questions are addressed:

- What are the benefits of recycling asphalt?
- What is the additional benefit of recycling surface course back into new surface course?
- How do the benefits of recycling compare to those of warm mix asphalt?
- By how much can moisture in RA diminish the benefits of recycling?
- How significant is durability in relation to recycled mixtures?

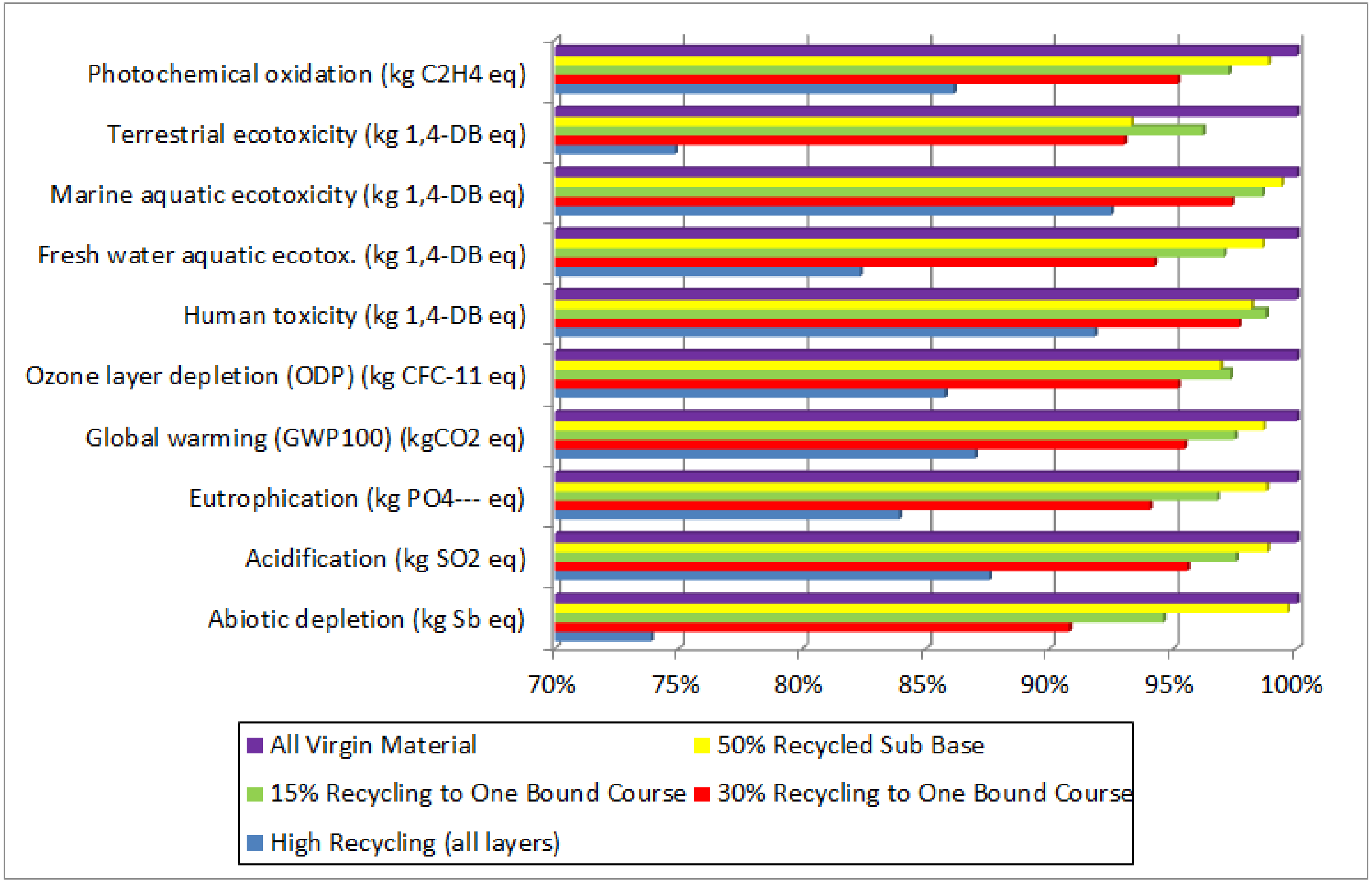
Varying recycling routes and rates

All results are presented against a virgin asphalt baseline

Virgin asphalt - conventional hot mix (165°C) stone mastic asphalt with a PmB binder

- 15% recycling to surface (regular aggregates)
- 30% recycling
- The "high recycling" scenario includes 30% recycled content in each bound course and 50% to the sub base, hence is "aspirational but achievable".

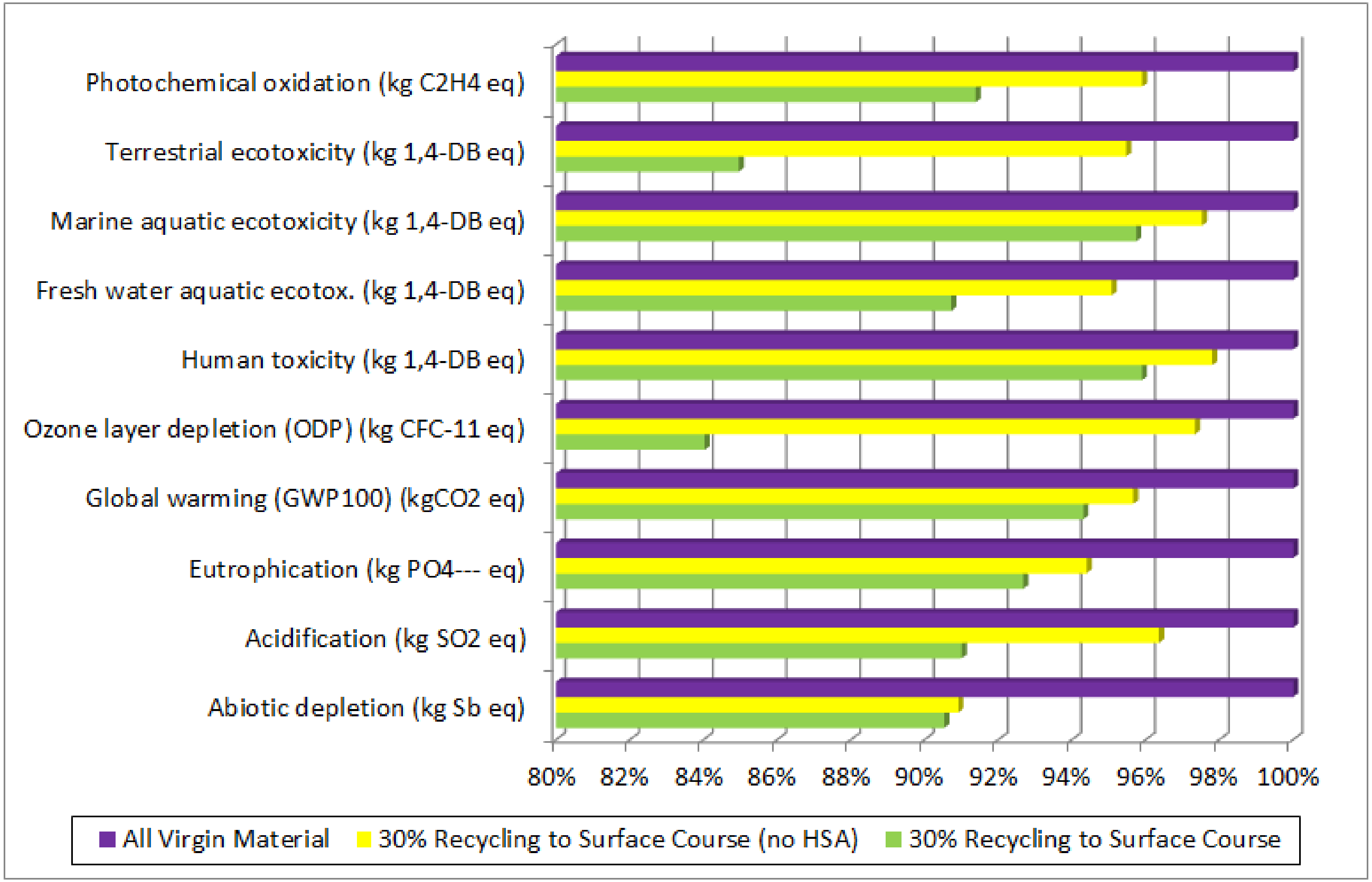
Results – varying recycling routes and rates



Surface-to-surface course recycling

- Preserving high specification aggregate in the this manner avoids the additional transport associated with these disparate sources of aggregate
- In this case the extra transport is 900 km by sea
- Examples would be Norway supplying Denmark; Northern England, Scotland and Wales supplying South-East England

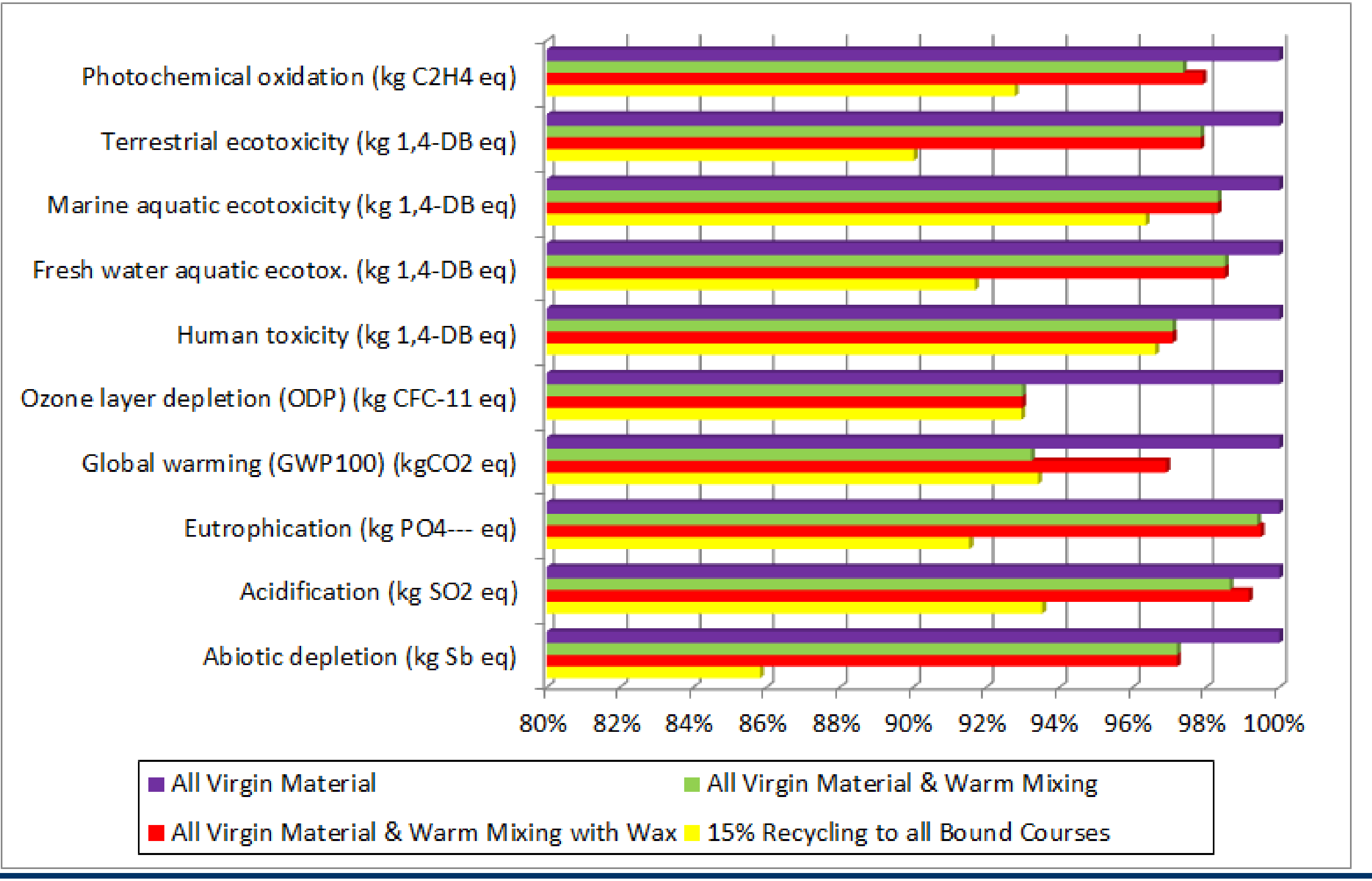
Results – exploring surface-to-surface course recycling



Warm mixing vs. recycling

- Here the attributes of recycling are compared to warm mixing, another prominent initiative in the asphalt industry
- Warm mixtures are mixed at 130°C as opposed to 165°C
- The recycling scenario utilises 15% recycled asphalt to each bound course
- The additional impacts of wax additive are included in a further scenario

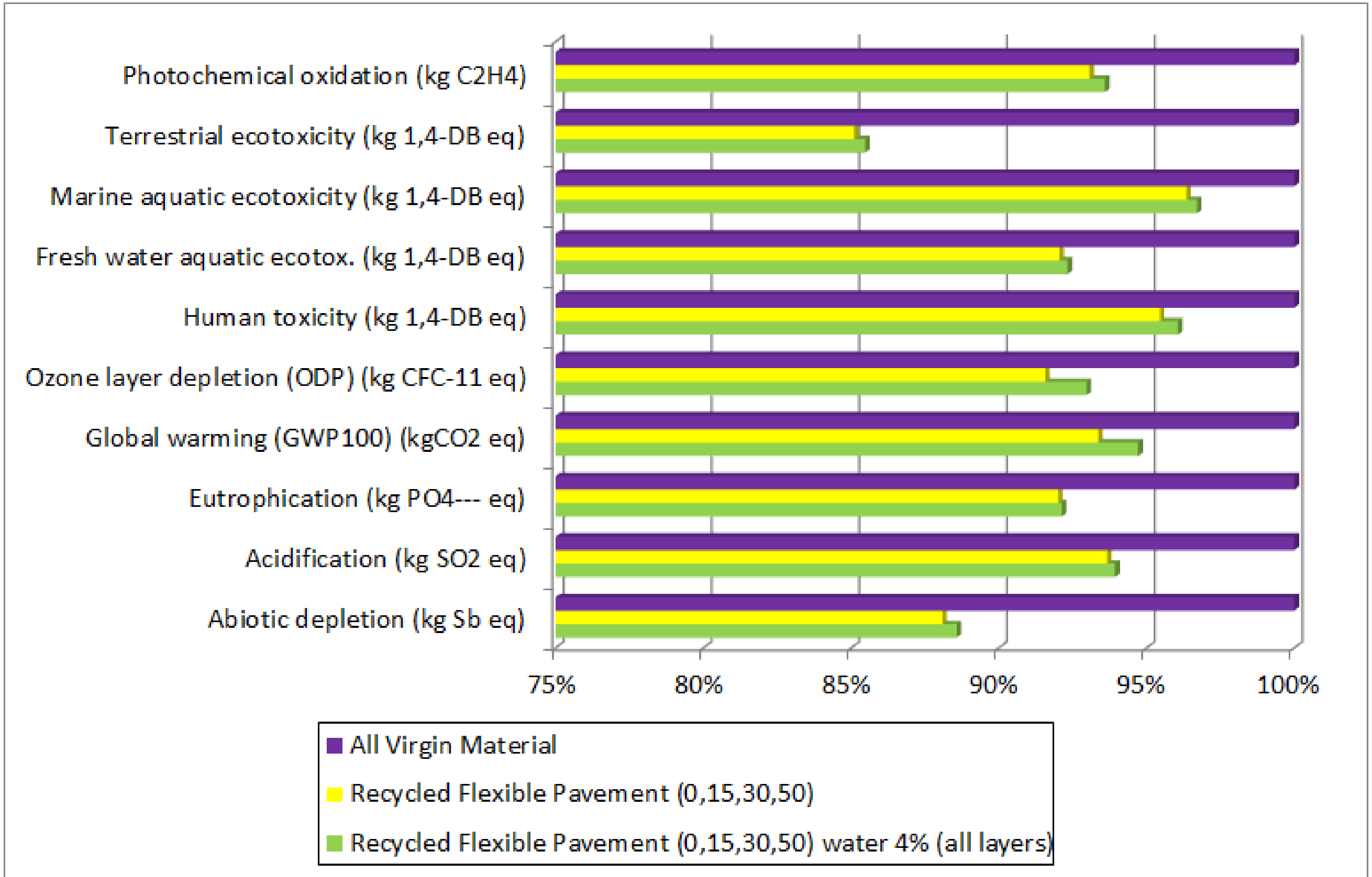
Results – comparing warm mixing and recycling



Excess moisture?

- Excess moisture is an attribute sometimes associated with recycled asphalt
  - Due to storage in exposed stockpiles?
  - Excess water used in planing-off?
- Here 4% moisture is considered – “average”
- Moisture has to be driven off in the dryer before mixing
- The additional impacts associated with this energy consumption are investigated here...

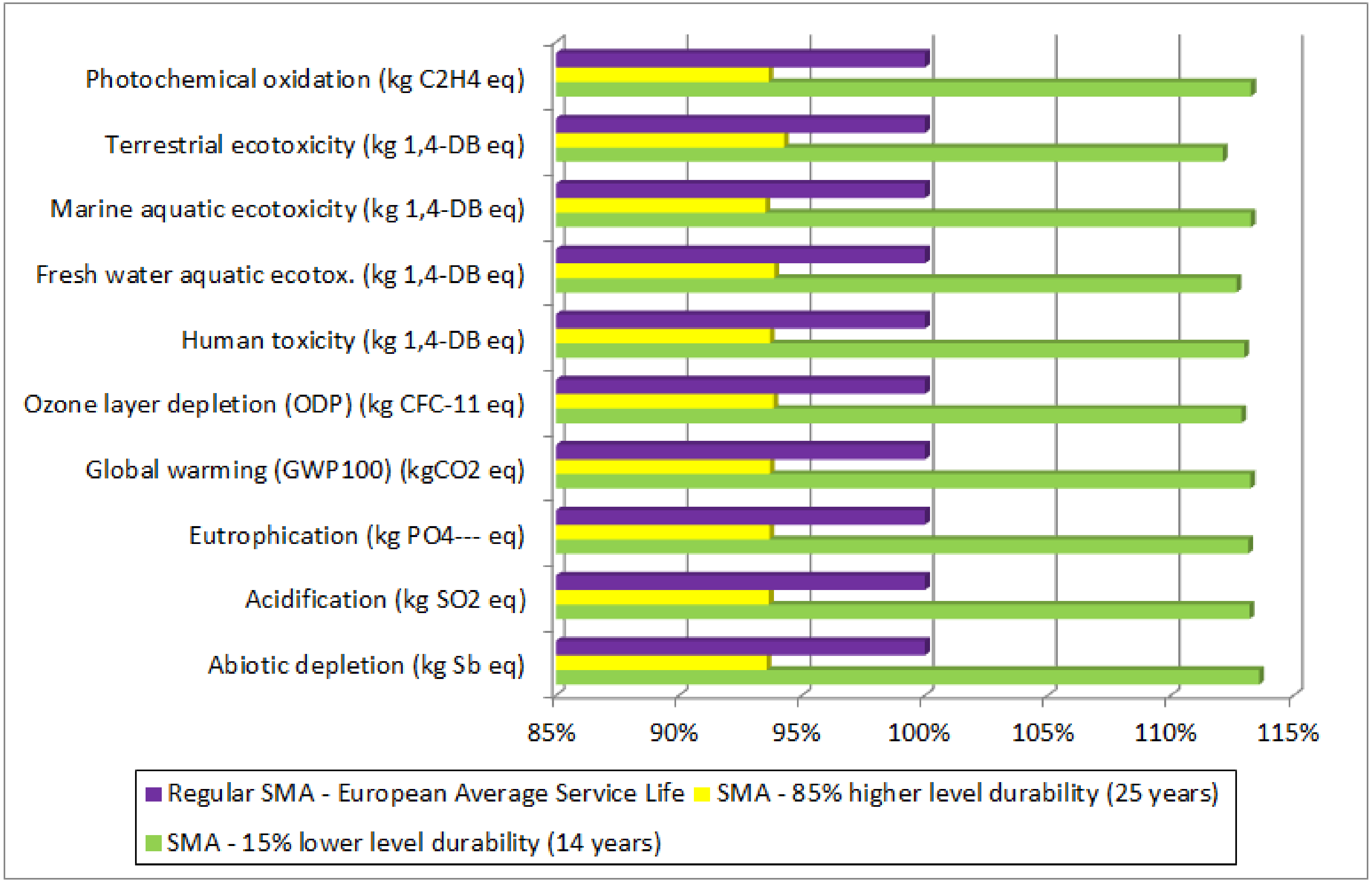
Results – excess moisture in RA



Variable durability

- Variations could be due to any number of factors - workmanship, laying temperature weather conditions
  - Not necessarily associated with RA content (more on this later)
- High and low ranges of durability are modelled (EAPA data)
  - 20 years is the average replacement age for SMA on motorways
  - 14 years (15% lower level)
  - 25 years (85% upper level)

Results – durability



Conclusions & recommendations

The results of the LCA suggest:

- Recycling asphalt to bound courses should be maximised
- Surface-to-surface course recycling can realise even greater gains
- Recycling should be prioritised over other environmental initiatives (e.g. warm mixing) since it yields greater benefits
- Moisture content in RA is not critical, though it should be minimised to maximise benefits
- Durability is potentially very significant and preservation of the road surface should be considered alongside *any* environmental initiative