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Review and update of the asPECT carbon footprinting tool for asphalt road pavements

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Executive Summary

The asphalt Pavement Embodied Carbon Tool (asPECT) is a carbon footprinting tool for asphalt road pavements. It was first developed a decade ago as part of a programme of work funded by the collaborative research programme, funded jointly by Highways England, the Mineral Products Association and Eurobitume UK, and was updated in May 2014 (version 3.1). In the 2018/19 collaborative research programme, TRL was tasked with reviewing the tool and updating the default carbon factors it contains. This report describes the details of the updated constants to be included in the next version of the tool and the findings of the review.

The first element of the review involved identifying the elements of asPECT that needed to be updated and its alignment with current international standards on lifecycle assessment. The tool contains values for the carbon dioxide equivalent emissions associated with the use of materials, energy and transport fuel. The main sources for these are the Department for Business, Energy and Industrial Strategy (BEIS) emissions factors, the Inventory of Carbon and Energy (ICE) database and Eurobitume UK's published figures, all of which have been updated since the tool was previous reviewed. New figures for these were sourced and are included in the report appendices.

The review also included exploring potential options for developing the tool and its use in the future. Since the tool's first development, the drivers for taking greater action to reduce carbon and industry activities in this area have greatly increased. The review looked at how asPECT could better support the industry in reducing carbon in the future. Examples of the use of carbon and LCA tools by national road administrations in other countries were compared and discussed. One potential avenue for development is converting asPECT into an Environmental Product Declaration (EPD) generator. This possibility was also reviewed. The results of the review were used to identify potential options for future development and recommendations for the collaborative partners to consider when planning the future for the tool. The recommendations included engaging with the industry to establish if what is currently available meets the current and future industry needs, investigating how asPECT and the Highways England carbon accounting tool could be used in conjunction with each other, exploring the need for and feasibility of expanding the scope of asPECT, evaluating the benefits and feasibility of converting asPECT into an EPD generator and carrying out dissemination activities to encourage greater use of the tool.

1 Introduction

1.1 Summary of tool and development timeline

The asphalt Pavement Embodied Carbon Tool (asPECT) was developed by TRL as part of a previous collaborative research programme funded by Highways England, the Mineral Products Association (MPA) and Eurobitume UK. The tool enables asphalt producers and contractors to calculate the lifecycle greenhouse gas emissions generated by the asphalt used in highways. The current version of the tool (version 3.1) was released in May 2014, and elements of the tool require updating. In particular, the default carbon values need updating as the emission factors are from 2013 and other factors are from data sources published from 2008 to 2011.

1.2 Sub-task objectives and scope

The objectives of sub-task 4.1 of the 2018/19 collaborative project were to:

- Carry out a review of asPECT to identify which areas of the tool need to be updated with more recent data and to establish what would be needed in order to transform asPECT into an Environmental Product Declaration (EPD) generator.
- Update the constants file of the tool and appendix of the user manual with new values where available and modify the allocation of the benefits of utilising recycled material in line with current standards and current industry practice.

1.3 Report structure

The remainder of this report consists of:

Section 2 – identification of the elements of asPECT that need to be updated.

Section 3 – examples of carbon and LCA tools used by national road administrations in other countries.

Section 4 – an overview of EPDs and discussion on how asPECT could be converted into an EPD generator.

Section 5 – recommendations on the future development and use of asPECT

Appendix A – tables of the constants to be replaced and proposed new values

Appendix B – an example of an Environmental Product Declaration

2 Review of asPECT version 3.1

This section identifies the data and methodology used in the current tool which needs to be updated as a result of new data becoming available or changes in standards/good practice.

2.1 Constants

The constants file of asPECT contains carbon equivalent (CO_2e) values for materials, fuel, electricity etc. and other values used in the calculations. This contains default data for the UK; users of the tool can amend these if they have more specific data related to their specific circumstances e.g. for different countries. The following types of values need to be updated:

- **DEFRA GHG conversion factors** – DEFRA factors from 2013 are currently used for grid electricity, vehicle fuel and transport of materials. Values from 2019 are available from the Department for Business, Energy and Industrial Strategy (BEIS); the factors are updated annually and published at the end of May.
- **Data from the ICE database** - material emission factors obtained from the Inventory of Carbon and Energy (ICE) database are from version 2 (2011). Version 3 was released in June 2019.
- **Eurobitume** – information from the Eurobitume 2012 Life Cycle Inventory 2nd Edition was used in the tool. An updated version (Version 3.1) of the Eurobitume Life Cycle Inventory was published in April 2020.

The details of the constants which need to be updated and the proposed updates are provided in Appendix A. These were confirmed with, Highways England, MPA and Eurobitume UK and the constants file and protocol were updated.

2.2 Allocation of recycled material

There are two options when allocating the environmental benefits of recycled material in carbon footprinting or LCA:

- In the end-of-life recycling approach (also known as avoided burden) environmental benefits are granted for the material that is recovered and recycled after the use phase (i.e. the material which can be recycled).
- In the recycled content approach (also known as cut off) environmental benefits are allocated to the actual fraction of secondary material in a product.

ISO 14040 is ambiguous on how to allocate the benefit of recycled material. In the current version of asPECT, the first approach is used; with 60 percent of the benefit allocated to the current mix and 40 percent to the source mix. A review of LCA practice suggests that this could be changed to the second approach so that 100 percent benefit is allocated to the mix containing the recycled content.

The choice of approach is judgement based on the recycling practices of the relevant industry and which actions should be incentivised. A 100:0 allocation is commonly adopted in industries where closed-loop recycling is not yet maximised and there is therefore a bigger incentive to gain the reduction by including recycled content i.e. instead of using unbound planings as aggregates. However, critics say this approach does not incentivise designing for recyclability. In this update of asPECT we have changed the default values to a 75:25 allocation to further encourage closed-loop recycling into asphalt mixtures whilst also acknowledging that asphalt is rarely wasted and is recycled, but not always to the highest value use. However, users of the tool can modify these values if they wish.

2.3 Alignment with current standards

This sub-section examines how the current version of asPECT compares to the latest standards and good practice relating to lifecycle analysis.

2.3.1 PAS 2050:2011

The *Publicly Available Specification 2050:2011 Specification for the assessment of the life cycle greenhouse gas emissions of goods and services* published by BSI provides a consistent method of assessing the lifecycle greenhouse gas emissions (GHG) of goods and services. The PAS is not a standard, but summarises good practice. The asPECT methodology was originally developed following the framework provided in the 2008 version of the PAS. The tool was updated in the 2013 review to align with the 2011 version. The PAS has not been updated since 2011.

2.3.2 ISO 14040 and 14044

'*ISO 14040:2006 Environmental management – life cycle assessment – principles and framework'* describes the principles and framework for life cycle assessment (LCA) and *ISO 14044:2006* the requirements and guidelines. These have not been updated since asPECT was created.

2.3.3 ISO 14067

The 2013 review considered how asPECT met *ISO/TS 14067:2013 Greenhouse gases - Carbon footprint of products - Requirements and guidelines for quantification*. This standard specifies the principles and requirements for studies to quantify the carbon footprint of a product based on life cycle assessment as specified in ISO 14040 and ISO 14044. The results of the 2013 review were that the asPECT methodology did not conflict with the standard in regard to the calculation of carbon footprints, but only partially met the requirements in terms of interpretation, reporting and communication of results. In 2018 there was an update to ISO 14067, which reduced its scope by moving the requirements on communication to ISO 14026, verification to ISO 14064-3 and Product Category Rules (PCR) requirements to ISO 14027. It also revised the treatment of biogenic carbon and electricity and better aligned definitions within the ISO 14067 group.

BS EN 15804:2012 provides guidance on core product category rules relating to Environmental Product Declarations (EPDs) for construction products and services (see Section 4.2).

3 Carbon and LCA tools used by other road authorities

The purpose behind any infrastructure carbon tool such as asPECT is to better understand the carbon emissions associated with producing and using materials in order to inform actions to minimise that impact. The UK government has committed to a target of net zero greenhouse gases by 2050, which requires addressing transport sector emissions. In their Sustainable Development Action Plan, Highways England states its aim to make a meaningful contribution to the Government's target to reduce greenhouse gas emissions and to work with its supply chain to seek ways to mitigate the carbon impact of new road design projects. Highways England has two Road Investment Strategy (RIS) performance indicators to assess environmental performance relating to the reduction of carbon emissions:

- Carbon dioxide equivalents (or CO_2e) in tonnes associated with Highways England activities and
- Carbon dioxide equivalents (or CO_2e) in tonnes to reduce carbon emissions within the supply chain activities.

In the context of the current Government and public focus on carbon reduction, it is timely to take this opportunity to consider how carbon tools such as asPECT can help the road sector to reduce carbon. Therefore, in this section descriptions of the tools used by national road administrations (NRAs) in Norway, Sweden and the Netherlands are provided in order to inform the discussion on the future role of asPECT. Further information on the different types of LCA tools used by national road authorities can be found in the review carried out by the LICCER project [1].

3.1 Norway

The Norwegian Public Road Administration (NPRA) is responsible for managing and maintaining the national and county roads in Norway. As part of a project called KraKK – "Krav til Klimakutt I Konkurransegrunnlag" (climate change requirements in public procurement), the NPRA are trialling the implementation of carbon reduction requirements in the procurement of construction, services/operational and maintenance tasks. The goal of the NPRA (as defined in the Krakk-programme) is to reduce the carbon footprint of the organisation in 2030 in relation to 1990 by:

Operations and maintenance	50%
Investments	40%

3.1.1 LCA tools

The NPRA use LCA at different project stages to help them achieve their carbon reduction goals. For example at the start of the planning phase LCA is carried out using a module in their cost-benefit software called EFFEKT. The results of this mandatory assessment are used to inform decisions on alignment and high level options such as whether to build the road over

[1] https://www.cedr.eu/strategic-plan-tasks/research/era-net-road/call-2011-energy/liccer-project-results/

a mountain or build a tunnel through it. Towards the end of the planning stage a tool called VegLCA is used, which helps to inform material and design choices, the construction equipment used and material sources. Default values for emission factors are included in the tool, but new values can be added. Figure 1 shows screenshots of VegLCA (the text is in Norwegian).

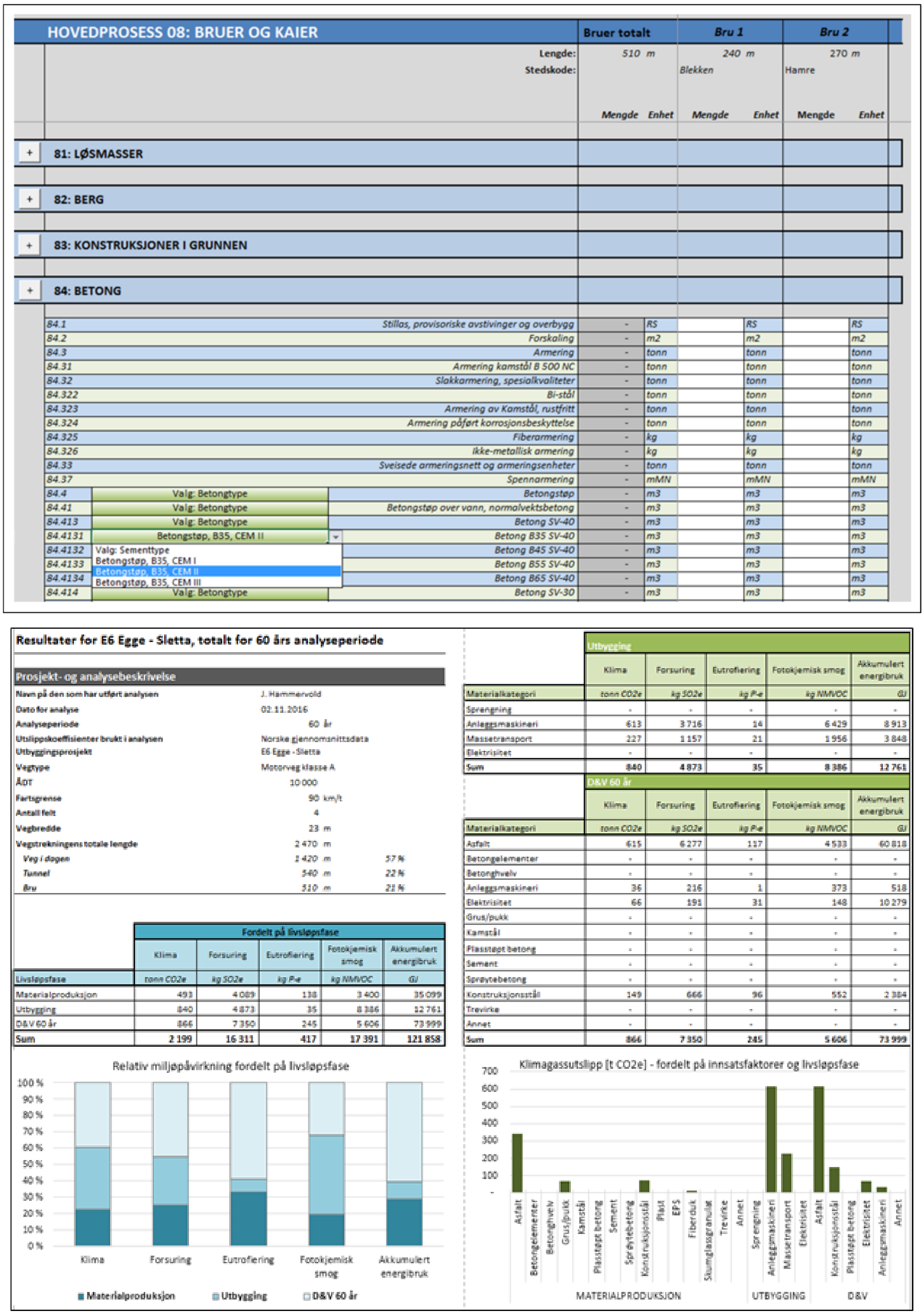

Figure 1. (a) input interface and (b) results sheet of the Norwegian LCA tool VegLCA

3.1.2 *Use of LCA tools in procurement*

NPRA are testing a new approach to sustainable procurement within selected projects as part of the KraKK project. VegLCA is being used in the procurement process of the pilot projects for environmental impact budgeting to inform the road administration procurement decision-making process.

The KraKK pilot projects are also trialling a bonus/malus approach to incentivise contractors to reduce carbon. It is targeting the largest sources of carbon; use of concrete, asphalt and steel and the construction equipment. The contractors receive a bonus for using less CO_2 intensive materials and using site plant and vehicles not powered by fossil fuel. They need to provide EPDs and the quantities of material used. The EPDs can be either certified EPDs obtained from third parties or self-produced by the contractors; to obtain the bonus they must be site-specific. Quantities and the carbon factor from the EPD are the basis for the calculation. NPRA will employ third party verification (by certified EPD verifiers) to carry out random checks on the contractor generated EPDs. Currently NPRA is only using EPDs for concrete and asphalt but eventually they also want to include construction steel.

The bonus granted is based on the extent of carbon emission reduction, based on the determined project specified requirements. The same applies - the other way around - for penalties paid by the contractors if the requirements are not met. For example, the KraKK-project has proposed the following bonus payments for the use of zero carbon machines or vehicles and will test this in the different pilot projects:

- Emission free excavator > 25 tonnes receives 400kr/h (€40/h); up to a maximum of 2,000 hours or 800,000kr (€80,000). (This is a standard Caterpillar excavator rebuilt in Norway to be powered by electric. It can be used for approximately 5 hours work before charging the battery, the first few were delivered in late 2018.)

NPRA sees the following advantages in using the bonus/malus system compared to a requirement based approach:

- No competitor will be excluded from the procurement/bidding process (otherwise: the competitor must be excluded if he cannot fulfil the requirements)
- Flexibility (project specific)
- Incentives to improve the performance constantly during the contract phase
- No formal limitation of paid results

The advantage of a bonus system is that contractors are incentivised to improve climate performance as part of the contract. It is intended that the contractor assumes they will receive the bonus when calculating their tender costs. The bonus needs to be greater than the higher cost of low carbon materials.

3.2 Sweden

Trafikverket (the Swedish Transport Administration) is responsible for the long-term planning of all transport modes and the construction, operation and maintenance of state roads and railways. The Swedish Transport Administration, based on national targets, has set a long-term goal to have climate neutral infrastructure by 2045, with interim targets of 15 percent reduction in GHG emissions by 2020, compared to 2015 values, and 30 percent reduction by 2025. In order to meet these targets it has introduced procurement requirements designed to reduce carbon emissions from its infrastructure projects. It decided its approach had to follow six basic rules:

- Take a long-term perspective
- Be technically neutral
- Include monitoring
- Provide incentives for doing more
- Impose a penalty for not fulfilling requirements
- Include an assessment of the impact.

The approach developed involves measuring the carbon emissions associated with an infrastructure project over its lifecycle, setting carbon reduction targets and providing suppliers with financial incentives to meet these targets. Functional specifications are utilised which provide tenderers with the freedom to suggest innovative materials and designs which reduce carbon, but still achieve the required functionality. There was a wide-spread consultation process involving contractors, material manufacturers and consultants before the procurement requirements were introduced and an impact study was carried out to assess the likely impact of introducing the new requirements.

3.2.1 Klimatkalkyl

The approach utilises an LCA tool developed by Trafikverket called Klimatkalkyl (Climate Calculator) to provide a consistent way for its staff and suppliers to estimate the GHG emissions and energy use associated with a project over its construction, operation and maintenance. Klimatkalkyl is used at different stages in the project planning and procurement processes, firstly by the NRA to establish a baseline and set appropriate targets, and then by the supplier to select a low carbon design for tender submission and establish the final carbon value after construction. As the project progresses, additional detail can be added providing a more accurate estimation. The tool was initially developed in Excel but is now available online. The user interface and results page are shown in Figure 2 (the text is in Swedish)

The tool uses information provided by the user about the specific materials and design being used in the project together with default data to calculate a CO_2e value for the project. Incorporated into the tool is a database containing emission factors for around 40 construction materials. The user selects the type of component/material, and provides the quantities and transport distances; information already recorded for costing purposes. It is reviewed and updated annually including adding data from new EPDs (verified by a third party). In February 2016 (version 5.0) it was expanded to enable the calculation of the carbon associated with the maintenance of existing roads.

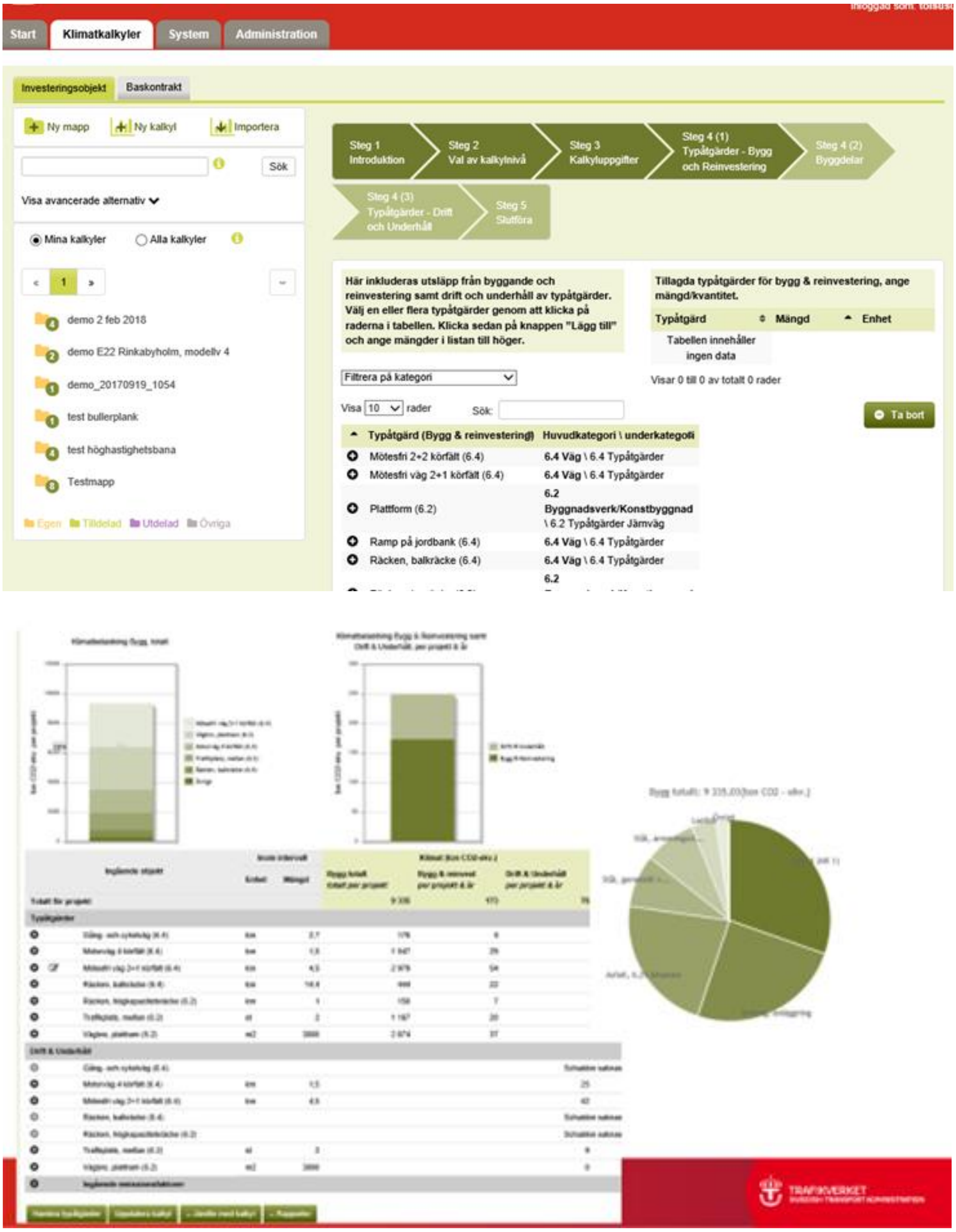

Figure 2. Klimatkalkyl user interface and results page

3.2.2 LCA in procurement

In April 2015 the Swedish Transport Administration made it mandatory to use Klimatkalkyl to calculate the GHG emissions and energy for all new infrastructure projects with a total budget over 50 million SEK (€5.4 million) due to be completed after 2020. Since February 2016 the tool has been used to set procurement requirements in projects that meet these criteria.

From March 2018 there are also requirements on materials and fuels in smaller projects (below 50 million SEK) and maintenance projects regardless of size. The requirements are directly on the climate performance of the materials and fuels since climate calculations are not performed on these. In 2019, requirements on pavement contracts and on summer and winter maintenance were also planned to be introduced.

As part of the early project planning process, Trafikverket establishes a baseline carbon value for each relevant project using the Klimatkalkyl tool. It uses the tool to compare different options, for example comparing the GHG emissions associated with different routes, or tunnels with bridges. Once a route is selected the assessment enables the identification of the main contributors of GHG and an internal workshop is held to identify potential measures to reduce GHG measures and set a realistic carbon reduction target for suppliers. Trafikverket defines the carbon reduction target for the project as a percentage of the baseline and assigns the bonus available for exceeding this target (currently this is a maximum of 10 percent of the project value). If a significant change to the scope of works is made during the project the baseline is updated, but the target is retained.

Although the targets will vary depending on the project, on average the target reductions are:

- 15% for contracts ending 2020 - 2029
- 30% for contracts ending 2030 or later

Based on Trafikverket's experience up to a 50 percent reduction in carbon over the project lifecycle can be achieved without increasing project costs. Often cost reduction and reduction of carbon go hand in hand. Even larger reductions (greater than 50 percent) can be achieved with only minor increase in cost. This is mainly because material type and quantity have a large impact on carbon emissions, whereas the main component of economic cost is labour. Therefore even if using lower carbon materials increases material costs by a few percent there is little impact on the overall project budget.

The NRA provides functional specifications, together with the baseline assessment and reduction targets. Suppliers submit tenders including measures to reduce GHG emissions and their estimate of the carbon savings calculated using Klimatkalkyl. In their tenders the suppliers do not need to show their calculations on how to reduce the emissions. They only guarantee that they will achieve the target. The tenders are not evaluated on their carbon reduction activities; instead a system of bonuses and penalties is employed to provide a financial incentive for reducing carbon. During the contract Trafikverket discuss the proposed measures with the contractor so that both parties are sure that they will be achieved. At the end of the project a climate declaration is submitted by the supplier providing the carbon value based on the actual materials and quantities used. If low carbon materials are used which are not contained within the tool database, the emission factors need to be verified by third party EPD auditors. The EPDs stored in the tool are available for download for suppliers (in Swedish only). Trafikverket obtains input from the industry regarding the EPDs and updates the tool accordingly. Development of the EPDs is a transparent process as sources are available (where it comes from and who developed it).

Once the climate declaration and any supported EPDs are submitted, Trafikverket applies its bonus and penalty system:

- A bonus is paid if the supplier achieved a reduction of GHG emissions greater than the target set. The bonus given normally corresponds to about 1% of the contract value for a reduction of 10% more than the requirement. There are plans to give bonuses up to 100% reduction for projects due to complete 2030 or later. They consider that these bonuses will not need to be more than 2 percent of the contract value for 100% reduction.
- If the requirements are not achieved, the contractor will not receive the carbon bonus or other bonuses e.g. for delivering on time.
- The amount of bonus or penalty applied is based on how far above or below the target the carbon value is.

The Traffic Authority's guideline TDOK 2015: 0007 (Climate Calculation - Energy Conservation and Climate Impact in a Life Cycle Perspective) (Swedish Transport Administration, 2015) provides information on when and how the tool should be used. The tool is available online (in Swedish) - http://webapp.trafikverket.se/klimatkalkyl/.

In parallel with the new procurement requirements Trafikverket has been working with suppliers on reducing the carbon associated with commonly used carbon intensive materials such as asphalt and steel. They have been reviewing their procurement requirements on selected materials such as steel, concrete and cement.

3.2.3 Geokalkyl

Trafikverket also use a GIS tool called Geokalkyl in the early planning phase of a project to evaluate road and railway routes and overall design concepts. Information on the proposed route and design standard together with maps of elevation, terrain, land use and soil are used to assess the proposed route and design. The tool enables the identification of the points where some form of crossing is required and compares the installation of a bridge or tunnel. It also lets the user compare geotechnical approaches such as cut and fill options, stabilisation techniques etc. In addition to estimating the construction cost of each option it also produces an estimation of the energy consumed and GHG emissions. This enables the user to make an informed decision based on both cost and environmental concerns.

More information on Geokalkyl can be found here (in Swedish only) - http://www.swedgeo.se/geokalkyl.

3.2.4 EKA tool

Trafikverket has developed an LCA tool called EKA (Energi och Koldioxid i Asfaltproduktion) which calculates the embodied energy and carbon of asphalt. It includes the production of the mix from its constituent materials, transport and laying on site. The default data as far as possible is based on real data collected by plant suppliers, aggregate producers etc. The tool enables the user to calculate the CO_2e saved by using recycled aggregate, reclaimed asphalt, cold/warm asphalt, local materials etc. so that the lowest carbon material that fulfils the project requirements can be selected. More information can be found here - http://www.h-a-d.hr/pubfile.php?id=1007

3.3 The Netherlands

Rijkswaterstaat (RWS), part of the Ministry of Infrastructure and Water Management, carries out the construction and management of the Dutch national road network and main waterways. RWS aims to be climate neutral by 2030 and has set targets related to the use of asphalt (20% reduction in CO_2 emissions by 2025) and groundworks (10% CO_2 reduction in five projects by 2020). It aims to use its procurement process to challenge suppliers to be more sustainable, using more sustainable working practices and materials.

3.3.1 DuboCalc

This includes the use of an LCA tool called DuboCalc developed by RWS to calculate the environmental impact of a construction design over its lifetime. The Life Cycle Analysis (LCA) methodology follows the ISO 14040 standard and calculates eleven environmental impacts including kg CO_2e. Weighting is applied to the different impacts, CO_2e has a 20 percent weighting. The output is a single value referred to as the Environmental Cost Indicator (MKI in Dutch). This enables designers to compare design and material options, but it is also used by RWS as part of their procurement process. Tenderers are required to submit the MKI as part of their proposal and demonstrate how they would achieve this. This value is used in the tender evaluation process, and if their proposal is successful obtaining the promised MKI becomes a contract requirement.

RWS passed the development and management of DuboCalc over to the software developer Cenosco and the engineering consultancy Royal Haskoning DHV. The latest version of the tool launched in 2017, DuboCalc 5.0,can be found here https://www.dubocalc.nl/en/

The tool is used not just for road construction, but all construction and civil engineering work. Having a single national method of calculating the environmental impact of construction underpins the approach as suppliers understand the requirements and the environmental impact of different proposals can be compared. DuboCalc uses data from the Dutch national EPD database which was produced by a government project and is now managed by an independent organisation (SBK). There are three types of information categorises in the database:

- Brand data verified by an independent third party according to the SBK verification protocol
- Generic data for non-branded materials, verified by an independent third party according to the SBK verification protocol
- Generic data for non-branded materials which have not been verified.

EPDs for new materials can be submitted to SBK who manage the database via an online procedure. They will approve the submission. The EPD verification protocol can be found here http://www.milieudatabase.nl/imgcms/SBK_Verification_Protocol_version_2_0_TIC_versie.pdf

3.3.2 LCA and procurement

RWS evaluate tenders based on the price/ quality ratio. Quality criteria for each project are developed to align with the project objectives and RWS's overall policy. RWS provides functional specifications for the project including a maximum MKI value based on a reference design assessed using DubCalc. They also provide suppliers with access to the DuboCalc assessment tool, handbook and the calculation procedure which will be used to monetarise the MKI. The proposal submitted by the suppliers includes a description of their design, the bidding price, MKI value calculated using DuboCalc and CO_2 performance level[2]. It is reported that, as a result, designers compare the environmental impact of different designs, suppliers try to use low temperature asphalt, more recycled and secondary materials and incorporate renewable energy projects into their design.

When comparing proposals, RWS monetarise the MKI value and subtract this from the bidding price and apply the Performance Level (PL) level discount. The suppliers offering the maximum MKI will receive no MEAT (Most Economically Advantageous Tender) discount, while those offering less than this will obtain an increasing level of discount up to a maximum discount value for the minimum MKI submitted. MEAT discounts are given for other criteria too (as set out in the contract specifications). The adjusted prices of each proposal are compared and the supplier with the lowest value selected.

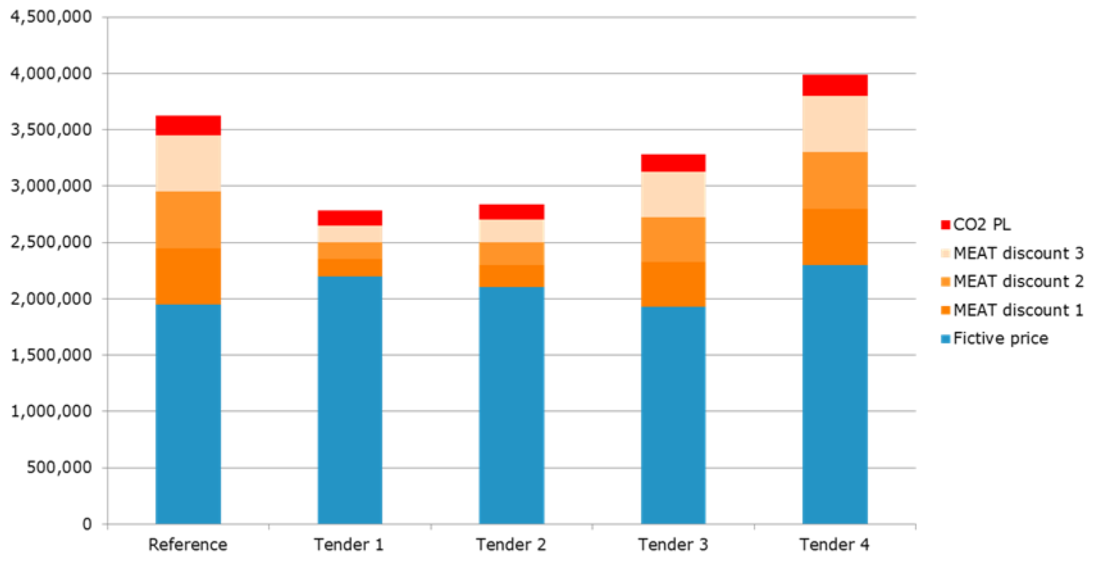

Figure 3. Tender evaluation using MEAT criteria

Once awarded the MKI and compliance with the PL commitments of the stated level become contract requirements. The MKI value is recalculated at delivery with the real data and

[2] The CO_2 Performance Ladder (PL) is a concept developed by ProRail the Dutch rail infrastructure owner, but is now also used by RWS (and other companies). The PL is a sustainability tool to help organisations assess and improve their approach to reducing CO_2, but it is also used in procurement. Suppliers gain an advantage during the tendering process according to their level on the ladder. There are five levels or rungs on the ladder, with 1 being the lowest and 5 the highest. Carrying out actions such as procuring green energy, more efficient uses of materials move an organisation up the ladder. Suppliers are awarded a 1% hypothetical reduction in the price of their proposal during the tender evaluation for each rung in the ladder providing a significant advantage over less sustainable competitors. The tool operates at an organisational level working in tandem with the project level DuboCalc.

independently verified. If the MKI meets the promised value, the supplier is paid the submitted price. If the MKI is exceeded a financial penalty is imposed. The fine imposed is normally 1.5 times the difference between the promised and delivered MKI value. If the MKI is lower a bonus is awarded. On average RWS has seen a 40 percent reduction in the carbon generated by projects as a result of this approach.

3.4 Summary

Carbon and LCA tools are being used by the national road authorities of different countries to help them reduce the carbon associated with constructing and maintaining highways. These are mostly bespoke tools originally developed or commissioned by the NRA itself, although they may be passed onto external software organisations to manage once established. The tools are used to calculate carbon emissions related to a whole project/ contract or a particular asset type or material. In some cases there are different tools for use at different decision points or project stages e.g. planning, detailed design and construction, others use the same tool with different levels of detail. The tool outputs may be used to inform material choices, part of the tender process or for carbon accounting, and their use can be optional or mandatory. None include emissions during use or end of life, all meet ISO 14040. Table 1 compares the tools and their use with asPECT.

Table 1. Comparison of carbon/LCA tools used by different NRAs

	UK	Norway	Sweden		The Netherlands
Tool name	asPECT	VegLCA	Klimatkalkyl	EKA	DuboCalc
Scope	Asphalt pavements (raw materials to end of life) Carbon only, per tonne per year	Road construction and maintenance projects, includes bridges, tunnels, earthworks etc. Full LCA Includes land use changes	Construction and now also maintenance projects for road and rail includes bridges, tunnels, earthworks etc. Carbon only, per year	Asphalt manufacturing (raw materials to laid product lifetime is being considered) Energy and carbon only, per tonne, per m^2 of paved asphalt or in total	Construction projects for road and rail Full LCA – produces an environmental cost indicator, per project (Euros)
Users	Contractors and asphalt manufacturers	NRA and contractors	NRA and contractors	NRA and asphalt industry	NRA and contractors
Project stage	Detailed planning or construction	Detailed planning	Pre-tender by NRA, proposal and post-construction by contractor	Detailed design	At tender stage
Data source	Contains default factors for materials and energy use or the user can enter their own.	Contains default factors for materials and energy use or the user can enter their own. Aligns with economic modelling.	Verified EPDs	Swedish Environmental Protection Agency, Eurobitume and machine suppliers	National EPD database
Advisory or mandatory	Advisory	Being trialled on pilot projects	Mandatory	Advisory	Mandatory
Use	To inform material decisions for asphalt pavements	Currently to inform material decisions, but inclusion in procurement is being considered	Integrated into the procurement process to encourage carbon reduction	To inform material choice	Integrated into the procurement process to encourage carbon reduction

The examples given help to inform the debate on the future of asPECT i.e. whether it continues in its present from or is developed further to better support carbon reduction in the UK highway sector. Some points for discussion are:

- **What decisions should the tool inform?** The tools used by the three NRAs are designed for a particular purpose and project stage. Different carbon/LCA tools can be used by an NRA for different purposes and one tool can be used in a different way for more than one decision point.
- **Who are the expected users of the tool?** The users of the tools reviewed are NRA staff and/or suppliers. All the NRAs emphasised the importance of engagement with the suppliers in developing and rolling out the tool.
- **How will the tool be used?** Use of some of the tools is optional whilst others are a mandatory part of planning or procurement. How the tool is used affects how robust and transparent the tool needs to be, its complexity and how much consultation is required before it is introduced. All the NRAs trialled the tool through pilot projects or only required its use on certain types of project before fully implementing the new approach.
- **How will it be accessed and maintained in the future?** Carbon/LCA tools require data which needs to be kept up-to-date and expanded on as materials and other details change. All the tools reviewed have a verification processes for including new data in the tool and are updated regularly. All were initially developed by the NRA, but Klimatkalkyl and DubaCalc are now managed by external organisations.
- **How does asPECT fit with the other carbon tools being used in UK road the industry?** These LCA tools are mostly project based, the Swedish tool includes defaults for common components not just materials. EPDs are product based. Highways England has a carbon tool for term maintenance contractors and major projects. This has just been updated and the new version published in June 2019 (see Figure 4). The Highways England tool includes default carbon factors, mostly sourced from ICE v3 and DEFRA. It is divided into different types of assets to align with the Specification of Highway Works.
- **How should the use of asPECT be incentivised?** If asPECT is not an obligatory part of the tender assessment process, then how else can its use be incentivised. Could it be included in tender specifications or project stage gateways? Or should its use remain voluntary, but encouraged through greater awareness raising and questions from Highways England sponsors about embodied carbon?

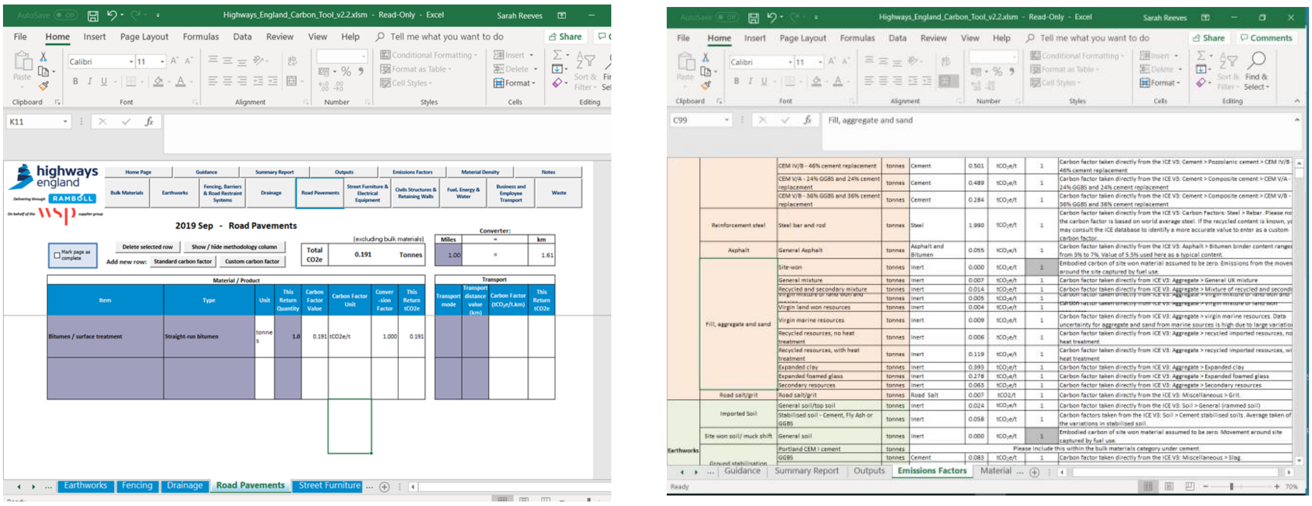

Figure 4. Highways England carbon accounting tool (a)Asphalt pavements input sheet and (b) List of emission factors

4 EPD generation

One potential avenue for asPECT's future development is to convert the tool into an EPD generator for different asphalt mixes. Section 4 discusses what this would involve.

4.1 What are EPDs

Environmental Product Declarations (EPDs) are documents which provide information on the lifecycle environmental impact of products in a standard verified form. They are normally produced by product manufacturers, often with help from life cycle analysis specialists, and verified by a third party. EPDs enable purchasers to make informed decisions in relation the products they procure, and are also an important data source for carbon and LCA calculators such as asPECT. Whilst not currently mandatory their availability and importance to clients is growing. Figure 5 provides an outline of the content of a typical EPD and example of an EPD is provided in Appendix B. EN 15804 includes seven impact categories: global warming, ozone depletion, photochemical ozone formation, acidification, eutrophication, mineral and fossil resource depletion, and non-fossil resource depletion. It has been criticised for missing some important impacts.

BS EN 15804: An EPD communicates verifiable, accurate, non-misleading environmental information for products and their applications, thereby supporting scientifically based, fair choices and stimulating the potential for market-driven continuous environmental improvement.

<u>The content of an EPD</u>

1. Description of the manufacturer

2. Description of the product / material

3. Components / materials of the product

4. Additional information (optional) e.g.:

- on production / assembly
- recycled content
- how the product is applied / incorporated in a building
- modelling of how the product might be used (eg indoor air quality)
- durability / whole life costing
- end of life: re-use, recycling and waste management

5. Life Cycle Assessment:

- Use of non-renewable primary energy
- Use of renewable primary energy
- Depletion of fossil energy resources
- Depletion of mineral resources.
- Use of renewable resources
- Use of fresh water
- Use of land resources
- Waste
- Global warming potential (GWP)
- Ozone depletion potential (ODP)
- Acidification potential (AP)
- Eutrophication potential (EP)
- Photochemical oxidant formation potential (POCP)

6. Statement of EPD review

Figure 5. EPD content (Greenspec, 2019)

4.2 EPD standards

EPDs are created following LCA methodology as defined in ISO 14040 and according to Type III environmental certification in ISO 14025. Before creating an EPD, the relevant product category needs to be identified, as each group of products has a set of Product Category Rules (PCR). PCRs are documents setting out the guidelines for developing EPDs for that type of product in order to enable transparency and comparison between products. If a PCR does not exist it needs to be created following *'BS EN 15804:2012 Sustainability of construction works — Environmental product declarations — Core rules for the product category of construction products'* for construction materials such as asphalt.

A PCR is defined in ISO 14025 as a set of specific rules, requirements and guidelines for developing Type III environmental declarations for one or more product categories.

4.3 EPD generators

Developing EPDs can be quite time consuming and requires specialist knowledge therefore some organisations have produced software tools to streamline and standardise the process. These tools consist of a calculation methodology, database of environmental impacts for different materials and activities, user interface and document template. Users select the types of raw material used, and input site specific information on transport, energy use etc. The tool calculates the overall environmental impact of the product based on this, producing it in a standardised EPD format.

One example of this is the EPD generator provided by LCA.no[3] for the Norwegian construction industry. This web-based tool includes a database of environmental impacts which cannot be changed by the user (see Figure 6). The datasets are verified by a third party and updated annually. A fee is required to use the tool, and there is an additional charge for every EPD produced.

[3] https://lca.no/en/

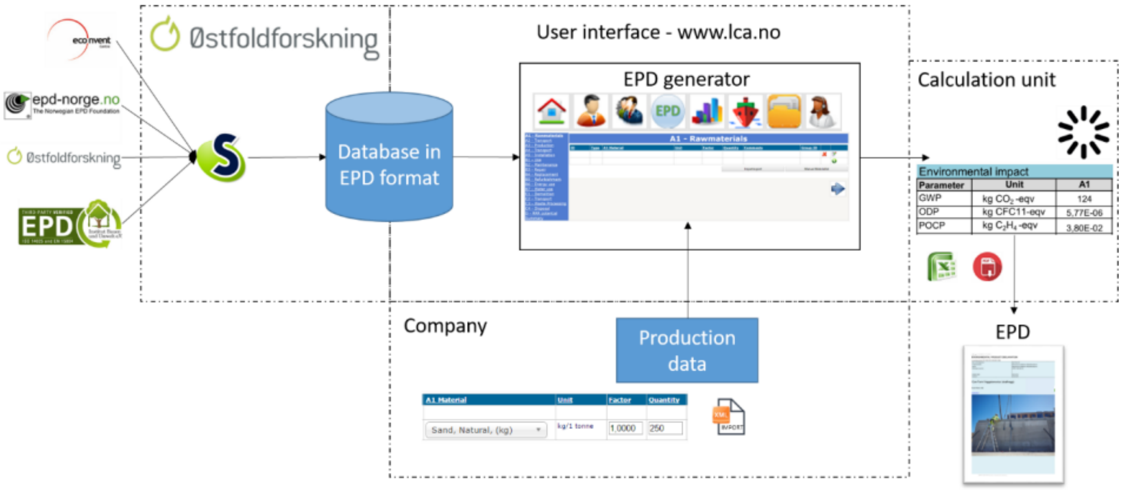

Figure 6. Overview of the Norwegian EPD Generator

An EPD generator for concrete products was produced by climate earth, a company based in the US[4]. This tool includes a smartphone version. For a setup fee and annual subscription any number of EPDs can be produced. It includes a database of environmental impacts.

There is also a Swiss company called project system engineer which has produced an EPD generator[5], a tool from a German company called thinkstep[6] and the Emerald eco-label tool from the US National Asphalt Pavement Association[7] which is linked to the LEED credit system.

The Irish Green Building Council operate EPD Ireland, a national EPD programme to ensure consistent verified EPDs are available to the Irish construction industry[8].

4.4 Conversion of asPECT into an EPD generator

The current version of asPECT differs from an EPD generator in a number of ways:

- It calculates embodied carbon not the full range of environmental impacts required for an EPD (potentially over twenty). The two main sources of data for asPECT, the DEFRA conversion factors and the ICE database, only provide information on carbon or GHGs. Additional sources of data would need to be found for a full LCA.
- asPECT and the default data it contains have not been verified by a certified third party. The default values can be modified and not all are based on verified data. In addition

[4] https://www.climateearth.com/epd-generator/

[5] https://www.pse-solutions.ch/web/epd-generator-211.html

[6] https://epd.thinkstep.com/services/epd-automation

[7] http://www.asphaltpavement.org/EPD

[8] https://www.igbc.ie/wp-content/uploads/2018/06/General-Programme-Instructions_June_18.pdf

to the LCA results, the manufacturing company and product details also need to be verified for an EPD.

- The current version of the tool does not produce outputs in the standard EPD format. One of the functions of an EPD is to present environmental data in a standardised format.
- asPECT would need to comply with ISO 14025 and EN 15804 in addition to ISO 14040/44.
- There is an existing proprietary PCR for asphalt mixtures (Europe, Australia) - PCR 2018:04 [9], and there are some differences between this PCR and the asPECT methodology:
    - asPECT produces results for per tonne of asphalt per year and the PCR states the functional unit is $1m^2$ of paved surface.
    - The default service life is 40 or 30 years and asPECT uses a range of design lives depending on type of pavement.
    - The PCR says lubricants should be included and they are not in asPECT.
    - The PCR states that sensitivity analysis and a data quality assessment needs to be carried out.
    - asPECT covers cradle to grave life cycle stages, but without the use phase. EPDs are normally cradle to gate, although it depends on the product. The PCR sets cradle to gate as the minimum boundary with inclusion of construction, use and end of life as optional. The categories are cradle to gate, cradle to gate with options and cradle to grave. The values for the different life stages defined in the PCR need to be quoted separately (which asPECT does). The calculation excludes the production of equipment to produce asphalt.
- There is also prEN 17392:2019 Sustainability of construction works - Environmental product declarations - Core rules for road materials Part 1: Bituminous Mixtures to be used in the International EPD System which is under development.

These differences mean that conversion of asPECT to an EPD generator would take substantial work. There would also need to be additional support items required such as putting in place a verification process and management of the tool.

[9] https://www.environdec.com/PCR/Detail/?Pcr=12328

5 The future of asPECT

5.1 Current and future use

Records show that there have been 1,964 downloads of asPECT version 3.1 from May 2013 to March 2019. The registered users are from a mixture of client, contractor, manufacturer and research organisations. The tool has been referenced and used by the road industry and researchers both in the UK and internationally. However, it is unknown if it has been used for its intended purpose i.e. to compare mixes, recycling content etc. and influence decision-making.

Since asPECT was first developed nearly ten years ago, political and public interest in addressing climate change has increased and so has the number of carbon tools available, the availability of environmental data (e.g. from EPDs) and sustainable procurement requirements. This would be an opportune time to consider the tool's functionality and use i.e. if it has the potential to play a greater role in decision-making and how it could be developed further. Carbon tools such as asPECT enable consistent and transparent measurement so that areas of focus can be identified and progress measured. They should align and feed into Highways England 's sustainable development action plan and its overall carbon reduction goals. Therefore the future of asPECT should be considered within this context, and in relation to the future needs of Highways England and its suppliers. There are a number of directions asPECT could be taken, and for informed decisions to be made further information and discussions are required.

5.2 Recommendations

5.2.1 asPECT development

In order for asPECT to be able to better support Highways England's and industry's carbon and sustainability goals, we have identified the following recommendations:

1) **Hold a wider discussion on carbon tools to establish if what is currently available meets the current and future industry needs**

Open up the discussion with different parts of Highways England and its suppliers on what is required in terms of carbon tools in the highway industry. For example - What type of tool (or more than one type of tool) is required? Which decisions is it supporting? Should its use be optional or mandatory? How does it affect procurement? How are the results verified? Who will use it?

It is recommended that this involves internal and external engagement activities such as:

- A cross-organisational workshop within Highways England
- An industry workshop for Highways England, contractors and manufacturers
- An online survey of stakeholders on views on carbon tools
- Discussions with other NRAs e.g. from Norway, the Netherlands and Sweden on how they use LCA and carbon tools.

- It would also be useful to know how the current version of asPECT is used, what issues people found and how they used it. A survey could be sent to users of the tool for their feedback, with follow up telephone interviews if appropriate.

2) Investigate how asPECT and the Highways England carbon accounting tool could be used in conjunction with each other to meet the needs established in recommendation 1

The Highways England carbon tool has just been updated and is published on the Highways England website. It is not a lifecycle tool so different standards apply, but it contains carbon factors for some of the same materials, fuels etc. as included in asPECT. The results of asPECT could feed into the tool instead of using the default asphalt value currently listed. A better understanding of how asPECT and other Highways England sustainability tools and policies could be employed in a more integrated manner to meet Highways England's objectives would be useful.

Transport Scotland also has a carbon tool, the road infrastructure projects tool[10], which is part of its carbon management system suite of tools. This also should be reviewed to check the three tools have no conflicting data or approaches.

3) Investigate the need for and feasibility of expanding the scope of asPECT

asPECT could be expanded to include:

- Other high carbon intensity materials used in highway construction.
- More novel / low carbon components e.g. tyre rubber
- Greater choice on % polymer or type of polymer in PMB
- Other types of environmental impacts i.e. to become an LCA tool rather than a carbon tool. However sourcing the data may be a challenge as it is less readily available than carbon data.
- Other asset types or activities e.g. bridges, earthworks.
- Alignment of inputs and outputs with BIM

This may require additional research if these figures are not available from existing studies. The benefits and feasibility of expanding asPECT in different ways could be evaluated and the results used to produce a tool development plan with a timeline and estimated costs.

4) Evaluate the benefits and feasibility of converting asPECT into an EPD generator

Converting asPECT into an EPD generator would represent a step-change both in the tool's development and how it is used. As discussed in Section 4 there are number of key differences between an EPD generator and asPECT. This recommendation would require

[10]Roads infrastructure projects tool

https://www.transport.gov.scot/media/3466/forth_replacement_crossing__frc______m9_junction_1a_____appendix_f.pdf recommendation 3 to be completed and ideally 1 and 2. It would also require modifications to the tool to meet the required standards and the addition of reporting template.

The conversion to an EPD generator also changes the use of the tool. The tool and its results would need more official verification and support. asPECT would change from an advisory research-based tool to a more official and commercial tool. If it is used in an official capacity it would need more formal documentation, presentation and management. Perhaps, as other NRAs have done, handing it to a third party to manage, so that regular maintenance, updates could be done and there is a help desk facility. It is possible users could be charged to use the tool to fund the support required. This type of tool is likely to be used more by the industry and be higher in profile, especially if recommendation 5 was also carried out. It is recommended that the internal and external appetite for such a tool and the benefits it would provide above the existing tool are mapped out, a feasibility study is carried out and deployment plan developed before this is undertaken.

5) Carry out dissemination of asPECT and encourage its use

There has not been much dissemination of asPECT since it was developed, and although some people within the industry are aware of the tool, a greater level of awareness is preferable. This could take the form of a workshop, conference presentation, trade publication articles and social media activity describing the updated tool.

Its use could be encouraged, for example by referring to it in the Highways England's carbon tool guidance.

5.2.2 Related activities

Some additional recommendations not directly related to asPECT, but related to the use of carbon tools to support GHG emission reductions are:

1) Lobbying for a national EPD database and standard methodology

In the longer term it would be useful to have a national database of carbon/ EPD data that the whole construction industry would use as well as an agreed methodology and verification process for inclusion of EPD and carbon data in the database. One verified source of information would reduce the resources required by the industry in calculating carbon and create a more consistent and robust basis for making procurement decisions.

This proposal is something that the collaborative partners could raise with DfT and BEIS. An industry wide consultation to provide evidence to support the proposal may be useful. With the recent UK Government target for net zero GHG emissions by 2050 and some major infrastructure projects planned this may be a good time to raise this.

2) Explore the use of carbon/LCA tools in procurement

There are a number of other countries using or exploring the use of carbon and LCA tools in sustainable procurement in order to encourage their supply chain to reduce carbon emissions. They reported that using carbon/LCA tools to measure and set targets for construction projects and providing financial incentives for meeting these targets successfully reduced carbon by a significant amount. Therefore it is suggested that the application of this approach in the UK is explored. This would align with Highways England's Road Investment Strategy performance indicator on reducing supply chain carbon emissions. Highways England has been collecting data on the carbon emissions associated major projects for a number of years, so should help to inform baseline targets.

asPECT's current product-based approach would not be directly suitable for this purpose, but it could feed into a suitable project-based tool, becoming one of a suite of carbon management tools. Use could be advisory or mandatory. It is recommended that there is an impact assessment with supply chain consultation and that the approach is piloted on selected projects before it is fully implemented.

Appendix A Proposed updates to asPECT constants file

The proposed changes to be made to the asPECT constants file as part of sub-task 4.1 are given in Table 2,

Table 3 and Table 4. These were related to material and transport carbon emissions. Other items such as pavement design lives and planning depths were not changed.

Table 2. Current and proposed material constants

Constant	asPECT v3.1 default (in $kgCO_2e$ per tonne unless otherwise stated)	Proposed new default (in $kgCO_2e$ per tonne unless otherwise stated)	Source
CO_2e content per tonne of virgin aggregate	5.99	4.93	New source ICE v3
CO_2e content per tonne of future bitumen	190	150	Old source Eurobitume 2012 New source Eurobitume 2020
Rate at which RAP is recovered and used in new mixtures	0.95	No change	
Proportion of soluble binder content in RAP	1	No change	
CO_2e per tonne impact anticipated for processing RAP excavated	1	1.009	Old source Defra 2013 New source asphalt closed loop recycling in the BEIS 2019 spreadsheet.
CO_2e per tonne impact associated with decomposition of excavated material in landfill	2	1.264	Old source Defra 2013 New source the waste to landfill for asphalt in the BEIS 2019 spreadsheet.
Proportion of recycling benefit to recycling in the current mix	60	75	Modified to encourage closed-loop recycling

Constant	asPECT v3.1 default (in $kgCO_2e$ per tonne unless otherwise stated)	Proposed new default (in $kgCO_2e$ per tonne unless otherwise stated)	Source
Proportion of recycling benefit to recycling future mixtures	40	25	Modified to encourage closed-loop recycling
Electricity UK grid (includes generation, transmission and distribution emissions and WTT) – per kWh	0.5600	0.31598	Old source Defra 2013 New source BEIS 2019
Renewable retain	0	No change	
Renewable sell	0.5600	0.31598	
Diesel fuel (forecourt) (includes emissions plus WTT)	Per tonne - 3866.3 12693 – kWh per tonne Per kWh - 0.3046 Per litre - 3.2382 10.63 – kWh per litre	3926.69 12615 0.3116 3.2984 10.60	Old source Defra 2013 (out of scope not included) New source BEIS 2019 (includes out of scope)
Petrol fuel (forecourt) (includes emissions plus WTT)	Per tonne – 3777.1 kWh per tonne - 13062 Per kWh (gross) - 0.2887 Per litre -2.7732 kWh per litre -9.606	3904.86 12804 0.30471 2.87766 9.44	Old source Defra 2013 (out of scope not included) New source BEIS 2019 (includes out of scope)
Natural gas (UK mains) (includes emissions plus WTT)	Per kWh – 0.2121 Per m^3 – 2.3277	0.2078 2.2946	Old source Defra 2013 New source BEIS 2019

Constant	asPECT v3.1 default (in $kgCO_2e$ per tonne unless otherwise stated)	Proposed new default (in $kgCO_2e$ per tonne unless otherwise stated)	Source
	kWh per m^3 – 10.97	11.06	
Gas oil (emissions and WTT)	Per tonne – 4101.9 kWh per tonne – 12610 Per kWh- 0.3253 Per litre – 3.5119 kWh per litre – 10.80	3970.56 12579 0.31564 3.39074 10.74	Old source Defra 2013 New source BEIS 2019
Fuel oil (emissions and WTT)	Per tonne - 3841.1 kWh per tonne – 12026 Per kWh – 0.3194 Per litre kWh per litre	3827.72 12015 0.31858 3.78229 11.87	Old source Defra 2013 New source BEIS 2019
Burning oil (emissions and WTT)	Per tonne – 3824.2 kWh per tonne – 12889 Per kWh – 0.2967 Per litres – 3.0667 kWh per litre – 10.34	3823.46 12828 0.29805 3.0686 10.30	Old source Defra 2013 New source BEIS 2019
Industrial coal (emissions and WTT)	Per tonne – 2732.1 Tonnes to kWh - 7473	2835 7428	Old source Defra 2013 New source BEIS 2019

Constant	asPECT v3.1 default (in $kgCO_2e$ per tonne unless otherwise stated)	Proposed new default (in $kgCO_2e$ per tonne unless otherwise stated)	Source
	Per kWh – 0.3656	0.3816	
Liquid petroleum gas (emissions and WTT)	Per tonne – kWh per tonne - Per litre – 1.6799 KWh per litre- 6.959 Per kWh – 0.2414	3306.16 13693 1.71497 7.099 0.24144	Old source Defra 2013 New source BEIS 2019
Naphtha	Per tonne – 3585.9 kWh per tonne - 13247 Per kWh - 0.2707	3783.67 13289 0.2847	Old source Defra 2013 New source BEIS 2019
Biodiesel (emission plus WTT)	Per litre - 0.95772 kWh per litre – 9.195 Per tonne – kWh per tonne - Per kWh – 0.1041	2.8885 9.564 3247.92 10750 0.302	Old source Defra 2013 (out of scope not included) New source BEIS 2019 (out of scope included)
Bioethanol (emission plus WTT)	Per litre – 0.9300 kWh per litre – 5.912 Per tonne –	3.1395 6.553 2693.63	Old source Defra 2013 (out of scope not included)

Constant	asPECT v3.1 default (in $kgCO_2e$ per tonne unless otherwise stated)	Proposed new default (in $kgCO_2e$ per tonne unless otherwise stated)	Source
	kWh per tonne - Per kWh – 0.1573	8250 0.4791	New source BEIS 2019 (out of scope included)
Biomethane	Per tonne – 1328.6 kWh per tonne – 13613 Per kWh – 0.0976	3358.27 15122 0.2221	Old source Defra 2013 (out of scope not included) New source BEIS 2019 (out of scope included)
Wood pellets	Per tonne – 183.9 kWh per tonne - 4715 Per kWh - 0.0390	1885.58 5080 0.3712	Old source 2013 (out of scope not included) New source BEIS 2019 (out of scope included)
Explosives – ANFO (cradle to grave + emission during explosion in kg)	4.067	Same	Old source estimate from IPCC emission factors, 2006
Explosives – Emulsion (cradle to grave manufacture + emissions during explosion in kg)	4.066	Same	Old source estimate from IPCC emission factors, 2006
Explosives – Nitro (cradle to grave + emission during explosion in kg)	4.0661	Same	Old source estimate from IPCC emission factors, 2006
Water (UK mains)	0.3441	0.344	Old source water 2011 New source BEIS 2019

Constant	asPECT v3.1 default (in $kgCO_2e$ per tonne unless otherwise stated)	Proposed new default (in $kgCO_2e$ per tonne unless otherwise stated)	Source
Adhesion agents	1200	Same	Old source industry average, 2009
Bitumen	190	150	Old source Eurobitume 2012 New source Eurobitume 2020
Bitumen emulsion (residual bitumen)	220	180	Old source Eurobitume 2012 New source Eurobitume 2020
Cement (Portland cement CEM I)	913	860	Old source BCA, CSMA, UKQAA, 2009. Factsheet was updated in 2019.
Fibres	0.78	0.199	Old source industry average 2009 New source industry average, 2019
Fluxes (kerosene based)	370	Same	Old source EC, 2009 – The ELCD database was discontinued in 2018.
GGBS	67	79.6	Old source mpa, csma and UK QAA factsheet 18. Factsheet was updated in 2019.
Hydrated lime	780	Same	Old source Hammond and Jones, 2011

Constant	asPECT v3.1 default (in $kgCO_2e$ per tonne unless otherwise stated)	Proposed new default (in $kgCO_2e$ per tonne unless otherwise stated)	Source
			Same as ICE v3
PFA (as binder)	4.0	0.1	Old source BCA, CSMA, UKQAA, 2009. New factsheet, 2019.
Polymer modified bitumen (this is based on a polymer content of 5%)	370	340	Old source Eurobitume 2012 New source Eurobitume 2020
PMB emulsion (residual bitumen)	350	300	Old source RBA, 2010 New source Eurobitume 2020
Wax (Fischer-Tropsch synthetic wax)	5700	2010	Old source European Joint Research Centre, 2008 New source Industry average, 2019.
Wax (crude derived paraffin wax)	370	Same	Old source EC, 2009

Table 3. Current and proposed road transport constants

Vehicle/load	asPECT v3.1 default (per km)	Proposed new default (per km)	Source
Rigid (>3.5 - 7.5 tonnes)/ 0% Laden (emissions plus WTT)	0.6652	0.56677	Old source Defra 2013 New source BEIS 2019
Rigid (>3.5 - 7.5 tonnes)/ 50% Laden (emissions plus WTT)	0.7224	0.61527	Old source Defra 2013 New source BEIS 2019
Rigid (>3.5 - 7.5 tonnes)/ 100% Laden (emissions plus WTT)	0.7795	0.66376	Old source Defra 2013 New source BEIS 2019
Rigid (>7.5 tonnes-17 tonnes)/ 0% laden (emissions plus WTT)	0.7958	0.68553	Old source Defra 2013 New source BEIS 2019
Rigid (>7.5 tonnes-17 tonnes)/ 50% laden (emissions plus WTT)	0.9075	0.78187	Old source Defra 2013 New source BEIS 2019
Rigid (>7.5 tonnes-17 tonnes)/ 100% laden (emissions plus WTT)	1.0205	0.87822	Old source Defra 2013 New source BEIS 2019
Rigid (>17 tonnes)/ 0% laden (emissions plus WTT)	0.9582	0.95008	Old source Defra 2013 New source BEIS 2019
Rigid (>17 tonnes)/ 50% laden (emissions plus WTT)	1.1657	1.15475	Old source Defra 2013 New source BEIS 2019
Rigid (>17 tonnes)/ 100% laden (emissions plus WTT)	1.3733	1.35942	Old source Defra 2013 New source BEIS 2019

Vehicle/load	asPECT v3.1 default (per km)	Proposed new default (per km)	Source
Articulated (>3.5 - 33t)/ 0% laden (emissions plus WTT)	0.883	0.79458	Old source Defra 2013 New source BEIS 2019
Articulated (>3.5 - 33t)/ 50% laden	1.1075	0.98962	Old source Defra 2013 New source BEIS 2019
Articulated (>3.5 - 33t)/ 100% laden	1.3266	1.18466	Old source Defra 2013 New source BEIS 2019
Articulated (>33t)/ 0% laden	0.8594	0.82169	Old source Defra 2013 New source BEIS 2019
Articulated (>33t)/ 50% laden	1.1415	1.08986	Old source Defra 2013 New source BEIS 2019
Articulated (>33t)/ 100% laden	1.4236	1.35804	Old source Defra 2013 New source BEIS 2019

Table 4. Current and proposed shipping and rail transport constants

Ship type	asPECT v3.1 default (per tonne km)	Proposed new default (per tonne km)	Source
Large RoPax Ferry	0.46	0.449435	Old source Defra 2013 New source BEIS 2019
Average Ro-RO Ferry	0.061	0.061638	Old source Defra 2013 New source BEIS 2019
Small RO-RO Ferry	0.0722	0.07295	Old source Defra 2013 New source BEIS 2019
Large RO-RO Ferry	0.0593	0.059885	Old source Defra 2013 New source BEIS 2019
Average Products Tanker	0.0107	0.010779	Old source Defra 2013 New source BEIS 2019
Products Tanker under 5k dwt	0.0539	0.054441	Old source Defra 2013 New source BEIS 2019
Products Tanker 5k to 10k dwt	0.035	0.035326	Old source Defra 2013 New source BEIS 2019
Products Tanker 10k to 20k dwt	0.0224	0.022624	Old source Defra 2013 New source BEIS 2019
Products Tanker 20k to 60k dwt	0.0123	0.01246	Old source Defra 2013 New source BEIS 2019

Ship type	asPECT v3.1 default (per tonne km)	Proposed new default (per tonne km)	Source
Products Tanker 60k+ dwt	0.0068	0.006896	Old source Defra 2013 New source BEIS 2019
Average Bulk Carrier	0.0042	0.004223	Old source Defra 2013 New source BEIS 2019
Bulk Carrier under 10k dwt	0.035	0.035326	Old source Defra 2013 New source BEIS 2019
Bulk Carrier 10k to 35k dwt	0.0095	0.009557	Old source Defra 2013 New source BEIS 2019
Bulk Carrier 35k to 60k dwt	0.0068	0.006896	Old source Defra 2013 New source BEIS 2019
Bulk Carrier 60k to 100k dwt	0.0049	0.00496	Old source Defra 2013 New source BEIS 2019
Bulk Carrier 100k to 200k dwt	0.0036	0.00363	Old source Defra 2013 New source BEIS 2019
Bulk Carrier 200k+ dwt	0.003	0.00303	Old source Defra 2013 New source BEIS 2019
Average General Cargo	0.0156	0.015788	Old source Defra 2013 New source BEIS 2019

Ship type	asPECT v3.1 default (per tonne km)	Proposed new default (per tonne km)	Source
General Cargo under 5k dwt (100+TEU)	0.0237	0.023954	Old source Defra 2013 New source BEIS 2019
General Cargo 5k to 10k dwt (100+TEU)	0.021	0.021171	Old source Defra 2013 New source BEIS 2019
General Cargo 10k+ dwt (100+TEU)	0.0132	0.013307	Old source Defra 2013 New source BEIS 2019
General Cargo under 5k dwt	0.0166	0.016815	Old source Defra 2013 New source BEIS 2019
General Cargo 5k to 10k dwt	0.0189	0.019115	Old source Defra 2013 New source BEIS 2019
General Cargo 10k+ dwt	0.0142	0.014397	Old source Defra 2013 New source BEIS 2019
Average Container	0.0191	0.01926	Old source Defra 2013 New source BEIS 2019
Container under 1k TEU	0.0435	0.043916	Old source Defra 2013 New source BEIS 2019
Container 1k to 2k TEU	0.0384	0.038834	Old source Defra 2013 New source BEIS 2019

Ship type	asPECT v3.1 default (per tonne km)	Proposed new default (per tonne km)	Source
Container 2k to 3k TEU	0.0239	0.024196	Old source Defra 2013 New source BEIS 2019
Container 3k to 5k TEU	0.0199	0.020082	Old source Defra 2013 New source BEIS 2019
Container 5k to 8k TEU	0.0199	0.020082	Old source Defra 2013 New source BEIS 2019
Container 8k+ TEU	0.015	0.015122	Old source Defra 2013 New source BEIS 2019
General Rail Freight	0.0329	0.04116	Old source Defra 2013 New source BEIS 2019
Aggregate Rail Freight	0.0211	No change	Old source 2001 AEA report for DfT[11]. Class 66 train used. 2019 - Class 66 still used. The proportion of trains with EASS[12] installed may have increased which could decrease emissions.
Loading/Unloading	1.8	No change	

[11] https://webarchive.nationalarchives.gov.uk/+/http:/www.dft.gov.uk/pgr/rail/researchtech/research/railemissionmodel.pdf

[12] AESS (Auto Engine Stop System) technology reportedly reduces idling time by a third. It is being fitted to an increasing number of class 66 trains.

Comments on the data sources

Defra emission factors

- From 2013 onwards annual figures rather than 5 year rolling averages are used.
- Emissions include autogeneration and imported electricity.
- For the more recent updates the user needs to add electricity generated and transmission/distribution figures together, the total is no longer provided.
- The figures don't include emissions from production and transport of fuel to power stations.
- Defra no longer publishes the emissions factors for company reporting. These are now published by the Department for Business, Energy & Industrial Strategy (BEIS). The figures here reflect the version of these factors published in November 2019[13].

ICE database v3

- Different values for recycled products and virgin materials were removed as these are too variable. Average recycled content is used instead.
- Data quality scores have been introduced.
- There are more statistics and references in the material profiles.
- There are additional items such as building materials and specific concrete mixtures.

[13] www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2019

Appendix B Example EPD

An example of an EPD is provided below. This is for asphalt and was published by Peab Asfalt in Sweden. https://www.environdec.com/Detail/?Epd=13378

Environmental Product Declaration – EPD

ECO-ASFALT®

ENVIRONMENTAL PRODUCT DECLARATION IN ACCORDANCE WITH ISO 14025 AND EN 15804

EPD registration number: S-P-01172

Date of publication: 2018-01-09

Version date: 2018-07-05

Date of validity: 2023-01-08

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Environmental Product Declaration

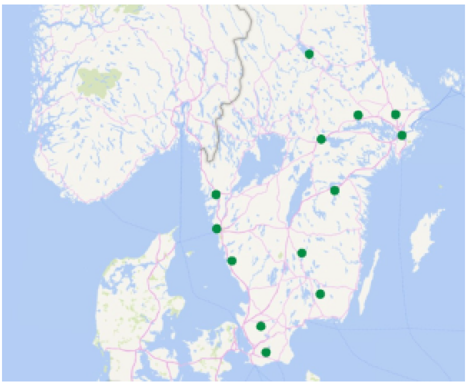
DESCRIPTION OF THE PRODUCT

The product ECO-Asfalt® was produced at thirteen of Peab Asfalt's stationary asphalt plants in Sweden in 2017, and total production of ECO-Asfalt® and ECO-Asfalt® Plus reached over 1.8 million tons. ECO-Asfalt® can completely replace conventional hot-mixed asphalt in all types of applications, such as high-speed roads, airfields, industrial plants, ports, streets and cycle paths.

The asphalt types covered in this EPD are AG, ABB, ABT and ABS, in all cases intended for the paving of roads. The intended use of the EPD is for business-to-business communication. As the variation in input between different production plants are small (t <10% in relation to all assessed impact categories), results are presented as averages for all thirteen plants.

ECO-Asfalt® is currently produced in the following stationary asphalt plants:

- Lekhyttan (Örebro)
- Dingtuna (Västerås)
- Västberga (Stockholm)
- Styvinge (Linköping)
- Kållered (Göteborg)
- Fröland (Uddevalla)
- Vålberg (Karlstad)
- Veberöd (Lund)
- Vidbo (Arlanda)
- Bjärsgård (Klippan)
- Rällsjön (Leksand)
- Linneryd (Linneryd)
- Sävsjö (Sävsjö)



Peab Asfalt intends to convert all of its remaining stationary asphalt plants in Sweden to producing ECO-Asfalt® by 2020.

PRODUCTION PROCEDURE

When making ECO-Asfalt®, bio-fuel is used for drying and heating the aggregate material, the process which requires the greatest amount of energy in the production process, see Figure 1. The asphalt plant receives unbound aggregate material in several fractions. These are dried, sieved and added to a pug mill in controlled proportions according to a recipe. The binder, bitumen, is stored in heated storage tanks and added to the aggregate material in the same way, together with an adhesive promoter, amine. When cellulose fibre is used (in ABS), it is added directly to the mixer. The pug mill drops the asphalt mix into isolated storage silos, according to mix type, after which trucks are loaded from the respective silo.

Reused asphalt (also illustrated in Figure 1) can be added to the mixture in a procedure similar to the drying of the aggregate material. This is further described in the section Additional environmental information.

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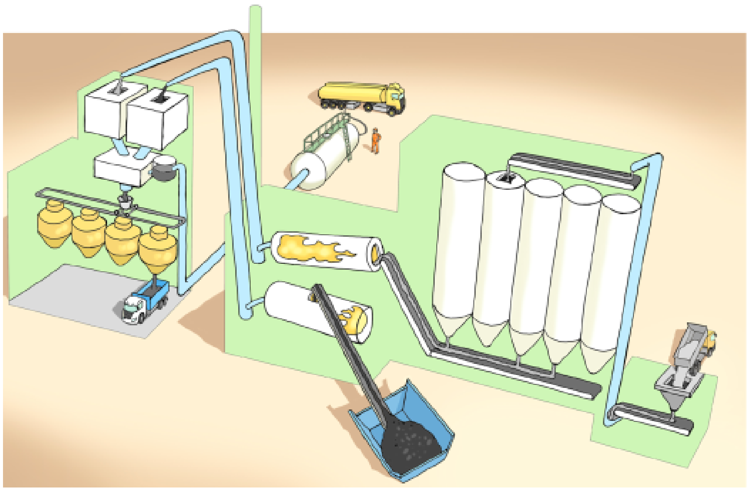

Figure 1 Illustration of the production procedure in an asphalt plant.

The composition of each type of asphalt produced in the plants included in the assessment is presented in Table 1, and details for each of the components are presented in Table 2.

Table 1 Composition declaration of the asphalt types declared. Data might not total 100% due to rounding.

Weight-%	AG 4,8%	ABB 5,2%	ABS 6,6%	AG 4,8% PMB	ABB 5,2% PMB	ABT 6,4% PMB	ABS 6,6% PMB	ABS 6,6% special stone	ABS 6,6% PMB special stone
Aggregate	95,20	94,80	93,36	95,20	94,80	93,60	93,36	28,00	98,00
Bitumen	4,80	5,20	6,60	-	-	-	-	6,60	-
Polymer bitumen (PMB)	-	-	-	4,80	5,20	6,40	6,60	-	6,60
Adhesion material	3,0E-04	3,0E-04	4,0E-04	4,0E-04	3,0E-04	4,0E-04	4,0E-04	4,0E-04	4,0E-04
Cellulose	-	-	0,035	-	-	-	0,035	0,035	0,035
Special stone	-	-	-	-	-	-	-	65,36	65,36

"E-" is written as a substitute for the number of zeros. For example 3,5 E-02 means 0,035.

Table 2 Details regarding the content of the asphalt type declared.

Component	Trade name	Substance name	CAS no	REACH no	Classification
Mineral rock aggregate	-	Granite, porphyry	-	-	-
Bitumen	Nynas 50/70, 70/100, 100/150, 160/220	-	8052-42-4	01-2119480172-44	Not classified
Adhesion material	Wetfix BE	Fatty acids, C18 unsaturated, reaction product with ammonia-ethanolamine reaction by-products	68910-93-0 272-756-1	01-2119492544-31-0000	H315 Skin irritation H318 Severe eye damages H400 Aquatic acute H410 Aquatic chronic
	Terra E	Ashes, Lime (CaO)	1305-78-8	01-2119475325-36-0030	H315 Skin irritation H318 Severe eye damages H335 May cause respiratory irritation
Cellulose	On-Way Arbocel ZG 8-1	Cellulose Calcium carbonate	9004-34-6 471-34-1	NA	NA
	Topcel	Cellulose Natural wax	9004-34-6 8002-53-7	NA	NA

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Life cycle assessment – General information

DECLARED UNIT

The declared unit is 1 ton (1000 kg) of asphalt at production plant gate. The asphalt is manufactured according to relevant standards, mainly described in SS-EN standards and AMA Anläggning 13.

METHODOLOGY

The environmental impact of Peab Asfalt's product ECO-Asfalt® was calculated according to the rules of the CEN standard EN 15804. The PCR Construction products and construction services 2012 v.2.2 (EPD International, 2012) is the basis for the calculation of the life cycle assessment (LCA) from cradle to gate, modelled in GaBi. The aim of the LCA was to serve as basis for the development of an EPD.

SYSTEM BOUNDARY AND ALLOCATION

The LCA covers the cradle-to gate stages, i.e. extraction and transports of raw materials (upstream modules A1-A2) and manufacturing to production plant gate (core module A3), see Figure 2 and Figure 3. The LCA covers all thirteen Swedish production plants where ECO-Asfalt® has been produced since January 2017.

Upstream	Core		Downstream														Other env. info
Production stage			Construction process		Use stage							End of life stage				Resource recovery stage
Raw material supply	Transport	Manufacturing	Transport	Manufacturing	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	De-construction demoli-tion	Transport	Waste processing	Disposal	Future reuse, recycling or energy recovery potential
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
X	X	X	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND

Figure 2 The system boundaries of the LCA. Modules of the production life cycle included in the EPD. (X = declared module; MND = not declared module).

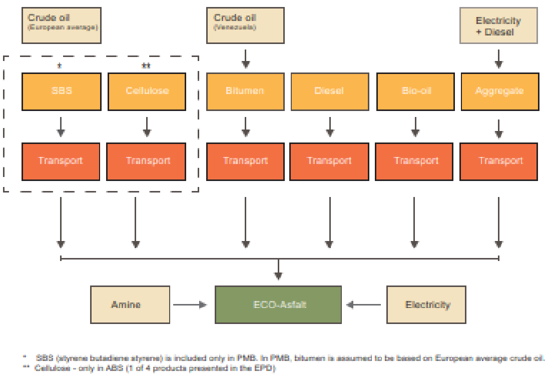

Figure 3 The declared modules are extraction and transports of raw materials (upstream modules A1-A2) and manufacturing to production plant gate (core module A3).

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In the life cycle inventory (LCI), mass allocation is used for extraction and transport and economic allocation is used when byproduct with lower economic value occurs e.g. for the refinery stage (Eurobitumen, 2012). Bio-oil used for energy provision in the production of ECO-Asfalt® was modelled with an economic allocation for the allocation of environmental burdens between the main product (vegetable oils used in the food industry) and by-products (free fat-acids sold as fuel under the name "bio-oil"). The allocation is based on the allocation methods presented in the PCR used in the development of the present life cycle assessment (LCA).

In accordance with the PCR used, LCI-data for a minimum of 95% of total inflows (mass and energy) to the upstream and core module were included, and no data with an assumed potential importance in the included modules were omitted from the modelling. Motor and hydraulic oil used in machinery, as well as waste generated from the use of such products were not included in the LCA. Neither were production packaging of input materials nor handling of these packaging waste.

COMPARABILITY

EPD of construction products may not be comparable if they do not comply with EN 15804.

Life cycle inventory data

All foreground data are site specific and collected over 12 months in each of the thirteen production plants where ECO-Asfalt® is produced. Data includes storage of bitumen at the production site. Site specific data was also used for modelling of production and transport of aggregate. As no EPD is available for the bitumen produced by Nynas, representative LCI data for Venezuela bitumen from Eurobitume (2012) was used.

For electricity used in the production process (module A3), data for green electricity (hydro power) is applied, using data from EPD (Vattenfall Vattenkraft AB, 2015). Diesel was used as transport fuel, using generic data from the GaBi database.

Background data was collected from the GaBi database, and is geographically representative of the production site location and less than five years old. The overall data quality can be described as good.

Life cycle assessment – Results

The results of the life cycle assessment of 1 ton (1000 kg) of asphalt of various types are given in Table 3 to Table 6, presenting Potential environmental impact, Use of resources, Waste production and Output flows.

Potential environmental impact

Table 3 Results of the LCA, modules A1-A3 – Potential environmental impact for 1 ton (1000 kg) of specific asphalt types.

Impact category	Unit	AG 16	ABB 22	ABT 16	ABS 11	AG 16 PMB	ABB 22 PMB	ABT 16 PMB	ABS 11 PMB	ABS 11 special stone	ABS 11 PMB special stone
Global Warming Potential*	kg CO_2-Equiv.	26,2	27,5	31,6	34,3	32,6	34,4	40,1	43,0	34,8	43,5
Acidification Potential	kg SO_2-Equiv.	0,3	0,3	0,3	0,4	0,4	0,4	0,4	0,4	0,3	0,4
Eutrophication Potential	kg Phosphate-Equiv.	0,1	0,1	0,1	0,1	0,1	0,1	0,1	0,1	0,1	0,1
Ozone Layer Depletion	kg R11-Equiv.	1,9E-06	1,9E-06	2,1E-06	2,2E-06	1,9E-06	1,9E-06	2,1E-06	2,1E-06	2,4E-06	2,4E-06
Photochem. Ozone Creation Potential	kg Ethene-Equiv.	3,5E-02	3,6E-02	3,9E-02	4,0E-02	4,3E-02	4,5E-02	5,1E-02	5,2E-02	3,3E-02	4,4E-02
Abiotic Depletion (elements)	kg Sb-Equiv.	3,1E-05	3,1E-05	3,1E-05	3,1E-05	3,1E-05	3,1E-05	3,1E-05	3,1E-05	3,7E-05	3,7E-05
Abiotic Depletion (fossil)	MJ	2316	2499	3056	3163	2402	2593	3171	3282	3180	3330

"E-" is written as a substitute for the number of zeros. For example 3,5 E-02 means 0,035.
* The GWP indicator does not account for biogenic carbon stored in the final product.

Environmental impact across all categories varies less than 5% between the asphalt plants.

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Use of resources

Table 4 Results of the LCA, modules A1-A3 – Use of resources for 1 ton (1000 kg) of specific asphalt types.

Impact category	Unit	AG 16	ABB 22	ABT 16	ABS 11	AG 16 PMB	ABB 22 PMB	ABT 16 PMB	ABS 11 PMB	ABS 11 special stone	ABS 11 PMB special stone
Use of renewable primary energy excluding renewable primary energy resources used as raw materials	MJ	267	267	267	267	267	267	267	267	268	268
Use of renewable primary energy resources used as raw materials	MJ	0	0	1	36	0	0	1	36	36	36
Total use of renewable primary energy resources (primary energy and primary energy resources used as raw materials)	MJ	267	267	267	303	267	267	267	303	304	304
Use of non-renewable primary energy excluding non- renewable primary energy resources used as raw materials	MJ	2161	2340	2882	2988	2253	2440	3005	3115	2988	3115
Use of non-renewable primary energy resources used as raw materials	MJ	162	167	182	185	160	165	180	182	230	227
Total use of non-renewable primary energy resources (primary energy and primary energy resources used as raw materials)	MJ	2323	2507	3064	3173	2413	2605	3185	3297	3218	3342
Use of secondary material	kg	0	0	0	0	0	0	0	0	0	0
Use of renewable secondary fuels	kg	0	0	0	0	0	0	0	0	0	0
Use of non-renewable secondary fuels	kg	0	0	0	0	0	0	0	0	0	0
Use of net fresh water	m^3	1,15	1,15	1,15	1,15	1,48	1,51	1,59	1,61	1,15	1,61

Waste production

Table 5 Results of the LCA, modules A1-A3 – Waste production for 1 ton (1000 kg) of specific asphalt types.

Results	Unit	AG 16	ABB 22	ABT 16	ABS 11	AG 16 PMB	ABB 22 PMB	ABT 16 PMB	ABS 11 PMB	ABS 11 special stone	ABS 11 PMB special stone
Hazardous waste disposed	kg	2,8E-06	2,8E-06	3,0E-06	3,1E-06	9,9E-05	1,1E-04	1,3E-04	1,3E-04	5,3E-06	1,4E-04
Non-hazardous waste disposed	kg	0,8	0,8	1,0	3,8	0,8	0,8	0,9	3,8	4,0	4,0
Radioactive waste disposed	kg	1,7E-04	1,8E-04	2,0E-04	8,6E-04	1,7E-04	1,8E-04	2,0E-04	8,6E-04	9,5E-04	9,5E-04

"E-" is written as a substitute for the number of zeros. For example 3,5 E-02 means 0,035.

Output flows

Table 6 Results of the LCA, modules A1-A3 – Output flows for 1 ton (1000 kg) of specific asphalt types.

Results	Unit	AG 16	ABB 22	ABT 16	ABS 11	AG 16 PMB	ABB 22 PMB	ABT 16 PMB	ABS 11 PMB	ABS 11 special stone	ABS 11 PMB special stone
Components for re-use	kg	0	0	0	0	0	0	0	0	0	0
Materials for recycling	kg	0	0	0	0	0	0	0	0	0	0
Materials for energy recovery	kg	0	0	0	0	9,3E-04	1,0E-03	1,2E-03	1,3E-03	0	1,3E-03
Exported energy	MJ	0	0	0	0	0	0	0	0	0	0

"E-" is written as a substitute for the number of zeros. For example 3,5 E-02 means 0,035.

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Additional environmental information

Asphalt is 100% recyclable, offering the possibility to reduce environmental impact by reducing the need for new raw materials. Today, reused asphalt is included in the manufacture of new asphalt for several applications, with maintained technical performance. The recommended amount will however vary from case to case. The below example shows the potential environmental impact from including 10% reused asphalt.

Table 7 Result of Potential environmental impact including 10% reused material content, modules A1-A3.

Impact category	Unit	AG 16 10% RAP	ABB 22 10% RAP	ABT 16 10% RAP	ABS 11 10% RAP	AG 16 PMB 10% RAP	ABB 22 PMB 10% RAP	ABT 16 PMB 10% RAP	ABS 11 PMB 10% RAP	ABS 11 special stone 10% RAP	ABS 11 PMB special stone 10% RAP
Global Warming Potential (exluding biogenic CO_2)	kg CO_2-Equiv.	25,1	26,4	30,5	33,2	30,9	32,7	38,4	41,3	33,7	41,8
Acidification Potential	kg SO_2-Equiv.	0,3	0,3	0,3	0,3	0,3	0,4	0,4	0,4	0,3	0,4
Eutrophication Potential	kg Phosphate-Equiv.	0,1	0,1	0,1	0,1	0,1	0,1	0,1	0,1	0,1	0,1
Ozone Layer Depletion	kg R11-Equiv.	1,89E-06	1,96E-06	2,15E-06	2,19E-06	1,87E-06	1,93E-06	2,13E-06	2,16E-06	2,44E-06	2,41E-06
Photochem. Ozone Creation Potential	kg Ethene-Equiv.	0,03	0,03	0,04	0,04	0,04	0,04	0,05	0,05	0,03	0,04
Abiotic Depletion (elements)	kg Sb-Equiv.	3,06E-05	3,06E-05	3,07E-05	3,08E-05	3,06E-05	3,06E-05	3,06E-05	3,08E-05	2,68E-05	2,68E-05
Abiotic Depletion (fossil)	MJ	2120	2290	2860	2960	2190	2380	2960	3070	2980	3090

"E-" is written as a substitute for the number of zeros. For example 3,5 E-02 means 0,035.

RAP = Reclaimed asphalt pavement

When using the Swedish Transport Administration's (Trafikverket) lifecycle calculation tool EKA, the results diverge from the results presented in this EPD. This is mainly due to two global warming potential values, GWP. The GWP value for bitumen used in EKA, from Eurobitume LCI 2012, is without regard to the actual crude bitumen oil source in Venezuela. The GWP value for bio-oil used in EKA considers the bio-oil to be carbon dioxide neutral with only a small contribution from extraction and transportation, in accordance with the sustainability criteria of the Swedish Renewables act (Hållbarhetslagen 2011) and as certified by the Swedish Energy Agency (Energimyndigheten). The results from EKA are presented in Table 8 and 9 with and without a 10% reused material content.

Table 8 Result of Potential environmental impact, according to Trafikverket´s tool EKA, modules A1-A3.

Impact category	Unit	AG 16	ABB 22	ABT 16	ABS 11	AG 16 PMB	ABB 22 PMB	ABT 16 PMB	ABS 11 PMB	ABS 11 special stone	ABS 11 PMB special stone
Global Warming Potential	kg CO_2-Equiv.	15,9	16,7	19,3	20,4	24,5	26,1	30,8	32,3	30,4	42,3

Table 9 Result of Potential environmental impact including 10% reused material content, according to Trafikverket´ s tool EKA, modules A1-A3.

Impact category	Unit	AG 16 10% RAP	ABB 22 10% RAP	ABT 16 10% RAP	ABS 11 10% RAP	AG 16 PMB 10% RAP	ABB 22 PMB 10% RAP	ABT 16 PMB 10% RAP	ABS 11 PMB 10% RAP	ABS 11 special stone 10% RAP	ABS 11 PMB special stone 10% RAP
Global Warming Potential	kg CO_2-Equiv.	14,4	15,2	17,8	18,9	22,3	23,8	28,6	30,1	28,8	40,0

RAP = Reclaimed asphalt pavement

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Verification details

DECLARATION OWNER
Peab Asfalt AB

PROGRAMME OPERATOR
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VERIFICATION
CEN standard EN 15804 served as the core PCR.

PCR:	PCR 2012:01 Construction products and Construction services. Version 2.2, 2017-05-30
PCR review was conducted by:	The Technical Committee of the International EPD® System. Chair: Massimo Marino. Contact via info@environdec.com
Independent verification of the declaration and data, according to ISO 14025:	☐ EPD process certification (Internal) ☒ EPD verification (External)
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Accredited or approved by:	The International EPD® System

DECLARATION NUMBER
S-P-01172

CENTRAL PRODUCT CLASSIFICATION
CPC 15330

REFERENCE YEAR FOR DATA
2017

REPRESENTATIVENESS OF GEOGRAPHICAL AREA
Sweden

EPD® THE INTERNATIONAL EPD® SYSTEM

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EPD ISSUE DATE
2018-01-09

VERSION DATE
2018-07-05

EPD VALID TO
2023-01-08

COMISSIONER OF LCA STUDY
Peab Asfalt AB

LCA PRACTITIONER
Yannos Wikström, IVL

DATE OF ISSUE OF LCA-REPORT
2018-05-17

ADDITIONAL INFORMATION
Peab Asfalt is quality certified according to ISO 9001 and environmentally certified according to ISO 14001.

All of Peab Asfalt's asphalt plants deliver CE-marked asphalt as required by SS-EN ISO 13108-1-8 and SS-EN ISO 13108-20-21.

Environmental product declarations within the same product category from different programs may not be comparable.

This EPD version includes thirteen asphalt plants instead of eight.

The EPD also includes results of the product's GWP-value when using the lifecycle calculation tool EKA.

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About Peab Asfalt AB

Peab Asfalt AB, a subsidiary of Peab AB, is one of Sweden's leading asphalt companies and the only one with a nation-wide coverage, specializing in the production and deployment of hot, semi-hot, cold-mixed asphalt and sealcoating, The company has approximately 700 employees, operates all over in Sweden and has a subsidiary in Norway, Peab Asfalt Norge AS.

The success of Peab Asfalt is based on strong local presence where the company's business is characterized by good business ethics, skills and professionalism, Peab Asfalt's ambition is to take responsibility throughout the entire value chain for the environmental impact, The strive is to reduce climate impact, ensure a highly material effective operation and work actively to phase out environmental and health hazardous materials.

Peab Asfalt is striving to reduce the waste of old asphalt in coating work by reusing asphalt as much as possible in the manufacture of new asphalt, Through the reuse of asphalt directly in place, transportations to landfills are reduced, as well as the need for bitumen and rock materials.

Find out more at peabasfalt.se.

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Review and update of the asPECT carbon footprinting tool for asphalt road pavements

Abstract

The asphalt Pavement Embodied Carbon Tool (asPECT) is a carbon footprinting tool for asphalt road pavements. It was first developed in 2009 as part of a programme of work funded by the collaborative research programme, funded jointly by Highways England, the Mineral Products Association and Eurobitume UK and was updated in 2014. This report summarises a review of asPECT, funded by the same organisations, covering the constants used in the tool and the way in which the tool deals with the allocation of the benefits of utilising recycled materials. The report also reviews how carbon and life cycle analysis (LCA) tools are used in several other countries and considers the potential of converting asPECT into an Environmental Product Declaration (EPD) generator.

Other titles from this subject area

PPR 574	Further guidance on the calculation of whole lifecycle greenhouse gas emissions generated by asphalt: Part of the asphalt Pavement Embodied Carbon Tool. M Wayman, I Schiavi-Mellor and B Cordell. 2014
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