ECOMONDO

THE GREEN TECHNOLOGIES EXPO

7-10 NOVEMBRE 2017

RIMINI ITALY

21ª FIERA INTERNAZIONALE DEL RECUPERO DI MATERIA ED ENERGIA E DELLO SVILUPPO SOSTENIBILE

IN CONTEMPORANEA CON

KEY ENERGY

www.ecomondo.com

GREEN AND CIRCULAR ECONOMY: RICERCA, INNOVAZIONE E NUOVE OPPORTUNITÀ

- **Rifiuti: strategie per la raccolta, valorizzazione, sistemi di gestione integrata, smaltimento in discarica, implementazione di un'economia circolare, compostaggio**
- **Gestione sostenibile della risorsa idrica**
- **Qualità dell'aria, monitoraggio, gestione e controllo delle emissioni odorigene**
- **Gestione e bonifica sostenibile nel quadro dell'economia circolare**
- **Industria biobased, innovazione nella bioeconomia**

La "Gru coronata grigia"
Mascotte di Ecomondo - 2017

Luciano Morselli
Gru coronata grigia
Acrilico su carta latte - 30x21 cm - 2017

www.ecomondo.com

Atti dei convegni aperti a *call for papers* a cura di Fabio Fava

ITALIAN EXHIBITION GROUP
A merger of Rimini Fiera and Fiera di Vicenza

MAGGIOLI EDITORE

RAp-CO_2: Development of a standardized method for the quantification of the avoided emissions of the asphalt production process due to the re-use of Reclaimed Asphalt Pavement (RAP)

Francesco Caridei, Roger Midence and Claudia Mosangini, fc@ecosurvey.it, Ecosurvey®, Bologna;
Daniele Raschiatore, DICAM, Università di Bologna, Bologna

Riassunto
È *proposto un metodo per quantificare le emissioni di CO_2e evitate nella produzione di conglomerato bituminoso mediante un Life Cycle Inventory Analysis (LCI), secondo la normativa ISO 14040:2006. La metodologia considera le attività evitate quando un processo lineare* è *convertito in uno circolare. Il calcolo delle emissioni evitate è svolto confrontando due scenari: il primo conosciuto come "business as usual" ed il secondo considerando un "efficient baseline". Nel caso di studio l'azione di mitigazione considerata per il miglioramento ambientale riguarda il ri-utilizzo del bitume e degli inerti che costituiscono il fresato stradale (RAP) originato da ricostruzione/manutenzione del manto stradale.* È *una analisi sito-specifica riferita ad un impianto di produzione di conglomerato bituminoso situato in Toscana dove sono stati installati dispositivi di telecontrollo che misurano in tempo reale la quantità di RAP ri-utilizzato nell'intervallo di tempo. Inoltre, è attivo un portale web per comunicare i risultati ottenuti, elaborati con il supporto di una matrice di calcolo.*

Summary
A standardized method to quantify the CO_2e avoided emissions from asphalt production has been proposed performing a life cycle inventory analysis (LCI), according to ISO 14040:2006. The methodology considers the avoided activities when a linear process is reconverted into circular. The avoided emission calculation is performed comparing two approaches: the first known as "business as usual" and the second considering an "efficient baseline". In the case study the mitigation action considered for environmental efficiency regards the re-use of RAP originated from road's reconstruction/maintenance. It is a site-specific analysis referred to an asphalt plant situated in Tuscan (Italy): an in situ kit is installed (remote control) that provides data of the RAP re-use in real time. A calculation matrix processes the data acquired and the results concerning avoided emissions are displayed on a dedicated web portal.

1. Introduction

Greenhouse gases emissions is currently a well know and studied field. Beyond the characterization and state determination, the development of strategies and actions to mitigate the associated impacts are necessary, considering the proper measurement of these emissions a critical step.
According to the European Environmental Agency [1] three different perspectives of air emissions quantification are used at the European Union (EU) level. These perspectives are: **a)** territorial, **b)** of production and **c)** from consumption. All of them consider different boundaries conditions and allocations, which set the baseline scenario concepts.
The present document shows the assessment of CO_2e emissions performed at one asphalt production plants located at the Tuscany region (Italy).

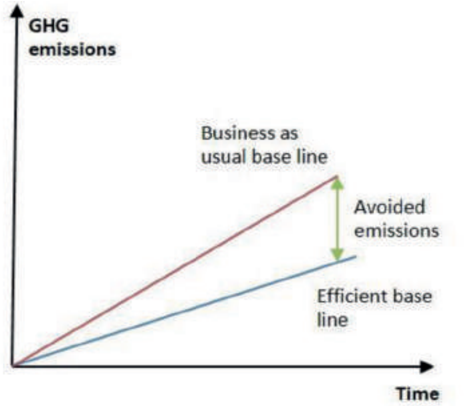

Figure 1 – *Greenhouse gas (GHG) emission profiles of different baseline case approaches. Source: IPCC, 2014*

The method proposed by this paper consider the comparison between two GHG emissions approaches (Figure 1) where the "avoided emissions" are quantified by the CO_2e calculations:
- **efficient baseline** case, which assumes that all resources are employed efficiently;
- **"business-as-usual**" baseline case, which assumes that future development trends follow those of the past and no changes in policies will take place [2].

1.1. The mitigation action assessed

The mitigation action considered on this analysis is the use of the "Reclaimed Asphalt Pavement" (RAP) in the asphalt production process. According the European Standard **EN 13108-8:2016- Bituminous mixtures. Material Specifications-Reclaimed asphalt,** RAP is a "bituminous conglomerate recovered by milling which can be used as constituent material for bituminous mixtures produced in a hot plant". The use of this material helps easing landfill pressures and reducing demand of extraction (aggregates and bitumen) [3].
According to EU Waste Catalogue (in Italy "Codice Europeo di Rifiuti-CER") in agreement to the **Commission Decision (EU) No 2014/955/EU**, RAP is classified also as a waste.
Therefore, many operators consider the RAP always as a waste, notwithstanding it could be re-used as byproduct. On this context, and a legal framework with more opinion and interpretations [1], Italy shows a limited use RAP (near 20%) [4] in comparison with other nation at the EU (Figure 2). Also considering that the commercialization and use of a part of RAP could be involved without permissions (and without registrations/accounting), the small % of RAP used in Italy, compared to the RAP available, can be considered an environmental damage.

[1] TAR Lombardia, judgment n. 2182 on August 10, 2012.

Figure 2 – *Use of RAP in some EU countries*

1.2. Legal emissions inventory framework
The necessity to quantify the industrial CO_2e emissions is supported by international agreements, among those, the Kyoto Protocol plays an important regulator role [5]. At European level, several actions have been activated to face the emissions reduction challenges. The Europe 2020 strategy [6] consider as target greenhouse gas emissions 20% lower than 1990 levels. These targets are monitored by controlling agencies of the EU as the EUROSTAT [7].

2. Report

2.1. Development of the avoided CO2e emissions methodology
To perform the assessment of the avoided emissions between the 2 baseline scenario concepts (see figure 1) the Life Cycle Thinking (LCT) and Life Cycle Assessment (LCA) have been used setting the following targets [8]:
- identify possible improvements for products and services;
- avoid shift of environmental issues between different phases of life cycle;
- provide economic and competitive opportunities.

2.2. ISO 14040:2006 and selection of the indicator
Several tools and methodologies have been analyzed to perform this specific LCA. Nevertheless, given the need to print the *comparability* of the method the ISO 14040:2006- Environmental management -LCA- Principles and framework has been selected. The ISO 14040 consent to perform different phases of the LCA, including the life cycle inventory analysis (LCI) which is the scope of the present study [9]. The ISO 14040:2006 provide reference about the category midpoint and endpoint to evaluate. The considered midpoint is "Climate Change", which, according the norm, can be quantified by an impact category indicator, in this case the CO_2e. Nevertheless, other indicators related to the land use, the visual impact or the loss of landscape are important aspects to consider in a potential enhancement of the present study.

2.3. Quality control review
As data quality assurance and control, five principles have been adopted as follow:

Principle:	Consideration:
Transparency	The 'calculated data' are displayed to ensure a proper interpretation of results.
Consistency	The measurements are performed continuously.
Comparability	Use of EN 16258:2012 for transport calculation. Use of UN ISO 14040:2006 as guidelines for the LCA and international standardized database emissions factors.
Completeness	The boundaries of the system are evaluated for accuracy of the analysis.
Accuracy	The input 'raw data' is taken directly from official and auditable information collected on site (e.g. bills, measurements, etc.) and provide traceability.

Table 1 – *Principles for the quantification of the emission's inventory*

2.4. Determination of the considered phases

The phases **a)** transport (during materials generation, procurements and disposal), **b)** production of raw materials, **c)** landfilling activities related to the asphalt production considered for the study have been determined to lower the complexity of the calculations but still gaining sufficient information to make the proper decisions (Figure 3).

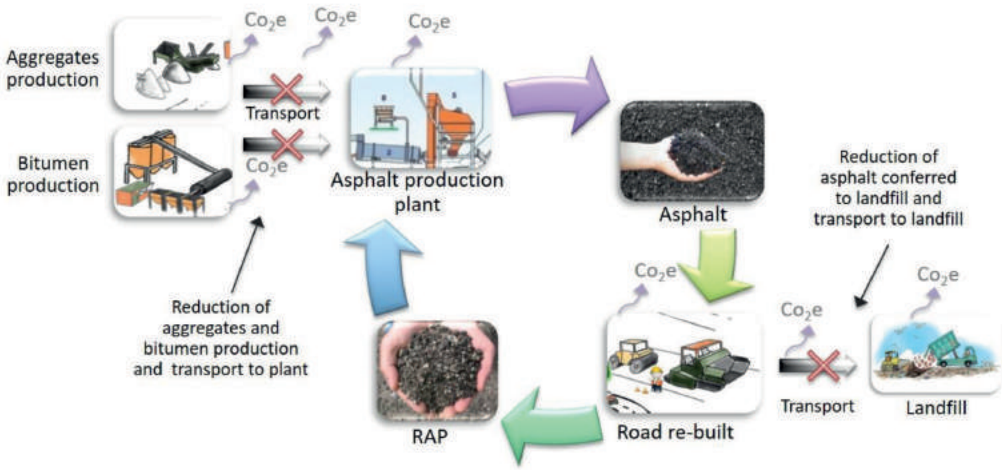

Figure 3 – *Simplified scheme of the phases related to the asphalt production using RAP*

2.5. Approaches for the measurement controls at all the stages

As mentioned before, the European Standard EN 16258:2012 is a methodology for calculation of GHG emissions of transport services. On this sense, the *well-to-wheel* approach have been incorporate due to the fact the emissions are produced when the vehicle is functioning but also upstream, from the fuel extraction to the refueling station (well-to-tank contribution), life cycle studies of the fuel production (well-to-wheel contribution) must be considered in order to analyses the global impact of the fuel utilization [10].

The activities considered for the production of CO_2e are: **a)** transports; **b)** Activities at the production site of aggregates (including site deforestation, in terms of CO_2 sequestration); **c)** refinery activities for bitumen production and **d)** landfilling activities.

2.6. Implementation of the monitoring system

In compliance with the accuracy principle (Table 1), a kit was installed at the asphalt plant including the electronic weighting instrument and a programmable logic controller (PLC). The entering RAP is measured and controlled in real time by remote control (Figure 4).

An implemented calculation matrix automatically elaborates the data acquired of the RAP amount used in the asphalt production process. Based on the EEA air pollutants guidebook [11] concept the overall calculation of emissions is referred to the denominated Tier 1 level of detail, where each activity (A) is multiplied by the respective emission factor (EF).

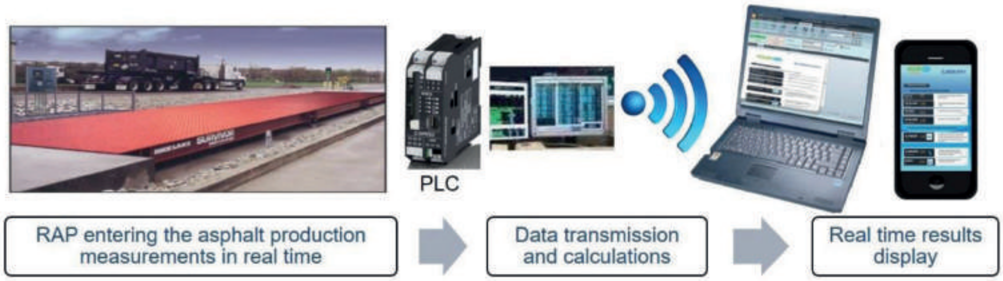

Figure 4 – *General scheme of the kit installed at the asphalt plant*

3. Results

3.1. Distribution of the emissions

The results of the executed calculations (Figure 5) shows the distribution of the percentage of emissions produced by the activities related to the asphalt production process. The activities in cave for the extraction of aggregates and the bitumen production (raw materials) represent the highest values; nevertheless, transport is an item to be considered as well.

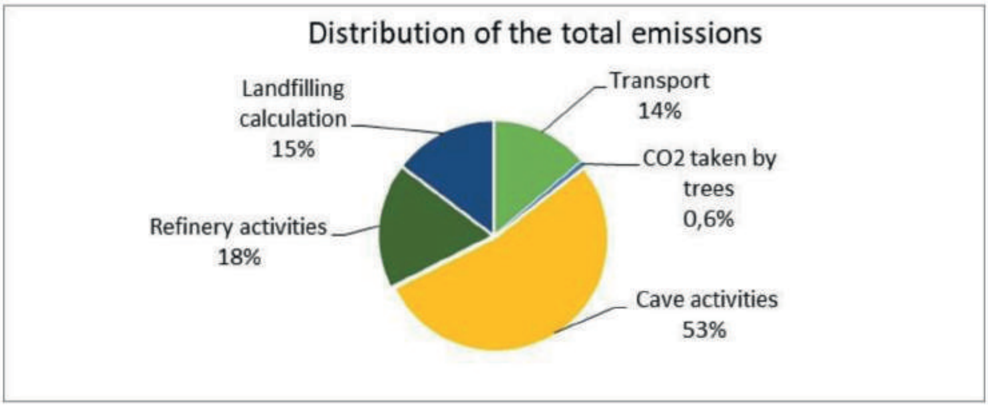

Figure 5 – *Distribution of the emissions from the activities related to the asphalt production*

3.2. Calculation of the avoided emissions

Figure 6 shows the trend of the greenhouse gas emissions over time for the two considered baseline case studies. Based on preliminary approaches, the difference between GHG emis-

sions of the two scenarios represents the avoided emissions. The difference between the two approaches is 5.965 tons of CO_2e avoided since 2008.
For the examined site, as a general reference value, the 11% in weight of the used RAP correspond to emissions of CO_2e. For example, 1 kg of used RAP in the asphalt production process avoids the emission of 0,11 kg of CO_2e. The coefficient of 0,11 is site-specific and is considered as a conservative preliminary result for the proposed methodology, still subject to further analysis.

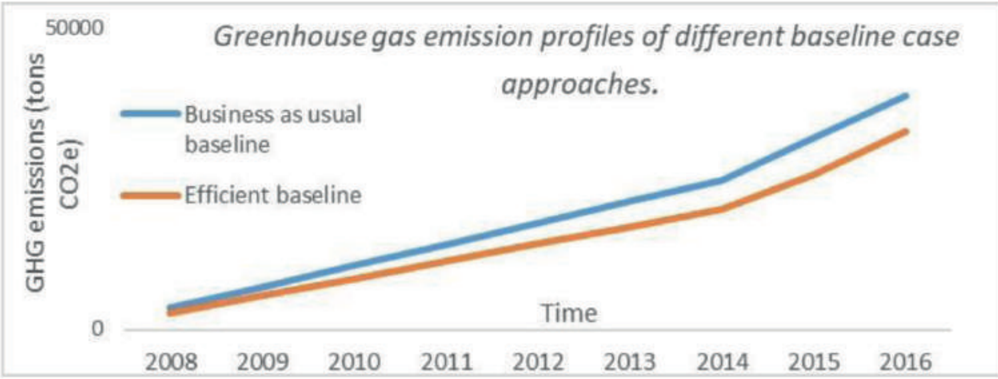

Figure 6 – *Greenhouse gas emission profiles of different baseline case approaches*

3.3. Communication of the results in real time
A web portal has been activated to display in real time the quantity of CO_2e that are being avoided since the year 2008 due to RAP use. The portal also includes the calculation of equivalencies to enhance the general public comprehension of the information. The equivalencies are: **a)** number of passenger vehicles removed from 1-year **b)** number of residential photovoltaic plants installed and **c)** number of trees (Figure 7).

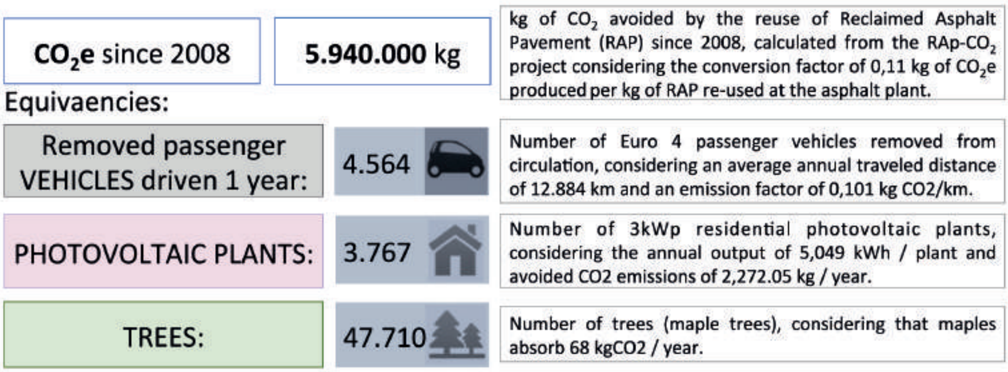

Figure 7 – *Screenshot of the web site dedicated to the real time monitoring*

4. Conclusions
As preliminary conclusions the study highlighted the following points:
- the activities of aggregates and bitumen's supply production (raw materials) represent the highest percentage of emissions by the asphalt production process (Figure 5);

- the mitigation action (use of RAP in the production process) reduced CO_2e emissions of the process about 5.940 tons of CO_2e since 2008;
- the coefficient of 0,11 (11%) is site-specific and is considered as a conservative preliminary result for the proposed methodology related to RAP use weight: 1 kg of RAP avoid 0,11 kg of CO_2e;
- -This site-specific CO2e assessment can be done in other production plants to improve methodology and technical approach.

Bibliography

[1] Europen Environmental Agency-EEA, "Inventory management, improvement and QA/QC," EMEP/EEA, Brussels, 2016.
[2] IPCC, "In: Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change," IPCC, Geneva, 2014.
[3] Y. Huang, R. Bird and O. Heidrich , "A review of the use of recycled solid waste materials in asphalt pavements," no. 52, pp. 58-73, 2007.
[4] European Asphalt Pavement Assosiation-EAPA, "Asphalt in figures," EAPA, Brussels, 2015.
[5] ISPRA – Istituto Superiore per la Protezione e la Ricerca Ambientale, "Italian Greenhouse Gas Inventory 1990 - 2015-National Inventory Report 2017," ISPRA, Rome, 2017.
[6] European Union, "COMMUNICATION FROM THE COMMISSION-EUROPE 2020 -A strategy for smart, sustainable and inclusive growth," Publication Office of the European Union, Brussels, 2010.
[7] eurostat, "INDICATORS TO SUPPORT THE EUROPE 2020 STRATEGY," Publications Office of the European Union, Luxembourg, 2016.
[8] European Commission-Joint Research Centre, "ILCD Handbook-Framework and requirements for Life Cycle Impact Asssessment models and indicators," Institute for Environment and Sustainability, Luxembourg, 2010.
[9] ISO, "UNI EN ISO 14040," UNI-Ente Nazionale Italiano di Unificazione, Milano, 2006.
[10] C. M. Silva , G. A. Gonçalves and L. L. Farias, "A tank-to-wheel analysis tool for energy and emissions studies in road vehicles," vol. II, no. 367, 2005.
[11] EEA-European Environmental Agency, "EMEP/EEA air pollutant emission inventory guidebook 2016," Publications Office of the European Union, Luxemburg, 2016.