SOCIOECONOMIC ASSESSMENT

Public Version

Legal name of applicant:	Rain Carbon bvba
Submitted by:	Rain Carbon bvba
Substance:	Pitch, coal tar, high-temp. (CTPht, CAS No. 65996-93-2) Anthracene oil (AO; CAS No. 90640-80-5)
Use title:	1A. Use of CTPht for the manufacture of formulations for various industrial uses 1B: Use of AO for the manufacture of formulations for various industrial uses
Use number:	1

Note

This complete version of the Socio-economic Assessment includes some text and figures that are highlighted in grey. The highlighted text is considered confidential and has been blanked out in the public version of this document. Full justification for confidentiality claims is provided in the Annex X (Section 7) of the present document.

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List of abbreviations

AO	Anthracene Oil
AfA	Application for Authorisation
AoA	Analysis of Alternatives
BPR	Biocidal Products Regulation
BTX	Benzene, toluene and xylene
CBF	Carbon Black Feedstock
CCSG	Coals Chemical Sector Group
CTPht	Coal Tar Pitch high temperature
PAHs	Polycyclic Aromatic Hydrocarbons
PBT	Persistent, Bioaccumulative and Toxic
SEA	Socio-Economic Analysis
SVHC	Substances of Very High Concern
vPvB	very Persistent and very Bioaccumulative

Declaration

The Applicant is aware of the fact that evidence might be requested by ECHA to support information provided in this document.

Also, we request that the information blanked out in the "public version" of the Socio-economic analysis is not disclosed. We hereby declare that, to the best of our knowledge as of today 19/02/2019 the information is not publicly available, and in accordance with the due measures of protection that we have implemented, a member of the public should not be able to obtain access to this information without our consent or that of the third party whose commercial interests are at stake.

Signature: 19/02/2019, Zelzate

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1 Summary

1.1 Introduction

This Socio-Economic Analysis (SEA) forms part of the Application for Authorisation (AfA) submitted by Rain Carbon bvba (hereafter Rain Carbon) for the continued use of Pitch, coal tar, high-temp. (CTPht - CAS No: 65996-93-2; EC No: 266-028-2) and anthracene oil (AO - CAS No: 90640-80-5; EC No: 292-602-7) in formulation activities. The formulations using CTPht and AO that are manufactured by Rain Carbon are placed on both the European Economic Area (EEA) and on markets outside the EEA markets [redacted]. Importantly, the use of these formulations is not subject to REACH Authorisation requirements; they are exempt as they are intermediate uses under REACH. As a result, neither Rain Carbon nor its relevant customers are applying for the Authorisation of these uses.

The requested review period for the continued use of CTPht and AO in formulations is 12 years.

1.2 "Use" of CTPht and AO

Not all formulation activities undertaken by Rain Carbon fall within the scope of this Authorisation. Those that are relevant include formulation of CTPht to create hybrid anode pitch and Søderberg paste, which are sold in the EEA (and outside the EEA in the case of anode pitch); CTPht may also be formulated together with AO to produce carbon black feedstock, which is sold in the EEA. All of the downstream uses of these formulations are intermediate uses and falls outside the scope of Authorisation. AO is also used to produce EU-type creosote and blended oils for export outside the EEA. They both fall outside the scope of Authorisation as EU-type creosote is an approved Biocidal product under the Biocidal Products Regulation.

1.3 Benefits from the Authorisation

If an Authorisation for the continued use of CTPht and AO (envisaged tonnages in 2020: [redacted] (range: 10,000-300,000) t/y and [redacted] (range: 10,000-100,000) t/y respectively) was not granted, Rain Carbon would have to stop the manufacture and sale of its formulations.

[redacted]

The CTPht is then used downstream for the production of electrodes for the aluminium industry and Søderberg paste.

As there is no market for non-formulated AO, the AO produced by the coal tar refinery could no longer be used in the EU, and Rain Carbon would try to export this to non-EU tank terminals or non-EU facilities within the overall Rain Carbon group for formulation and sale to non-EU markets or re-import.

The benefits from Authorisation of the current formulation activities would therefore include:

- Continuation of Rain Carbon's refinery operations, with this safeguarding net profits and [redacted] investments across the CTPht and AO formulation activities estimated at

€[redacted] million (€100 - 500 million) in present value terms over the requested 12-year review period (2018 prices, discounted at 4%);

- Continued employment resulting in 53 jobs directly involved in formulation activities, together with a further 504 indirect jobs in Belgium and elsewhere, with a combined social value of €39.8 million in present value terms;

- The continued ability of Rain Carbon to produce hybrid pitches and [redacted] and to supply these and Søderberg paste to the EEA (and non-EEA) aluminium, calcium carbide and ferroalloy sectors;

- The continued ability of Rain Carbon to produce high yield carbon black feedstock for sale to EEA users; and

- The continued ability of Rain Carbon to produce AO mixtures for export.

1.4 Residual Risks

Estimates of the excess lifetime cancer risks for both workers and humans via the environment are calculated in the CSR, based on exposures from relevant activities for workers and from off-site emissions monitoring data. 53 workers are directly exposed at the site, with exposures also taken into account for local residents, local workers and regional residents with an estimated 17.2 million people potentially exposed.

Combining these figures with exposure estimates leads to an estimated 0.0023 fatal lung and bladder cancer cases, and a further 0.0011 non-fatal cancer cases over the 12-year period. These translate to monetised residual risks of around €3,380 in total.

With respect to the PBT properties of CTPht and AO, the CSR estimates that the total emissions of PAHs from Rain Carbon's activities would equate to 993.1 grams per year in total, broken down into:

- Air: 935.8 grams per year; and
- Surface waters: 57.3 grams per year

Over the 12 years, emissions to air, water and sludge would equate to 11.92 kg in total.

1.5 Balance between benefits and costs

The aggregate present value benefits from the continued use for formulation of CTPht and AO equate to €[redacted] (range: €100 – 500 million) (not including lost investment in [redacted]), adjusted after subtracting the average gross annual salaries of the workers involved in formulation activities, over the requested 12-year review period. These compare to the aggregate monetised human health risks of around €3,380, for a benefit to cost ratio of €[redacted] (range: €100 – 1,000 thousand) and a NPV of €[redacted] (range: €100 – 1,000 million). This NPV figure translates to a cost per kg of PBT removed/reduced of €[redacted] (range: €10 – 100 million) over the 12 years.

To this calculation it needs to be remarked that there is no additional emission or exposure as a result of formulation over manufacture; the equipment used for formulation are the storage tanks and their auxiliary equipment for the manufactured pure substances.

1.6 Factors relevant to the duration of the review period

This SEA is not accompanied by a detailed Analysis of Alternatives (AoA) as the two substances do not have a specific functionality at the formulation (mixing) stage apart from being incorporated into a mixture that is used in downstream uses that fall outside the scope of REACH Authorisation. For these downstream uses, there is no regulatory impetus to substitute CTPht or AO and the applicant cannot see realistic alternatives for all uses becoming available in the foreseeable future.

Given that use of the relevant mixtures is expected to continue indefinitely, justified argumentation for a specific review period cannot be provided. The most relevant criterion used by SEAC for deciding on long review periods criterion to this analysis is the one referring to the balance of risks and benefits of continued use. In this context, it should be noted that formulation is a standard operation in all coal-tar or petroleum refineries, and that the formulation step takes place in a closed tank farm by mixing and pumping. The same equipment/process is used for storage of the pure substances after manufacture. This is borne out by the very low releases of PAHs from the coal tar refinery, as indicated in the figures presented above for both environmental emissions and risks to workers and humans via the environment.

As there is no need for customers to move to alternatives where their uses are exempt from Authorisation and there is a lack of alternatives for customers, a long review period of 12 years would be appropriate for the continued use of CTPht and AO in formulation activities at Zelzate.

Finally, a refused authorisation would halt [redacted] #D# [redacted].

2 Analysis of Substance Function

2.1 Aims and scope of SEA

2.1.1 Aims of the SEA

Pitch, coal tar, high-temp. (hereafter referred to as CTPht – CAS No: 65996-93-2; EC No: 266-028-2) and anthracene oil (hereafter referred to as AO - CAS No: 90640-80-5; EC No: 292-602-7) have been identified as 'substances of very high concern' (SVHCs). In June 2017, the substances were listed on Annex XIV of REACH due to their carcinogenic (Article 57a), Persistent, Bioaccumulative and Toxic (PBT) (Article 57d) and very Persistent and very Bioaccumulative (vPvB) (Article 57e) properties. Both CTPht and AO have been given a Latest Application Date of 4 April 2019 and a Sunset Date of 4 October 2020.

This Application for Authorisation (AfA) concerns CTPht and AO that is used in formulation activities by Rain Carbon bvba (hereafter referred to as Rain Carbon). The formulations of CTPht and AO that are manufactured by Rain Carbon are consequently placed on both the EEA and non-EEA markets. Importantly, the use of these formulations is not subject to REACH Authorisation requirements (e.g., they are exempt as they are intermediate uses under REACH); as such, neither Rain Carbon nor the relevant customers of Rain Carbon are applying for the Authorisation of their uses.

Rain Carbon wishes to be able to place on the market formulations that contain CTPht and AO beyond the Sunset Date as these are sources of significant income to the applicant and technically important to the customers. This SEA document aims to discuss and demonstrate the following:

- The socio-economic impacts that would arise for Rain Carbon, its relevant customers and its upstream supply chains, if the applicant was not granted an Authorisation for the continued use in formulations of CTPht and AO with an appropriate review period; and

- The overall balance of benefits of continued use far outweigh the risks to human health and the environment from the CMR and PBT/vPvB effects of CTPht and AO.

It is noted that this SEA is accompanied by a 'basic' AoA document. According to REACH Article 2.8, intermediates are exempted from Title VII of REACH. This is also confirmed in ECHA Guidance, "*where a mixture is prepared by a 'formulating company' but the mixture is only 'used' at another site by a downstream user to which the mixture is supplied, formulation activities by the 'formulating company'* (…) *an AoA for the formulation use is not necessary because there is no function per se provided by the Annex XIV substance*" (ECHA, 2017a). This is the case for Rain Carbon.

2.1.2 Scope of the SEA

Formulation activities within the scope of Authorisation

Not all formulation activities undertaken by Rain Carbon fall within the scope of this Authorisation. The relevant ones are shown in **Table 2-1**.

It should be emphasised that there is currently existing guidance on the applicability of the Authorisation requirements on formulation steps that precede uses of substances that are exempt from Authorisation. This is in the form of Q&A on the ECHA website, for instance:

- ECHA Q&A No. 1027 on formulation for medicinal products, food or feedingstuffs, plant protection products, biocidal products, motor fuels, cosmetic products and food contact materials;

- ECHA Q&A No. 1028 on fuels;
- ECHA Q&A No. 1029 on medical devices and human health; and
- ECHA Q&A No. 1030 on Scientific Research and Development.

These Q&As explain that the uses of a substance upstream and preceding an exempted end-use are also exempted but only in the volumes ending up in the exempted end-use. This is of relevance to the formulation of EU-type creosote which is a biocidal product (i.e. the conditions of ECHA Q&A No. 1027 apply).

Furthermore, the use of a substance as an intermediate is exempt from REACH Authorisation; however, similar guidance from ECHA prescribing that the use of a substance upstream preceding such an exempted (i.e. intermediate) end-use is also exempted has not been issued. As such, all of the non-creosote mixtures produced by Rain Carbon are used in the EEA in applications that have been verified to be intermediates and are thus exempt from REACH Authorisation.

Rain Carbon is therefore only applying for the Authorisation of its preceding formulation use, and this application is being made only to cover the business risk of additional guidance that might be released on whether or not these formulation activities are exempt when performed in a closed system and where the downstream use is exempted (as per Q&A 1027 and 1028). The coloured column table given in the below summarises the formulation activities of Rain Carbon that fall within the scope of the present AfA.

Table 2-1: Formulation activities within and outside the scope of this Application for Authorisation (2020 onwards)

SVHC	Mixture type	Mixture sold in…		Nature of downstream use	Authorisation required for…	
		EEA	Non-EEA		Formulation by Rain Carbon	Use by Rain Carbon's customers
CTPht	Anode pitch	[redacted]	[redacted]	[redacted]	✓	[redacted]
CTPht	Søderberg paste	[redacted]	[redacted]	#C for all table# [redacted]	✓	[redacted]
CTPht AO	Carbon Black Feedstock	[redacted]	[redacted]	[redacted]	✓	[redacted]
AO	EU-type creosote	[redacted]	[redacted]	[redacted]	✗	[redacted]
AO	Blended oils for export	[redacted]	[redacted]	[redacted]	✓	[redacted]

Source: Rain Carbon

Temporal scope

The temporal boundaries of the analysis take into account:

- When impacts would be triggered;
- When impacts would be realised; and
- For how long the continued use of CTPht and AO would be required by Rain Carbon as a minimum.

The impact assessment periods used in this analysis and the key years are presented in **Table 2–2**.

Table 2–2: Temporal boundaries of impact assessment			
Present value year		2018	
Start of discounting year		2019	
Impact baseline year		2020	
Scenario	**Impact type**	**Impact temporal boundary**	**Notes**
"Applied for Use"	Mortality and morbidity of workers	12-year period with cancer effects occurring in 20* years' time to account for latency	Analysis is based on the length of requested review period*. This takes into consideration the minimum time required for the implementation of an alternative substance or technology. Sensitivity analysis is based on the length of working lifetime used in RAC's Exposure-Risk Relationship
	Mortality and morbidity of humans exposed via the environment	12-year period with cancer effects occurring in 20* years' time to account for latency	Analysis is based on the length of requested review period*. This takes into consideration the minimum time required for the implementation of an alternative substance or technology. Sensitivity analysis is based on the length of general population lifetime used in RAC's Exposure-Risk Relationship
	Environmental impacts	12 years	Based on the length of requested review period
"Non-use"	Loss of profit along the supply chain	12 years	Based on the length of requested review period
	Loss of employment	1.6 years	Average period of unemployment in Belgium (Dubourg, 2016)
*A latency period of 20 years has been assumed here for both lung and bladder cancer. In reality, cancer cases may occur sooner following exposure or much later – for example, research has found that cases of bladder cancer for example not occurring until 30 plus years from some occupational exposure situations.			

Geographic scope

Rain Carbon's production site is in Zelzate, Belgium. One of the main activities there is the distillation of coal tar, leading to, amongst other products, the manufacture of CTPht and AO. In addition to its own production volume, an additional volume of CTPht per year is delivered to Rain Carbon from other EEA countries or is imported from non-EEA countries.

As there is no market for unformulated AO, the entire AO quantity is used in formulation activities in Zelzate.

For CTPht, the formulation step concerns hybrid anode pitches and Søderberg pitches. [redacted] #B#

CTPht and AO formulations are sold to both EEA-based and non-EEA customers. EEA-based customers are relevant to the use of CTPht-based anode pitch [redacted] #C#, CTPht-based Søderberg paste [redacted] users of Carbon Black Feedstock (CBF) [redacted]). In addition, CTPht-based anode pitch and AO-based blended oils are relevant to non-EEA customers. As such, downstream user impacts within the scope of the present analysis are relevant to both CTPht-based formulations and AO-based formulations.

2.2 Definition of the "Applied for Use" Scenario

2.2.1 Coal tar distillation

Coal tar is a by-product of the production of metallurgical coke. CTPht is one of the substances resulting from the distillation of high temperature coal tar. AO also always results from this same distillation process, together with other products, such as naphthalene oil and other tar oils as illustrated in **Figure 2-1** below. This interlinkage is important as it means that impacts on the continued use of one of these products, e.g. CTPht or AO, will have impacts on the viability of the entire refinery.

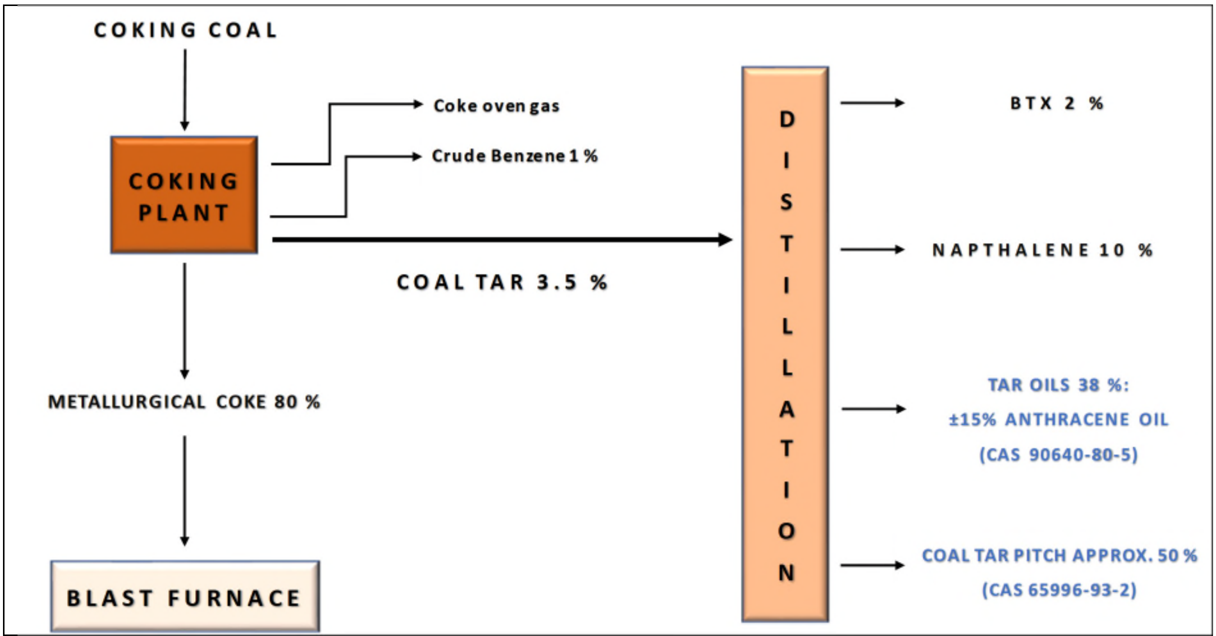

Figure 2-1: Diagram illustrating the production of coal tar and its distillation into CTPht, anthracene oil and various other products
Source: (CCSG, 2015)

2.2.2 Coal tar distillation and deliveries

Coal tar is purchased from several suppliers within and outside of Europe and delivered to Zelzate, where it is distilled on-site. CTPht and AO are produced during the distillation process and stocked in several large storage tanks in the centre of the plant, close to the tar refinery. Rain Carbon produces approximately up to #B# (range: 100,000-1,000,000) tonnes CTPht and #B# (range: 10,000-100,000) tonnes AO per year. In addition to their own production volume, between ca. #B# (range: 10,000-500,000) tonnes of CTPht per year are delivered to Rain Carbon from other EEA countries or are imported from non-EEA countries.

For AO, the possibility of exchange between the different sites of the Rain Carbon group is present, but this is much less frequent and quantities are much lower. For instance, in 2017 #B# (range: 100-1,000) tonnes was delivered to Rain Carbon.

The following table provides a high-level overview of the volumes of CTPht and AO handled by Rain Carbon in Belgium.

Table 2–3: Manufacture and deliveries of CTPht and AO to Rain Carbon (2017)						
Substance	Volume manufactured by Rain Carbon (tonnes)		Volume delivered to by Rain Carbon (tonnes)		Total volume handled by Rain Carbon (tonnes)	
	2017	2020 onwards	2017	2020 onwards	2017	2020 onwards
CTPht	[redacted]	[redacted]	[redacted]	[redacted] #B for all table#	[redacted]	[redacted]
AO	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Reasons for future trends	Market-dependent		Market-dependent		Market-dependent	
Source: Rain Carbon						

During formulation activities, certain amounts of CTPht and/or AO are mixed with other streams of the coal tar distillation (e.g. liquid pitch or oils) in order to obtain the desired composition (according to specified, pre-calculated proportions) of the end mixtures.

CTPht formulation is essential in the formulation of Søderberg and hybrid pitches.

[redacted] #B#

[redacted] #D#

A smaller part of CTPht can be blended with coal tar distillates for the production of CBF or Søderberg pitches. Production of carbon black and Søderberg electrode mass are intermediate uses and are thus also exempt from REACH authorisation.

As far as AO is concerned, of the total annual volume of [redacted] #B# ktonnes/y (range: 10,000-100,000) that can be generated/processed on-site, certain amounts are used in the formulation of EU-type creosote, which is sold as a biocidal product and is not relevant to REACH Authorisation. The remaining quantity that is generated as AO substance ([redacted] #B#) (range: 10,000-100,000) is then formulated into two mixtures:

- CBF, alongside CTPht; and
- Blended oils exclusively intended for export to non-EEA customers.

The key characteristics of these blends are shown below. This information is provided for completeness only.

Table 2–4: Types of mixtures formulated with CTPht and AO by Rain Carbon (2017 and post-2020)		
CTPht/AO-based formulation	**Components**	**Downstream uses**
Hybrid Anode pitch	#A for all table# [redacted]	Electrodes for the aluminium industry
Søderberg paste	[redacted]	Electrodes for the aluminium and ferroalloy industries
Carbon Black Feedstock	[redacted]	Manufacture of carbon black
Blended oils for export	[redacted]	Blend components for coal tar oil mixtures

Details of the tonnages of the above mixtures are presented in **Table 2-5**. The tonnages relevant to EU-type creosote are given for completeness. AO is not placed on the market as a neat substance., except for a small amount exchanged with the sister site of Rain Carbon Germany.

Table 2–5: Downstream applications of CTPht and AO-based formulations manufactured by Rain Carbon and associated tonnages sold (2017)					
SVHC	**Mixture type**	**Tonnages supplied downstream (as expressed by tonnes CTPht or AO)**			
		EEA customers (t/y)		**Non-EEA customers (t/y)**	
		2017	**Assumed tonnage 2020 onwards**	**2017**	**Assumed tonnage 2020 onwards**
CTPht	Hybrid Anode pitch	[redacted]	#B for all table# [redacted]	[redacted]	[redacted]
CTPht	Søderberg paste	[redacted]	[redacted]	[redacted]	[redacted]
CTPht	Carbon Black Feedstock	[redacted]	[redacted]	[redacted]	[redacted]
AO		[redacted]	[redacted]	[redacted]	[redacted]
AO	EU-type creosote	[redacted]	[redacted]	[redacted]	[redacted]
AO	Blended oils for export	[redacted]	[redacted]	[redacted]	[redacted]
Reasons for future trends		No significant changes envisaged [redacted]		No significant changes envisaged	
Source: Rain Carbon					

2.3 Definition of the “Non-use” Scenario

2.3.1 Introduction

As can be seen above, formulation activities are relevant to CTPht and AO that is generated by Rain Carbon. Both CTPht and AO are generated through the refinery distillation process, where all fractions are produced simultaneously. The inability to undertake formulation activities using CTPht or AO, or to otherwise sell one fraction has implications for the viability of the refinery as a whole.

As a result, definition of the “Non-use” Scenario for Rain Carbon’s operations at Zelzate is not straightforward. Potential “Non-use” Scenarios and the logic underlying them are detailed separately below for CTPht and AO, together with the “Non-Use” Scenarios that are carried forward as being the most likely outcomes of a refused Authorisation.

2.3.2 The "Non-use" Scenario for Coal Tar Pitch high temperature

As indicated above, CTPht is used in three different types of formulations, and each of these needs to be considered with respect to the "Non-use" Scenario:

- Use of CTPht in the production of high-yield carbon black feedstocks (CBF) would cease under the "Non-use" Scenario, with this representing up to [redacted] (range: 1– 10 ktpa) tonnes of CTPht per annum at present (losses from this product are considered in section 2.3.3);

- Formulation of CTPht with tar oils to create Søderberg paste would cease, with this representing up to [redacted] (range: 10 - 1,000 kpta) tonnes of CTPht per annum at present;

- Formulation of CTPht with alternative pitches would cease, with this impacting up to [redacted] (range: 100 – 1,000 kpta) tonnes of CTPht per annum; and

- The development of hybrid pitch formulations would cease.

[redacted] As a result, formulation of the above materials would be lost to Rain Carbon. This would impact not only on formulation of the CTPht produced by the coal tar distillation carried out by Rain Carbon at Zelzate, but also on the intake of ca. [redacted] (range: 10,000 – 1,000,000 tpa) of CTPht from EEA and non-EEA sources. The losses in gross operating profit stemming from this would equate to:

- Loss of hybrid anode pitch formulation: €[redacted] (range: 10 – 100 million) per annum; and
- Loss in added value form the use of CTPht in Søderberg paste/pitches: €[redacted] (range: €100,000 – 1million).

[redacted]

[redacted]

[redacted]

[redacted]

2.3.3 The "Non-use" Scenario for Anthracene Oil

For AO, the situation is more complex since all customer specifications worldwide (based on their process requirements) require formulation activities. There currently is no market/application for non-formulated AO. As a result, if an authorisation is not given to the formulation of AO mixtures, then there would be impacts on the following activities carried out at Zelzate:

- Formulation of AO into CBF, with this representing up to [redacted] (range: 10-100 ktpa) AO at present; and
- Formulation of AO in tar oil fractions for export, with this representing up to [redacted] (range: 10-100 ktpa) AO at present.

The worst case "Non-Use" Scenario with respect to AO would be the closure of the entire coal tar refinery, due to the potential inability to find any EEA or non-EEA markets for its unformulated use. The shutdown of the tar distillation plant would have additional unintended consequences: Rain Carbon could no longer produce naphthalene. Consequently, Rain Carbon's two phthalic anhydride plants would have to shut down due to a lack of feedstock. As the company would take all actions possible to avoid this outcome, alternative scenarios are considered here to be more realistic, at least in the short term.

A series of alternatives have therefore been developed in the **table 2-6** below to reflect possible responses for the different formulation activities of AO. They are presented and analysed further below to identify the least cost one.

Table 2-6: Potential AO Non-Use Scenarios

Formulation	Non-Use scenario	Impacts on Rain Carbon
AO in CBO	Sell AO in pure form for use as CBO	Would require installation of a dedicated storage tank for AO. Would require identification of appropriate tankers for shipping of the AO; must meet temperature requirements. Requires finding customers for this grade of oil.
	Export CBF raw components (AO, CTPht and others) out of the EU and formulate there for local sales	As for above, would also require a non-EU tank farm for formulation of the AO. The market where we have received inquiries for CBO import is [redacted] this requires exporting [redacted] The case of export for formulation and re-import would allow to preserve the current customer base, but creates extremely difficult logistics which can hardly be overcome.
AO in tar oil formulations (for export)	Export oils individually and formulate in non-EU country of destination	As for above, but individual transport of oils would increase logistic costs due volumes being below ship tank sizes (i.e. creation of "dead freight") For a small part (ca. [redacted]), the current logistic chain would allow for formulation on the non-EU side. For the majority ([redacted]), it would also need creation of a non-EU terminal with appropriate quality control for blending purposes and to produce an in-spec products.
AO production	Cessation of coal tar processing and closure of the refinery	Would also impact on CTPht, naphthalene production and hence phthalic anhydride production

AO – Alternative 1: sell pure AO in the EU as CBF

Under this hypothetical alternative, pure AO would be shipped to EU customers and sold as a carbon black feedstock. Unfortunately, at the present time, pure AO does not meet any of the existing CBF specifications and there is therefore no market for non-formulated AO for this purpose. Research and development together with customers would be required to create a new product. In addition, customers would need to invest in a dedicated storage tank for the AO or a blending facility within their current CBO tank farms would be needed. A #C# [redacted] (range: 1000 – 10,000 m^3) heated tank requires approximately #C# [redacted] (range: €1 – 10 million) in capital expenditure, with permitting plus construction taking two years. In addition, shipping costs (barge and sea-going depending on location of customers) would be incurred on this transport of the pure AO. The yearly cost of a barge is estimated at ca. € #C# [redacted] (range: 1 – 10 million), while the base annual fee for a sea-going ship is € #C# [redacted] (rang: 1 – 10 million), plus costs of fuel, harbour fees etc. Apart from the storage, also the port unloading infrastructure is an issue; currently ports are generally not able to handle the high crystallisation temperature. So, new unloading port infrastructure will need to be constructed.

Given that this scenario would not create savings or new value added to customers, and would face many unsolved logistic obstacles, it is not considered further to reflect the least-cost outcome (especially as there is a very low likelihood it could succeed).

AO – Alternative 2: export AO for formulation outside EEA

Alternative 2 would involve the export of CBF raw components (AO, plus a fraction of CTPht and other materials) and AO blended with tar oils for export for formulation in non-EEA sites. This alternative demands a series of logistic and transport issues to solve, but it is the most likely to occur.

Storage considerations

In total, Alternatives 2 would operationally require installation of additional dedicated tanks for storage of the pure AO produced by the refinery while awaiting shipment. Related costs are estimated as follow:

- A [redacted] (range: 1000 – 10,000 m^3) has a capital cost of [redacted] (range: €1 – 10 million);
- A #C# [redacted] (range: 1000 – 10,000 m^3) has a capital cost of #C# [redacted] (range: €1 – 10 million).

The permitting plus construction time for both tanks would be ca. 2 years.

Shipping as part of export

The shipping of the AO poses non-resolved problems at this point in time. These include the following:

- Because of the high crystallisation temperature of AO (up to ±100°C versus 20-70°C for the formulated AO), shipping temperatures of 115-120°C would be necessary. The existing fleet of inland and sea chemical tankers have temperature limitations of 70 to 90° maximum for construction reasons. There are no oil carrying ships that can maintain a temperature of 120°C; and

- Relying on pitch tankers would enable 120°C in logistics, but the specifications for both Carbon Black Feedstock and Creosote are not compatible with carriage of pitch; the resulting product would be out of specification for the CBF. Pitch tankers are very specific ships, the number available is extremely limited, and they are already fully occupied with the transport of pitch for the aluminium industry. Therefore, a dedicated ship is necessary.

As the full quantity of AO in CBO would need to be exported, together with the other components of the CBO to be manufactured and sold outside the EU (potentially #C# [redacted]), this would require ca. #B# (range: 10,000 – 100,000) tonnes per annum of CBO raw materials to be shipped out of the EU.

Additionally, #B# [redacted] (range: 10,000 – 100,000) tonnes per annum of AO, now used in tar oils formulations, would have to be shipped for formulation in #C# [redacted].

- As a result, at least two sea tankers would need to be chartered. The related costs are estimated as follows:

  – For a sea-going ship, the base annual fee is [redacted]. Adding the costs of fuel, harbour fees etc., the cost increases up to around #C# [redacted], assuming full capacity utilization of the ship [redacted]). It is assumed that for the export of the CBO materials, combined with the 15 ktpa AO in 'mixtures for export' (see alternative 2), the applicant would need one ship at full capacity utilisation #C# [redacted] and a second ship at ca. 50 % capacity utilisation [redacted]) to cover the full logistics.

a. Export AO and the other components for formulation as CBO outside the EEA

The most likely possibility would be the export of the entire set of CBO materials (AO + CTPht + other components), non-formulated to a non-EU facility for formulation and marketing. The non-EU customer base and logistics would need to be created by Rain Carbon, with [redacted] as a potential target region.

To separate AO from the remaining CBO material, and cover the 7,000 tonnes net load of the sea tanker, we would need to install one #C for the rest of this section# [redacted] and [redacted] tank at the production site, with estimated costs of [redacted] (range: €1 – 10 million) respectively. Assuming a 20-year life for the tanks, their annualised costs equate to roughly €[redacted] and €[redacted] per annum (range: 100,000-500,000, assuming a 4% discount rate).

The exact plan for the delivery in the country of destination is not entirely sorted yet and it is ignored how many additional storage tanks would have to be installed in the non-EU formulation site. For the purpose of this analysis we have assumed the construction cost for two tanks of [redacted] (range: 1,000 – 10,000 m^3) in the non-EU site as a first indication. Total annualised cost for both tanks are estimated at ca. €[redacted] (range: €100,000-€500,000, assuming a 4% discount rate).

In addition, there would be a loss in GOP of ca. €[redacted] (range: €10 – 100 per tonne) [redacted]

The possibility for export for formulation and re-import in the EU to the current customer base is more complex in logistics and extremely unlikely to occur:

- The current customer base uses both inland barges and sea tankers, in parcels of [redacted] tonnes;

- The scenario in which a sea tanker brings [redacted] tonnes out of the EU and returns after formulation with the same material, would still need an EU storage & distribution point to distribute the [redacted] tonnes over time in [redacted] tonnes parcels to the EU customers; and

- Installing this at the manufacturing site still demands separated tanks to avoid formulation: 2 tanks of [redacted] m^3, total [redacted]. It has to be considered that filling imported CBO, formulated in the non-EU facility, on a non-empty tank in the Zelzate industrial site might also be interpreted as formulation.

All things considered, the possibility of exporting raw materials for CBO and re-importing the formulated product in the EU is not further considered.

b. Export oils for formulation in non-EU country of destination

This hypothetical "Non-use" Scenario would see the current volume of AO used in the formulation of blended oils for export outside the EEA being exported for formulation outside the EEA and sale in the existing markets. It is assumed that Rain Carbon would export #B# maximum (range: 10 - 100 ktpa) of AO to a non-EU terminal #C#

This scenario would require the following considerations for circa #B# (range: 10 - 100 ktpa) of the AO that would fall under this scenario:

- Full formulation by the non-EEA formulator taking place at the non-EEA manufacturer's site; there would be a consequent loss in gross operating profit per tonne of sales due to the quantities that would have to be placed on the market;

- Investment by Rain Carbon in storage capacity at Zelzate, as described above;

- The shipping issues and costs for a sea-going tanker given above would apply. At an operational level, the AO and the rest of the mixture would need to be shipped separately, for blending together at a non-EEA terminal in the country of destination;

- As deliveries from Zelzate and to the end users to/from the non-EEA terminal may take place 24/7, two tanks would be needed in the non-EU terminal: one tank for reception of AO/formulation/quality control plus one tank to hold in-spec product for deliveries. The estimated cost of renting an additional tank is € #C# (range: €100,000 – 1,000,000) per year; and

- Organisationally, quality control would need to be established/installed at the non-EU terminal to ensure that blending results in an in-specification product.

For the remaining #B# (range: 1 – 10 ktpa) of the AO that would fall under this scenario, the current logistics chain would allow for non-EU blending. As a result, the increase in costs associated with this scenario would relate to the need for new on-site storage at Zelzate and the shipping issues discussed above.

AO – Alternative 3: Cessation of coal tar processing and closure of the refinery

The final hypothetical scenario with respect to AO would be cessation of coal tar processing and hence closure of the refinery.

Although this scenario would not be the first that Rain Carbon would resort to in practice, it cannot be excluded as a possible outcome on the long run, given the cost increase of the logistics under the other alternatives, which will significant affect the viability of on-going operations.

2.3.4 Least-cost Non-use Scenario

Given the above discussion, the least cost "Non-use" Scenario with respect to the AO produced at its refinery will be export (alternative 2), assuming that the logistical issues regarding transport and storage described above can be overcome. There is considerable uncertainty as to whether this would be the case, and hence that the costs/losses that would be incurred are not greater than those set out above.

Table 2-7 sets out the current GOP realised by Rain Carbon on its various formulations of both CTPht and AO.

Table 2-7: Gross operating profits on mixtures current situation and with export				
Formulations	ktpa	GOP		
		Basis 2017-2018 €/t	Basis 2017-2018 €/t	Total value into future €000
Current situation				
CTPht				
Anode pitch	#B for column#	#C for the rest#		[redacted]
Søderberg pitch	[redacted]	[redacted]		[redacted]
Special CBO grade	[redacted]		[redacted]	[redacted]
AO				
CBF	[redacted]		[redacted]	[redacted]
AO oil formulations for export	[redacted]	[redacted]		[redacted]
The GOP values provided for each product are calculated subtracting costs of material from gross sales, without considering the cost of labour.				

Table 2-8 provides a summary of the total GOP and logistic costs that would arise under the non-use scenario for CTPht and AO (alternative 2), providing separate estimates for the additional logistic costs associated with the export of CBF components. As can be seen from this table, the total estimated losses to Rain Carbon would be € #C# (range: €10 – 100 million) per annum. These compare to the value of gross profits for the plant which is typically around € #C# per annum (range: €10 - 100 million). This clearly shows how significant the impact would be on Rain Carbon's financial viability into the future.

Table 2-8: Losses to Rain Carbon in gross operating profits under the Non-Use Scenario		
	Annual losses	Present value losses (12 years @4%)
GOP losses		
No sales of hybrid pitch [redacted]	#C for table#	[redacted]
Søderberg pitch valorisation loss to CTP+CBO	[redacted]	[redacted]
AO + rest of CBO export to [redacted]	[redacted]	[redacted]
Total GOP loss	[redacted]	[redacted]
Logistic costs for AO (alternative 2)		
New storage tanks at Rain Carbon*	[redacted]	[redacted]
Tank rental	[redacted]	[redacted]
Additional logistic costs for export to non-EU sites		
Yearly cost IMO ship – annual average capacity	[redacted]	[redacted]
Yearly cost IMO ship – full capacity	[redacted]	[redacted]
New storage tanks, non-EU formulation site*	[redacted]	[redacted]
Total yearly GOP effect		
Total	[redacted] **(range: €10-100 million)**	[redacted] **(range: €100-1,000 million)**
*Capex: assumes life of 20 years, with costs annualised at 4%; [redacted]		

In addition to the above economic impacts on Rain Carbon's operations, the complexity of having to create additional storage tanks and complex logistics chains, involving a higher number of transfer operations than is currently the case to markets outside of the EEA, is unlikely to result in a net reduction in risks to man and/or the environment.

Shifting the formulation to a non-EU location would also introduce quality assurance risks: currently the refinery ships a verified in-spec product. In a situation where the refinery would ship components of the product to a non-EU location, the final formulation and QC step will be done in a site with less possibilities then the refinery.

2.3.5 The "Non-use" Scenario for customers of Rain Carbon

Under the above "Non-use" scenarios for CTPht and AO, customers of Rain Carbon's Zelzate plant would be impacted in varying ways, as shown in **Table 2-9**. In correspondence with the least cost "Non-Use" Scenarios, some customers of Rain Carbon would either have to import raw material from outside the EEA or would be forced to opt for sub-optimal alternatives due to a lack of supply from alternative EEA-based suppliers. In other cases, the impacts would be more minimal, e.g. in relation to the exported AO-based tar oil fractions.

Table 2-9: Description of the "Non-use" Scenario for Rain Carbon's customers				
Customer group	**Number and location of customers**		**Availability of alternative sources of raw material for EEA-based customers**	**Envisaged reaction/impact for EEA-based customers under the "Non-use" Scenario**
Manufacturers and users of anodes made of CTPht-based mixture	[redacted] (range: 1-10) EEA-based customers	[redacted] #C for all table# [redacted]	The aluminium industry is the key customer of CTPht-based formulations generated by Rain Carbon. Whilst the aluminium industry is expected to grow year-on-year in value, the general economic/industrial context shows that the CTPht shortage in the market that appeared in 2017/2018 will continue, leading to a tight/short CTP availability for the aluminium industry. It is unlikely that the required volumes would be available on the EEA market; firstly, other EU-based suppliers are currently facing a similar REACH Authorisation challenge and thus the future availability of hybrid CTPht from them cannot be guaranteed. [redacted]	If other applicants were granted an Authorisation, EEA-based customers of Rain Carbon would switch their supply to them. If no supplier is granted an Authorisation, aluminium smelters would seek to import hybrid CTP from outside the EEA; however, due to the lack of coal tar in key global markets, aluminium output in the EEA could be reduced
	[redacted] (range: 1-10) non-EEA-based customers	[redacted]		
Manufacturers and users Søderberg electrodes made of CTPht-based mixture	[redacted] (range: 1-10) EEA-based customers	[redacted]	Søderberg electrodes are used in the ferroalloys and calcium carbides industries. There is currently no alternative to CTPht-based blends. If Rain Carbon were not granted an Authorisation but other manufactures were, then Rain Carbon's customers would buy the missing product from Authorisation holders, as long as the market had sufficient capacity to supply these customers. If no supplier was granted an Authorisation, non-EEA sources of the paste would be sought or relocation of electrode manufacture might occur	If other applicants were granted an Authorisation, Søderberg electrode manufacturers would switch their pitch supply to those. If not, EEA-based customers of Rain Carbon would seek to import feedstock from outside the EEA or even relocate operations out of the EEA
	No non-EEA customer	[redacted]		

Table 2-9: Description of the "Non-use" Scenario for Rain Carbon's customers

Customer group	Number and location of customers		Availability of alternative sources of raw material for EEA-based customers	Envisaged reaction/impact for EEA-based customers under the "Non-use" Scenario
Manufacturers of carbon black made of CBF	[redacted] (range: 1-10) EEA-based customer	[redacted]	Alternatives exist in the form of other PAH-containing materials, partly coal tar based, partly petroleum based. However, the availability of high yield CBF, which is what Rain Carbon places on the market is limited; alternative materials very probably have a lower yield. Alternative suppliers of CBF exist in the EEA. However, it can be reasonably expected that the other EEA-based suppliers are currently facing a similar REACH Authorisation challenge. Therefore, if Rain Carbon was not granted an Authorisation, competitors might also be denied an Authorisation. Thus, the future availability of high-yield CBF from EEA-based sources could not be guaranteed. Overall, the quantity of CBO Rain Carbon delivers to the EU carbon black industry is significant and cannot easily be replaced.	If other applicants were granted an Authorisation, carbon black manufacturers would switch their CBF supply to those. If not, EEA-based customers of Rain Carbon would seek to import feedstock from outside the EEA or consider a switch to lower yield alternative feedstock.
	No non-EEA company	N/A		
	No non-EEA customer	N/A		
Users of AO-based blended oils for export	No EEA-based customer	N/A	Impacts on non-EEA based customers are not considered here, but could include increased costs associated with the need for increased storage and other equipment for own formulation.	Outside the scope of this analysis
	[redacted] (range: 1-10) non-EEA customer	Not specified		

Source: Rain Carbon

2.4 Information for the length of the review period

This AfA is not accompanied by a detailed Analysis of Alternatives (AoA) as the two substances do not have a specific functionality at the formulation (mixing) stage apart from being incorporated into a mixture that is used by downstream customers in uses which fall outside the scope of REACH Authorisation (intermediate uses plus uses that take place outside the EEA). For these downstream uses, there is no regulatory impetus to substitute CTPht or AO and the applicant cannot see realistic alternatives for all uses becoming available in the foreseeable future. Given that use of the relevant mixtures is expected to continue indefinitely, justified argumentation for a specific review period cannot be provided.

Nevertheless, having knowledge of the criteria used by the SEAC in deciding on long review periods (ECHA, 2013), and as demand for these mixtures and therefore use of CTPht and AO in their formulation may continue for a very long review period, the analysis presented in this SEA is based on an appropriately long review period of 12 years.

In order to highlight the relevance and fulfilment of the SEAC criteria and conditions that may lead to the recommendation of a long review period, the applicant has summarised key points in **Table 2-10** at the end of this Section.

As can be seen from the above table most of the criteria are not applicable to the present AfA. The most relevant criterion to this analysis is the one referring to the balance of risks and benefits of continued use. In this context it should be noted that formulation is a standard operation in all coal-tar or petroleum refineries.

The formulation step takes place in the same closed tank farm that is used for storage after manufacture of the substances by mixing and pumping using the same equipment; therefore, emissions to the environment and human exposures are at the same level as if formulation did not occur.

Given there is no need to move to alternatives where uses are exempt from Authorisation, a long review period of 12 years would be appropriate for the continued use of CTPht and AO in formulation activities in Belgium.

Table 2-10: How the applicant fulfils ECHA criteria and considerations for a 'long' review period

SEAC criteria and considerations that would lead to a recommendation of a long review period		How applicant fulfils criteria / considerations
1	The applicant's investment cycle is demonstrably very long (i.e. the production is capital intensive) making it technically and economically meaningful to substitute only when a major investment or refurbishment takes place	This criterion is not relevant to this AfA which concerns the formulation of mixtures which are destined for uses which are not subject to REACH Authorisation requirements. Theoretically speaking, an investment in technology other than the one currently employed in the applicant's distillation plant would be economically infeasible and would require a very long time. [redacted] #D#

Table 2-10: How the applicant fulfils ECHA criteria and considerations for a 'long' review period		
SEAC criteria and considerations that would lead to a recommendation of a long review period		How applicant fulfils criteria / considerations
2	The costs of using the alternatives are very high and very unlikely to change in the next decade as technical progress (as demonstrated in the application) is unlikely to bring any change. For example, this could be the case where a substance is used in very low tonnages for an essential use and the costs for developing an alternative are not justified by the commercial value	This criterion is not relevant to this AfA which concerns the formulation of mixtures which are destined for uses which are not subject to REACH Authorisation requirements
3	The applicant can demonstrate that research and development efforts already made, or just started, did not lead to the development of an alternative that could be available within the normal review period	This criterion is not relevant to this AfA which concerns the formulation of mixtures which are destined for uses which are not subject to REACH Authorisation requirements
4	The possible alternatives would require specific legislative measures under the relevant legislative area in order to ensure safety of use (including acquiring the necessary certificates for using the alternative)	Not relevant for this AfA
5	The remaining risks are low and the socio-economic benefits are high, and there is clear evidence that this situation is not likely to change in the next decade	The excess lifetime cancer risks for both workers and humans via the environment over the 12-year period lead to an estimated 0.0023 fatal lung and bladder cancer cases, and a further 0.0011 non-fatal cancer cases; the present value economic damage costs of these health effects are calculated at €3,380 for the 12-year period at a 4% discount rate. Emissions to the environment are predicted to be around 993 grams per year in total across air and surface water. Over the 12-year review period, total emissions would equate to approximately 11.9 kg

3 Analysis of Impacts

3.1 Human health and environmental impacts

3.1.1 Hazard Profile

Coal tar pitch, high temperature (CTPht)

Coal tar pitch, high temperature (CTPht) is the residue from the distillation of high temperature coal tar (CAS no. 65996-89-6) in closed systems under vacuum (ECHA, 2009c). According to the EINECS description, it is a "*black solid with an approximate softening point from 30°C to 180°C. It is composed primarily of a complex mixture of three or more membered condensed ring aromatic hydrocarbons*". The composition of the substance includes a large variety of polynuclear aromatic constituents, including heterocyclic derivatives (ECHA, 2009).

CTPht is classified as a carcinogen (Carc. Cat. 1A; H350), mutagen (Muta. Cat. 1B; H340), and reproductive toxin (Repr. 1B; H360-FD) according to Annex VI, part 3, Table 3.2 (the list of harmonised classification and labelling of hazardous substances from Annex I to Directive 67/548/EEC) of Regulation (EC) No 1272/2008.

With respect to human health concerns, CTPht was listed on Annex XIV of REACH due to its carcinogenic properties.

In addition, CTPht is classified for skin sensitization (Skin Sens. 1; H317) according to a joint entry of industry registrants.

Anthracene oil

Anthracene oil (AO) has index number 648-079-00-6 in Annex VI, part 3, Tables 3.1 and 3.2 of Regulation (EC) No 1272/2008. The substance is classified as a carcinogen (Carc. Cat. 1B; H350) according to part 3 of Annex VI, Table 3.2 (the list of harmonised classification and labelling of hazardous substances from Annex I to Directive 67/548/EEC) of Regulation (EC) No 1272/2008.

However, under Article 62 (4)(d) of REACH, it is further specified that AO:

> *"Does not meet the criteria for identification as a carcinogen if it contains < 0.005 % (w/w) benzo[a]pyrene (EINECS No 200-028-5)".*

The CSR has revealed that the AO with the CAS no. 90640-80-5 produced and used by Rain Carbon contains benzo[a]pyrene in concentrations below 0.005%. Consequently, AO is not considered a carcinogen and the human health risks of workers and of humans via the environment will not be addressed for this substance in the rest of this section.

3.1.2 Number of people exposed

Exposure scenario

The formulation of CTPht/AO mixtures is described in detail in the CSR. As the CSR notes, there are three worker contributing scenarios (WCS) to the exposure scenario for the use of CTPht/AO. These are examined in more detail in the CSR and include:

- WCS1: supervising the distillation process and controlling the production parameters (plant operators) (PROC 3) and logistics activities (PROC 8b);

- WCS2: taking the samples into the laboratory and placing them into the fume hood (PROC 15); and
- WCS3: maintenance tasks on formulation equipment, dismantling and cleaning pumps at an operating temperature of ≤ 40°C; if this is not possible "in situ", the pump is transported to the workshop for reparation (PROC 28).

Number of workers exposed

As described in the CSR, the following numbers of workers are allocated to and associated with potential exposures to CTPht and AO under each of the WCS.

Table 3–1: Number of Rain Carbon's workers potentially exposed to PAH under the "Applied for Use" Scenario (direct exposure during formulation of mixtures)

WCS	Number of workers potentially exposed
WCS 1: plant operators	7
WCS 1: logistic operators	7
WCS 1: supervising (chief) operators	8
WCS 2: lab technicians	10
WCS 3: maintenance workers	21
Total number of workers potentially exposed	**53**
Source: CSR	

Number of humans exposed via the environment

The basis and scope of the analysis of human health impacts for exposures of human via the environment are as follows:

- The population that is potentially exposed 'locally' includes all of those persons spending a substantial amount of time in the area, as defined by a circle of 1km radius around the notional point source of PAHs, i.e. the tar distillation unit of Rain Carbon. This includes workers working within facilities that can be found within this area (for 8 hours a day, 1752 h per year, 219 days per year) and any local residents living in residential dwellings within this area (theoretically exposed to PAH for 24 hours a day, 365 days per year); and

- The population that is potentially exposed 'regionally' is that falling within an area equivalent to 40,000 km^2 around the point source, i.e. within the area of a circle of 113-km radius around the notional point source of PAH. This area is based on the size of a 'region' within the default assumptions of the EUSES software.

The Rain Carbon site is located in the outskirts of Zelzate near the Belgian-Dutch border. The location of Rain Carbon is shown in **Figure 3–1**.

Figure 3–1: Aerial view of the Rain Carbon site in Belgium (via Google Maps)

The following number of exposed individuals will be taken into consideration:

- **'Local' exposure of residents:** consideration is given to populations within a radius of 1,000 metres from the point of release for which, conservatively, exposure levels estimated at 100 metres from the point source are assumed to apply. The industrial site is located in the municipality of Zelzate, in the Belgian province of East Flanders, with a total population of 12,700. **Figure 3-2** shows that the relevant exposure area covers some residential blocks, thus the total number of the residents 'locally' exposed is estimated to be **2,540**, erring on the side of caution;

- **'Local exposure' of workers**: as above, consideration is given to populations within a radius of 1,000 metres from the point of release for which, very conservatively, exposure levels estimated at 100 metres from the point source are assumed to apply. As can be seen in **Figure 3-2**, the businesses falling within the 1km radius area are Rain Carbon, a ship repair company and a dredging company further downstream along the river. It is difficult to estimate an accurate number of workers. We assume that **100** are potentially exposed to PAH on the "local" level via the environment. It should be noted that unlike the general population, for workers, we assume that they will be exposed for 8 hours a day (compared to 24h for local residents) and for an assumed 240 days per year (compared to 365 days for local residents);

Figure 3-2: "Local exposure" area for population potentially exposed to PAH via the environment (via Scribble Maps)

- **'Regional' exposure of residents:** consideration is given to the population within a radius of 113km from the point of release. The notional area of the circle includes entirely the Belgian Regions of Brussels – Capital, and Flanders. The two regions together have a total population of 7,707,615.

  The 'regional' exposure area (see **Figure 3-3**) also covers a large part of the Region of Wallonia with a total population of 3,585,214. However, the Metropolitan Area of Liege, that has a total population of 749,100[1] and is also part of Wallonia, falls outside the 'regional' exposure area. Of the Netherlands, three regions are included in the notional area, with this being 100% of Zeeland, 90% of South Holland, 50% of North Brabant. This amounts to a total number of residents of 4,869,378 from the Netherlands. To conclude, 30% of the French Region of Hauts-de-France falls within the radius, amounting to a total number of 1,791,930 residents.

  The overall population of the notional 'region' is thus calculated at 17,237,094 inhabitants. Of this number, the 'local' resident population of 2,540 should be extracted to avoid double-counting, bringing the number of 'regionally exposed' residents to **17,234,554**. All these are assumed to be the members of the 'general population' i.e. potentially exposed to PAH during 24 hours a day, 365 days per year.

[1] https://en.wikipedia.org/wiki/Li%C3%A8ge accessed on 9 October 2018.

Figure 3-3: "Regional exposure" area for population potentially exposed to PAH via the environment (via Scribble Maps)

Table 3-2 provides a summary of the estimated population exposed within the region under the "Applied-for-Use" Scenario. **Table 3-3** combines these regional estimates with the figures for the directly exposed workers and the "local" exposure of worker to give the total figure for humans potentially exposed to PAH under the "Applied for Use" Scenario.

Table 3–2: Calculation of "regional" population potentially exposed to PAH

Country	Region with potential exposure	Total population	% exposed	Population potentially exposed
Belgium	Brussels - Capital	1,191,604	100%	1,191,604
Belgium	Flanders	6,516,011	100%	6,516,011
Belgium	Wallonia	3,585,214	80%	2,868,171
Netherlands	Zeeland	380,621	100%	380,621
Netherlands	South-Holland	3,600,784	90%	3,280,784
Netherlands	North Brabant	2,415,946	50%	1,207,973
France	Hauts-de-France	5,973,098	30%	1,791,930
			Total 'regional' population	17,237,094
			Total 'regional' population minus 'local' population	**17,234,554**

Sources:
https://en.wikipedia.org/wiki/Provinces_of_Belgium accessed on 9 October 2018
https://en.wikipedia.org/wiki/Provinces_of_the_Netherlands accessed 9 October 2018
https://en.wikipedia.org/wiki/Hauts-de-France accessed 9 October 2018

Table 3–3: Number of humans potentially exposed to PAH under the "Applied for Use" Scenario	
Population group	**Number of humans potentially exposed**
Rain Carbon directly exposed workers	53
Local residents	2,540
Local workers	100
Regional residents	**17,234,554**
Total number of potentially exposed humans	**17,237,247**

3.1.3 Worker exposure and excess cancer risk estimates

Relevant exposure pathways

As stated in the CSR, the relevant human exposure pathways at the plant are chronic inhalation and dermal exposure. The CSR confirms that the dermal pathway is negligible in the context of the total exposure. Thus, inhalation exposure is the only pathway relevant to worker exposure that is considered in this SEA analysis.

Total cancer risks for inhalation exposure are calculated by adding up risks obtained for the two main tumour locations (lung and bladder). Based on epidemiological evidence, risks for tumours at any other location are considered low compared to these two main sites. Where biomonitoring data are used, risks for bladder tumours are considered by transforming 1-OH pyrene concentrations into benzo(a)pyrene air concentrations, using the relationship provided by RAC (ECHA, 2018).

During manufacture and formulation CTPht is handled in closed systems. While working in these plant areas and handling the hot substance (e.g. during sampling), workers are required to wear protection against hot materials. Any contact with the substance would immediately cause burns. Furthermore, any contamination of work clothes and gloves with the deep black substance and mixtures is immediately detected. Therefore, regular contamination of the skin can safely be excluded for most activities and no quantitative dermal exposure estimation is provided here.

Exposure levels

Levels and frequency of potential exposure are presented in **Table 3–4**, alongside the estimated increase in excess lifetime cancer risk, as described in the CSR.

Table 3–4: Exposure levels and excess cancer risk for workers under the "Applied for Use" Scenario						
Group of workers	No. of workers	WCS number	PAH exposure, TWA, P90 [ng BaP/m³]	Excess lifetime cancer risk		Combined excess lifetime risk
				Lung	Bladder	
Plant operators	7	WCS1	3.64	2.04 E-05	1.46 E-05	3.50 E-05
Logistics Operators	7	WCS1	45.21	2.53 E-04	1.81 E-04	4.34 E-04
Chief operators	8	WCS1	0.0	0	0	0
Laboratory technicians	10	WCS2	0.0	0	0	0
Maintenance workers	21	WCS3	0.084	4.70E-07	3.36 E-07	8.06 E-07
Source: CSR Notes: All values are rounded to three significant figures, but unrounded values were used for risk calculation * Includes both inhalation and dermal exposure and risk estimates; all other values based on air monitoring and biomonitoring, the latter also covering dermal exposure						

Calculation of excess number of statistical cancer cases

For the "Applied for Use" Scenario the number of excess statistical cancer cases is calculated using the RAC's ERR (ECHA, 2018). Using figures for the number of potentially exposed workers and the estimated excess total cancer risks shown in the CSR, the excess statistical cancer cases that might arise from continued exposure to PAHs are calculated.

Importantly, the RAC's ERR reflects total number of cases and thus to ensure appropriate monetisation of excess cancer risks amongst the exposed worker population, it is important to distinguish between fatal and non-fatal cases. To achieve this, data for both lung and bladder cancer are taken from Cancer Today, which collects global data on cancer incidence, mortality, and prevalence for cancer.

Table 3–5: Incidence and mortality of Lung cancer in Belgium, 2018					
Sex	Type of cancer	Incidence	Fatalities	Mortality Ratio	Survival Ratio
Male & female	Lung	9,424	7,037	**74.67%**	**25.33%**
Source: http://gco.iarc.fr/today/home (accessed on 30 January 2019)					

Table 3–6: Incidence and mortality of Bladder cancer in Belgium, 2018					
Sex	Type of cancer	Incidence	Fatalities	Mortality Ratio	Survival Ratio
Male & female	Bladder	4,458	1,134	**25.44%**	**74.56%**
Source: http://gco.iarc.fr/today/home (accessed on 30 January 2019)					

On this basis, estimates can be generated on the excess statistical cancer cases over the 12-year assessment period for the relevant worker population at Rain Carbon; the results are shown in **Table 3-7** overleaf.

Table 3–7: Number of excess statistical fatal and non-fatal cancer cases among workers at Rain Carbon's plant under the "Applied for Use" Scenario (90th percentile exposure estimates)								
WCS	**Number of workers potentially exposed**	**Excess lifetime Lung cancer risk (from CSR)**	**Excess lifetime Bladder cancer risk (from CSR)**	**Excess number of lifetime cancer cases**	**LUNG CANCER - Number of excess lifetime fatal cancer cases**	**LUNG CANCER - Number of excess lifetime non-fatal cancer cases**	**BLADDER CANCER Number of excess lifetime fatal cancer cases**	**BLADDER CANCER Number of excess lifetime non-fatal cancer cases**
WCS1 – operators	7	2.04 E-05	1.46 E-05	2.45 E-04	1.1E-04	3.65 E-05	2.65 E-05	7.62 E-05
WCS1 - logistics	7	2.53 E-04	1.81 E-04	3.04 E-03	1.3 E-03	4.5 E-04	3.2 E-04	9.45 E-04
WCS1 – chief operators	8	0.00 E+00	0.00 E+00	0.00 E+00	0.0 E+00	0.0 E+00	0.0 E+00	0.00E+00
WCS2 - lab	10	0.00 E+00	0.00 E+00	0.00 E+00	0.0E+00	0.0E+00	0.0 E+00	0.00E+00
WCS3	21	4.70 E-07	3.36 E-07	1.69 E-05	7.4 E-06	2.5 E-06	1.8 E-06	5.26 E-06
Working lifetime, 40 years				**3.30 E-03**	**1.44 E-03**	**4.87 E-04**	**3.50 E-04**	**1.03 E-03**
Assessment period, 12 years				**9.90 E-04**	**4.31 E-04**	**1.46 E-04**	**1.05 E-04**	**3.08 E-04**
Annual values				**8.25 E-05**	**3.59 E-05**	**1.22 E-05**	**8.75 E-06**	**2.57E-05**

3.1.4 General population exposure and excess cancer risk estimates

Relevant exposure pathways

Exposure to the general population can happen via the environment by means of inhalation and oral exposure. Inhalation cancer risks, derived from epidemiological data, are given separately for the two main target organs: lung and bladder.

It is noted that there is no available epidemiological data regarding the impact on human health from oral exposure to PAHs. As a result, epidemiological data on animals have been considered instead. Such data have shown that animals can suffer a wide range of cancer types but, for the purpose of estimating excess cancer risks, it is assumed that the exposure to PAHs can only be associated with oral exposures leading to lung cancer. Obviously, such an assumption results in a very conservative estimation within the EUSES model. This accounts for the substantial discrepancy between the lung cancer excess lifetime cancer risk for the general population and that for workers.

Table 3–8 summarises the results of the calculations performed in the CSR, regarding excess cancer risks for humans exposed via the environment in the "local" and "regional" areas around the Zelzate unit.

Table 3–8: Excess cancer risks for human exposure via the environment under the "Applied for Use" Scenario (CSR results)

Scale - population	Total exposure to Benzo[a]-pyrene		Lung Cancer Excess lifetime cancer risk	Bladder Cancer Excess lifetime cancer	Assumptions and notes
	Oral	Inhalation			
Local assessment (1 km radius) – general population	2.25 E-02* Total daily intake oral (PEC_{oral}) for sum PAH4 EFSA [ng/kg/d]	1.86 E-05 Annual average local PEC in air (total) [ng/m^3]	4.65 E-08 (oral)	3.91 E-10 (inhalation and oral)	Assumed that all residents within the 1km radius are exposed to PAH levels in air similar to those currently being monitored at **100 m** from the point source; oral exposure conservatively taken from modelling
Local assessment (1 km radius) – workers onsite not involved in formulation activities	1.86 E-05 Annual average local PEC in air (total) [ng/m^3]		1.04 E-10 (inhalation and oral)	7.44 E-11 (inhalation and oral)	Assumed that all workers within the 1 km radius are exposed to PAH levels in air similar to those currently being monitored at **100 m** from the point source; oral exposure conservatively taken from modelling
Regional assessment (113 km radius) – general population	3.90 E-04** Total daily intake oral (PEC_{oral}) for sum PAH4 EFSA [ng/kg/d]	1.30 E-09 Regional PEC in air (total) [ng/m^3]	8.04 E-10 (oral)	2.73 E-14 (inhalation and oral)	Based on modelling.

Source: CSR
*Sum of Benzo[a]-pyrene, Chrysene, Benzo[b]-fluoranthene, Benz[a]-anthracene
** Sum of Benzo[a]-pyrene, Chrysene, Benzo[b]-fluoranthene, Benz[a]-anthracene

The oral exposure assumes that all food items consumed (milk, meat, fish etc.) come from the vicinity of the site, which is unrealistic. This fact is also acknowledged in the ECHA Guidance (ECHA, 2012).

Furthermore, the above excess cancer risk estimates are substantially overestimated as they are based on 90th percentile values derived from current monitoring results but also because they disregard the distance of exposed populations from the point source.

Following the same approach as for workers, the calculation of the excess cancer cases among the general population can be presented in **Table 3-9** overleaf.

3.2 Monetised human health impacts

3.2.1 Basis for economic valuation of excess statistical fatal and non-fatal cancer cases

The economic valuation of the health impacts takes into account two important welfare components, the costs associated with mortality and morbidity. The basis of our calculations is the study led by the Charles University in Prague (Alberini and Ščasný, 2014) and undertaken for ECHA. That study was critically reviewed by ECHA in 2016 and the results of that review have been the basis of the economic valuation performed here (ECHA, 2016b). The values used are:

- **Value of statistical life for the avoidance of a death by cancer**: €3.5 million (2012 prices) (ECHA, 2017b); and
- **Value** of **cancer morbidity:** €0.41 million (2012 prices).

It is considered appropriate to update these two figures to 2018 prices (updated to first and second quarter values of 2018). This has been achieved by use of the Eurostat EU GDP deflator[2]. This suggests that the aforementioned figures should be multiplied by a factor of 1.0660. Thus, the following values are employed in the analysis below:

- **Value of statistical life (mortality)**: €3.5 million × 1.0660 = €3.70 million (rounded); and
- **Value of cancer morbidity**: €0.41 million × 1.0660 = €0.44 million (rounded).

[2] Available at http://bit.ly/GDPDeflatorNEW and http://bit.ly/GDPDeflatorOLD (accessed on 12 February 2018). Data were available and used for Q2-Q4 of 2012 and Q1-Q3 of 2017.

Table 3-9: Number of excess fatal and non-fatal cancer cases among citizens potentially exposed to PAH via the environment during the 12-year assessment period under the "Applied for Use" Scenario									
Exposure route	Scale	Lung cancer - Excess lifetime cancer risk (from CSR)	Bladder Cancer – Excess lifetime cancer risk	Number of persons potentially exposed	Number of excess statistical lifetime cancer cases				
					Total	Fatal		Non-fatal	
						Lung	Bladder	Lung	Bladder
Inhalation + Oral	Local - Residents	4.65 E-08	9.49 E-10	2,540	1.21 E-04	8.82 E-05	2.53 E-07	2.99 E-05	7.41 E-07
Inhalation + Oral	Local - Workers	1.04 E-10	7.44 E-11	100	1.78 E-08	7.77 E-09	1.89 E-09	2.63 E-09	5.55 E-09
Inhalation + Oral	Regional	8.04 E-10	2.73 E-14	17,234,554	1.39 E-02	1.03 E-02	1.20 E-07	3.51 E-03	3.51 E-07
Exposed population lifetime (70 yrs gen pop / 40 yrs workers)					**1.40 E-02**	**1.04 E-02**	**3.74 E-07**	**3.54 E-03**	**1.10 E-06**
Assessment period, 12 years					**2.40 E-03**	**1.79 E-03**	**6.44 E-08**	**6.07 E-04**	**1.89 E-07**
Annual values					**2.00 E-04**	**1.49 E-04**	**5.37 E-09**	**5.06 E-05**	**1.57 E-08**

In addition to such values, and for the purpose of quantifying human health impacts, consideration has also been given to:

- **Annual medical treatment costs for morbidity**: these are estimated to be €14,533 for lung cancer cases[3] and €2,176 for bladder cancer cases (Gerace *et al.*, 2017). With respect to lung cancer morbidity cases, we have taken a survival rate of 19% after 1 year, 13% after 5 years, and 5% after 10 years (LuCE, 2016). With respect to bladder cancer morbidity cases, we have considered 72% survival after 1 year, 54% after 5 years, 50% after 10 years[4];

- **Annual medical treatment costs for mortality**: among those who contract cancer and eventually die, many receive medical treatments over several years before death occurs. Since the value of statistical life does not cover the willingness to pay to avoid healthcare costs, we added annual medical treatment costs to quantify the costs of morbidity cases. We chose an average value of €7,578 to account for the total medical treatment costs for fatal bladder and cancer cases; and

- **Annual value of productivity losses**: these are estimated to be €1,052 for lung cancer (Luengo-Fernandez *et al.*, 2013) and €1,606 for bladder cancer (Gerace *et al.*, 2017). Both values are adjusted to 2018 prices. Costs of lost productivity due to cancer-related morbidity comprise both the costs associated with individuals taking sickness leave for a defined period of time (temporary absence), and the costs of individuals being declared incapacitated or disabled because of cancer (permanent absence).

With respect to the timing of the cancer effects, these are assumed to have an average latency of 20 years. As a result, cases first occur in 20 years' time and then occur annually for an additional 12 years corresponding to the applied for review period. This applies to both lung cancer and bladder cancer. It is generally assumed that the latency period for solid tumours such as these is between 10 to 50 years (Rushton and et al, 2010), with various studies confirming that a figure of 20 years is not unreasonable (Miyakawa *et al.*, 2001).

3.2.2 Monetisation of impacts on workers under the "Applied for Use" Scenario

The selected values for mortality and morbidity are applied to the estimated annual number of excess statistical fatal and non-fatal cases among Rain Carbon's workers, respectively. The annual human health costs are then discounted from year 20 over a 12-year period, at a rate of 4%. The baseline year is 2018, discounting starts in 2019 and impacts to workers' and the general population's health theoretically manifests in 2040 (i.e. to allow for the assumed 20-year time lag between exposure to a carcinogenic agent and disease manifestation).

Table 3-10 presents the estimated number of lung cancer and bladder cancer cases and associated costs, in present value terms, over the assessment period.

[3] Such value results from the average of the estimated costs of lung cancer medical treatments from four different studies: (Braud *et al.*, 2003) (France, 2003), (Dedes *et al.*, 2004) (Switzerland, 2004), (Leal, 2012) (UK, 2012), (García Gómez *et al.*, 2012) (Spain, 2012).

[4] These values are based on a study conducted by Cancer Research UK on adults aged 15-99 in England and Wales from 2009-2013.

Table 3-10: Present value and annualised economic value of mortality and morbidity effects on workers at Zelzate (discounted from year 20 over 12 years 4% per year)		
	Mortality	Morbidity
Total number of excess cancer cases among workers	5.36 E-04	4.54 E-04
Annual number of cases among workers	4.47 E-05	3.78 E-05
Present Value cost (2018 prices)	€ 738	€ 77
Total Present Value costs (over 12 years)	**€ 815**	
Total annualised cost	**€ 183**	
Note: figures are rounded to nearest €		

3.2.3 Monetisation of impacts on the general population from exposure via the environment for the "Applied for Use" Scenario

As for workers, the selected values for mortality and morbidity were applied to the estimated annual number of excess statistical fatal and non-fatal cases amongst the general population. The annual human health costs are then discounted from year 20 over 12 years at a rate of 4%. **Table 3-11** presents the estimated number of cancer cases and associated costs, in present value (2018) terms, over the 12-year assessment period.

Table 3-11: Present value and annualised economic value of mortality and morbidity effects on the general population in Belgium (discounted from year 20 over 12 years 4% per year)		
	Mortality	Morbidity
Total number of excess cancer cases among general population	1.79 E-03	6.07 E-04
Annual number of cases among general population	1.49 E-04	5.06 E-05
Present Value cost (2018 prices)	€ 2,462	€ 103
Total Present Value costs (over 12 years)	**€ 2,565**	
Total annualised cost	**€ 576**	
Note: figures are rounded to nearest €		

3.3 Environmental impacts

3.3.1 Environmental classification

According to notice 2018/C 239/03 of the Official Journal of the European Union (9.7.2018), and taking into account the Court judgment on C-691/15P, CTPht is no longer classified as Aquatic Acute 1 and Aquatic Chronic 1. It is classified as hazardous to the aquatic environment (Aquatic Acute 4; H413) according to a joint entry of industry registrants. AO is not classified for hazards to the environment.

However, the twelve indicator PAHs according to Annex VI, part 3, Table 3.2 of Regulation (EC) No 1272/2008) are classified for hazards to the environment, and these classifications are provided in **Table 3-12**.

Table 3–12: Classification and labelling of the twelve indicator PAHs for environmental hazards according to Regulation (EC) No 1272/2008 (Annex VI, part 3, Table 3.2), taking into account recent changes (see text above)			
Substance	CAS no [Index No]	Classification	
		Hazard Class and Category Code(s) [specific concentration limits]	Hazard statement Code(s)
Anthracene	120-12-7	*,**	*,**
Phenanthrene	85-01-8	*	*
Fluoranthene	206-44-0	*	*
Pyrene	129-00-0	*	*
Benz[a]anthracene	56-55-3 [601-033-00-9]	Aquatic Acute 1 Aquatic Chronic 1	H400 H410
Chrysene	218-01-9 [601-048-00-0]	Aquatic Acute 1 Aquatic Chronic 1	H400 H410
Benzo[a]pyrene	50-32-8 [601-032-00-3]	Aquatic Acute 1 Aquatic Chronic 1	H400 H410
Benzo[b]fluoranthene	205-99-2 [601-034-00-4]	Aquatic Acute 1 Aquatic Chronic 1	H400 H410
Benzo[k]fluoranthene	207-08-9 [601-036-00-5]	Aquatic Acute 1 Aquatic Chronic 1	H400 H410
Benzo[ghi]perylene	191-24-2	*	*
Dibenzo[a,h]anthracene	53-70-3 [601-041-00-2]	Aquatic Acute 1 Aquatic Chronic 1	H400 H410
Indeno[1,2,3-cd]pyrene	193-39-5	*	*

Key:

*: No classification in the context of Regulation (EC) No. 1272/2008

**: Xi; R38 N;R50-53 (in the context of Directive 67/548/EEC) proposed in the draft risk assessment report on anthracene (Greece, 2008) [translated according to Table 1.1 of Annex VII of Regulation (EC) No. 1272/2008 into: Skin Irrit. 2; Aquatic Acute 1; Aquatic Chronic 1]

N: Dangerous for environment; R50-53: Very toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment.

Aquatic acute 1, Aquatic chronic 1: Hazardous to the aquatic environment

H400: Very toxic to aquatic life; H410: Very toxic to aquatic life with long lasting effects.

3.3.2 Existing Risk Management Measures

A range of risk management measures are currently in place at Rain Carbon's Zelzate facility. In particular, operating conditions are specified in the permits granted to the facility under the Industrial Emissions Directive (IED, 2010/75/EU) from the relevant regional Belgian authorities.

As required by the IED, permits must take into account the whole environmental performance of the plant, thus covering emissions to air, water and land, generation of waste, use of raw materials, energy efficiency, noise, prevention of accidents, and restoration of the site upon closure. The permit conditions must identify emission limit values measured on the basis of the Best Available Techniques (BAT). Each National Authority is then permitted a certain degree of flexibility about the ways to apply the directive to the companies operating in its territory.

In addition to the Industrial Emissions Directive, other regulations also combine to control the emission of PAHs in the environment from Rain Carbon's facilities. These concern specific requirements for the control of wastewater before it is discharged into surface waters:

- The Environmental Quality Standards (EQS) Directive 2008/105/EC lays down standards for priority hazardous and certain other pollutants for the protection of surface waters as provided for in Article 16 of the Water Framework Directive 2000/60/EC. Under the EQS Directive and in Decision 2455/2001 (EC), the group of polyaromatic hydrocarbons is included in the list of Priority Hazardous substances; and

- Directive 91/271/EEC on urban waste water treatment.

In addition, Directive 2004/107/EC relates to the setting of target values in ambient air of pollutants including PAHs, as measured by benzo(a)pyrene (with this Directive amended by Directive (EU) 2015/1480). This Directive together with the Air Quality Daughter Directive 1999/30/EC) will work to reduce industrial emissions of PAH to air (and as far as economically possible in the latter case).

3.3.3 Emissions and Exposures

The environmental impacts arising from water and air emissions due to manufacture and formulation activities involving CTPht and AO at Rain Carbon, Zelzate are negligible. Moreover, the calculated values overestimate the real exposure conditions as detailed below.

Emissions to air

PAH air emissions relevant for this AfA come from four different scrubbers: two scrubbers from the pitch storage park (scrubbers K101 and K102), one scrubber from the storage park for tar oils (scrubber K100A) and one scrubber from combined oils and pitch (31B101). Note for the storage park for tar oils that the tanks dedicated to storage of AO (= AO low; which is the AO subject to this AfA) only account for 66.1% of the park and the total PAH emission from scrubber K100A overestimates the emission coming from AO formulations by 33% (CSR, pag.68).

In total, the yearly emissions to air relevant to this SEA are calculated at 935.8 g/year (see the CSR for further details).

Emissions to surface water

The entire formulation process carried out at Rain Carbon is waterless, plus the complete production and formulation area is paved. No water is used during truck or ship loading, so there are no emissions to water as a result of these processes.

Water coming from other sources, such as rainwater, water used in cleaning of equipment, water from the steam production and other technical applications is gathered and treated before it is released into the Ghent–Terneuzen Canal. The water gathered on-site undergoes a treatment process (decantation, coagulation, filtration, adsorption on styrene-divinylbenzene resins), but it is noted that no biological treatment is conducted. This explains why emissions of PAHs to air via volatilization can be considered as negligible and why no bio-sludge is generated.

Total yearly emissions to surface waters are calculated at 57.3 g/year (see the CSR for further details).

Emissions to sludge

As there is no biological treatment of water collected on-site, there are no calculated emissions to sludge, as indicated above.

Summary

The table below summarises the PAH emissions to the relevant compartments that can be ascribed to the formulation's activities of Rain Carbon. As can be seen from **Table 3-13**, total PAHs emissions into the environment are low. As the average half-life values in surface waters for the various PAHs are less than 83.5 days, there will be no significant increase in environmental stocks over the 12-year review period. This aspect is not therefore considered further. Analogously, there will be no significant increase in environmental stocks in air as degradation rates in the atmosphere are usually very low (The Netherlands, 2008).

Table 3-13: PAH emissions from the STP to various compartments			
PAHs	Emission to Surface Water (g/year)	Emissions to Sludge (g/year)	Emissions to Air (g/year)
Anthracene	7.3	0.0	118
Phenanthrene	12.1	0.0	642
Fluoranthene	14.5	0.0	117
Pyrene	8.2	0.0	57.8
Benzo[a]anthracene	3.2	0.0	0.00
Chrysene	4.1	0.0	0.00
Benzo[a]pyrene	3.1	0.0	0.00
Benzo[k]fluoranthene	2.6	0.0	0.00
Benzo[ghi]perylene	2.1	0.0	0.9
Total	**57.3**	**0.0**	**935.8**
Source: CSR[5]			

3.3.4 Summary of PBT properties

In the SVHC Support Document (ECHA, 2009), it was concluded that seven of the twelve indicator PAHs, fluoranthene, pyrene, benz[a]anthracene, chrysene, benzo[a]pyrene, benzo[k]fluoranthene and benzo[ghi]perylene are both, PBT and vPvB substances. Based on a re-assessment, phenanthrene does not fulfil the vPvB/PBT criteria. Anthracene fulfils the PBT but not the vPvB criteria. For benzo[b]fluoranthene, dibenzo[a,h]anthracene, and indeno[1,2,3-cd]pyrene, no experimental data relevant for the P/vP and/or B/vB assessment in accordance with Annex XIII of the REACH Regulation are available and, thus, no definitive conclusion can be drawn on their PBT/vPvB properties.

Since CTPht contains approximately 7 % of PAH-constituents with both vPvB and PBT properties it is considered as a PBT and vPvB substance (ECB, 2008; The Netherlands, 2008; ECHA, 2009). However, this assessment based on single constituents does not take into consideration that CTPht as such is practically insoluble in water and hence the matrix-bound PAHs are not bioavailable. Therefore, the applicability of the criteria for P/vP as well as B/vB is questioned due to the inherent refractory properties of the UVCB substance. Aquatic acute and chronic standard toxicity testing failed to reveal adverse effects.

[5] benzo[b]fluoranthene is not included in the table since it is not a PBT/vPvB substance (See CSR for more details)

Table 3–14: Conclusions on fulfilment of the (v)P-, (v)B- or T-criteria for the twelve indicator PAHs					
Substance	**Persistence**	**Bioaccumulation**	**Toxicity human health**	**Toxicity Aquatic Environment**	**Conclusion**
Anthracene	vP	B	-	T	PBT
Phenanthrene *	vP (previous assessment, under discussion)	vB (previous assessment) B (reassessment, see above)	-	-	vPvB (previous assessment) not PBT (reassessment)
Fluoranthene *	vP	vB	-	T	PBT/vPvB
Pyrene *	vP	vB	-	T	PBT/vPvB
Benz[a]anthracene	vP	vB	T	T	PBT/vPvB
Chrysene	vP	vB	T	-	PBT/vPvB
Benzo[a]pyrene	vP	vB	T	T	PBT/vPvB
Benzo[b]fluoranthene	vP	No experimental data	T	- (No signs of toxicity up to limit of water solubility)	-
Benzo[k]fluoranthene *	vP	vB	T	T	PBT/vPvB
Benzo[ghi]perylene	vP	vB	-	T	PBT/vPvB
Dibenzo[a,h]anthracene	No experimental data	vB	T	T	-
Indeno[1,2,3-cd]pyrene	No experimental data	No experimental data	-	T	-
* Note: PBT classification of fluoranthene, phenanthrene, pyrene, and benzo[k]fluoranthene is currently in the commenting phase of the SVHC-listing process, thus not yet definitely decided upon					

3.3.5 Risk Characterisation

Although it is not the aim of this AfA to follow a threshold approach for PBT substances, the CSR calculates Risk Characterisation Ratios (RCRs) to help illustrate the differences between Predicted Environmental Concentrations (PECs) and no effect concentrations. The comparison of these data shows that the PECs of all compartments are orders of magnitude lower than the respective PNECs. Accordingly, the local Risk Characterisation Ratios (RCRs), which are obtained by dividing the local PEC by the PNEC for each compartment, indicate a very low (<<1) risk for environmental effects, see **Table 3-15**.

Table 3–15: Local Risk Characterisation Ratios (RCRs) for diverse compartments as calculated by EUSES			
	RCR fresh water [mg/L]	RCR fresh sediment [mg/kgdwt]	RCR soil [mg/kgdwt]
Anthracene	6.31E-04	6.65E-04	1.27E-05
Phenanthrene	8.18E-05	2.44E-05	4.72E-06
Fluoranthene	1.15E-02	5.84E-04	1.55E-06
Pyrene	2.97E-03	7.18E-05	9.12E-07
Benz[a]anthracene	1.38E-03	1.38E-02 [a]	6.08E-08
Chrysene	3.36E-04	3.36E-03 [a]	1.05E-07 [a]
Benzo[a]pyrene	5.75E-04	5.75E-03 [a]	1.61E-07
Benzo[k]fluoranthene	6.44E-04	6.44E-03 [a]	3.16E-07 [a]
Benzo[ghi]perylene	9.23E-04	9.23E-03 [a]	1.89E-05 [a]
[a] The equilibrium partitioning method was used to calculate the PNEC and an extra assessment factor of 10 was applied to the PEC/PNEC ratio in EUSES (in all cases the PAH has a log K_{OW} > 5), leading to a 10-fold increase of the RCR			

Beside the low RCRs, the CSR also provides a comparison of the local PEC values in freshwater with the Environmental Quality Standards in inland surface waters set under Directive 2008/105/EC (EC, 2008), available for anthracene, fluoranthene, benzo[a]pyrene, benzo[k]fluoranthene and benzo[ghi]perylene. This comparison shows that the water emissions from Zelzate have a negligible impact on the environment. The calculated PEC bulk freshwater-values of the individual PAHs are between two and five orders of magnitude lower than the Environmental Quality Standard for inland surface water (**Table 3–16**). Accordingly, the PECs are much lower than the published background concentrations of PAHs in inland surface waters.

Table 3–16: Comparison of PEC values for bulk freshwater with Environmental Quality Standards for inland surface waters			
	PEC freshwater, bulk [a] [mg/L]	Environmental Quality Standard AA-EQS [b] Inland surface waters [c] [mg/L]	Ratio
Anthracene	6.76E-08	1.00E-04	6.76E-04
Phenanthrene	1.12E-07	-	
Fluoranthene	1.42E-07	6.30E-06	2.26E-02
Pyrene	7.80E-08	-	
Benz[a]anthracene	3.68E-08	-	
Chrysene	4.63E-08	-	
Benzo[a]pyrene	3.84E-08	1.70E-07	2.26E-01
Benzo[k]fluoranthene	3.20E-08	d	
Benzo[ghi]perylene	2.64E-08	d	
[a] The PEC freshwater bulk was calculated from the PEC freshwater for comparison with the Environmental Quality Standards [b] This parameter is the EQS expressed as annual average value (AA-EQS). Unless otherwise specified, it applies to the total concentration of all isomers [c] Inland surface waters encompass rivers and lakes and related artificial or heavily modified water bodies [d] For the group of priority substances of PAHs, the biota EQS and corresponding AA-EQS in water refer to the concentration of benzo[a]pyrene, on the toxicity of which they are based. Benzo[a]pyrene can be considered as a marker for the other PAHs, hence only benzo[a]pyrene needs to be monitored for comparison with the biota EQS or the corresponding AA-EQS in water.			

3.4 Economic impacts

3.4.1 Impacts of "Non-use" Scenario on Rain Carbon

Overview

The consolidated gross profit of Rain Carbon's operations in Zelzate is ca. [redacted] (range: €10-100 million) per year for the years 2017-2018 [redacted]. This profit is foreseen to persist over the requested review period under the "Applied for Use" Scenario.

Assuming that:

- The annual gross operating profits (GOP) from sales of all formulated mixtures is and remains at €[redacted] (range: €10-100 million) per year (see **Table 3-17** below),
- An assessment period of 12 years applies, and
- A business discount rate of 4% applies,

the Present Value gross operating profits arising to Rain Carbon over the period can be estimated at €[redacted] (€100-1,000 million) in 2018 prices.

The "Non-Use" Scenario

As discussed in Section 2.3, the "Non-Use" Scenario for Rain Carbon comprises separate assumptions on the least-cost response for CTPht and for AO. These can be summarised as follows:

1. For CTPht, the following impacts would arise:

    a. Loss of sales of hybrid pitch formulations, [redacted]

    b. The [redacted] being made redundant, with the loss of much of the capital value of this investment (although some savings in maintenance costs would be realised),

    c. Loss of sales of the Søderberg paste formulations, and

    d. Loss of sales of special grade of carbon black feedstocks.

2. For AO, the following impacts would arise:

    a. Reduce margin on pure AO and on other oils due to the need to export/transport as unblended/unformulated product;

    b. Additional losses due to need to ship out of the EEA for formulation and sale on non-EEA market.

The implications of these losses are discussed further below.

Losses under the Non-Use scenario for CTPht

Sales of anode pitch account for ca. [redacted] of sales in the EU from 2020 onwards and up to ca. [redacted] of sales to non-EEA customers (see also **Table 2-5**). [redacted]

As an average, sales of anode pitch account for [redacted] (range: 50 – 100%) of profits, or around € [redacted] (range: €10 – 100 million) per annum for 2017/18. Based on ca. [redacted] (range 100 – 1,000 thousand tonnes) of anode pitch being placed on the market per year (sales in 2017 linked to this profit level), this equates to profits of around € [redacted] (range: 100 – 1,000) per tonne of CTPht. Based on [redacted] (range: 10 – 100 thousand) tonnes of Søderberg paste placed on the market, this equates to profits of around € [redacted] (range: 100-1,000) per tonne of CTPht used in the mixture, [redacted] (10-100 thousand tonnes). Based on ca. [redacted] (range 10-100 thousand tonnes) of AO and CTPht blended with other raw materials to produce CBF, this equates to profits of around € [redacted] (range:10-100) per tonne of the two substances used. A summary is provided in the **Table 3-17** below.

Table 3–17: Gross profit figures for Rain Carbon's formulations for the period 2017 – 2018 (rounded)

Product	Relevant tonnages of CTPht and AO (rounded)			Gross Operating Profits		
	EEA Customers (t/y)	Non-EEA Customers (t/y)	Total (t/y)	€ per annum	€ per tonne	% of total
Anode pitch	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Søderberg paste	[redacted]		[redacted]	[redacted]	[redacted]	[redacted]
CBF (AO + CTPht)	[redacted]		[redacted]	[redacted]	[redacted]	[redacted]
AO (oils for export)		[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Totals			[redacted]	[redacted]		**100%**

As detailed in Section 2.3.2, if formulation were not to be allowed, then Rain Carbon would no longer be able to produce hybrid pitches. [redacted]

In addition to the loss of anode pitch formulation, Rain Carbon would no longer be able to manufacture Søderberg paste or use CTPht in carbon black feedstock production. In total, these uses equate to around [redacted] (range: 10,000 – 100,000) tonnes of CTPht from 2020 onward. The volumes of CTPht used in CBF would be exported together with AO to produce CBF in the non-EEA industrial site. Losses from the CTPht used in the CBF are calculated in the section below together with the AO shipped to [redacted].

[redacted]

This suggests that losses in profits to Rain Carbon from the loss of CTPht formulation activities would equate to roughly € #C# (range: €10 – 50 million) per annum, or € #C# (range: €50 – 500 million) in present value terms over the 12-year period (see **Table 3-18**). #D#

Losses under the Non-Use scenario for AO in other formulations

In addition, the profits associated with AO formulation activities would be lost. As noted in **Table 2-5** roughly #B# (range: 10 - 50 kta) of AO are used in formulations to produce carbon black feedstock and blended oils for export. These formulations account for roughly #C# (when including CBF) of the gross operating profits attributable to the sales of formulated mixtures by Rain Carbon, based on 2017-2018 data account. This is calculated as around #C# (range: 1 – 10 million) per annum (see **table 3-17** above).

The losses in profit on the AO used in the manufacture of carbon black feedstock are assumed to be #C# to Rain Carbon Zelzate's facility. The losses arising from the need to ship CBF components to #C#, ca. #C# (range: 10,000 – 100,000) are calculated at approximately #C# (range: €1 – 10 million), assuming a profit margin of #C# per tonne of raw material. The AO sold for non-EEA formulation into blended oils will also be affected by an increase in logistic costs. These losses were given in **Table 2-8**, which is repeated here for ease of reference as **Table 3-18**. The additional costs under the Non-Use Scenario associated with shipping and the need of new storage facilities were discussed in Section 2.3.3, and are also re-presented in **Table 3-18**.

Table 3–18: Losses to Rain Carbon in gross operating profits under the Non-Use Scenario		
	Annual losses	**Present value losses (12 years @4%)**
GOP losses		
No sales of hybrid pitch [redacted]	#C for all table#	[redacted]
Søderberg pitch valorisation loss to CTP+CBO	[redacted]	[redacted]
AO + rest of CBO export to [redacted]	[redacted]	[redacted]
Total GOP loss	[redacted]	[redacted]
Logistic costs for AO (alternative 2)		
New storage tanks at Rain Carbon*	[redacted]	[redacted]
Tank rental	[redacted]	[redacted]
Additional logistic costs for export to non-EU sites		
Yearly cost IMO ship – annual average capacity	[redacted]	[redacted]
Yearly cost IMO ship – full capacity	[redacted]	[redacted]
New storage tanks, non-EU formulation site*	[redacted]	[redacted]
Total yearly GOP effect		
	[redacted] (range: €10-100 million)	[redacted] (range: €100–1,000 million)
*Capex: assumes life of 20 years, with costs annualised at 4%; [redacted]		

As can be seen from this table, the total estimated losses to Rain Carbon would be ca. € #C# million (range: €10 – 100 million) per annum. These compare to a total value for gross profits which is expected to remain at € #C# (range 10-100) million per annum.

In present value terms, total losses are estimated at €#C# [redacted] (range: €100 – 500 million) over the 12-year period (discounted at 4%). The impacts of no longer being able to formulate AO are of particular concern for Rain Carbon, as it is not clear that they will be able to identify a non-EU market for the AO and the final transport and logistics costs may be greater than those estimated here.

Should Rain Carbon's site cease to be viable, in particular, due to the costs of exporting AO for formulation outside of the EU, then this would impact on other production activities. In particular, the naphthalene produced by the refinery as part of coal tar distillation is important to Rain Carbon's operations, as it is the feedstock for two phthalic anhydride units. This is important as the EEA market for phthalic anhydride is balanced, i.e. there is no spare capacity. As the users of phthalic anhydride all rely on a steady supply of the molten substance, there are geographical limits to alternative suppliers. If Rain Carbon's production stopped, additional capacity would have to be built within the EEA, with this likely to take between 3-5 years.

Furthermore, continued operations would also avoid decommissioning costs across both the refinery and the phthalic anhydride units. Given that these include large tank farms, these costs would be substantial.

3.4.2 Impacts of "Non-use" Scenario on Rain Carbon's customers

Impacts on non-EEA formulators

As noted in Section 2.3, the non-EEA formulators accepting Rain Carbon's export of AO would need to install additional storage capacity at their sites in order to receive the AO, set up the blending capacity, and undertake blending and quality assurance of their formulated products. These costs could be significant and be over €1 million for each non-EEA formulator. Although these are impacts on entities outside of the EEA, it is certain that these costs will be forwarded to Rain Carbon.

Impacts on EEA manufacturers and users of anodes (aluminium industry)

The following table summarises the likely impacts on the manufacturers and users of anodes under the "Non-use" Scenario.

Table 3–19: Potential impacts for manufacturers and users of anodes under the "Non-use" Scenario

Possible Scenario	Likely impact on Rain Carbon's customers
Other Authorisation applicants are granted an Authorisation	Customers would be inconvenienced for a short time, while establishing contracts with new EEA-based supplier(s). #E# [redacted] • The availability of hybrid pitches in the future would be severely limited, together with #E# [redacted] • This might also have an effect on the total quantity of anode pitch available: without hybrid pitches this is limited to unformulated coal tar pitch. With the availability of coal tar pitch limited (as demonstrated in the past years), this can have issues in the downstream industries. Supply shortages can occur, so impacts could end up resembling those described immediately below.

Table 3–19: Potential impacts for manufacturers and users of anodes under the "Non-use" Scenario	
Possible Scenario	**Likely impact on Rain Carbon's customers**
No Authorisation applicant is granted an Authorisation	**Aluminium smelters**: operating costs would increase due to increases in the cost of electrodes, through increased transportation costs for importing (pitch or) prebaked anodes. However, the volumes of CTPht involved are significant and there is currently a shortage in the coal tar market; as such, sourcing the anodes or pitch from other suppliers could be problematic and this could precipitate a reduction in capacity utilisation in the EEA smelters and a loss of market share for aluminium smelters in the global markets that they sell their metal product. On the other hand, it is of note that Rain Carbon is selling even larger quantities of pitch to non-EEA smelters; these customers will face the same supply challenges as the EEA customers. At the same time, the aluminium market is global and so there is a significant aluminium capacity out of the reach of Rain Carbon (e.g. China); in time, the lost aluminium capacity will probably shift. **Users of aluminium**: if EEA-based production of aluminium was reduced in volume, non-EEA made aluminium could enter the EEA market but still, market shortages could push market prices up

Impacts on EEA users of CTPht-based Søderberg paste (ferroalloy and calcium carbides industry)

The following table summarises the likely impacts on the users of Søderberg paste under the "Non-use" Scenario.

Table 3–20: Potential impacts for manufacturers and users of Søderberg paste under the "Non-use" Scenario	
Possible Scenario	**Likely impact on Rain Carbon's customers**
Other Authorisation applicants are granted an Authorisation	Customers would be inconvenienced for a short time, while establishing contracts with new EEA-based supplier(s)
No Authorisation applicant is granted an Authorisation	**Ferroalloy and carbide manufacturers**: operating costs would increase due to increase in the cost of paste/electrodes, through increased transportation costs for importing the paste from outside the EEA. However, there is currently a shortage in the coal tar market; as such, sourcing the paste could prove problematic and might also incentivise relevant customers of Rain Carbon with non-EEA operations to relocate production to regions with easier access to the required electrode paste **Users of ferroalloys and carbides**: if EEA-based production of these metal products was reduced in volume, non-EEA made alloys and carbides could enter the EEA market but, still, market shortages could push market prices up

Impacts on EEA carbon black manufacturers and their customers

The following table summarises the likely impacts on the manufacturers and users of carbon black under the "Non-use" Scenario.

Table 3–21: Potential impacts for manufacturers and users of carbon black under the "Non-use" Scenario	
Possible Scenario	**Likely impact on Rain Carbon's customers**
Other Authorisation applicants are granted an Authorisation	Customers would be inconvenienced for a short time, while establishing contracts with new EEA-based supplier(s). Impacts can be considered minimal

Table 3–21: Potential impacts for manufacturers and users of carbon black under the "Non-use" Scenario	
Possible Scenario	**Likely impact on Rain Carbon's customers**
No Authorisation applicant is granted an Authorisation	**Carbon black manufacturers**: customers of Rain Carbon would aim to obtain feedstock from outside the EEA. Quantities on the market may not be sufficient for high-yield feedstock originating from CTPht. Productivity would likely be impacted. Transportation costs would increase the cost of the feedstock. If production capacity of carbon black in Europe would not meet demand, carbon black producers from Belarus/CIS could step in to export increased volumes of carbon black to the EEA, thus acquiring increased shares of the EEA market. Alternatively, Rain Carbon's sister plant in Canada may try and create an EEA market for its product. **Users of carbon black**: it is considered likely that shortages in the carbon black market would arise; impacts on market prices would likely be significant. Users may need to establish contracts with new (non-EEA) suppliers

3.5 Social impacts

3.5.1 Number of jobs lost under the "Non-use" Scenario

Job losses at Rain Carbon

Rain Carbon employs #A# (range: 100 – 1,000) workers in Zelzate. Under the "Non-use" Scenario, it is assumed that those involved in formulation activities would lose their jobs, with this being 53 workers. This is the total number of people directly employed in the formulation activities.

Job losses in the wider EEA economy (multiplier effect)

It is important to keep in mind that sectoral developments are not independent of each other but reflect interrelationships across the economy, which in turn reflect the way that production is organised. The output of one sector, therefore, is often the input of another sector, so that fluctuations in the output of the latter because of the economic cycle will inevitably affect the former. As output is affected, so are jobs in these various sectors (Stehrer and Ward, 2012). In the context of the present analysis, a plant closure and job losses for the applicant is expected to precipitate job losses both within the specific Member State but also across the EEA.

A 2012 study by Stehrer & Ward for the European Commission quantified these inter-sectoral linkages and their role both during the recession and during recovery with respect to employment. The analysis was based on tables from an ongoing project (WIOD) which collects input-output data for 40 countries (including all EU Member States) which are consistent with National Accounts and are linked across countries so that one can also take account of domestic versus foreign effects (Stehrer and Ward, 2012). This study developed employment multipliers for the year 2005. Although these would appear to be rather old, they are used in the absence of more a recent analysis that can provide domestic and interregional employment multipliers for each EU Member State. The relevant multipliers used in the analysis here are those for the chemicals sector.

In the case of Belgium, the domestic employment multiplier for the chemicals sector is 2.2 and the interregional one is 7.3. We may use these values to estimate the number of jobs that would indirectly be lost if the applicant's plant were to shut down. The total number of jobs that would be indirectly lost can be estimated at ca. 504 across the EEA.

Table 3–22: Estimation of indirect job losses in the EEA arising under the "Non-use" Scenario					
Country	Direct job losses	Domestic indirect job losses		Interregional indirect job losses	
		Multiplier	Job losses	Multiplier	Job losses
Belgium	53	2.2	117	7.3	504

3.5.2 Monetisation of social impacts

Monetisation of social impacts of direct job losses

The proposed approach to valuing unemployment impacts comprises the following components (ECHA, 2016a):

- The value of productivity loss during the period of unemployment;
- The cost of job search, hiring and firing;
- The impact of being made unemployed on future employment and earnings (a typical opportunity cost also referred to as 'scarring' effect); and
- The value of leisure time during the period of unemployment.

The quantification of these components requires assumptions with regard to wage rates and labour costs, duration of unemployment, scarring effects, reservation wages and the value of leisure time, and the costs of job search, hiring and firing. Dubourg (2016) gives numerical examples to illustrate how the various bits of evidence, data sources, and components of cost could be brought together to estimate the value of the impacts of the loss of one job as a direct result of an authorisation decision (ECHA, 2016a).

The general conclusion that can be drawn from the approach is that the welfare cost of one job lost is about 2.7 times the annual pre-displacement wages (excluding taxes paid by the employer) of this job, with the variation largely driven by the average duration of unemployment in the individual EU Member States (ECHA, 2016a). With specific regard to Belgium, the ratio of social cost per job loss over annual pre-displacement wage is 3.03 (Dubourg, 2016).

The monetisation of the social cost arising from the loss of 160 jobs at Rain Carbon is based on the multiplication of the gross wages of those 160 workers by the aforementioned ratio of 3.03. As far as the gross salaries of the affected workers are concerned, according to Statbel, the average gross monthly wage of full-time workers in the province of East Flanders where Zelzate is located was €3,309 in 2015 (Statbel, no date). Specifically in the chemical and petrochemical industry, the average gross salary in 2015 was €4,343-5,292 (Statbel, no date). For the purposes of this analysis, we consider that the average gross wage of Rain Carbon's workers in Zelzate will be the median of the €3,309-5,292 range or ca. €4,300 per month. For simplicity, the role of inflation is ignored and this value is assumed to equally apply to the year 2018.

Thus, the social cost of direct job losses under the "Non-use" Scenario would be 3.03 × 0.925 × 53 × 12 × €4,300= ca. €7.8 million in 2018 prices[6].

Monetisation of social impacts of indirect job losses

It was estimated above that an additional 504 jobs might be temporarily lost across the EEA under the "Non-use" Scenario. Given the uncertainty this estimate embodies, we treat this number as "EU jobs"

[6] 0.925 is the discounting factor for the year 2020 (Year 2, when it is assumed that the impacts would arise), using a social impacts discount rate of 4%.

lost, rather than allocate them to a specific country. This means that, as per the approach taken above, the welfare cost of one such job lost is about 2.7 times the annual pre-displacement wages. As far as wages are concerned, we have taken an average annual gross wage for Belgium as the basis for these calculations, as it is assumed that most jobs would be lost in Belgium, with this being around €2,130 per month or around €25,560 per annum across all sectors (Jobs Europe, 2017).

Thus, the Present Value social cost of indirect job losses under the "Non-use" Scenario would be 2.7 × 0.925 × 504 × €25,560 = ca. €32 million in 2018 prices [7].

3.5.3 Summary of social costs

Table 3–23: Social costs expressed in 2018 prices				
Indicator	**Job losses**	**Welfare cost/ pre-displacement wage**	**Average annual salary (€)**	**Total costs (€)**
Direct job losses	53	3.03	51,000	7,700,000
Indirect EU job losses	504	2.70	25,560	32,100,000
Total	**557**			**39,800,000**

3.6 Wider economic impacts

Non-Authorisation would have significant wider economic impacts:

- Loss of competitiveness for the EEA industry: as previously noted, for some of the mixtures currently placed on the market by Rain Carbon (anode pitch, CBF), non-Authorisation would impact upon the ability of the EEA chemical industry to supply these mixtures. This would create favourable conditions for non-EEA suppliers to step into the market and, perhaps more importantly, it would offer a competitive advantage for those competing against Rain Carbon's customers. Examples of such an effect would be:
    - Aluminium smelters in the EEA might have difficulty in sourcing anodes, thus their productivity would suffer. On the contrary, smelters located outside the EEA (e.g. in India, China or the CIS) would have easier access to anodes and therefore gain an advantage over EEA smelters. The end result could be that EEA exports of aluminium would decline while non-EEA aluminium could have easier access onto the EEA market;
    - If EU manufacturers of CTPht are deprived of their formulation possibilities, innovation on alternative pitches would be impacted. Non-EEA competitors could become more competitive and non-EEA locations would become more attractive to innovators. The inability of the Zelzate plant to formulate could also precipitate an internal shift within the Rain Carbon group of production capacity from the EEA to non-EEA manufacturing sites in an attempt to stem the loss of competitiveness;
    - Carbon black manufacturers in Belarus or the CIS could acquire market share at the expense of EEA-based carbon black manufacturers whose productivity could be impacted by their reduced access to high-yield CBF;

[7] 0.925 is the discounting factor for the year 2020 (Year 2, when it is assumed that the impacts would arise), using a social impacts discount rate of 4%.

  - Ferroalloy and carbide production outside the EEA might become more attractive if EEA-based manufacturers and users of Søderberg see their access to pitch being restricted;

- Changes in trade flows: EEA industries such as aluminium smelting, ferroalloys and carbon black manufacture have a strong exporting element. Limiting the supply of raw materials to these sectors would, at the very least increase the imports of said raw materials into the EEA, but more importantly would harm the EEA exports of the end products (aluminium metal, alloys, carbon black) in favour of non-EEA made commodities; and

- Impacts on the government revenues: in the event of a non-authorisation for the continued used of CTPht and AO, Rain Carbon's inability to place its formulations on the market, and hence the loss of income to its Zelzate operations, would cause losses in income for the Belgium government. These would include losses in corporation taxes, social insurance contributions, etc.

4 Combined Assessment of Impacts

4.1 Comparison of impacts

The following table summarises the impacts described in the previous sections and sets out the differences between the "Applied-for Use" Scenario and the selected "Non-use" Scenario over the 12-year review period applied for. Whenever a quantification of benefits and costs was not possible, a qualitative assessment is provided instead.

Since the calculation of losses to the applicant in the event of non-authorisation were based on the use of GOP for each product, which did not include labour costs, the total average gross salaries of the workers employed in the formulation activities need to be subtracted from the total benefits in order to avoid double counting in the assessment of impacts.

Assuming an average annual salary of €51,600 (based on a monthly salary of €4,300, see **section 3.5.2**) of the 53 workers involved in formulation activities, the total gross wage costs amount to ca. €2,528,400 million (discounted to the 2018 present value) per annum. The present value of these costs over 12-year review period is equal to ca. €22.8 million. Subtracting this value from the total benefits to the applicant as calculated in **Section 3.4**, the adjusted present value of economic benefits of continued use over the 12-year review period is € #C# (range: 100 – 500 million).

Table 4–1: Summary of socio-economic benefits and risks of continued use

Socio-economic benefits of continued use		
Economic actor	**Indicator**	**Monetised value**
Benefits to the applicant	Net present value profits lost and export costs over 12 years	#C# (€100 - 500 million)
	Capital investment made redundant	#D# (€100,000 – 1 million)
Social benefits linked to continued employment	Direct employment 53 workers	€7.7 million
	Indirect employment 504 jobs	€32.1 million
Benefits to downstream users, including wider economic benefits	Security of supply, competitiveness, and reduced cost impacts for the aluminium, carbon black, calcium carbide and ferroalloy sectors	Not monetised; downstream uses are all intermediate uses and fall outside the scope of Authorisation
Impacts on consumers	Prices and availability of final goods	Uncertain, but likely to be negative and could be significant
Aggregated present value benefits of continued use)		€ #C# (€100 - 500 million)
Excess risks associated with continued use		
Human health impacts on workers – numbers exposed and aggregate present value costs	53 directly exposed workers	€815
Human health impacts on local workers and residents, and on regional residents – numbers exposed and present value costs	17,237,194 indirectly exposed	€2,565

Table 4–1: Summary of socio-economic benefits and risks of continued use		
Socio-economic benefits of continued use		
Annual emissions of PAH to the environment	993.1 grams total = 57.3 to water 935.8 to air	Not valued
Aggregated present value excess risks	Cancer cases avoided only	€3,380

Overall, the benefits of the continued formulation of mixtures using CTPht and AO significantly outweigh the residual risks from this continued use. Although only a partial indicator in this case, due to an inability to value the impacts associated with emissions of PAHs to the environment, the benefit to cost ratio for the present value monetised economic benefits vs costs is calculated as follows:

$$\frac{Benefits\ of\ continued\ use}{Costs\ to\ human\ health}$$

This calculation takes into account the direct lost profits associated with the applicant's operations at Zelzate ([redacted]adjusted to €[redacted] (range: €100 – 1,000 million)) and the social benefits of employment (€ #C# (range: € 10 - 1000 million)), versus the total human health costs under the "Applied-for-Use" Scenario (€ 3,380). The resulting figures are summarised in the tables below.

Table 4–2: Net present value and benefit-monetised risk ratio	
Net benefits (€)	€ #C for table# (€100 – 1,000 million)
Net costs (€)	€3,380
Benefit/monetised risk ratio	[redacted] (range: €100 – 1,000 thousand)

This net present value estimate for the benefits of continued use translates to a net loss under the "Non-Use" Scenario of around € #C (range: 10 – 100 million) per kg emitted to the environment per annum (based on 0.9 kilograms of PAHs annual emissions), after taking into account human health impacts. More importantly, with respect to the total emissions over time, this translates to € #C# (range: 10 – 100 million) per kg of the entire amount of emissions (11.9 kilograms) at the end of year 12.

Table 4–3: Costs of Non-Use per kg per year		
	Annualised	Over the 12-year period
NPV benefits (€)	#C for table# (10-100) million	[redacted] (100 – 1,000) million
Total emissions (kg)	0.993	11.92
Ratio (€/kg)	[redacted] (10– 100) million	[redacted] (10 – 100) million

Both of these estimates are significantly higher than the potential benchmarks identified by IVM in their study for SEAC (Oosterhuis and Brouwer, 2015). This study proposes that the costs of PBT emissions reductions or the costs of reducing the use of a PBT as incurred in the past provides information on the "public willingness to pay" for such reductions. Taking all of the available evidence into account and also differences between PBTs/vPvBs and their effects, the study identifies a very wide 'grey zone' of somewhere between **€1,000 and €50,000 per kg** PBT substituted, remediated or emission reduced. Within this 'grey' zone, measures may be either proportionate or disproportionate from a cost-effectiveness perspective (depending on factors including the nature of the PBT/vPvB).

Moreover, the formulation at the refinery has no additional effects on man/environment compared to a manufacturing only scenario; the used equipment is the same as the storage equipment that is part of manufacture.

The above calculations indicate that the economic costs under the "Non-Use" Scenario for continued formulation activities Rain Carbon would be around 100,000 – 1,000,000 the upper bound figure of €50,000 per kg.

4.2 Distributional impacts

The above estimates for the net present value losses under the "Non-Use" Scenario and the benefit to cost ratio do not take into account a range of other impacts, including those on downstream users and some which would relate to transfers such as redundancy costs, corporation taxes and tariffs, income tax and other social payments that would arise under the "Non-use" Scenario. The distribution of impacts is summarised in **Table 4-3** below.

Table 4–4: Costs of Non-Use per kg per year		
Affected group[1]	**Economic impact**	**Health and environmental impact**
Economic operator		
Applicant: Rain Carbon Zelzate	€ [redacted] subtracting wage costs) million from cessation of formulation activities, export, and including loss of investment [redacted]	
Suppliers of alternatives in the EU	None as other suppliers also facing authorisation and alternatives are not relevant for downstream users; downstream uses are either intermediate uses, are approved under the BPR or take place outside the EU	
Suppliers of alternatives outside the EU	Not relevant	
Competitors in the EU	Not considered as they must also apply for authorisation	
Competitors outside the EU	Not estimated but will be positive for competitors most likely located in China, India and CIS	
Customer group 1: Electrode / anode users in the aluminium, calcium carbide and ferroalloy industries	Negative impacts due to the loss of anode pitch and Søderberg pastes from Rain Carbon. Increased costs from need to import pitch or pastes, or electrodes/anodes, in the face of increasing global shortages. Likely reduction in competitiveness	Increased externalities from increased transport distances for pitch and pastes; shift of risks to non-EEA producers
Customer group 2: Carbon black manufacturers	Negative impact due to increased transport costs, increased production costs and/or concerns over EU shortages	Shift to less yielding feedstock could lead to an increase in CO_2 emissions; Increased externalities from increased transport distances

Table 4–4: Costs of Non-Use per kg per year		
Affected group[1]	**Economic impact**	**Health and environmental impact**
Customer group 4: Blended AO oils	Negative impacts due to the loss of blended oils from Rain Carbon and the need to undertake own formulation (potentially including the need to invest in storage facilities).	Increased externalities from increased transport distances for CTPht; shift of risks to non-EEA producers
Public at large in the EU (identify)	Negative impacts if impacts on customer groups 1 and 3 in particular face significant increases in prices	Monetised excess health risks equating to roughly €2,565*
Wider economy	If EU production is impacted, loss of exports from the carbon black, aluminium, steel, ferroalloy and carbide production.	
Geographical scope		
Belgium	Loss of corporation and income tax, loss of social and health insurance contributions	11.9 kg reduction in emissions of PAHs to the environment over 12 years
Within the applicant's business and employment more generally		
Employers/Owners	Loss of profits – see above [redacted] #D#	
Exposed and Non- exposed workers	Loss of direct employment equating to €7.7 million in social costs	Monetised excess health risks equating to roughly €815 for exposed workers
Contract and other workers indirectly affected by closure of the plant	Loss of indirect employment equating to €32.1 million in social costs	Monetised excess health risks equating to roughly €2,565 including local workers and local residents*
* This monetised excess health risk figure should only be considered once as it reflects risks to both the public at large as well as to local workers.		

4.3 Uncertainty analysis

There are several sources of uncertainty within the above assessment. These include:

- The local and regional populations which would be exposed to emissions from the refinery operations and the magnitude of these exposures. A worst-case approach has been adopted here, with the resulting figures likely to be significant overestimates of the residual risks from Rain Carbon's formulation activities;

- The calculated emissions to the environment, which are considered by the CSR to represent an overestimate of emissions to both air and water;

- The appropriate discount rate for converting Rain Carbon's future profits to a present value figure and for discounting human health impacts. In both cases, we have applied a figure of 4%. However, adopting a higher rate for discounting profit losses and a lower rate for future cancer cases avoided would not significantly change the balance between the benefits of continued use and the monetised risks.

- At an 8% discount rate, gross profit losses fall from €[redacted] to €[redacted] #C# (range: €100-1,000 million);
- At a 2% discount rate, the monetised risks to human health rise to around €5,508; and
- Combined, the revised Net Present Value losses would equate to around €[redacted] #C# (€100 - 500 million), which still translates into many millions per kg of PBT removed/reduced.

Given the low excess lifetime cancer risks associated with Rain Carbon's formulation activities, consideration of a 40-year period for the human health impacts would not affect the conclusions of this assessment to any significant degree.

Other uncertainties stem from the assumptions made as to the level of profits that Rain Carbon could continue to realise on unformulated CTPht and AO placed on the market. The analysis presented in Section 3.3 assumes that significant levels of profits on current products would be lost due to the loss in the value added by formulation activities. However, it has been assumed that Rain Carbon would be able to continue its current activities using CTPht with unformulated CTPht, while for AO this would not be possible.

There is no current market for unformulated AO and Rain Carbon would essentially have to create these markets and logistic chains leading to them.

Continuing the activity would then rely on exporting the unformulated AO out of the EEA, for non-EEA formulation and marketing. It is not certain that this would be possible for the remaining volumes of AO that are currently used in formulation, as the logistic routes and the non-EEA market still have to be created.

As a worst-case scenario, if Rain Carbon is unable to find alternative outlets for the AO, then the refinery would have to cease operations resulting in also the loss of the produced volumes of CTPht and other substances (e.g. naphthalene oil).

Assuming the Applications for Authorisation of CTPht and AO formulation activities being made by Rain Carbon's competitors would be refused if Rain Carbon is refused, and given the absence of alternatives for the key products, then it is likely that downstream users would be forced to replace the mixtures produced by Rain Carbon with imports. Thus, the loss of profits to Rain Carbon translates to a loss in value added for the EU.

For this reason, and due to the fact that the benefits of continued use for only one year would significantly outweigh the human health and environmental damages over the 12-year period, we do not provide calculations for sensitivity purposes of a reduced time period for the profit losses. It is clear that taking a shorter period of losses would not change the conclusions of this assessment.

5 Conclusions

5.1 Introduction

This Socio-Economic Analysis (SEA) forms part of the Application for Authorisation (AfA) submitted by Rain Carbon bvba (hereafter Rain Carbon) for the continued use of Pitch, coal tar, high-temp. (CTPht - CAS No: 65996-93-2; EC No: 266-028-2) and anthracene oil (AO - CAS No: 90640-80-5; EC No: 292-602-7) in formulation activities. The formulations using CTPht and AO that are manufactured by Rain Carbon are placed on both the European Economic Area (EEA) and on markets outside the EEA markets [redacted]. Importantly, the use of these formulations is not subject to REACH Authorisation requirements; they are exempt as they are intermediate uses under REACH. As a result, neither Rain Carbon nor its relevant customers are applying for the Authorisation of these uses.

The requested review period for the continued use of CTPht and AO in formulations is 12 years.

5.2 "Use" of CTPht and AO

Not all formulation activities undertaken by Rain Carbon fall within the scope of this Authorisation. Those that are relevant include formulation of CTPht to create anode pitch and Søderberg paste, which are sold in the EEA (and outside the EEA in the case of anode pitch); CTPht may also be formulated together with AO to produce carbon black feedstock, which is sold in the EEA. All of the downstream uses of these formulations are intermediate uses and fall outside the scope of Authorisation. AO is also used to produce EU-type creosote and blended oils for export outside the EEA. Both of these fall outside the scope of Authorisation as EU-type creosote is an approved Biocidal product under the Biocidal Products Regulation.

5.3 Benefits from the Authorisation

If an Authorisation for the continued use of CTPht and AO (envisaged tonnages in 2020: [redacted] (range: 100,000-1,000,000) t/y and [redacted] (range: 10,000-100,000) t/y respectively) was not granted, Rain Carbon would have to stop the manufacture and sale of its formulations. The majority of CTPht handled at the site is formulated into mixtures which are then used downstream for the production of electrodes for the aluminium industry, and is central to [redacted]

The AO produced by the coal tar distillation process could no longer be used, and Rain Carbon would try to export this to non-EU formulating facilities such as terminals or possibly other facilities within the overall Rain Carbon group for formulation. The ability to do this successfully is highly uncertain.

The benefits from Authorisation of the current formulation activities would therefore include:

- Continuation of Rain Carbon's refinery operations, with this safeguarding net profits and [redacted] investments across the CTPht and AO formulation activities estimated at €[redacted] million (€100 - 500 million) in present value terms over the requested 12-year review period (2018 prices, discounted at 4%);

- Continued employment resulting in 53, jobs directly involved in formulation activities, together with a further 504 indirect jobs in Belgium and elsewhere, with a combined social value of €39.8 million in present value terms;

- The continued ability of Rain Carbon to produce hybrid pitches and [redacted] and to supply these and Søderberg paste to the EEA (and non-EEA) aluminium, calcium carbide and ferroalloy sectors;

- The continued ability of Rain Carbon to produce high yield carbon black feedstock for sale to EEA users; and

- The continued ability of Rain Carbon to produce AO mixtures for export.

5.4 Residual Risks

Estimates of the excess lifetime cancer risks for both workers and humans via the environment are calculated in the CSR, based on exposures from relevant activities for workers and from off-site emissions monitoring data. 53 workers are directly exposed at the site, with exposures also taken into account for local residents, local workers and regional residents with an estimated 17.2 million people potentially exposed.

Combining these figures with exposure estimates leads to an estimated 0.0023 fatal lung and bladder cancer cases, and a further 0.0011 non-fatal cancer cases over the 12-year period. These translate to monetised residual risks of around €3,380 in total.

With respect to the PBT properties of CTPht and AO, the CSR estimates that the total emissions of PAHs from Rain Carbon's activities would equate to 993.1 grams per year in total, broken down into:

- Air: 935.8 grams per year; and
- Surface waters: 57.3 grams per year

Over the 12 years, emissions to air, water and sludge would equate to 11.92 kg in total.

5.5 Balance between benefits and costs

The aggregate present value benefits from the continued use for formulation of CTPht and AO equate to €[redacted] (range: €100 – 500 million) (not including lost investment in [redacted]), adjusted after subtracting the average gross annual salaries of the workers involved in formulation activities, over the requested 12-year review period. These compare to the aggregate monetised human health risks of around €3,380, for a benefit to cost ratio of €[redacted] (range: €100 – 1,000 thousand) and a NPV of €[redacted] (range: €100 – 1,000 million). This NPV figure translates to a cost per kg of PBT removed/reduced of €[redacted] (range: €10 – 100 million) over the 12 years.

To this calculation it needs to be remarked that there is no additional emission or exposure as a result of formulation over manufacture; the equipment used for formulation are the storage tanks and their auxiliary equipment for the manufactured pure substances.

5.6 Factors relevant to the duration of the review period

This SEA is not accompanied by a detailed Analysis of Alternatives (AoA) as the two substances do not have a specific functionality at the formulation (mixing) stage apart from being incorporated into a mixture that is used in downstream uses that fall outside the scope of REACH Authorisation. For these downstream uses, there is no regulatory impetus to substitute CTPht or AO and the applicant cannot see realistic alternatives for all uses becoming available in the foreseeable future.

Given that use of the relevant mixtures is expected to continue indefinitely, justified argumentation for a specific review period cannot be provided. The most relevant criterion used by SEAC for deciding on long review periods criterion to this analysis is the one referring to the balance of risks and benefits of continued use. In this context, it should be noted that formulation is a standard operation in all coal-tar or petroleum refineries, and that the formulation step takes place in a closed tank farm by mixing and pumping. This uses the same equipment and processes as storage of the unformulated substances in a manufacturing only case. This is borne out by the very low releases of PAHs from the refinery, as indicated in the figures presented above for both environmental emissions and risks to workers and humans via the environment.

As there is no need to move to alternatives where their uses are exempt from Authorisation and there is a lack of alternatives for customers, a long review period of 12 years would be appropriate for the continued use of CTPht and AO in formulation activities at Zelzate.

Finally, a refused authorisation would halt [redacted] #D# [redacted].

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7 Annex: Justifications for confidentiality claims

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

Table 7-1: Justifications for confidentiality claims			
Reference type	**Commercial Interest**	**Potential Harm**	**Limitation to Validity of Claim**
[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]		[redacted]

Table 7-1: Justifications for confidentiality claims			
Reference type	**Commercial Interest**	**Potential Harm**	**Limitation to Validity of Claim**
[redacted]	[redacted]	[redacted] [redacted] [redacted]	[redacted] [redacted]
[redacted]	[redacted]	[redacted]	[redacted]