HOCHSCHULE DER MEDIEN

Bachelor thesis

in the degree programme Audiovisual Media

Opportunities and limitations of carbon calculators on the road to sustainable film and television productions

Revised version 1.4 – 27th October 2020

submitted by
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at Hochschule der Medien in Stuttgart
on 28th August 2020

to obtain the academic degree of a
Bachelor of Engineering

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Bibliographic data

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Möglichkeiten und Grenzen von CO_2-Rechnern auf dem Weg zu nachhaltigen Film- und Fernsehproduktionen. *(Überarbeitete Version 1.4 – 27. Oktober 2020)*

Opportunities and limitations of carbon calculators on the road to sustainable film and television productions. *(Revised version 1.4 – 27 th October 2020)*

63 pages, Hochschule der Medien, Faculty of Electronic Media, Bachelor thesis
Stuttgart 2020

*This is an **informal translation** based on the original German version "Möglichkeiten und Grenzen von CO_2-Rechnern auf dem Weg zu nachhaltigen Film- und Fernsehproduktionen". The German version can be requested directly from the author or from Mr. Prof. Michalski.*

This English version was translated with the help of www.deepl.com/translator.

Abstract

Over the last decade, the use of carbon calculators has emerged as a method of accounting GHG emissions of film and TV productions. Several countries have developed different carbon calculators, which differ widely in structure and methodology. This thesis examines five existing carbon calculators and observes the differences and similarities between the calculators by comparing their structure and features. By means of expert interviews with the hosts of the calculators, expectations and experiences with the use of the calculators are gathered and analysed. In order to find out which possibilities and limitations carbon calculators face, the calculators and their use are critically examined. The analysis shows that carbon calculators have a lot of potential: they can help in the planning and implementation of sustainable measures and their use can raise the awareness of users and teams. The collected data can be used to make comparisons and reports or to record a data situation. The calculators have many limitations at the same time. Carbon calculators only look at GHG emissions and therefore cannot provide a comprehensive environmental footprint, nor can they consider the economic and social dimensions linked to holistic sustainability. It is concluded that a carbon calculator cannot be the only instrument to produce film and television in a sustainable way. Furthermore there is a lack of international standardisation and cooperation between hosts to establish the use of carbon calculators internationally. With the collected findings of the comparisons and expert interviews, recommendations are made which should help to improve or newly design carbon calculators.

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List of abbreviations

BAFTA	British Academy of Film and Television Arts
BBC	British Broadcasting Corporation
BMZ	Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung
CCF	Corporate Carbon Footprint
CDP	Corporate Disclosure Project
CO2	Carbon dioxide
CO2e	Carbon dioxide equivalents
EU	European Union
GHG	Greenhouse Gas
GPG	Green Production Guide
GWP	Global Warming Potential
IPCC	Intergovernmental Panel on Climate Change
ISO	International Organization for Standardization
MFG	Medien- und Filmgesellschaft Baden-Württemberg mbH
PCF	Product Carbon Footprint
PGA	Producers Guild of America
PGAF	Producers Guild of America Foundation
pers. commun	Personal communication
RFI	Radiative Forcing Index
SDG	Sustainable Development Goal
SPA	Sustainable Production Alliance
T.a.	Translation of the author
US/USA	United States of America
VAF	Vlaams Audiovisueel Fonds (Flanders Audiovisual Fund)
l.	Line

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Research question, objectives and structure

A growing awareness of sustainable production in the film and television industry has become apparent over the last two decades. Due to the global debate on climate change, sustainable development in the media industry has focused particularly on the ecological dimension. In the USA, the early awareness of environmentally friendly filmmaking manifested itself with the establishment of the *Producers Guild of America Foundation's PGA Green* initiative in 2009. In the same year, the *EcoProd* initiative was formed in France and the foundation of the *albert Consortium* in 2011 laid the foundation for environmentally friendly television productions in the UK. The Cine-Regio Group's *Green Reports* also show a steady development of climate-conscious activities in the film and television industry throughout Europe.

In order to increase the industry's awareness of its own influence on climate change, the use of carbon calculators has become increasingly popular over the last ten years, in addition to numerous Best Practice Guides and offers of workshops or training courses. Every production, whether in film or television, generates greenhouse gases and thus contributes to the anthropogenic greenhouse effect. In accordance with the principle "You can't manage what you can't measure", carbon calculators are designed to help calculate the actual amount of greenhouse gas emissions from film and television production, identify reduction potential and take sustainable measures based on the findings.

Since carbon calculators for film and television productions have only become more popular in the last ten years, the topic has not yet been widely covered in the scientific community. Within the framework of the EU-funded *Green Screen* Project, Helsing and Wu (2018) compiled the case study *Green Film Criteria for the Southern Swedish Context: A case study of sustainable film production and carbon footprinting*. For the study, a Swedish feature film production was simultaneously calculated with the US carbon calculator PEAR and the British carbon calculator of the *albert Consortium*. Helsing and Wu analyse whether the existing calculators are suitable for the use in the Swedish context and show how the calculated results differ noticeably between the two computers with the same data input. The study shows significant differences between the calculators in terms of use and calculated results. Schnetzer (2016) has a similar result in his scientific work on the sustainable pilot project "Tatort: Fünf Minuten Himmel". The data collected in the course of the feature film

production was entered and calculated by Schnetzer in four different carbon calculators. Schnetzer noticed clear differences in the results and the data input possibilities between the carbon calculator PEAR, the calculator of the *albert Consortium* and the so-called Carbon'Clap of the initiative *EcoProd*. However, Schnetzer does not carry out an in-depth analysis of the differences between the calculators. Both studies look at the carbon calculators from the user's perspective and analyse the different calculators only in the context of a case study. Therefore, this work is intended to provide a comprehensive comparison and in-depth analysis of currently existing carbon computers in the film and television industry and furthermore to consider the viewpoint of the calculators' providers.

The theoretical foundation is established at the beginning of the work. The term "sustainability" is defined and its relevance to the present is examined. The explanation of the greenhouse effect will show that the consideration and reduction of the carbon footprint is necessary in order to produce film and television productions in a more ecologically sustainable way. The terms "carbon footprint" and "carbon calculator" are explained and it is shown how the carbon calculator is used to calculate the carbon footprint.

This is followed by a content-based comparison of five carbon calculators currently being used internationally. The structure and functions of the calculators are analysed. Expert interviews with the respective hosts form the core of the work. The interviews with experts from Medien- und Filmgesellschaft Baden-Würtemberg mbH (MFG), KlimAktiv, Flanders Audiovisual Fund (VAF), British Academy of Film and Television Arts (BAFTA) and the Sustainable Production Alliance (SPA) are also intended to provide an insight into the motivation and goals behind the use of the carbon calculators. The expert interviews also reveal the expectations and experiences of the various hosts. The content-based comparison and the expert interviews are intended to show the current state of carbon calculators in the film and television industry.

Under the thesis question, which opportunities and limitations of carbon calculators exist on the road to sustainable film and television productions, the following research questions arise:

- What are the motivations and goals of the hosts of carbon calculators? How are these reflected in the design and application of the calculators?
- What experiences have been gained with the calculators so far and what are the hosts' expectations?

- How can carbon calculators be improved by the experiences gained so far?

After looking at the five carbon calculators, a look is taken at current developments and future prospects, as several new carbon calculators are currently under development, revealing new targets and motivations among hosts.

Based on the collected findings of the work, recommendations are summarised and explained in the last part, as to how a carbon calculator can be improved or newly developed today. The work is completed by a conclusion.

1 Theoretical foundation

1.1 Sustainability

"Sustainability is the buzzword of the hour" [Translation of the author (T.a.)][1] (Pufé, 2017, p. 23). We encounter the term in politics, in businesses, in the media but also in our private everyday lives. While shopping, planning for the future or when confronted with the topic of environmental protection.

The years 2018 and 2019 are among the hottest summers in Germany since the beginning of weather recording[2] and together with the Fridays for Future movement, which started in 2018, climate change does not remain a dry theory for scientists and environmentalists, but is directly present in our everyday lives.

By focusing on climate change, sustainability is often linked to the environmental aspect of the concept. In many sustainability concepts, the ecological dimension is still given a central place (Pufé, 2017, p. 99). However, under the current impact of the COVID 19 pandemic, it is clear how essential a stable economy and a resilient health system are for sustainable development. Only the equal consideration of the economic, social and ecological dimensions forms a holistic sustainability.

This holistic sustainability is also established by the United Nations in the Sustainable Development Goals (SDGs) in the Agenda 2030. Agenda 2030, adopted in New York in 2015 by all United Nations Member States, contains 17 SDGs which "take all three dimensions of sustainability - social, environmental and economic - equally into account for the first time," [T.a.] explains the Federal Ministry for Economic Cooperation and Development (BMZ)[3].

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[1] „Nachhaltigkeit ist das Schlagwort der Stunde"

[2] Deutscher Wetterdienst. (n.d.). *Wetter und Klima– Deutscher Wetterdienst– Presse– Deutschlandwetter im Sommer 2019*. Retrieved 30 June 2020, from https://www.dwd.de/DE/presse/pressemitteilungen/DE/2019/20190830_deutschlandwetter_sommer2019_news.html

[3] "Die 17 SDGs berücksichtigen erstmals alle drei Dimensionen der Nachhaltigkeit – Soziales, Umwelt, Wirtschaft – gleichermaßen." BMZ. (n.d.). *Die Agenda 2030 für nachhaltige Entwicklung.* Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung. Retrieved 30 June 2020, from http://www.bmz.de/de/themen/2030_agenda/index.html

But sustainability is not a buzzword or trend that has only become established in the 21st century through the debate on global warming and the corona crisis. Ulrich Grober even describes sustainability as "our most primordial world cultural heritage" [T.a.][4] (2010, p. 13).

Definition

The term "sustainability" originated in 1713 with Hans Carl von Carlowitz, who, with his demand for "a consistent and sustainable use of the forest" [T.a.][5], for the first time conceptually recorded the principle of sustainability (Carlowitz, 1713, quoted after Pufé, 2017, p. 37). Carlowitz thus pursued the sustainable concept in forestry that only as many trees are logged as can grow again normally[6].

Today, sustainability is widely described by the definition given in the report of the United Nations World Commission on Environment and Development (also: Brundtland Commission):

> "Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs"

Models of sustainability

In order to illustrate the concept of sustainability, several models have been developed in the scientific discourse on the subject. The most significant are: the three-pillar model, the intersection or triad model and the triangle of sustainability[7] (see also: Pufé, 2017, p. 110 ff.).

The triangle of sustainability to be examined in more detail here is cited as a further development of the other two models (Pufé, 2017, p. 112). The creation of the triangle of sustainability is intended to emphasise in particular the inseparable dependence of the three fields of sustainability. The isosceles triangle is intended to show that the three dimensions of ecology, economy and social aspects must be considered equally in order to ensure holistic sustainability (ibid., p. 113).

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4 „unser ursprünglichstes Weltkulturerbe“

5 „eine beständige und nachhaltende Nutzung des Waldes“

6 BMEL. (n.d.). *Über 300 Jahre forstliche Nachhaltigkeit.* BMEL. Retrieved 1 July 2020, from https://www.bmel.de/DE/themen/wald/wald-in-deutschland/carlowitz-jahr.html

7 Pufé, I. (2014, Juli 21). *Was ist Nachhaltigkeit? Dimensionen und Chancen* | APuZ. bpb.de. Retrieved 11 August 2020, from https://www.bpb.de/apuz/188663/was-ist-nachhaltigkeit-dimensionen-und-chancen

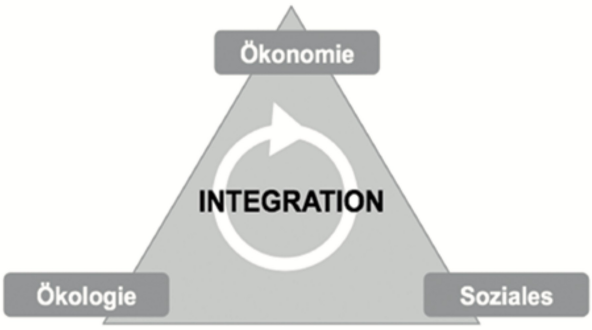

Figure 1: The triangle of sustainability (Pufé, 2017, p. 113)
Ökonomie = economy, Ökologie = ecology, Soziales = social affairs

At the centre lies the integration, the indispensable combination and connection of the three dimensions[8].

Push and pull factors

The motivations for taking sustainable measures can be divided into two categories: push and pull factors (Pufé, 2017, p. 26). Pull factors include all aspects that attract actors towards sustainable development. These include economic benefits or financial savings, which are thus seen as positive incentives. On the other hand, there are the much more extensive push factors. These include all negative, repulsive reasons that call for the strengthening of sustainable development. Besides numerous factors such as world hunger, poverty or resource depletion, "environmental problems [...] are currently the strongest push factors" [T.a.][9] (ibid.).

As a result, in addition to the Agenda 2030 for sustainable development, the Paris Climate Change Agreement was agreed upon a few months later. The parties to the convention agreed to limit global warming to an increase of 1.5°C. "In order to achieve this goal, no more climate-damaging gases may be emitted in the second half of this century than are removed from the atmosphere by so-called sinks, such as forests."[10] This is a clear reference to the original Carlowitz principle of "sustainable use" (cf. p. 2).

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[8] Vgl. Pufé, I. (2014, Juli 21). *Was ist Nachhaltigkeit? Dimensionen und Chancen* | APuZ. bpb.de. Retrieved 11 August 2020, from https://www.bpb.de/apuz/188663/was-ist-nachhaltigkeit-dimensionen-und-chancen

[9] „Umweltprobleme [...] aktuell die stärksten Push-Faktoren"

[10] BMU. (n.d.). *Die Klimakonferenz in Paris*. Bundesministerium für Umwelt, Naturschutz und nukleare Sicherheit. Retrieved 30 June 2020, from https://www.bmu.de/themen/klima-energie/klimaschutz/internationale-klimapolitik/pariser-abkommen/

1.2 Greenhouse effect

The greenhouse effect is a natural process in the earth's atmosphere. The effect is analogously comparable to the way a greenhouse functions. In both systems, short-wave solar radiation enters practically unhindered. The emitted, long-wave heat radiation, on the other hand, is absorbed by the system. In the earth's atmosphere, the heat radiation is absorbed by naturally occurring greenhouse gases (GHG). The natural greenhouse effect results in a global average air temperature of 15°C. Since the beginning of industrialisation, anthropogenic activities have increased the amount of greenhouse gases. This increased concentration of GHGs means that heat radiation is absorbed more strongly by the atmosphere. Scientists relate this process to the increase in global warming[11].

Carbon dioxide (CO2) is seen as the anthropogenic greenhouse gas with the greatest impact and is regarded as the keyword for climate change. However, carbon dioxide is not the only greenhouse gas emission. The Kyoto Protocol, adopted in 1997, identified the following greenhouse gases as relevant for the emission reductions agreed there Carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulphur hexafluoride (SF6) and nitrogen triflouride (NF3).

1.3 Sustainability in film and television productions

"Every film production and every TV programme causes greenhouse gas emissions that have a lasting impact on our environment." [T.a.][12] (Gutsche, 2019, p. 625)

Gutsche's statement clearly expresses that sustainable development is also necessary in the film and television industry. At the same time, however, Gutsche states that "despite global climate change, the media industry has for a long time paid little attention to the overall social development of climate protection" [T.a.][13] (ibid.). Internet research and research of grey literature on the present

[11] Umweltbundesamt. (2013, August 3). *Wie funktioniert der Treibhauseffekt?* Umweltbundesamt. https://www.umweltbundesamt.de/service/uba-fragen/wie-funktioniert-der-treibhauseffekt

[12] „Jede Filmproduktion und jede TV-Sendung verursacht Treibhausgasemissionen, die unsere Umwelt nachhaltig beeinflussen."

[13] „die Medienbranche trotz der globalen klimatischen Veränderungen die gesamtgesellschaftliche Entwicklung zum Klimaschutz lange Zeit kaum beachtet"

thesis has confirmed this statement. It is only in the last ten years that the topic has been dealt with comprehensively in the industry. Many publications, initiatives, or developments on sustainable media productions have increasingly emerged only in the second part of the last decade. It can thus be argued that the film and television industry has missed its responsibility for sustainable development and climate protection. However, it is much more important to recognise that we are currently undergoing a steady development towards sustainably produced film and television productions.

As already pointed out in the introductory chapter of this paper (see p. IX) and further elaborated later in chapter 2, an emergence of sustainable actions in the film and television industry can be observed in the USA and Europe. Sustainability initiatives have been founded, and a large number of Best Practice Guides, sustainability criteria for funding decisions, workshops on the topic, and much more already exist (cf. Gutsche, 2019, p. 629). However, these developments are usually limited to certain regions, are mergers of studios and broadcasters or come from film funding and commissions. In the example of Germany, Gutsche states that "sustainability and climate protection (...) are only present in some regions" and that "there is not yet a uniform nationwide ecological action plan" [T.a.][14] (2019, p. 631 + p. 636).

The actions and initiatives for sustainable film and television productions that have emerged over the last decade focus mainly on environmentally friendly production and thus on the ecological aspect of sustainability. The focus here is on converting production processes to such an extent that the impact on the environment and especially the GHG emissions are significantly reduced (cf. Gutsche, 2019, p. 627). As already stated in the introductory sentence, every film or television production is linked to GHG emissions and thus contributes to the anthropogenic greenhouse effect.
A significant amount of the greenhouse gases emitted during a production process falls within the mobility sector[15]. During travel and transport, the combustion of fuel produces CO2 and other GHG emissions. Another major source of emissions is electricity consumption. Electricity is used in

[14] „Nachhaltigkeit und Klimaschutz (…) nur in einigen Regionen präsent“ sind und es „noch keinen bundesweit einheitlichen ökologischen Maßnahmenplan“ gibt.

[15] The Albert calculator shows that 86.4% of GHG emissions from TV productions are accounted for by travel and transport. Cf. https://calc.wearealbert.org/UK/productiondashboard/ (Retrieved 13 August 2020, User: demo.area, Password: letmein)

many different areas of production. This starts with lighting, the power supply for technical equipment, offices and computers and servers in post-production, and extends to the use of e-vehicles. The electricity consumed from the socket is drawn from the national power grid. Since fuel is used to generate the electricity, the use of electricity causes indirect GHG emissions (Helsing & Wu, 2018, p. 7). Other significant areas of emission production include mainly all fuel consumption outside mobility (e.g. generators), accommodation, waste, use of materials and catering (ibid., p. 7 ff.).

According to estimates by the albert Consortium, the average GHG emission for one hour of produced television time is 13.5 tonnes of CO2[16]. According to the French initiative EcoProd, a feature film production emits on average 200 tonnes of CO2[17]. As a ratio, the average German citizen produces 7.9 tonnes of CO2 over a whole year[18]. The albert Consortium, which has an extensive collection of data on GHG emissions in the British television industry, also expresses a frightening insight into the increase in GHG emissions in the industry: "The only way is up, or at least it has been so far. (...) footprints have doubled in the last seven years "[19].

It is difficult to measure the true extent of the overall impact of the film and television industry. In order to gain insight into this and to be able to put GHG emissions into figures, the use of carbon calculators has emerged over the last decade. The calculators are designed to help calculate the carbon footprint of film and television productions.

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16 Albert Consortium & BAFTA. (2019). *Albert Annual Report 2018*. https://s3.eu-west-1.amazonaws.com/m.mediagreenhouse.co.uk/02094/00545/e299ef/albertReport2018_03.pdf

17 Appelgren, C. (Ed.). (2017). *Cine-Regio: Green Report 2017: On sustainability in the european regions.* Cine-Regio. https://www.cineregio.org/dyn/files/pdf_download/10-file/CineRegio2017_GreenReport_INTERNET_single_pages.pdf, p. 16

18 Statista. (2020, April). *CO2-Ausstoß je Einwohner in Deutschland bis 2019.* Retrieved 11 August 2020, from https://de.statista.com/statistik/daten/studie/153528/umfrage/co2-ausstoss-je-einwohner-in-deutschland-seit-1990/

19 Albert Consortium & BAFTA. (2019). *Albert Annual Report 2018*. https://s3.eu-west-1.amazonaws.com/m.mediagreenhouse.co.uk/02094/00545/e299ef/albertReport2018_03.pdf

1.4 Carbon footprint

The determination of various "footprints" is regarded as an indication of sustainability. A footprint is a quantitative measure that describes the use of natural resources by humans (Hoekstra, 2008, p. 10). The carbon footprint has become the most important indicator of the environmental balance (Čuček et al., 2012; Mußler et al., 2010; Wiedmann & Minx, 2007). Mußler et al. argue, however, that an exclusive accounting of greenhouse gas emissions, thus the carbon footprint, is "not a comprehensive environmental balance" and that "other environmental impacts such as water consumption, waste volume, etc., are not considered" [T.a.][20] (2010, p. 76).

The carbon footprint comprises the total amount of carbon dioxide or other greenhouse gases that is directly or indirectly caused by an activity or accumulated over the life phases of a product or people (Wiedmann & Minx, 2007, p. 4).

The quantity of greenhouse gases emitted is measured in tonnes or kilograms. To standardise the calculation of the carbon footprint, the various greenhouse gases are converted into carbon dioxide equivalents (CO2e or CO2eq or CO2-e). The carbon dioxide equivalent of a greenhouse gas is also known as the *Global Warming Potential* (GWP). The GWPs were defined by the *Intergovernmental Panel on Climate Change* (IPCC) of the United Nations and describe the contribution of a greenhouse gas to the greenhouse effect over a specified period of time (usually 100 years) in comparison to carbon dioxide[21].

In the corporate sector, the carbon footprint comes in two forms. The *Product Carbon Footprint* (PCF) describes "the balance of greenhouse gas emissions along the entire life cycle of a product in a defined application" [T.a.][22] (Grießhammer & Hochfeld, 2009, p. 4). Accordingly, when balancing a product from the cradle to the grave, all greenhouse gas emissions are considered that are accumulated during the entire value chain (Mußler et al., 2010, p. 82). The *Corporate Carbon Footprint* (CCF), on the other hand, is company-specific and includes the amount of greenhouse gases emitted by all business activities of a company from gate to gate (ibid.).

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[20] „keine umfängliche Umweltbilanz“ ist und „weitere Umwelteinflüsse wie Wasserverbrauch, Abfallmenge etc. [...] nicht betrachtet“ werden.

[21] Umweltbundesamt. (2013, August 29). *Treibhausgas-Emissionen in Deutschland*. Umweltbundesamt. https://www.umweltbundesamt.de/daten/klima/treibhausgas-emissionen-in-deutschland

[22] „die Bilanz der Treibhausgasemissionen entlang des gesamten Lebenszyklus eines Produkts in einer definierten Anwendung“

Film and television productions are services in which a product is created: a television programme, a film, a series. Thus, the carbon footprint of a film or television production can be assigned to the PCF (cf. S. Schunkert, personal communication, 7 May 2020, l. 30 ff.). In particular, it should be noted that the product, for instance a film, is basically produced only once (ibid.).

Pufé subordinates the calculation of the carbon footprint to "sustainability reporting", which "allows the conversion of diffuse data into clear, measurable units, sizes and ratios" [T.a.][23] (2017, p. 221). The advantage of considering the carbon footprint is that it is easy to quantify in tonnes or kilograms (Mußler et al., 2010, p. 76), whereas social or ecological sustainability is more difficult to quantify in figures (Pufé, 2017, p. 225). This quantifiability facilitates communication and thus promotes awareness of the anthropogenic greenhouse effect. In particular, however, determining the carbon footprint should be seen as a first step towards identifying carbon reduction potentials and avoiding and reducing greenhouse gases (Mußler et al., 2010, p. 76; Williams et al., 2012, p. 56).

1.5 Calculation of the carbon footprint

The method of calculating the carbon footprint varies according to the area of application and the objective of the calculation. The methodology of carbon accounting is constantly evolving, but standards and norms can be used to determine and calculate GHG emissions (Kellner et al., 2017; Pandey et al., 2011). The *Greenhouse Gas Protocol* (*GHG Protocol*) is one of the most widely used standards worldwide. It lays down the principles and requirements for greenhouse gas accounting for activities in the public and private sectors[24]. In addition, ISO standards 14064 and 14067 are widely used at international level and, together with the *GHG Protocol*, form the basis for most GHG accounting guidelines (Kellner et al., 2017; Pandey et al., 2011; Mußler et al., 2010).

[23] „Nachhaltigkeits-Reporting“, das „erlaubt, diffuse Daten in klare, messbare Einheiten, Größen und Ratios umzuwandeln.“

[24] World Resources Institute & World Business Council for Sustainable Development. (n.d.). *About Us | Greenhouse Gas Protocol*. Retrieved 2 July 2020, from https://ghgprotocol.org/about-us

Definition of the objective

The motivation and objectives for calculating the carbon footprint can vary. The carbon footprint can help to identify reduction potentials and take measures to reduce GHG emissions. In the business sector, corporate communication also plays an important role. The carbon footprint can be used in internal communications to raise awareness of the issue and its relevance. In public relations work, in addition to improving the image, the competitive advantage of the company can also be sought by communicating the results to the public (Mußler et al., 2010).

Definition of the system boundaries

The generation of a carbon footprint is a balance between the accuracy of the calculation and the associated expenditure of time and resources (Williams et al., 2012, p. 60). Depending on the objective, system boundaries must therefore be set that define which emission sources are included in the balance. According to Williams et al. (2012, p. 59) and Mußler et al. (2010, p. 84 f.), organisational, geographical and temporal boundaries need to be defined. The organisational boundaries define which system processes or activities are included in the calculation. The geographical boundaries define the geographical coverage, e.g. whether only the emission sources of a country or of a specific site are considered. In addition, the temporal boundaries define the period to be considered in the calculation (ibid.).

To limit the scope of the emission sources included, the *GHG Protocol* categorises them into three so-called "Scopes" (Mußler et al., 2010, p. 83; Williams et al., 2012, p. 58, p. 56; Kellner et al., 2017, p. 60):

> *Scope 1:* Direct emissions that result from the actions of a population, a system or an activity and are thus directly responsible (in the case of film and television productions, e.g: consumption of fuel, heating oil and natural gas)
>
> *Scope 2:* Indirect emissions resulting from purchased energy (e.g. externally purchased electricity or heat)
>
> *Scope 3:* All other indirect emissions that occur as a consequence of defined system processes or activities but are beyond organisational or geographical control (e.g: travel, transport of equipment or goods, disposal of materials, accommodation)

Data collection and calculation

In accordance with the established system boundaries, all GHG emissions over the defined period will be determined and their quantity recorded. Direct measurement of GHG emissions can be carried out, for example, using CO2 measuring equipment. However, this methodology usually involves a great deal of effort and cannot be applied to every emission source (Pandey et al., 2011, p. 146; Kellner et al., 2017, p. 61). The simplest and most common method calculates the amount of a GHG emission using emission factors. This involves recording an activity at an appropriate reference level (e.g. electricity used in kilowatt hours, fuel consumed in litres) and converting it into tonnes or kilograms of CO2 or CO2e by multiplying it by the specific emission factor. Emission factors are provided by norms, standards and inventories such as the *GHG Protocol* or the *IPCC*. In many countries and regions, region-specific emission factors are also provided by the country or region (Pandey et al., 2011, p. 146).

Reporting

In addition to the exact specification of the calculated results, reporting should document in detail which objective and which system boundaries were chosen, how the data collection and calculation were carried out, and which emission factors or norms and standards were used for the calculation (cf. Williams et al., 2012). In addition, the credibility and transparency of the calculation can be strengthened by verification and validation by an external, impartial authority (cf. Mußler et al., 2010, p. 86).

1.6 Carbon calculator

A carbon calculator is a program that measures and evaluates the GHG emissions of a population, system or activity (Čuček et al., 2012, p. 15; Mulrow et al., 2019, p. 33). In addition to carbon calculators for products or companies, the carbon calculator for private individuals is particularly widespread. The carbon calculators allow a household or a private individual to estimate their personal carbon footprint by providing information on their everyday behaviour. For private individuals and households, carbon calculators are available online in hundreds of different versions from a variety of organisations (Pandey et al., 2011, p. 147; Birnik, 2013, p. 280).

Perhaps the first carbon calculator designed specifically for balancing film and television productions was the Carbon'Clap from France, which was made available in 2010. Several other calculators have been developed to date, a selection of which will be examined more closely in the following chapters. The carbon calculators provide the possibility to estimate the carbon footprint of a production. The calculations are carried out by providing data and information on the production process. In addition to the mere calculation, a large number of calculators also have additional content and functions that can motivate sustainable measures.

2 Introduction to five carbon calculators

In examining the use of carbon calculators in the film and television industry, this thesis focuses on five carbon calculators:

- *Production Environmental Accounting Report* (hereafter referred to as PEAR) of the *PGA Green Committee* of the *Producers Guild of America Foundation* (PGAF) and the *Sustainable Production Alliance* (SPA)
- the carbon calculator of the *albert Consortium* led by *BAFTA* (hereafter referred to as Albert)
- Carbon'Clap of the *EcoProd* collective
- E-Mission of the cultural and film funding *Vlaams Audiovisueel Fonds*
- the carbon calculator of the *Medien- und Filmgesellschaft Baden-Württemberg* (hereafter referred to as MFG calculator)

The selection of calculators is based on certain criteria: the calculators are explicitly provided for the use in film and television productions. The respective calculators are hosted by an industry member of the film and television industry (funder, studio, industry initiative, broadcaster) or have industry members as stakeholders. In addition, the calculators are currently in use and are established in the industry.

The selection is based on the fact that the present thesis aims to present a current state of carbon calculators for film and television production. It also examines the motivations, goals and experiences of the hosts in the context of the sustainable development of the industry. Members of the film and television industry have a direct influence on the productions calculated with carbon calculators and, in addition to their considerable responsibility (Gutsche, 2019, p. 630), also have a direct interest in the sustainable development of the industry. For this reason, the selection of calculators refers to the direct or indirect participation of industry members as hosts or stakeholders of the carbon calculators.

2.1 Description, origin, host and stakeholders of the calculators

PEAR

The PEAR carbon calculator was made available in 2011 as part of the US film and television industry's *Green Production Guide* (GPG) environmental programme. The GPG programme was established in 2010 as a partnership between the *PGA Green Committee* of the *Producers Guild of America Foundation* (PGAF) and the *Sustainable Production Alliance* (SPA). Members of the SPA include Amazon Studios, Amblin Partners, Disney, Fox Corporation, NBCUniversal, Netflix, Participant Media, Sony Pictures Entertainment, WarnerMedia and ViacomCBS[25]. Major stakeholders from the film, television and video-on-demand industries are thus involved in the programme.

In addition to the PEAR carbon calculator, GPG also offers a database of service providers of sustainable materials and equipment, the Best Practice Guide *Production Environmental Actions Checklist* (PEACH) and several other information sheets. The PEACH is a comprehensive Excel file that encourages film and TV productions to take sustainable measures by asking questions and making recommendations. In the PEAR manual, the reasons for developing the calculator are described as follows:

> „As we launch our Carbon Calculator in 2011 it will be easier for filmmakers to track carbon footprints and, most importantly, implement and achieve goals toward carbon emissions reductions. (…) Calculating the carbon of our productions is one of the ways we can visualize the true nature of our impact, monitor our progress, and evaluate the potential solutions to eliminate global warming pollution."[26]

In the context of the present thesis the current version 3.3.0[27] of the calculator is examined.

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[25] Green Production Guide. (o. J.). *About The Green Production Guide – Green Production Guide.* Retrieved 8 September 2020, from https://www.greenproductionguide.com/who-we-are/

[26] Green Media Solutions, & Green Production Guide. (n.d.). *Carbon Calculator Tutorial.* Retrieved 30 July 2020, from https://www.greenproductionguide.com/?smd_process_download=1&download_id=2193

[27] Heruntergeladen am 9 July 2020, from https://www.greenproductionguide.com/?smd_process_download=1&download_id=2192

Albert

The Albert carbon calculator was developed in 2010 by the *British Broadcasting Corporation* (BBC). The public broadcaster launched a sustainability strategy in the same year (Perry, 2014). The programme's objectives included the development and promotion of sustainable production. In order to identify the impact of the productions and the potential for reduction, the Albert carbon calculator was then developed[28] and used for a large number of BBC productions (Perry, 2014). The Albert Calculator has been adopted by the *British Academy of Film and Television Arts* (BAFTA) in 2011. As BAFTA is an independent organisation, the handover of the calculator to the British academy provided the opportunity to offer Albert for use throughout the industry without building on competitive structures (Perry, 2014). At the same time, the BAFTA-led *albert Consortium*, a group of broadcasters and independent production companies, was formed. The consortium covers a broad part of the British film and television industry with members such as BBC, ITV, Channel 4, Sky, Netflix and BT Sport.

The collaborative project *albert* no longer just stands for the carbon calculator. The project also offers on its website the *Production Handbook* with tips, recommendations and case studies that are intended to help change productions in a sustainable way[29]. The website also contains the *Planet Placement* guide. It provides suggestions on how to incorporate environmental sustainability into storytelling in order to raise awareness of the topic among the audience. Since 2014, the Albert calculator offers the possibility of certification. By means of a questionnaire, a production can be certified by fulfilling a certain scope of sustainable measures[30].

As goals of the Albert carbon calculator, BAFTA states:

> „Albert has two major aims: to help programme teams reduce the amount of CO2 produced during the making of their programmes, and to raise awareness of the environmental impact of programme-making.“[31]

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28 BBC. (2011). *Part 2: BBC Executive's review and assessment for 2010/11.* British Broadcasting Corporation. http://downloads.bbc.co.uk/annualreport/pdf/bbc_executive_2010_11.pdf

29 Albert. (n.d.). *Home– Albert*. Retrieved 9 July 2020, from https://wearealbert.org/

30 Albert. (n.d.). *Production Tools*. Retrieved 9 July 2020, from https://wearealbert.org/production-handbook/production-tools/

31 BAFTA. (n.d.). *An Introduction to Albert.* Retrieved 9 July 2020, from http://www.bafta.org/about/sustainability/introduction-albert

In the context of the present thesis the demo version[32] of Albert is examined. The only difference between demo and full version is that only the results of the full version used by productions are included in the data collection of *albert*. Structure and functions are therefore identical between the two versions[33].

Carbon'Clap

In 2010, Carbon'Clap was developed as the first carbon calculator for the film and television sector[34]. The calculator is provided by the French collective *EcoProd*. *EcoProd* was founded in 2009 as a network of film sponsors, broadcasters and environmental organisations. With key members of the French film and television industry, the group now brings together in its steering committee the CNC, CST, Film France, Film Paris Region, Canal+ Group, TF1 Group, France TV Group, Pôle Media Grand Paris and Audiens.

On its website[35], the collective offers the *Guide de l'éco-prodcution*, which contains recommendations on sustainable measures as well as key data and information on the impact of the audiovisual sector on the environment. EcoProd also provides information sheets with practical tips on sustainable production and a list of further sources of information on relevant service providers, organisations, certifications and festivals that promote sustainable development.

The Carbon'Clap is based on the methodology of the carbon calculator *Bilan Carbone*. The *Bilan Carbone* was developed by the French environmental agency ADEME for GHG accounting of organisations[36]. To fine-tune the methodology of the Carbon'Clap, experts from the TF1 and France Télévision television channels, among others, were consulted and a study of 10 film productions by the Canal+ channel was examined[37]. According to the Carbon'Clap homepage, the calcu-

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32 Albert. (n.d.). *Albert.* Retrieved 9 July 2020, from https://calc.wearealbert.org/UK Access via: User: demo.area Password: letmein

33 Bourns, W. (2020, April 28). *Albert-login for research purposes* [pers. commun]. Appendix C: Email-correspondence A.

34 Appelgren, C. (Ed.). (2015). *Cine-Regio: Green Report 2015: On sustainability in the european regions.* Cine-Regio. https://www.cineregio.org/dyn/files/pdf_download/8-file/CineRegioGreenReport2015_INTERNET_SinglePages.pdf, p. 8

35 EcoProd. (n.d.). *Accueil*. Retrieved 19 August 2020, from https://www.ecoprod.com/fr/

36 Appelgren, C. (Ed.). (2015). *Cine-Regio: Green Report 2015: On sustainability in the european regions.* Cine-Regio. https://www.cineregio.org/dyn/files/pdf_download/8-file/CineRegioGreenReport2015_INTERNET_SinglePages.pdf, p. 8

37 Zen'to Technologie. (2016). *Guide des méthodes et valeurs: Version 3.4.* p. 3

lator is designed to be quick and easy to use and therefore relies on several estimates when entering data. It is also stated that the result of the calculation is an estimate accurate to 30% and not an absolute value[38].

The Carbon'Clap homepage expresses as goals for the use of the calculator:

> „Measuring the carbon footprint of its production makes it possible to identify the main sources of carbon emissions and thus start an effective progress process using the other tools made available by the collective on the www.ecoprod.com website." [T.a.][39]

The current version[40] of the Carbon'Clap is examined for the present thesis.

E-Mission

With the *e-Mission* initiative, the Flemish funding body *Vlaams Audiovisueel Fonds* (VAF) has been promoting sustainable film in the audiovisual sector of the Flemish Region of Flanders in Belgium since 2010. As a first step of the *e-Mission* initiative, the VAF provided the film industry with a Best Practice Guide[41]. Three years later, a cooperation was established with the environmental consultancy agency *Zero Emission Solutions* (ZES) to develop further tools[42]. Together with ZES, a carbon calculator was developed (Heidsiek, 2014, p. 8), which is called "E-mission" here for convenience.

Since 2013 it is mandatory for every VAF-funded film or television production to produce sustainably and to balance the production with the E-Mission calculator[43]. VAF also awards the e-Mission label as a distinction for films or series produced in a particularly sustainable way. In addition to the

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http://www.carbonclap.ecoprod.com/document/ECOPROD%20-%20Guide%20methode%20et%20valeurs.pdf

38 EcoProd. (n.d.). *Carbon'Clap.* Retrieved am 10 July 2020, from http://www.carbonclap.ecoprod.com/fr/index/accueil/

39 Ibid. „Mesurer l'empreinte carbone de sa production permet d'identifier les principales sources de carbone et démarrer ainsi une démarche de progrès efficace en utilisant les autres outils mis à disposition par le collectif sur le site www.ecoprod.com."

40 EcoProd. (n.d.). *Carbon'Clap.* Retrieved am 10 July 2020, from http://www.carbonclap.ecoprod.com/

41 Vlaams Audiovisueel Fonds. (2016). *E-Mission – a methology for a more sustainable audiovisual industry in Flanders: E-Mission Year Report 2015*. https://www.vaf.be/sites/vaf/files/duurzaam_filmen/e-mission_-_year_report_2015.pdf, p. 1

42 Ibid.

43 *E-Mission – a Methology for a More Sustainable Audiovisual Industry in Flanders: E-Mission Year Report 2015*, 2016, p. 1

carbon calculator and the Best Practice Guide, VAF also offers calculation tools to support decisions on sustainable measures.

The VAF is also a member of the European *Green Screen* partnership project from 2017 to 2021. The *Interreg Europe*-funded project works with partners from eight different EU countries to improve policies and achieve measurable results in reducing the carbon footprint of the film and TV industry[44]. Between 2020 and 2021 VAF is working with other *Green Screen* partners on a new calculator[45] (see also chapter 5.2.2).

As a reason for using the E-Mission calculator, the VAF states that

> „Measuring is knowing. That is why we calculate the CO2 emissions of every major Flemish feature film or series made with production funding from the VAF." [T.a.][46]

The calculator aims to help make productions more sustainable, examine long-term developments and provide an overall picture of the carbon footprint of the Flemish film production sector[47].

In the context of the present thesis the current version[48] of the calculator for film productions is examined. The separately offered calculator for series does not differ in the data entries that contribute to the calculation of GHG emissions[49].

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44 Appelgren, C. (Ed.). (2020). *Cine-Regio: Green Report 2020: On sustainability in the european regions.* Cine-Regio. https://www.cineregio.org/dyn/files/pdf_download/11-file/CineRegio_GreenReport2020_25022020_SinglePages.pdf, p. 9.

45 Vlaams Audiovisueel Fonds. (n.d.). *Green Screen – Regional Action Plan Flanders Audiovisual Fund.* https://www.interregeurope.eu/fileadmin/user_upload/tx_tevprojects/library/file_1592226440.pdf

46 „Meten is weten. Daarom berekenen we de CO2-uitstoot van elke majoritair Vlaamse speelfilm of reeks die gemaakt wordt met productiesteun van het VAF." Vlaams Audiovisueel Fonds. (n.d.). *CO2-calculator | Vlaams Audiovisueel Fonds.* Retrieved 10 July 2020, from https://www.vaf.be/duurzaam-filmen/co2-calculator

47 Vlaams Audiovisueel Fonds. (n.d.). *Green Screen – Regional Action Plan Flanders Audiovisual Fund.* https://www.interregeurope.eu/fileadmin/user_upload/tx_tevprojects/library/file_1592226440.pdf

48 Vlaams Audiovisueel Fonds. (2019, Oktober 18). *Carboncalculator voor films (e-Mission).* https://www.vaf.be/sites/vaf/files/duurzaam_filmen/cc_film_naam_film_datum_v2016.xlsx

49 Ibid.

MFG calculator

As part of its *Green Shooting* initiative, the *Medien- und Filmgesellschaft Baden-Württemberg* (MFG) initiated the film "Tatort: Fünf Minuten Himmel" produced in 2015 as the first pilot project "to establish resource-saving production methods" [T.a.][50] (Schega & Schwarz, 2016, p. 3). Television film production should be produced using "largely ecological production methods" [T.a.][51] (ibid.). As a result, Schega and Schwarz show that the climate protection measures taken enabled the production to save around 42% in GHG emissions compared to conventional production (2016, p. 17). Based on the results obtained, MFG, in cooperation with *Südwestrundfunk* (SWR) and the Tuebingen-based agency *KlimAktiv*, developed a carbon calculator[52] tailored to German film and television productions in 2017.

The *Green Shooting* initiative of MFG promotes the ecologically sustainable development of film productions. In addition to the carbon calculator, MFG offers a guide with recommendations for resource-saving production methods and a directory of sustainable service providers as support[53]. In addition, MFG gives workshops and supports productions with a grant of up to 5,000 euros for the assignment of a "Green Consultant "[54].

Since MFG is a regional film funding body, the MFG calculator is mainly used regionally in Baden-Württemberg, but currently also nationally in Germany to a limited extent[55].

On the website of the MFG carbon calculator, the aim of the calculator use is stated:

> „In order to give you a concrete overview of your own CO2 consumption in your film productions and to identify and realise potential savings, we [MFG] (...) have developed a carbon calculator especially for film and TV productions." [T.a.][56]

Version 2.2 of the MFG calculator, which is currently available, is examined for the present thesis[57].

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50 „zur Etablierung von ressourcenschonenden Produktionsweisen"

51 „weitgehend ökologische Herstellungsweise"

52 KlimAktiv. (n.d.). *Rollout des CO2-Rechners für Film und Fernsehen.* Retrieved 10 July 2020, from https://www.klimaktiv.de/de/337/

53 MFG. (n.d.). *Green Shooting.* Retrieved 10 July 2020, from https://greenshooting.mfg.de/

54 MFG. (n.d.). *Zuschuss Green Consultant*. Retrieved 10 July 2020, from https://greenshooting.mfg.de/zuschuss-green-consultant/

55 For the sustainability initiative "100 Grüne Produktionen" (100 Green Productions), the productions involved throughout Germany are to be balanced with the MFG calculator. Bavaria Fiction GmbH. (2020, Februar 24). *Arbeitskreis „Green Shooting" startet Nachhaltigkeitsinitiative.* Retrieved 10 July 2020, from https://www.bavaria-fiction.de/newsroom/filmbranche-nachhaltigkeitsinitiative

56 "Damit Sie eine konkrete Übersicht über den eigenen CO2-Verbrauch bei Ihren Filmproduktionen erhalten und potentielle Einsparmöglichkeiten erkennen und realisieren können, haben wir [MFG] (...) einen CO2-Rechner speziell für Film- und TV-Produktionen entwickelt." MFG. (n.d.). *CO2-Rechner.* Retrieved 10 July 2020, from https://greenshooting.mfg.de/co2-rechner/

57 MFG. (n.d.). *Der Greenshooting CO2-Rechner für Film- und TV-Produktionen.* CO2-Rechner Film- und

2.2 Structure of the calculators

The five calculators to be examined differ not only in the motivation of the hosts and the content of the calculators but also in their structure. Therefore, the following is a compact overview of format, user interface, transparency and methodology, language and unit of measurement.

The language of the calculators is examined first. Apart from the E-Mission calculator, all calculators use the national language of the host. The E-Mission is available in Flemish and French due to the Flemish based host VAF and the bilingualism of the host country Belgium. An English version of the calculator is also available[58]. All five calculators have been specially designed for the host country and the choice of language is therefore justified. However, the lack of language selection, especially for the Carbon'Clap in French and the MFG calculator in German, limits the use of the calculator in foreign-language countries despite the cost-free, freely available offer. The language barrier can make the work in an international team more difficult, especially for co-productions.

	Country / Host	**Language**	**Format**	**unit of measurement in t**
PEAR	USA / PGAF	English	Excel spreadsheet	CO2
Albert	United Kingdom / BAFTA	English	Online platform	CO2e
Carbon'Clap	France / EcoProd	French	Online platform	CO2e
E-Mission	Belgium / VAF	Flemish French English	Excel spreadsheet	CO2
MFG calculator	Germany / MFG	German	Online platform	CO2e

Table 1: Comparison of the carbon calculators on language, format and unit of measurement in t

There are two different formats among the five calculators. The first is an Excel spreadsheet that must be downloaded and then edited locally. The web-based format, in which the calculator is offered on an online platform, is not locally bound, but requires an Internet connection. The PEAR as well as the E-Mission calculator are Excel-based, whereas the Albert, Carbon'Clap and MFG calculators are designed in different web-based setups.

TV-Produktionen. Retrieved 10 July 2020, from https://mfg.greenshooting.de/de_DE/page/

[58] T. Wagendorp, pers. commun, 28 Mai 2020, l. 121f

For the calculation and reporting of the calculators, tonnes or kilograms of CO2 or CO2e are given as the unit of measurement. PEAR and E-Mission calculators, unlike the other calculators, only use the unit CO2. The separate information sheet on PEAR methodology (see Table 2) also shows that only CO2 emissions and no other GHG emissions are included in the calculation as CO2 equivalents. With regard to the E-Mission calculator, no statement can be made as to whether, despite the fact that CO2e is not specified in the calculator, it nevertheless includes other GHG emissions, as no information on the methodology has been published.

	Transparency of data
PEAR	Methodology is fully presented in a separate sheet[59]. - Emission factors - Sources of reference: > U.S. Energy Information Administration (EIA) > The Climate Registry (TCR) > U.S. Environmental Protection Agency (EPA) > and more.
Albert	Methodology is fully presented in a separate sheet[60]. (Information sheet not public, only available by direct request from BAFTA) - Emission factors - Sources of reference: > Department for Environment, Food & Rural Affairs (Defra) > Greenhouse Gas Protocol (GHG Protocol) > U.S. Environmental Protection Agency (EPA) > International Energy Agency (IEA) > and more.
Carbon'Clap	Methodology is partially presented in a separate sheet[61]. - Emission factors
E-Mission	No information

[59] ENVIRON International Corporation. (2013). *Studio 6 Production Carbon Calculator Emission Calculation Methodology and References: For Carbon Calculator Version 3*. Retrieved 14 July 2020, from https://www.greenproductionguide.com/?smd_process_download=1&download_id=2194

[60] Greenstone+ Ltd. (2019). *albert Methodology Paper: v3 October 2019.* [Received through personal communication with R. Canela-Mas (2020, 15 October). Requestable via: albert@bafta.org].

[61] Zen'to Technologie. (2016). *Guide des méthodes et valeurs: Version 3.4.* Retrieved 14 July 2020, from http://www.carbonclap.ecoprod.com/document/ECOPROD%20-%20Guide%20methode%20et%20valeurs.pdf

	Transparency of data
MFG calculator	Methodology is partially presented directly in the calculator[62]. - Sources of reference: > Intergovernmental Panel on Climate Change (IPCC) > Greenhouse Gas Protocol „Product Life Cycle Accounting and Reporting Standard“ (2011) > Technical Specification ISO/TS 14067 > Conversion of GHG to CO2e according to IPCC AR4 > RFI data according to ISO/TS 14067

Table 2: Transparence of the carbon calculators

It is crucial for the transparency of the calculators that the methodology of calculation and the norms, standards and emission factors used are presented (cf. Williams et al., 2012). When examining the calculators directly and researching on the associated websites, no information on the methodology is available from Albert and E-Mission calculator. There is a lack of transparency in this respect, which can influence the credibility and understanding of the results (Padgett et al., 2008, p. 107). For Albert, an information paper on the methodology of the calculator is only available upon direct request. For the PEAR, E-Mission, MFG calculators and the Albert, emission factors and reference sources, as listed in Table 2, are provided to the user for information.

[62] MFG. (n.d.). *Bericht | MFG Greenshooting CO2-Rechner.* Retrieved 14 July 2020, from https://mfg.greenshooting.de/de_DE/page/record/?record_id=101
Via: Verwaltung > Berichte > Berichte verwalten > Bericht anzeigen (with existing balance)

3 Content-based comparison of the calculators

3.1 Objective

In the following chapter, a purely content-based comparison will be made between the five selected calculators. The comparison is intended to provide an overview of the contents of the calculators with regard to the system boundaries and the qualitative structure. The content-based comparison is intended to create a basis and to be expanded and put into context with the expert interviews examined in the following chapter.

The methodology of the calculators is not examined in the content-based comparison, as there is not enough information on this (cf. Chapter 2.2). Furthermore, no comparison of calculated results is made by entering the same data in the different calculators. Such an examination of the calculators has already been examined in the studies by Helsing and Wu (2018) and Schnetzer (2016). Both studies already show the differences between the results obtained by different calculators using the same data input.

3.2 Basis of the comparative methodology

As already explained in the introduction to the present thesis, there has been very little scientific research on carbon calculators for film and television productions to date. In contrast, the carbon calculator for private individuals has been examined in numerous scientific studies over the past two decades. Due to the similarities between carbon calculators for private individuals and carbon calculators for film and television productions, several of the studies have been examined and used as a guide for the content-based comparison. Padgett et al. (2008) compared 10 carbon calculators for US-American private individuals. Using the same data input, they found significant differences between the calculated balances of the calculators. The authors recognise the potential of carbon calculators to raise public awareness and motivate political change. At the same time, however, they call for a higher degree of standardisation of the calculators. By examining existing literature and studies, Birnik (2013) establishes a set of 13 principles for evaluating carbon calculators. Using the principles developed, Birnik carried out an evidence-based comparison of 15 online carbon calculators. Birnik also underlined the lack of consistency between the carbon calculators and called for standardisation. The 2019 study by Mulrow et al. evaluates carbon calculators for private individuals by establishing a "Feature Index". In contrast to Birnik (2013) and Padgett et al. (2008),

they do not examine the methodology of the calculators, but rather the calculator design and the user's possibilities for data input and interaction. The study underlines the importance of combining detail-oriented calculator functions with user-friendly calculator functions.

The establishment of the "Feature index" by Mulrow et al (2019) and the evaluation criteria used helped guide the comparative basis used in this thesis. For the basis of comparison, an extensive examination and test use of all calculators to be compared was also carried out.

3.3 Methodology

The five carbon calculators are comprehensively analysed for their *depth of input options*. For this purpose, 9 input categories have been defined, which are most frequently examined in the calculators: electricity on location and in the office, other energies, mobility, air travel, accommodation, materials, waste / disposal, catering and post-production. For these 9 input categories, the *possibility of data input* (e.g. *whether* data input is possible for air travel) and the *possibilities of data recording* (e.g. *how* data can be collected for air travel - by specifying the distance in kilometres or using airport codes etc.) are analysed. For the analysis, only the data input possibilities of the calculators were considered, which actually influence the calculated emission value of the balance.
In addition to the input options, the *display of the results* as well as the *help and guidance* on sustainable measures integrated into the calculator or other *special features* of the calculators were also examined. For the *display of the results*, the extent to which the results and effects are communicated to the user during and after completion of the CO2 balance was evaluated. With the integrated *help and guidance* on further measures or other *special features*, it was examined whether the calculator, in addition to calculating GHG emissions, also informs the user about further options for action or whether the calculator offers further aspects that were not examined in the present comparison.

The results of the analysis were then summarised and compared between the calculators. Based on this, tables were created to display the results obtained in a qualitative and comparable manner. Each calculator was given a rating of Low, Medium, High for each of the 9 input categories - based on the following evaluation criteria - as well as the extent to which the results are displayed and whether further help, guidance or special features are provided. The rating was highlighted in colour in the table: Low = dark red, Medium = yellow, High = green and also light red with a red dotted frame for the lack of an input category in a calculator.

3.3.1 Evaluation criteria for the *depth of the input options*

The methodology of Mulrow et al (2019) served as an orientation for the determination of the evaluation criteria and was supplemented by the author himself based on the examination of the carbon calculators and research on the topic.

The evaluation of the *depth of input options* is based on the assumption that broad data retrieval and the broad possibility of data recording is considered good. A broad data retrieval leads to an accurate result. If the user is limited to only a few possibilities of data recording (e.g. energy consumption can only be entered in kWh), this reduces user-friendliness. In addition, an evaluation is good if the data retrieval is conducted in a detailed scope. This includes, among other things, the diversity of the emission sources queried (e.g. range of possible fuels or means of transport), the possibility of specifying green energy and the country or region of the emission source.

The use of green energy can significantly reduce GHG emissions and should therefore be considered in principle (cf. Gutsche, 2019, p. 642). However, since the term "green energy" is not legally protected (so far the case in Germany with the term "Ökostrom")[63], not every green energy is actually linked to sustainably produced, low-CO2 electricity. When choosing a provider of green energy, it should therefore always be checked whether the green energy on offer is actually produced by renewable energies and is therefore low in CO2 emissions or whether it is simply labelled and marketed as such[64]. From a purely practical point of view, every electricity user receives the same mix of electricity from the grid connection, whether he or she buys green energy or not. Nevertheless, the use of electricity by a provider of green energy promotes the expansion of renewable, low-carbon energy sources and should therefore be taken into account in the carbon calculator and evaluated as positive[65].

The level of CO2 emissions per kilowatt hour of electricity varies from country to country. For example, due to the different composition of the electricity mix of the countries, one kilowatt-hour of electricity generated in Germany corresponds to about 440 grams of CO2, whereas the same

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[63] Vgl. und siehe auch: Horn, C. (2018, Juli 30). *Wie öko ist Ökostrom wirklich?* NDR Info. https://www.ndr.de/ratgeber/verbraucher/Wie-oeko-ist-Oekostrom-wirklich,oekostrom166.html

[64] Ibid.

[65] Cf. ibid.

amount in France corresponds to only about 58 grams of CO2[66]. Therefore, examining the origin of the emission sources is also essential for CO2 accounting.

User-friendliness is also included in the evaluation. For example, whether the data entry of air travel is partially automated by entering the airport codes, thus simplifying the calculation.

The concretely applied evaluation criteria of the results are listed in Tables 3-6, each separated by semicolons and were used for the evaluation as follows, depending on the input category:

- *Electricity*
  - High rating: 1) several possibilities of data recording (e.g. kWh, area times days of use, estimation) are offered, 2) office consumption is taken into account, 3) country and region are taken into account and green energy is offered as an option.
  - Medium rating: When a criterion is not met.
  - Low rating: When only one criterion is met.
- *Other energies*
  - High rating: 1) at least three energy sources (types of heating or fuels) are offered, 2) use of heating, use of generator and 3) the country and the region are considered.
  - Medium rating: If a criterion is not met.
  - Low rating: If only one criterion is met.
- *Mobility*
  - High rating: 1) several types of vehicles, 2) several types of fuel, 3) several possibilities of data recording (e.g. by route, cost, amount of fuel) are offered 4) train, 5) public transport, 6) ship and 7) freight is considered.
  - Mean rating: If only three to five criteria are met.
  - Low rating: If only up to two criteria are met.
- *Air travel*
  - High rating: 1) the selection of the flight class and 2) the indication of the trips by entering the airports is offered.
  - Medium rating: If a criterion is not met.
  - Low rating: If no criterion is met.

[66] European Environment Agency. (2018, Dezember). *CO2-Emissionen durch Stromerzeugung in der EU 2016.* Statista. https://de.statista.com/statistik/daten/studie/1009521/umfrage/co2-emissionen-durch-stromerzeugung-in-der-eu/

- *Accommodation*
  - High rating: 1) several types of accommodation and 2) the country and the region is taken into account.
  - Medium rating: If one criterion is not fulfilled.
  - Low rating: If only one criterion is fulfilled.
- *Material*
  - High rating: 1) at least 4 material types are considered, 2) several possibilities of data recording on the amount of material are offered.
  - Medium rating: If a criterion is not fulfilled.
  - Low rating: If only one criterion is fulfilled.
- *Waste / disposal*
  - High rating: 1) Indication of at least three types of waste and 2) different indications on types of disposal (recycling, compost, incineration) are offered.
  - Medium rating: If a criterion is not met.
  - Low rating: If no criterion is met.
- *Catering*
  - High rating: 1) possibilities to indicate if meals are vegetarian, 2) what type and volume they are, and 3) on type and production.
  - Medium: When a criterion is not met.
  - Low rating: When no criterion is met.
- *Post-production*
  - High rating: 1) information on the type of electricity used, 2) the country and region and 3) detailed electricity consumption is examined.
  - Medium rating: When a criterion is not met.
  - Low rating: When only one criterion is met.

3.3.2 Evaluation criteria for the *display of the results* and the *help and guidance*

With regard to the evaluation criteria for the *display of the results* and the *help and guidance*, particular attention is paid to how the calculated results are communicated and how calculators influence emission-related user behaviour. The criteria are also based on the methodology of Mulrow et al (2019) and supplemented by the author himself.

It is evaluated as good if the *display of the results* is detailed and broken down to the different areas. The more detailed the display of the results is, the easier it is for the user to identify significant emission sources and thus also reduction potentials. It is also important whether users are provided with a qualitative analysis of their GHG emissions to which they can relate and which they can understand. Further *help and guidance* and additional support from the calculator to help the user or to trigger further behavioural changes are to be evaluated as good.

- *Display of the results*
  - High rating: If 5-6 of the evaluation criteria are met: 1) the display is divided into at least 5 categories (such as electricity, mobility, catering, etc.), 2) these are shown in kilograms of CO2 and as a percentage of the overall result, 3) whether there is a detailed display of calculated emissions for individually entered positions, 4) comparisons are made, 5) benchmarks are displayed and 6) whether the calculated emissions are displayed during the data input.
  - Medium rating: If 3-4 evaluation criteria are met.
  - Low rating: If 0-2 evaluation criteria are met.
- *Help and guidance / special features*
  - High rating: If 4-5 of the evaluation criteria are met: 1) questions are integrated to identify further sustainable measures, 2) repeated CO2 balancing is encouraged, 3) links or guidance to further information on sustainability or reduction of the carbon footprint, 4) certification connected to the calculator, 5) other special features are provided.
  - Medium rating: If 2-3 evaluation criteria are met.
  - Low rating: If 0-1 evaluation criteria are met.

3.4 Results

In the following evaluation tables (Tab. 3-5), the possibilities of data recording during data entry are indicated in abbreviated form:

{V} = various volumes (e.g. m³, litre, gallons)	[d] = days
{C} = various costs (e.g. €, $, GBP)	[h] = hours
{Pcs} = Quantity/piece	[kWh] = kilowatt hours
{D} = various distance information (e.g. km, miles)	[l] = litre
{A} = various areas (e.g. m², hectare)	[t] = tonnes
{M} = different mass indications (e.g. kg, lb, t)	[km] = kilometre
(l,m,h) = low, middle, high consumption	

In the Albert, for example, the consumption of a generator can be indicated by specifying different volumes, masses or costs and is therefore shown below:

- Entry generator: {V}, {M}, {C}

In the electricity sector, on the other hand, the MFG calculator allows the electricity consumption of the technical equipment to be given in kWh or by means of an estimate, choosing between low, medium and high consumption and indicating the number of days of use:

- Technical consumption [kWh] or estimation: (l,m,h)[d]*

Electricity (location and office) – *Table 3*

Table 3 shows that the energy consumption of a production can be indicated in all calculators via the quantity indication in kilowatt hours. With the exception of Carbon'Clap, the calculators offer different possibilities of data recording for the indication of energy consumption. PEAR, E-Mission calculator, MFG calculator and Albert also give the user the possibility to indicate whether green energy was used. PEAR, Albert and Carbon'Clap take into account the origin of the emission sources. PEAR and Albert are exemplary and offer green energy, choice of origin and office information. Albert also provides the possibility to measure electricity consumption by means of benchmarks. The MFG calculator, on the other hand, is particularly user-friendly thanks to the option of indicating consumption via estimates. Especially for productions that have not collected exact values for electricity consumption, comprehensive estimates can be helpful as an alternative.

Data input 1/3	Electricity (locations and office)	Other energies	Mobility
Evaluation criteria	several possibilities of data recording; consider office; option green energy; country / region	at least 3 energy sources; heating; generator; land / region	number of vehicle types; number of fuels; possibility to enter train; public transport; ship; freight
PEAR	- Consumption [kWh], {A}*[d], {C} per location, office, stage, warehouse - Option green energy - Select country/region	- Energy consumption of heating oil and natural gas in {V}, {A}*d, {C} - Entry generator {V}, {C} - 16 fuel types - Select country/region	- 9 vehicle types, 12 fuel types {V}, {C}, {D}
Albert	- Consumption in 6 units (e.g. kWh, m^3, t) per location and office - Indication of benchmarks - Option green energy - Select country/region	- Energy consumption of heating, FX, catering, others: {V}, {M}, {C} - Entry generator: {V}, {M}, {C} - 23 fuel types	- Road: 10 vehicle types, 23 fuel types {C}, {M} - Train: National, International, City Railway, Subway {D}, {C} - Ship: 3 types, {D}, {V} - Cargo: ship or train [kg]* [km]. - Courier: very extensive
Carbon'Clap	- Consumption [kWh] per location and office - Select country	- Specification 4 types of heating for offices and film locations - Technical consumption: Generator {V} or mains current [kWh] and selection of country	- Vehicle [km] - Train National o. Europe - Freight: truck or plane [t]*[km]
E-Mission	- Consumption [kWh] per location - Consumption [kWh], {A}*[d] for pre- and post-production - Option green energy	- Specification 3 types of heating - Green energy in [%]. - Indication whether heating season or not - Energy consumption [kWh], {A}*[d] for pre- and post-production - Energy consumption [kWh] per location - Generator specification [l]	- 3 types of vehicles, including entry of CO2/km, 3 fuel types [l], [km] - Play car: 3 types of fuel [l] - Work routes by car [l], [km] - Work routes rail transport {C} - Taxi ride, courier {C} - Cargo: minibus, truck, ship, train, plane [l], [km].
MFG calculator	- Technical consumption [kWh] or estimation: (l,m,h)*[d] - Studio consumption [kWh], estimation (l,m, h)*[d]*[h]*[m^2]. - Office consumption: (l,m,h)*[d]*[m^2] - Green energy option	- Specification 7 types of heating - Estimate by building type*consumption (l,m, h)*{A}*d - Generator [l], or estimation by continuous power, load, duration	- consumption {C}, {V} - 7 fuels (including electricity, green energy) - Estimate for cars [km]. - Taxi {C} - Train, bus, public transport [persons.km]

Table 3: Depth of input options (1/3)

Other energies – *Table 3*

For other energies, mainly the information on the use of heating and generators in the calculators is examined. All five calculators cover most of this information, each offering different possibilities of data recording and a wide choice of emission sources. Only PEAR and Carbon'Clap take into account the country of the emission source. Particularly for shoots abroad or longer sections abroad, such as co-productions, it is crucial to consider the country of origin.

Mobility – *Table 3*

Average values from the data collection of the Albert and E-Mission calculators show that a large part of the GHG emissions of a film or TV production originates from the mobility sector (transport of people and material, including air travel)[67]. For this reason, a detailed examination of

[67] Both calculators show average values for the respective industry. In the case of E-mission, 42% of all

mobility is essential. Albert and E-Mission serve as role models. Both calculators examine a variety of transport types and offer many possibilities of data recording. The Carbon'Clap and the MFG calculator sometimes lack important transport areas such as freight, public transport or ship transport. PEAR weakens most in this area and ignores the examination of train, freight, public transport and ship transport.

Data input 2/3	Air travel	Accommodation	Material
Evaluation criteria	Selection of flight class; input via airport codes	several types; country/region	at least 4 material types; several calculation options
PEAR	- Flights {D} - Reference to external route calculator - Consumption jet, helicopter {V}, [h], {D}	- Overnight stays {Pcs} - 4 hotel classes, flat, medium, large house - Country/Region	NO data input (possibility to provide information, not included in the calculation)
Albert	- Flights {D}, {C} or airport codes - Flight class - Consumption of charter and helicopter [h]	- Overnight stays {Pcs} - 4 hotel classes, flat, medium, large house - Country/Region	- Colour: 3 types {Pcs} - Paper: [m²]*{Pcs} - Construction timber: {C}, {Pcs} - Textile: [kg], [m²].
Carbon'Clap	- Flights {Pcs} - Selection short or medium - Flight class	- Overnight stays {Pcs}	- Costume, make-up, equipment {C} - Batteries, paper {Pcs} - Techn. devices in the office {Pcs}
E-Mission	- Flights [km]	- Overnight stays {Pcs}	- Equipment , Costume {C} - Paper {Pcs}
MFG calculator	- Integrated flight data computer - Flight class - Estimation (short, medium, long)	- Overnight stays {Pcs} - 3 hotel classes, holiday flat [m²], youth hostel	- Scenery: 8 Material types {C}, {Pcs} - Costume: {C} - Purchase or rent, if rented: Washing details - Props {C} - Paper: Type, {Pcs}

Table 4: Depth of input options (2/3)

Air travel – *Table 4*

Air travel is examined by all calculators and is usually collected in an area separate from mobility. PEAR and Albert even include the use of helicopters, private jets and other means of air transport. Since air travel makes a significant contribution to GHG emissions, the area should be examined in even greater detail. E-Mission and Carbon'Clap are very weak in this respect. E-Mission only offers air travel in kilometres, without being able to select the flight class. Furthermore, the mere indication of kilometres is ambiguous, as it is not clear whether passenger kilometres or route kilometres

emissions are attributed to the mobility sector, in the case of Albert even 86.4%.
Vlaams Audiovisueel Fonds. (2019, Oktober 18). *Carboncalculator voor films (e-Mission).* https://www.vaf.be/sites/vaf/files/duurzaam_filmen/cc_film_naam_film_datum_v2016.xlsx
Albert. (n.d.). *albert– Production Dashboard.* Retrieved 26 August 2020, from https://calc.wearealbert.org/UK/productiondashboard/

are queried. Carbon'Clap, on the other hand, takes the flight class into account, but collects the data solely on the number of flights, which are categorised as short or medium distances. Albert and the MFG calculator are examples. Both calculators offer the user the possibility to select the flight class and also to record the data collection by entering the airport codes. This option gives largely exact values and is also user-friendly.

Accommodation – *Table 4*

PEAR and Albert are exemplary for the data collection of accommodation. Both calculators use exactly the same methodology to examine the use of accommodation. The user enters the number of overnight stays and can choose between four hotel classes, flat and medium or large house as accommodation type. The MFG calculator offers similar possibilities and examines three hotel classes, holiday flat with indication of the area and youth hostels. However, the information in which country or region the accommodation is located is missing in the MFG calculator and can be entered in PEAR and Albert. Carbon'Clap and E-emissions neglect the area and only give the option of entering the emissions by indicating the number of overnight stays.

Material – *Table 4*

Each calculator examines different materials during the balancing process. The MFG calculator and the Albert offer the most extensive range of possible entries. PEAR allows to provide information on the use of plywood via the separate sheet "EAR Metrics" (see p. 34), but without affecting the calculation.

Waste / disposal – *Table 5*

Data on waste and disposal are not included in the calculation of PEAR and E-Mission. The Carbon'Clap takes a very limited look at the area with information on the amount of used material for the scenery in square metres and the number of plastic bottles and cups. Albert and the MFG calculator are exemplary in examining basic types of waste and types of disposal.

Data input 3/3	Waste / disposal	Catering	Post-production
Evaluation criteria	at least 3 types of waste; specification of disposal types	Whether vegetarian; meal types; type and production	Information on type of electricity; country/region; information on electricity consumption
PEAR	NO data input (possibility to provide information, not included in the calculation)	NO data input	NO data input
Albert	- 8 Material types [kg] or container size - 3 types of disposal	NO data input	- Editing [d] - Whether green energy - Country/Region
Carbon'Clap	- Scenery [m³] - Plastic bottles, cups {Pcs}	- Meals {Pcs}	- VFX, editing, sound, laboratory [d]
E-Mission	NO data input (Detailed questionnaire on measures)	- Meals {Pcs} - Vegetarian meals {Pcs}	- Editing, sound [d] - FX, laboratory {C}
MFG calculator	- Residual waste, paper, bio, packaging [kg]. - Disposable cutlery and cups {Pcs}	- Meals {Pcs} - 6 types of meals (in terms of volume) - 8 specifications on type and production	- Image in source, Quantity, [h]: CPU/GPU green energy/conventional - Waste heat recovery or cooling (- Sound can only be determined externally) - Hard disks {Pcs}

Table 5: Depth of input options (3/3)

Catering – *Table 5*

Although catering is an important aspect to be examined in film and television productions (cf. Gutsche, 2019), it is not included in the PEAR and Albert. The Carbon'Clap, on the other hand, only offers an indication of the number of meals. The same option is also offered by the E-mission, and the number of vegetarian meals can also be specified. Only the MFG calculator includes the catering in detail and extensively. The user can specify the number of meals and choose from several meal types and give several details about the type and production of the meal.

Post-production – *Table 5*

Post-production is only marginally examined by all five calculators. While the PEAR does not explicitly include post-production, users of the Carbon'Clap and E-Mission can only specify the amount of days and costs for post-production. Albert and the MFG calculator are more comprehensive but still not accurate enough. Especially the power consumption, which can be considerable in post-production not only by editing, sound, colour correction but especially by rendering, is examined in all five calculators with little to no accuracy.

Display of results / help	Display of results	Help and guidance / Special features
Evaluation criteria	Number of cat.; in kg and %; detailed display of individual inputs; comparisons; benchmark; display of emissions during input	1=red, 2=yellow, ≥4=green: Questions; repeated accounting; further information; certification; further extras
PEAR	- Information: Overall result, per shooting day - Diagr. [kg] and [%], 4 Cat. - 4 equivalents	- Occasional questions on sustainable measures - Page "EAR Metrics": 6 topics
Albert	- Disclosure of overall result - Diagr. [kg] and [%], 9 Cat. - Comparison with industry standard (for TV) - Diagr. [kg] and [%], 3 Emission type. - Table on individual categories - Comparison with industry standard of the last 6 months: Diagr. in 9 cat., comparison with total average, same production format, same genre	- Possibility of certification via questionnaire - Repeated balancing is encouraged
Carbon'Clap	- Total result, per running minute - Diagr., [kg], 9 Cat. - Diagr., by 5 production phases - Detailed table: individual inputs/emission sources, [kg]	- Extensive questions on sustainable measures - Further links for additional measures
E-Mission	- Disclosure of overall result - Comparison with Flemish average - Diagram and table, [kg] and [%], 9 cat. - Diagram and table, [kg] and [%], 3 production phases, 9 cat. - Diagrams and tables, [kg] and [%], people and product transport, 5-6 cat. - Diagrams and tables, [kg] and [%], waste and room and board - 4 equivalents	- Extensive questions on sustainable measures - Possibility of certification via questionnaire
MFG calculator	- Disclosure of overall result - Diagr., [kg], 6 Cat. - Specification for RFI - Tab., detailed list of individual sectors, [kg] and [%]. - During input, directly specify [kg] + diagrams of the sector [kg] for each position	- Option on "externally measured emissions". - Repeated balancing is encouraged

Table 6: Display of results / Help and guidance / Special features

Display of results – *Table 6*

The display of the results is very different in all calculators. In addition to displaying the overall result, all calculators divide the calculated GHG emissions into different categories. With the exception of Carbon'Clap, all calculators display the various categories in kilograms or tonnes as well as in percentage values. Albert and E-Mission also offer comparisons and benchmarks. PEAR and E-Mission try to simplify the communication of the results by showing equivalents. In E-Mission, for example, the overall result is set in relation to the number of households that produce the same emissions per year. Exemplary is the very detailed presentation of individual positions of the MFG calculator. Not only at the end of the calculation but also during data entry, the user can see which specific position (e.g. an air trip, heat requirement of a motif, etc.) produces how much GHG emissions. Such a very detailed and transparent presentation can help to identify and reduce individual hotspots in a production. Distributed over all five calculators, there are many helpful displays of the results and communication aids. The individual calculators themselves, however, each show shortcomings.

Help and guidance / Special features – *Table 6*

Help and guidance on sustainable measures and additional features are offered differently from calculator to calculator. PEAR offers a entire Excel spreadsheet for further ecological activities. In the so-called "EAR Metrics" the user can provide further information, such as waste management, material donations or water consumption. However, all specifications are not included in the GHG calculation. The PEAR also asks the user individual questions about sustainable measures. The use of questions to indicate further ecological activities is also reflected in the E-Mission and Carbon'Clap. The Carbon'Clap also provides links to further information on the topic. Certification is possible in Albert and E-Mission and is built directly into the calculators. Albert and the MFG calculator also encourage the repeated balancing of a production by the design of the calculators. Another helpful feature of the MFG calculator is the possibility to enter externally determined emissions in the data retrieval. This enables precise data entry, for example if the post-production house determines its own emissions and passes the calculated values on to the production.

3.4.1 Presentation of the comparison results in radar charts

Using the evaluation tables, a radar chart was created for each of the five calculators in order to provide a qualitative and visual display of the results obtained. In the radar charts, the 11 aspects compared (9 input categories; display of the results; help and guidance) were each assigned to an axis, which represents the respective evaluation in whole values from 0 to 3. The numerical scores are derived from the evaluation in the table as follows: High (green) = 3, Medium (yellow) = 2, Low (dark red) = 1, lack of data entry (light red, red dotted frame) = 0. The ratings were drawn into the radar charts and the points on each axis were connected.

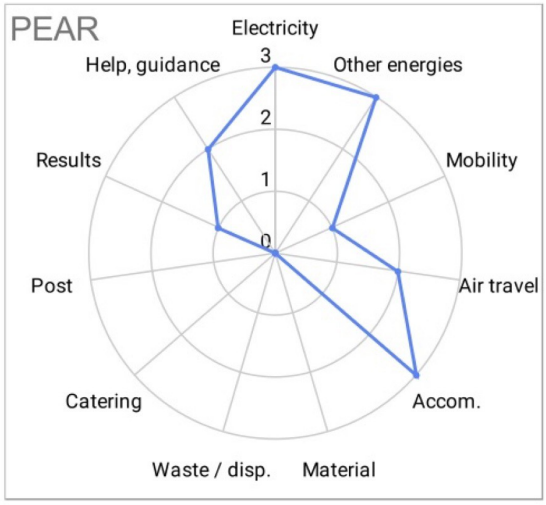

Fig. 2: Radar chart - PEAR

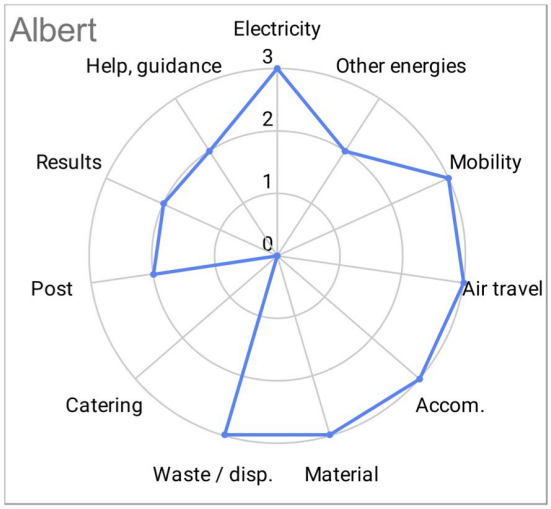

Fig. 3: Radar chart - Albert

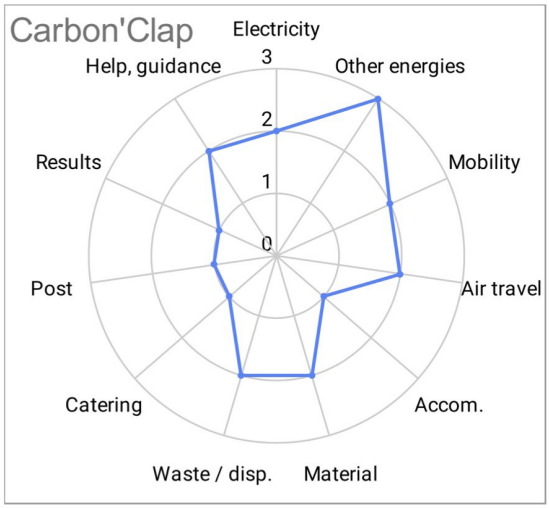

Fig. 4: Radar chart - Carbon'Clap

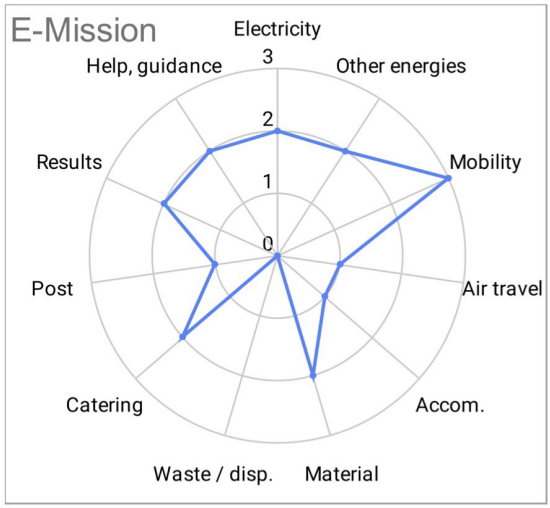

Fig. 5: Radar chart - E-Mission

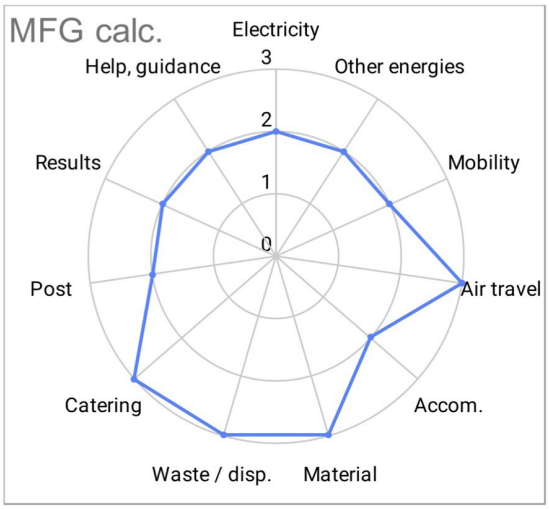

Fig. 6: Radar chart - MFG calculator

3.5 Conclusion

The respective radar charts visualise the results of the content-based comparison. The examination of the five calculators shows how different the structure and functions of the carbon calculators are. Many exemplary functions and user-friendly features can be seen in the different calculators. At the same time, however, the content-based comparison also reveals many shortcomings in the design of the carbon calculators. Certain areas remain completely unnoticed in some calculators, some lack broad possibilities of data recording or lack user-friendliness. When examining the five calculators, it can be seen that they have clearly different focuses.

The PEAR focuses on the areas of energy, transport and accommodation. Energy and accommodation in particular are examined extensively. In contrast, the user is not offered data input for several areas.

The radar chart for the evaluation of the Carbon'Clap shows that, in contrast to the PEAR, the calculator includes all examined input categories in the balance. Despite the wide range of data queries, the calculator lacks depth. Due to often simplified and not very detailed data input options, the calculator weakens as a whole. As already mentioned in chapter 2.1, *EcoProd* aims with its calculator at a quick and easy operation. This also explains the many estimates and simplifications in the calculator.

A similar evaluation is to be made of the E-Mission, which, apart from waste management, considers all examined input categories in the balancing. E-Mission also lacks depth in many areas. In comparison, the calculator uses questions on sustainable measures most extensively. The calculator also takes waste management into account, again only in the form of a questionnaire, which has no influence on the calculation of GHG emissions.

The radar charts for the Albert and MFG calculators show a clear advantage in performance of both calculators. The MFG calculator examines all input categories equally from medium to high rated depth with special regard to catering, waste management and material. Similarly, the Albert is to be evaluated, which however has its strengths especially in energy, transport, accommodation, material and waste management. Only catering is not examined in the Albert.

All five calculators show potential for improvement in the display of the results and in further help and guidance. None of the calculators achieves a high rating for both aspects in the content-based comparison.

4 Expert interviews with hosts of the calculators

4.1 Methodology

The content-based comparison carried out in chapter 3 takes a purely theoretical look at the five carbon calculators. In addition, it will be analysed how the calculators are used in practice, what experiences have been gained in using the calculators to date, and with what motivation, goals and expectations the hosts offer the calculators. In order to gain insights into this, expert interviews were conducted with the hosts of the carbon calculators. The survey of the hosts was intended to provide a comprehensive view of the development, use, expectations, data usage, improvements and future prospects regarding the respective carbon calculators.
For all five carbon calculators examined in this thesis, the hosts were contacted for an expert interview. It was ensured that the interviewees work as hosts of the calculators, that their position is directly linked to the calculator in question and that they are fully familiar with the development and use of the calculators. In total, (video)phone interviews were conducted on four of the calculators.

To examine the PEAR, an interview was conducted with two employees of the US media group *ViacomCBS*. The interview partners Audrey Vinant-Tang and Victoria Dubeau work at *ViacomCBS* on corporate sustainability initiatives of the company. Vinant-Tang also takes part in the executive committee of the *Sustainable Production Alliance* (SPA), which manages the *Green Production Guide* and thus also the calculator PEAR together with the *Producers Guild of America Foundation*. Vinant-Tang and Dubeau speak on behalf of the SPA about the use of the PEAR in the US industry.

Regarding the Albert calculator, Roser Canela-Mas was interviewed. As Industry Sustainability Manager at BAFTA, she manages the Albert and the international partnerships of the *albert* project.
Tim Wagendorp was interviewed about the E-Mission calculator of the VAF. Wagendorp works at VAF as Sustainability Coordinator and also represents the Flemish funding body in the EU-funded *Green Screen* project and is thereby a member of the *Eureca* project[68].
For an insight into the MFG calculator, an interview with Maria Dehmelt and another interview with Stephan Schunkert were conducted. Schunkert is managing director of the agency *KlimAktiv*

[68] More information about the *Green Screen*-project and the *Eureca*-project can be found in chapter 5.2.2

and has contributed to the development of the calculator. Dehmelt works in MFG's production funding department and is also in charge of the *Green Shooting* initiative of MFG, to which the carbon calculator belongs.

There was no personal conversation with the hosts of the calculator Carbon'Clap. However, in order to take a look at the French calculator, the calculator's website and publicly available information for relevant information were included in the results.

The interviews were conducted by telephone call or Zoom video call. The interviews were held between May and June 2020. The interviews were conducted in a semi-structured manner, recorded and transcribed. The complete transcripts can be found in the appendix.
The interview guide used was divided into four sections:
1) Development, objectives, motivation. 2) Users and application. 3) Results, feedback, conclusions. 4) Current state and future prospects.
The guide was adapted individually for each interviewee and developed further over the period of the interviews. The basic guide can also be found in the appendix.

4.2 Results

The results of the interviews are divided into subject areas in the following chapter. In each area, similarities, differences and particularities of the different calculators are examined and evaluated.

4.2.1 Motivation and goal

As already described in *chapter 1.4 Carbon footprint*, the goals and motivations for a carbon accounting can vary. The objective of a balancing can also influence the methodology used for the calculation. If, for example, the aim of a balancing is simply to create a data situation and to express the impacts of a production in values, a mere GHG balancing may be sufficient. If, however, the objective is, for example, to raise the user's awareness and inspire him to take sustainable measures, a calculator can also contain information, recommendations or questions on possible measures in addition to the mere balancing. The differences in the design of the calculators can thus also be attributed to the objectives of the hosts.

Among the calculators examined there is a common objective. All hosts state that one objective is to quantify the GHG emissions of productions and thus their impact.

Dehmelt comments on the development of the MFG calculator that a broad data situation should be created especially for the German film and television industry in order to better identify hotspots of GHG emissions (personal communication [pers. commun], 06 May 2020, l. 23 ff.). With regard to the E-Mission, Wagendorp notes that the calculator should help to present the sustainable measures taken by a production and to make productions aware of their impacts (pers. commun, 28 May 2020, l. 13 ff. + l. 84 f.).

With regard to the US and British film and television industry, the introduction of an industry standard is seen as a further motivation for the development of a carbon calculator. Vinant-Tang explains that before the development of the PEAR, "the major studios in the United States were all using slightly different approaches" to account for CO2 emissions from their productions (pers. commun, 02 June 2020, l. 10 f.). The PEAR was intended to help to introduce the same methodology across the industry in order to better compare between productions. PEAR should also enable crew members working for different studios to use the same calculator everywhere (l. 9 ff.).

The development of Albert can be examined in a similar way. After its effective use at BBC, the carbon calculator was passed on to the independent BAFTA to enable the calculator to be used throughout the industry and to set an industry standard (R. Canela-Mas, pers. commun, 19 June 2020, l. 6ff). Currently Albert is hosted by BAFTA and used by various broadcasters and production companies. It can be assumed that the motivation and objectives of the stakeholders involved in the deployment of Albert vary.

4.2.2 Use during production and expectations of the hosts

With the use of carbon calculators for film and television productions, the question arises in particular of *how* the calculators are used and *when* carbon accounting is carried out. Here, further goals and expectations of the hosts can be identified.

Various hosts expect that accounting is carried out before and after a production. Schunkert explains that a pre- and post-balancing should help "to plan and thus also to avoid" [T.a.][69] (pers. commun, 7 May 2020, l. 160ff). He adds that balancing alone after production is of little help, as the findings are no longer of any use after the completed production. On the other hand, balancing before production can reveal reduction potentials and sensitise the user (ibid.). For example, when using the MFG calculator, there is an expectation that the balancing will be done twice (M. Dehmelt, pers. commun, 6 May 2020, l. 65ff). Accordingly, the structure of the MFG calculator also includes the possibility of repeated balancing (cf. chapter 3.4). Dehmelt states that the aim is in particular to sensitise users (cf. 72ff). Often, however, users only carry out a single post-balancing because there is no time for the pre-balancing (ibid.).

A similar expectation can be seen in Albert's case. The calculator offers to generate a "Predicted-" and a "Final-Footprint". In the "Predicted" balancing prior to the start of production, the user should provide as many estimates as possible of how the production will turn out. This predicted-balancing should then in turn help to communicate the expected impacts to the entire crew and to take sustainable measures (R. Canela-Mas, pers. commun, 19 June 2020, l. 116ff). In summary, Canela-Mas explains, "you can't reduce your impact in the end, you have to do it in the beginning" (l. 120f).

Wagendorp also supports this statement, although the VAF only demands a single balancing when using E-Mission (pers. commun, 28 May 2020, l. 342ff). Although he considers balancing before the start of production, as promoted by Albert and the MFG calculator, to be helpful, however according to his statement it remains a very rough estimate and requires time (ibid.). He prefers the approach of the Spanish funding body Promálaga, which automatically calculates a rough estimate of GHG emissions based on the budget calculation of a production (l. 120ff). This can save time, which in his view is better invested in the actual planning of sustainable measures (l. 353ff).

The members of the SPA apply an alternative approach in the planning phase. Vinant-Tang and Dubeau refer to the Best Practice Checklist called PEACH, which is also offered by the *Green Production Guide*. During the pre-production phase, the PEACH checklist should help to define sustainable measures for a production (pers. commun, 2 June 2020, l. 76ff). Vinant-Tang and Dubeau also consider a roughly estimated pre-balancing of GHG emissions to be only partially

[69] „zu planen und so auch zu vermeiden“

helpful and also mention the time required as a deficit (l. 193ff). Thus, the SPA works with two tools. With PEACH for planning from the pre-production stage on and with PEAR to draw up a carbon footprint at the end of production (l. 76ff).

Canela-Mas' statement "you can't reduce your impact in the end, you have to do it in the beginning" (cf. l. 41) is thus supported by all hosts, but approached in different ways.

4.2.3 Recruit new users

> „The potential of calculators to raise awareness and reconfigure practices can only be realised if they are used.“ (Salo et al., 2019, p. 662)

According to the principle of Salo et al., one of the fundamental tasks of hosts is to recruit new users. The expert interviews show that active recruitment is essential for attracting new users. Since carbon accounting for a production means additional expenditure, the initiative to use the calculator is very rarely taken by the users themselves (M. Dehmelt, pers. commun, 6 May 2020, l. 173f). In order to recruit new users, the various hosts pursue different approaches.

Dehmelt notes that for the introduction of the MFG calculator in 2017, MFG used several events and workshops to introduce the calculator to the industry (pers. commun, 6 May 2020, l. 100ff). MFG also endeavours to introduce the carbon calculator to students through seminars and lectures at film academies (l. 187ff). In addition, the calculator has become more widespread through the sustainability initiative "100 Grüne Produktionen" of the *Green Shooting* working group (l. 116ff). The national initiative committed itself to producing a total of 100 productions in 2020 and 2021 in an ecologically sustainable manner[70]. The MFG calculator will be used at national level for the carbon accounting of the participating productions (l. 122ff). Since July 2020, all productions that receive production funding from MFG are also obliged to use the MFG calculator for carbon accounting (l. 85ff).

The direct link between funding and carbon accounting has already been introduced at VAF in recent years[71]. The productions funded by VAF are obliged to balance their GHG emissions

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[70] Bavaria Fiction GmbH. (2020, Februar 24). *Arbeitskreis „Green Shooting“ startet Nachhaltigkeitsinitiative.* Retrieved 26 July 2020, from https://www.bavaria-fiction.de/newsroom/filmbranche-nachhaltigkeitsinitiative

[71] Vlaams Audiovisueel Fonds. (2016). *e-Mission – a methology for a more sustainable audiovisual industry in*

by means of the E-Mission in order to receive the last 10% of the funding[72]. The E-Mission has also found its way into the Flemish broadcaster VRT and other broadcasters (T. Wagendorp, pers. commun, 28 May 2020, l. 288ff). However, VAF concentrates primarily on its funded productions (l. 229f). However, Wagendorp admits: "The feeling that I have now, is that the projects we funded is just the tip of the iceberg" (l. 239f). In order to achieve a broader resonance and to establish carbon accounting as a habit, VAF also makes its carbon calculator available for student projects (l. 236f).

As many members of SPA report the GHG emissions of the entire company in the *Corporate Disclosure Project* (CDP)[73], the companies account for the majority of its programmes. For this purpose, productions that are not produced in a sustainable framework are also included in the carbon accounting. However, the independent use of the PEAR and the adoption of further sustainable measures are based on the shows' own initiative. When a show is interested in sustainability, the production is introduced to the tools of the *Green Production Guide*, including PEACH and PEAR (l. 59ff).

A clear advantage can be seen in the use of the Albert in the British film and television industry. Nowadays, every production produced or commissioned by a member of the *albert Consortium* is obliged to balance its carbon footprint with the Albert (R. Canela-Mas, pers. commun, 19 June 2020, l. 64ff). As the members include several major players in the British industry, the Albert receives a very wide use. Canela-Mas even states that balancing with Albert has become established to such an extent that some productions that are not obliged by the broadcaster to balance their emissions nevertheless do so out of habit (l. 71ff). Thus, the *albert Consortium* can be an example of how the cooperation of several important and also public sector players can establish the use of a carbon calculator across an entire industry.

Flanders: E-Mission Year Report 2015. Retrieved 10 July 2020, from https://www.vaf.be/sites/vaf/files/duurzaam_filmen/e-mission_-_year_report_2015.pdf

72 Ibid.

73 The CDP is a non-profit organisation that enables investors, companies, cities, states and regions to publish and manage their environmental data, such as greenhouse gas emissions.
CDP. (n.d.). *Home– CDP*. Retrieved 21 July 2020, from https://www.cdp.net/en

4.2.4 Support and introduction

In order to support users in using the calculator, all hosts noted a one-to-one support. The hosts are available by email or telephone to answer questions or provide support. In addition, explanatory videos or instructions are available for most calculators on the corresponding website. MFG also uses workshops to present their calculator and explain its application (M. Dehmelt, pers. commun, 6 May 2020, l. 108f).

All hosts see it as particularly important that new users are introduced to the calculator before production. The user should be made aware of the amount of data to be collected before production starts. This is to avoid that after the end of production necessary data are not collected and are missing for the calculation. If, on the other hand, the user is informed from the beginning which data are necessary for the calculation, they can be specifically monitored and collected during production.

4.2.5 Users and target group

The use of carbon calculators and the calculation of resulting GHG emissions raises user awareness and can contribute to behavioural change (Padgett et al., 2008; Birnik, 2013; Salo et al., 2019). In the case of a film or television production, it is particularly important to examine the fact that an entire team and not an individual is involved in the generation of GHG emissions. This raises the questions: who actually uses the calculator? Which team member is responsible? At the same time, the question arises: how is the data collected and to whom is it passed on?

Throughout the expert interviews it is clear that the production department is generally responsible for filling out the calculator. Which position actually bears the final responsibility varies from production to production and usually depends on the size of the project. The hosts name in particular production assistants, production managers, the accounting department, production coordinator and sustainability managers (also called "Green Consultants").

However, Wagendorp criticises that "being sustainable as a production (...) is not a one person responsibility, [the] entire crew is responsible" (T. Wagendorp, pers. commun, 28 May 2020, l.

280f). Like Canela-Mas, Wagendorp is striving for a division of responsibility. Producers, Production Head Ofs or Production Executives (hereinafter referred to as "Project Managers") bear the financial responsibility for a production and should therefore also be included in the examination of the carbon footprint. As sustainable measures are also financial measures (cf. T. Wagendorp, pers. commun, 28 May 2020, l. 283ff). The hosts explain, therefore, that the Project Managers would make sense as users of the carbon calculator, but that they usually lack the time and are unable to take over the work of collecting and entering the data.
With divided responsibilities, Wagendorp and Canela-Mas nevertheless aim for Project Managers to be responsible for ensuring that carbon accounting is carried out. However, filling in the calculator should be the responsibility of another position, such as a production assistant. Communication is therefore the responsibility of the Project Managers. As team leaders, they should call on all departments to record the consumption produced in their area (e.g. electricity consumption in the lighting department) and pass this on to the position responsible for data collection (cf. R. Canela-Mas, pers. commun, 19 June 2020, l. 92ff). Data collection is facilitated because the request to the team comes from the Project Managers, thus "from above" (cf. ibid.). The co-responsibility of the Project Managers can result in a greater interest in the carbon accounting and the results on the part of the Project Managers.

It is also important that the person responsible for data collection and filling out the calculator is present during production to the extent that all relevant data can be collected over the entire production period.

Wagendorp even goes one step further and puts forward the idea of including the entire team in the carbon accounting (cf. pers. commun, 28 May 2020, l. 289ff). Each team member can balance his or her individual travel, alimentation or consumption data himself or herself. By presenting the individual personal emissions, the CO2 calculation can then become a motivational tool for the entire team (l. 295ff).

4.2.6 Collection and use of data

With every carbon accounting, consumption data is collected and GHG emissions are calculated. This raises the question of whether and how this data is collected and used by the hosts.
MFG and VAF collect data on the productions they fund. With the data collected in the sustainability initiative "100 Grüne Produktionen" MFG also aims to "create a comprehensive data situation" [T.a.][74] (l. 122f).
The VAF uses their collected data for the annual report of the funding body (T. Wagendorp, pers. commun, 28 May 2020, l. 440ff). Wagendorp mentions the advantages of being able to put the results into perspective and compare them (l. 448ff).

With the calculator Albert an extensive data collection is created. BAFTA uses the data to ascertain industry averages and to enable comparisons between productions within a production company (R. Canela-Mas, pers. commun, 19 June 2020, l. 227ff). This enables users of the Albert to compare their own production with the industry average as well as with other productions of the same company.
Comparisons between productions can be helpful to illustrate ratios and differences and to draw conclusions. However, constructive comparisons are particularly difficult for film productions. A basis for comparison is lacking, as films are not industrially manufactured products in the same format and in large numbers, but vary greatly from production to production (cf. S. Schunkert, pers. commun, 7 May 2020; T. Wagendorp, pers. commun, 28 May 2020). In contrast, the members of the SPA and, in the specific example, *ViacomCBS* have an advantage in the production of series. For a series, Vinant-Tang and Dubeau can compare the calculated data from season to season (A. Vinant-Tang & V. Dubeau, pers. commun, 2 June 2020, l. 210ff). Since a series often remains in the same or similar basic frame and scope, comparisons here are much more constructive. In the pre-production of a series season, Vinant-Tang and Dubeau use the data collected from the previous season to retrospectively examine the measures and results with the production. In this way, examining the results of completed seasons can help to improve previously high-impact areas with measures and thus reduce the output of a following season (ibid., l. 145ff). Vinant-Tang and Dubeau explain that on the basis of the data collected they have already been able to implement sustainable measures within a series and also company-wide (pers. commun, 2 June

[74] „eine flächendeckende Datenlage schaffen“

2020, l. 219ff, l. 267ff). *ViacomCBS* and other members of the SPA also use the data collected to disclose the company's GHG emissions in the CDP (l. 23ff).
BAFTA uses the data collected by Albert to communicate findings within the *albert Consortium* (R. Canela-Mas, pers. commun, 19 June 2020, 244ff). Since the *albert Consortium* includes important players of the industry, BAFTA can initiate sustainable measures throughout the industry based on its collected data situation. As an example, Canela-Mas cites the "Creative Energy" project, which supports the use of renewable energies within the industry and thus reduces the CO2 focus of energy consumption (l. 246ff).

Canela-Mas and Dehmelt both stress the importance of collecting calculated data and thus being able to present hard facts that can raise awareness and also contribute to taking action (R. Canela-Mas, pers. commun, 19 June 2020, l. 244ff; M. Dehmelt, pers. commun, 6 May 2020, l. 464ff).

4.2.7 Display and communication of the results

The strength of carbon calculators is that they can give an individual evaluation of GHG emissions in relation to consumption for a specific activity or action. It is important that the results are communicated and displayed in a meaningful and comprehensible manner (cf. Salo et al., 2019, p. 662).
Vinant-Tang and Dubeau underline the importance of communicating results to the productions individually. In addition to the display of the results within the PEAR, they send the productions further comparisons and benchmarks as well as tips on what can be improved. They also show how the sustainable measures of a production have affected the CO2 balance (A. Vinant-Tang & V. Dubeau, pers. commun, 2 June 2020, l. 130ff + 143ff).

There is no individual communication of the results when using Albert. Users only receive the results and comparisons presented in the calculator (R. Canela-Mas, pers. commun, 19 June 2020, l. 184f). This can be attributed to the fact that between 2017 and 2019 alone, more than 200 productions were balanced with Albert[75] and thus a volume is reached that cannot be covered by individual support from BAFTA. Canela-Mas, however, expresses the knowledge that productions

[75] Barrat, J. (2020). *Green matters: Environmental sustainability and film production: An overview of current practice.* p. 21. https://www.bfi.org.uk/sites/bfi.org.uk/files/downloads/bfi-green-matters-uk-screen-sector-report-2020-v1.pdf

want more details and comparisons that are currently not available in Albert (ibid., l. 187ff). BAFTA aims to improve the display of the results. Canela-Mas cites as an objective that productions should be able to understand the results easily and autonomously and thus become more independent (ibid., l. 194).

As sustainability coordinator, Wagendorp individually supervises the productions funded by VAF (cf. T. Wagendorp, pers. commun, 28 May 2020, l. 29ff). Compared to Albert, the number of productions measured by E-Mission is significantly lower[76] and individual support is therefore easier. After completion of production and balancing, Wagendorp prepares a report adapted to the production. In this report he can show what the calculator does not show. Where improvements are still needed, where measures have been successful and how much GHG emissions have actually been saved by sustainable measures (ibid., l. 385ff). Wagendorp emphasises that it is important to communicate the lessons learned in production, so that what has been learnt can be applied in future productions (ibid., l. 394ff).

It can be assumed that individual communication is the best solution for presenting the results of the carbon calculators in a comprehensible way and for initiating targeted measures. However, if the use of carbon calculators becomes more widespread and the number of users in relation to the support (hosts) increases, it will be particularly important that the results are communicated in a meaningful and comprehensible way already in the calculator, so that users can easily understand their carbon accounting and learn from it independently.

[76] Between 2012 and 2015 a total of 19 VAF-funded productions were balanced with the E-Mission. Vlaams Audiovisueel Fonds. (2016). *E-Mission - a methology for a more sustainable audiovisual industry in Flanders: E-Mission Year Report 2015*. https://www.vaf.be/sites/vaf/files/duurzaam_filmen/e-mission_-_year_report_2015.pdf

4.3 Conclusion: Opportunities and limitations

The expert interviews provided further insight into the practical use of carbon calculators. The full interviews are much more extensive than they are summarised in the results of this chapter. The results summarised here reflect the most relevant findings for the thesis. For a deeper insight into the topic, it is recommended to read the interviews in the appendix in full length.

The discussions provided answers on how the calculators and the collected data are used by the hosts and how users apply the calculators. It was shown that hosts have different goals and motivations for using carbon calculators. This results in very different approaches and experiences of how the calculators are used depending on host and user. Many positive experiences and opportunities can be seen across the interviews. At the same time, a large number of improvement potentials, challenges and limitations are addressed.

The following table summarises the opportunities and limitations of carbon calculators as identified by the expert interviews and the content-based comparison.

	Opportunities of carbon calculators	Challenges and limits of carbon calculators
Calculators and hosts	GHG emissions from productions can be expressed in values. This allows to identify reduction potentials.	Carbon calculators only calculate GHG emissions and therefore do not show a comprehensive ecological footprint. Only the ecological dimension of sustainability is examined.
	In addition to mere carbon accounting, carbon calculators can also motivate sustainable measures through questions, tips or guidance.	Calculators do not generally provide tips and recommendations for sustainable measures.
		Current carbon calculators provide mere information on the resulting GHG emissions. However, they do not indicate how much GHG emissions have been saved through sustainable measures.
	Through obligation on the part of a fund or the client, the use of carbon calculators can be widely established and become a habit.	New users must be actively recruited for the use of carbon calculators.
		There is currently no standardisation of carbon calculators for film and television productions.
		Country-specific calculators can only be used in the respective country. Carbon calculators must be adapted for each country due to varying emission factors.
		There is currently a lack of cross-country calculators. Especially necessary for international co-productions.
Users and application	A pre-balancing can help in planning a production. Reduction potentials can be identified and measures can be taken.	Pre-balancing is based on rough estimates and not on real data.
		Carbon accounting involves a resource and time input. Lack of automation.
	Carbon calculators can raise awareness and motivate users to take sustainable measures.	Usually calculators are only used and filled in by one or two people. The sensitisation of the whole team and of non-users cannot be supported by calculators.
		Calculated results are often difficult for users to understand without assistance. Results must be communicated and displayed within the calculator in a meaningful and understandable way to ensure the independent understanding of the user.
		Project managers who are responsible for financial decisions are usually not involved in the use of the calculator. Sensitisation of project managers is therefore more difficult.
		The correct and complete filling out of the calculator lies in the responsibility of the user. If the user is not familiar with the application, it may result in missing data or inaccurate information.
		Users may not be aware of consumption in units such as: km, kWh, l. This has implications for the quality of data entry and user-friendliness.
Usage of collected data	Comparisons can be made between productions, production companies, etc.	Comparisons are complicated by the fact that productions are extremely heterogeneous. In addition, emission factors vary between regions and countries, which makes cross-country comparisons difficult.
	A data situation can be created. This may cover a production company or a regional/national/international industry.	
	A carbon accounting can be a formal proof of sustainable production, e.g. in connection with a grant.	
	Calculators would become important tools for managing the carbon footprint if carbon budgets were imposed.	
	Data from accounted productions can be further used for the CCF of a production company.	
	Data collection can help to raise awareness within a production, a company or a regional industry through hard facts and help to implement measures and sustainability strategies.	

Table 7: Opportunities and limitations of carbon calculators for film and television productions

5 Current developments

5.1 Country-specific calculators

With the first emergence from the beginning of the 2010s, carbon calculators for film and television productions are still a recent development. The presented thesis shows a current state of constant change. The interviewees state that the calculators examined have been optimised in their methodology and design over the years and are still further evolving. Besides the improvement of already existing calculators, new calculators are currently being developed. Both country-specific and cross-country carbon calculators are being developed. The five calculators examined in this thesis are specifically designed for the respective country of origin and are therefore country-specific.

Helsing and Wu (2018) show in their case study *Green Film Criteria for the Southern Swedish Context: A case study of sustainable film production and carbon footprinting* that a country-specific calculator cannot be adapted for another country without problems. In their study, they carry out the carbon accounting of a Swedish film production using the US-american PEAR and the British Albert. The authors also carry out their own calculation of GHG emissions. Clear differences can be seen between the results of the three different calculations. Helsing and Wu also point out several shortcomings in the design of the calculators, which are insufficient for the Swedish context (ibid., p. 9f). In their conclusion, Helsing and Wu therefore call for a calculator specifically adapted for Sweden (ibid., p. 13). The study shows that the adaptation of a carbon calculator for a specific country or region is necessary to produce a qualified and appropriate CO2 balance.

The *Cine-Regio: Green Report 2017* mentions a development of a new carbon calculator under the direction of the Italian film commission *Sardegna Film Commission Foundation*[77].

In addition, a country-specific carbon calculator is currently being developed in Austria. In the country directly neighbouring Germany, the *Lower Austrian Film Commission* is working together with *KlimAktiv* on a carbon calculator especially for Austrian film and television productions[78].

KlimAktiv was already involved in the development of the German MFG calculator. This raises the

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[77] Appelgren, C. (Hrsg.). (2017). *Cine-Regio: Green Report 2017: On sustainability in the european regions*. Cine-Regio. p. 17

[78] LAFC. (n.d.). *LAFC - CO2-Rechner.* Lower Austrian Film Commission. Retrieved 5 August 2020, from https://www.lafc.at/greenguide/tools.php?ggid=1&aid=23&cp=0

question of whether the MFG calculator could not be used directly for productions in neighbouring Austria.

Co-developer of the MFG calculator and managing director of KlimAktiv Schunkert mentions the difficulty that emission factors vary from country to country (pers. commun, 7 May 2020, l. 89ff). A concrete example is the difference in emission factors for a train journey. In Germany, the average emission per person-kilometre of rail travel is 32 grams of CO2e[79]. In Austria the value is 5 grams of CO2e[80]. Significant differences can also be seen in energy factors based on the different electricity mixes of the countries (cf. chapter 3.3.1). Therefore, if German emission factors are used for the balance in Austria, there may be significant differences between the calculated results and the actual GHG emissions. Helsing and Wu (2018) as well as Schnetzer (2016) show different calculation results when the same data are entered into different carbon calculators. These differences between the calculators can be explained, among other aspects, by emission factors that vary from country to country.

5.2 Standardisation and cross-country calculators

As the content-based comparison in chapter 3 shows, the currently existing carbon calculators are structured very differently. The system boundaries of each calculator are set differently and the depth of input options varies greatly between the calculators. Chapter 2.2 also showed that the methodology and emission factors of the respective calculators are based on different reference sources. Thus it can be clearly seen that there is still a lack of standardisation of carbon calculators for film and television productions.

A standardisation can be facilitated by establishing and using a uniform methodology across-country. The development of industry-wide standardisation is one of the reasons for the development of cross-country carbon calculators. At the same time, cross-country calculators have other advantages. About 20% of all productions in Europe are international co-productions (Cabrera Blázquez et al., 2018). Heidsiek therefore calls for a carbon calculator that can be used for interna-

[79] Umweltbundesamt. (2020, Juli 13). *Emissionsdaten*. (2020, Juli 13). Retrieved 5 August 2020, from https://www.umweltbundesamt.de/themen/verkehr-laerm/emissionsdaten

[80] Umweltbundesamt. (2020, Mai). *Emissionsfaktoren für Verkehrsmittel.* Retrieved 5 August 2020, from https://www.umweltbundesamt.at/fileadmin/site/themen/mobilitaet/daten/ekz_pkm_tkm_verkehrsmittel.pdf

tional co-productions[81]. She also states that in addition to standardised carbon accounting, a cross-country calculator can also enable constructive comparisons between productions from different production countries.

According to the interviewees, the PEAR and Albert calculators have established themselves as industry standards in the USA and Great Britain respectively. The advantage of using the same calculator regardless of the studio or broadcaster is mentioned as being that the use of the calculators for productions has become a habit[82]. In the case of co-productions, on the other hand, the problem today is often that different countries use different calculators or even do not currently have a country-specific calculator. However, if each production or co-production can use the same calculator for all countries, this could establish an industry-wide use and habit of carbon calculators at international level.

Finally, a cross-country calculator can also provide a factual basis. With an internationally uniform data situation, evidence-based sustainable measures can be taken at European or international level.

As previously analysed, the emission factors that vary from country to country pose a particular challenge (see chapter 5.1). These must be incorporated into the methodology of cross-country calculators without making their use more complex (cf. S. Schunkert, pers. commun, 7 May 2020, l. 116ff).

In the following two current developments of cross-country calculators are examined.

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81 Appelgren, C. (Hrsg.). (2020). *Cine-Regio: Green Report 2020: On sustainability in the european regions.* Cine-Regio. https://www.cineregio.org/dyn/files/pdf_download/11-file/CineRegio_GreenReport2020_25022020_SinglePages.pdf, p. 37

82 Vgl. R. Canela-Mas, pers. commun, 19. Juni 2020, l. 71ff; A. Vinant-Tang & V. Dubeau, pers. commun, 2. Juni 2020, l. 11ff

5.2.1 International Albert calculator

The *albert* project led by BAFTA is currently working on an international carbon calculator[83]. The cross-country calculator is intended to give film and television productions worldwide the possibility of carbon accounting. It should also help media companies to balance their overall carbon footprint. This includes all international productions, which so far cannot be calculated with the Albert specified for UK use. The British media company *Fremantle* is aiming for such carbon accounting of its entire programme, which is produced over numerous international territories. (R. Canela-Mas, pers. commun, 19 June 2020, l. 37ff). This goal has been one of the impulses for the development of the global Albert calculator as a partnership between *albert* and *Fremantle* (ibid., l. 35ff).

According to Canela-Mas, the new cross-country calculator should replace the current country-specific calculator (pers. commun, 19 June 2020, l. 41f). The new calculator should make carbon accounting easier for co-productions and allow users from different companies to work on a single carbon footprint (ibid., l. 392ff). Canela-Mas states that the new calculator is intended to place a special focus on reporting in addition to CO2 calculation and certification (ibid., l. 42ff + 50ff). Especially for companies that want to measure and publish their CCF, a qualified reporting of the GHG emissions of their production is essential (ibid.).
According to information from *albert*'s website, the calculator should be available at the beginning of 2021[84].

5.2.2 European Environmental Calculator – Eureca

A further current development of a cross-country calculator is the *European Environmental Calculator* (*Eureca*), which is designed for Europe-wide use[85]. The development of the calculator is based on the results of the *Interreg Europe* funded *Green Screen* project (see appendix D: Annex A). The *Green Screen* project is a collaboration of eight partners from the EU audiovisual industry with the aim of reducing the carbon footprint of European film and TV productions[86]. Within the *Green*

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83 Albert. (2020, Januar 24). *A Global Carbon Calculator is coming!* Retrieved 8 August 2020, from https://wearealbert.org/2020/01/24/a-global-carbon-calculator-is-coming/

84 Ibid. (67)

85 Vlaams Audiovisueel Fonds. (n.d.). *Green Screen – Regional Action Plan Flanders Audiovisual Fund*. Retrieved 8 August 2020, from https://www.interregeurope.eu/fileadmin/user_upload/tx_tevprojects/library/file_1592226440.pdf

86 Interreg Europe. (n.d.). *Green Screen.* Retrieved 8 August 2020, from

Screen project, the project members analysed existing carbon calculators[87]. Based on their findings that existing calculators have strong potential for improvement and are exclusively country-specific, the development of *Eureca* was initiated[88]. The project is also funded by *Interreg Europe* and is a collaboration between three partners of the Green Screen project: *Promálaga*, *Slovak Film Commission* and *Vlaams Audiovisueel Fonds* (VAF)[89].

An information sheet received through personal communication with Tim Wagendorp (VAF) lists the objectives of *Eureca* (see appendix D: Annex A). The *Eureca* calculator is supposed to:

- not only focus on the evaluation and reporting of GHG emissions, but should also help productions to take sustainable measures, especially during the planning stage.
- be uniform and consistent at EU level and use reliable, scientifically based emission factors.
- facilitate the collection of data from different productions at regional level. It should thus help regional institutions or funding bodies to decide on measures and sustainability strategies[90].
- be user-friendly and cost-effective for users.

The calculator is also intended to promote the standardisation of carbon accounting for film and TV productions in Europe[91]. According to the information sheet, *Eureca* will be made available in 2021 (see appendix D: Annex A).

https://www.interregeurope.eu/index.php?id=1552

87 Vlaams Audiovisueel Fonds. (n.d.). *Green Screen – Regional Action Plan Flanders Audiovisual Fund*. Retrieved 8 August 2020, from https://www.interregeurope.eu/fileadmin/user_upload/tx_tevprojects/library/file_1592226440.pdf

88 Ibid.

89 Ibid.

90 Ibid.

91 Ibid.

6 Findings, recommendations and conclusion

6.1 Issue

Opportunities and potentials, limitations and challenges were identified in this work. When examining the five carbon calculators and the current developments of new calculators, one issue can clearly be identified: a lack of consistency and cooperation.

Today, the international film and television industry has a large number of different carbon calculators, which results in a lack of a basis for cooperation and comparison. Each country develops its own sustainability strategies and its own country-specific carbon calculator. Currently, two developments towards cross-country calculators can be observed. However, the two calculators Albert and Eureca are being worked on independently of each other, although the same goal is being pursued. In the very extensive report *Green matters: Environmental sustainability and film production: an overview of current practice* (2020) by the *British Film Institute* (BFI) and *Bigger Picture Research*, Barrat repeatedly criticises the lack of international cooperation on sustainability and work on carbon calculators. A lack of exchange and cooperation can also be seen in the discussions with the interview experts. Since holistic sustainability and the challenges of climate change are not regional problems, but are the responsibility of society as a whole, regional, national and international cooperation is indispensable.

6.2 Limitations and challenges

A summary look will be taken at the limitations and challenges of carbon calculators. Table 7 of chapter *4.3 Conclusion: Opportunities and limitations* already provided a comprehensive insight into the limitations of carbon calculators.

One of the most significant difficulties is the lack of standardisation. This is linked to the challenge of varying emission factors. Through cooperation between different hosts and industry members, it is possible to work together on this issue in order to create an industry-wide basis more quickly, without which it is not possible to achieve and monitor common changes.

Another challenge is the use of pre- and post-balancing. Balancing with real data is only possible after the production. At the end of production, however, it is usually too late to use the

results and values for targeted measures. Pre-balancing can help to identify reduction potentials before production starts. However, the pre-balancing is based on fictional data and thus remains a very rough estimate.

The unit CO2 is still a very abstract indication for users today. To understand values and results, the user needs support. Personal communication can be the most constructive way of doing this. However, with an increasing number of users this cannot be ensured. Therefore, the display of the results within the calculators must be developed to such an extent that the user can understand them independently and learn from them.

A clear limit of carbon calculators is the absolute concentration on the GHG impact of a production. By mere accounting of GHG emissions, carbon calculators examine only a fraction of the carbon footprint. Furthermore, only the ecological dimension of sustainability can be evaluated and controlled.
It should also be noted that a low CO2 activity is not directly sustainable. Relevant for media productions is to be examined as an example the generation of electricity by different energy sources. The low CO2 production of electricity is not fundamentally more environmentally friendly. For example, electricity generation by nuclear power plants is significantly lower in CO2 emissions compared to other energy sources, but at the same time a considerable amount of nuclear waste is produced1. However, this is not taken into account in mere carbon accounting. As the hosts repeatedly stated in the expert interviews, a carbon calculator cannot be the only tool for sustainable development in film and TV productions.

As GHG emissions are a significant part of the environmental impact of productions, carbon calculators remain nevertheless an important tool on the road to sustainable film and TV productions.

6.3 Possibilities, potentials and recommendations

The examination of the five calculators also reveals a potential and many possibilities to push forward the sustainable development of film and television productions. Based on the findings of the previous chapters and the research and intensive examination of the various hosts and calculators, recommendations are to be made which could support sustainable productions with regard to carbon calculators. The following recommendations are intended as possible guidance for the improvement or conception of carbon calculators.

At the beginning, for each calculator, the following questions need to be asked: what are the objectives of using carbon calculators? Is the focus on mere balancing and data collection, raising user awareness or monitoring sustainable measures? Depending on the objective, a calculator can also be set up differently. Two counterweights in particular must be taken into account. Every carbon calculator is a *balance between time and accuracy*. The more accurate the balance is to be, the more data has to be queried, which requires more time. Every use of carbon calculators is also a *balance between carbon accounting and actual implementation of measures*. A simple carbon accounting does not promote sustainable development. Measures must be taken to achieve this. However, calculators can be used to support the implementation of measures.

Offer of carbon calculators
Accounting as a requirement: e.g. by linking it to funding criteria. Active recruitment to attract new users is essential.
Education: offers for students. Offering the calculators for student productions, offering seminars. Integrate calculators early in education. In this way, their use can become a matter of course for future generations.
Low-cost or free offer: to reach as many users as possible.
Establish a habit: a universal calculator that is used throughout the industry. This means that crew members can always use the same calculator regardless of the production.

Table 8: Recommendations for the offer of carbon calculators

On Table 8: The primary aim of offering carbon calculators is to establish their widespread use. In addition, the establishment of carbon calculators as a matter of course and habit should be a goal. The calculators should not only become a standard in the industry, but also be introduced in education.

Structure of the carbon calculators
Standardisation: calculators should be universal, standardised and cross-country. Encourages use in co-productions and promotes international cooperation for sustainability.
Online Software: web-based, accessible to everyone online without downloaded software. Therefore not locally bound and error-prone like an Excel spreadsheet.
Scientific and up-to-date: calculator should use scientific, standardised factors and be updated regularly. Results and values are therefore scientifically reliable.
Exact data retrieval: see chapter *3 Content-based comparison of the calculators*. An exact data retrieval will give a precise result.
Reduction to the essential: reduction of the query, automation of the balancing. Goal: Reduce time expenditure.
Display avoidance: calculators currently only show the emission output - the always negative CO2 footprint. Another measure that could be displayed is the avoided GHG emissions. Keyword: CO2 handprint[92].
User-friendliness: see chapter *3 Content-based comparison of calculators*. Ensure the independence of the users. Support can be reduced.
Value for users: understandable and sensitising for users, should encourage them to take sustainable measures. Users should also learn from a comprehensible display of the results in a sustainable way.
Value for hosts: good reporting, automated data collection, transparent display of the results. Making data usable for hosts to implement measures and strategies.

Table 9: Recommendations for the structure of carbon calculators

[92] The CO2 handprint is understood to be the avoided amount of GHG emissions. For example, when using an e-vehicle instead of a petrol or diesel vehicle (cf. S. Schunkert, pers. commun, 7 May 2020, l. 195ff)

On Table 9: The aim of setting up carbon calculators is to make them easy to use and valuable for users and hosts alike. To this end, calculators should be standardised, cross-country, online accessible to all and user-friendly. In particular, the balance between accuracy and time expenditure should be discussed. Thus, for the balancing, a reduction to the essentials must also be strived for. Not every activity that can be measured contributes to a considerable extent and is not necessarily relevant for comprehensive balancing.

Hosts, i.e. broadcasters, studios or funding bodies, should benefit from the calculators as much as the users themselves. Since hosts are usually the leading initiators of sustainable strategies and measures, the carbon calculators should help hosts to establish a factual basis.

Usage and users
Division of responsibilities: see chapter *4.2.5 Users and target group*. Responsibility for the balancing lies with project managers. Responsibility of completion lies with another position.
Involvement of financially responsible persons: project managers should be involved in carbon accounting through co-responsibility.
Presence of the person collecting the data: position responsible for collecting data and filling in the calculator should be present throughout the production period to be balanced.
Involve the entire crew: due to low participation in data collection, the carbon calculator can also become a motivational tool (see chapter *4.2.5 Users and target group*)
Help with planning: checklist or questionnaire bound or separate to calculator should help to take sustainable measures before the start of production. Pre-balancing can also be helpful. However, this remains a rough estimate and is time consuming. But through automation or connection to budget calculation, time can be reduced.
Communication cannot be replaced: communication is more important than theoretical accounting. Especially also the personal communication of the results.
Ensure independence: personal communication cannot be provided if the number of users/productions increases. Independence must be achieved.

Table 10: Recommendations on the use and users of carbon calculators

On Table 10: With regard to users, the question of who uses the calculator and who is responsible for the balancing must be examined. The responsibility and use can be distributed to several positions or by involving the whole team the calculator can become a motivational tool.
For a sustainable production, a single balancing in the end may not be sufficient. Especially in the planning phase, users must be supported in taking sustainable measures. This can be done directly in the calculator or in a separate tool, such as a checklist.
It is undisputed that personal communication is the most important method on the road to sustainable film and television productions. Nevertheless, independence must be ensured, especially in the display of the values and results.

6.4 Conclusion

Carbon calculators for film and television productions face limits and challenges. At the same time, however, they also offer many opportunities to further pave the way for sustainable development. The efficient possibilities can be found in different parts of each calculator and complement each other when examined as a whole. Thus, the hosts of the different carbon calculators can learn from each other and make progress through an exchange. In fact, however, there is a lack of fruitful exchange and open cooperation within the industry at both national and international level. Issues such as political relations, the quest for image improvement, competition or economic growth continue to be major obstacles that slow down the path to sustainable film and television productions. However, sustainability and climate change demand responsibility for society as a whole and must therefore not be subordinated to economic competition and growth.

In the course of the research and the expert interviews, the topic of artistic freedom came up repeatedly. It was repeatedly stated that artistic freedom may not be restricted by sustainable measures. Thus, if a screenwriter demands New Zealand as a location and several hundred extras, this should not be restricted by ecological issues. In the current situation of the COVID 19 crisis, however, the film and television industry has adapted rapidly to the crisis, including - by necessity - artistic freedom. Locations remain regional, actors are reduced and kept at a distance. If we now examine the far more serious crisis of climate change, there should be no taboo on restricting artistic freedom either. Scriptwriters should not be curtailed in their creative power. Rather, their creativity should be challenged to write and act sustainably already in the script. In order to make progress in

sustainable development, it is not enough to examine the effects with carbon accounting at the end of production. The question of sustainability must also be asked at the beginning, when writing the script, in order to prevent impacts directly.

Today, the use of carbon calculators always raises the question of purpose. Only when the question can be answered what purpose the use of a carbon calculator fulfils can its use also be of value. After all, hotspots and reduction potentials are already known. For almost a decade, several hosts of carbon calculators have been balancing a large number of productions and have extensive data collections. However, here again there is a lack of constructive exchange and extensive communication of the results. Exact statistics from the individual hosts are sparse and can only be found through in-depth research.
Nevertheless, it is clear that mobility and power consumption on the set and in the office are the biggest GHG hotspots. Material usage or catering, on the other hand, have very little effect on the extent of the carbon footprint. Nevertheless, the examination of material and catering, for example, is not irrelevant for sustainable development. On the other hand, it looks much more at waste, health or fair food production, which represent important sustainability issues. In a carbon accounting, however, these issues cannot be captured.

Thus the question of the *balance between time and accuracy* arises again. Carbon accounting can only put a value on one aspect of sustainable development: the environmental impact of GHG emissions. When calculating the carbon footprint, a reduction to the essential can can save time without reducing the value of carbon accounting. In turn, the time gained can shift the focus of the *balance between carbon accounting and actual implementation of measures*. A carbon calculator itself does not reduce GHG emissions. A carbon accounting itself does not make productions more sustainable. Only taken measures can make this possible. These can in turn be driven by carbon calculators.

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Particularly mentionable literature or sources that are recommended for further interest are **highlighted in bold**.

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Appendix

The supplementary material can be requested directly from the author:
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Content

Acknowledgements

My family, my friends, mes amis ! My first thanks go to you. Many thanks to my supervisors: Ms. Heidsiek, who did not know me and nevertheless immediately agreed to support me. Mr. Michalski, not only for the support during my thesis, but also for the support throughout my studies. A big thank you to my interview partners, who not only nourished me with information, but with whom I was always able to have friendly and respectful conversations: Ms Dehmelt, Mr Schunkert, Mr Wagendorp, Ms Vinant-Tang, Ms Dubeau, Ms Canela-Mas. Thanks to all my professors, lecturers and the staff at the Hochschule der Medien for the support and the unforgettable studies. Thanks to all my fellow students who made my studies so unforgettable.

This thesis was researched and written in :

Rue Donissan, Bordeaux
Bibliothèque Universitaire des Sciences de l'Homme, Bordeaux
Talstraße, Filderstadt
Hochschule der Medien, Stuttgart-Vaihingen
TGV: Stuttgart – Paris – Bordeaux
Rue Henri IV, Bordeaux
Université Bordeaux Montaigne, Pessac
Dresdner Straße, Filderstadt
Starbucks – Königsbau Passagen, Stuttgart
Holzapfel – Calwer Straße, Stuttgart