Sustainable Game Development

Mapping the climate impact and the negative impact reduction actions in the Swedish gaming industry

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Abstract

The purpose of this study is to map the current state of the Swedish gaming industry with regards to its climate impact and negative impact reduction actions. With the organization and the game development pipeline in focus this study set out to explore how game development activities have an impact on the climate, where the industry is focusing its actions to reduce this impact, and how the issue is perceived and handled by industry practitioners.

Game development and the gaming industry in general is not commonly recognized for its climate impact because of it being digital in nature. As gaming is becoming more accessible, game devices more powerful, and the world more reliant on data centers and networks, the climate impact of digital products and services must be acknowledged. To understand the full scope of the impact of the gaming industry, it is imperative to identify that there is a problem and to what extent. To do so, there is a need to know where the industry's climate footprints lie and how to calculate them. Then, strategic actions to reduce the climate impact from the Swedish gaming industry can be taken.

This study presents a framework that outlines the product life cycle of a game and its relation to the organization's greenhouse gas emissions. The framework presented in the study can help researchers and practitioners identify where emissions occur and simplify the calculations of their climate footprint. Furthermore, reports and guides presented by some of the active climate initiatives were interpreted and analyzed in relation to the framework to map what emissions the reduction actions are targeting. To understand the Swedish aspect, and the organizational aspect, primary data was collected from sustainability reports published by Swedish gaming companies. These reports were used to identify how they are conducting their climate work, what their climate footprint is, and what actions they are taking to reduce their negative impact. Finally interviews with practitioners in the Swedish gaming industry were conducted to understand how climate change and climate actions affect their day-to-day activities. By triangulating the data collected from initiatives, sustainability reports and interviews, the intersection between initiatives and the industry was identified. The findings in this triangulation in combination with previous research and the presented framework can then be used to map the current state of the Swedish gaming industry with regards to its climate impact and its negative impact reduction action.

Populärvetenskaplig Sammanfattning

Världen idag har ett ökat beroende av energi för att fungera och tendensen vi ser är att behovet ökar i en högre grad än vad förnyelsebara energikällor kan komplettera. Det ställer krav på dagens industrier att öka sin energieffektivitet och reducera klimatpåverkan. En bidragande faktor till det ökade behovet ligger i att samhället blivit mer och mer beroende av digitala produkter. Exempelvis har digital underhållning blivit mer åtkomligt och således tagit en större plats i våra dagliga liv. Datorspelsindustrin har sett en stor ökning av både spelare och utvecklare som följd av den ökade åtkomligheten och idag är det uppskattat att omkring en tredjedel av världens befolkning spelar datorspel. Tre fjärdedelar av dessa uppskattas ha spelat ett spel som är skapat i Sverige, vilket sätter i kontext den globala inverkan ett land i denna industri kan ha i det digitala rummet.

På senare år har klimatpåverkan av digitala produkter börjat belysas och även så i datorspelsindustrin. Sedan 2019 har flertalet initiativ med syftet att informera och vägleda spelutvecklare i klimatarbetet börjat ta form, men ämnet är fortfarande relativt outforskat i en akademisk kontext. Spelföretag och leverantörer av infrastrukturer är de som har störst potential att styra datorspelbranschens framtida klimatpåverkan. Det ligger således både i forskares och utövares intresse att utforska de komplexa frågor som uppstår i skärningspunkten mellan miljömässig hållbarhet och spelutveckling.

Syftet med den här studien var att kartlägga vilken klimatpåverkan datorspelsindustrin har, samt vilka åtgärder för att reducera klimatpåverkan som är implementerade idag. Med ett fokus på organisationen och spelutvecklingsprocessen utforskar denna studie var spelutveckling har en påverkan på klimatet, vilka åtgärder industrin fokuserar på för att reducera sin klimatpåverkan, samt hur klimatutmaningen uppfattas och hanteras av aktiva i industrin.

De resultat som har tagits fram är för det första ett ramverk som kartlägger produktlivscykeln för ett spel och hur organisationens växthusgasutsläpp står sig i relation till denna. Ett spels produktlivscykel innefattar de sex stadier som ett spel genomgår från början till slut, vilka är: val av mjukvara och visuella verktyg; design och utveckling; uppladdning till internet; nedladdning från internet; användarinteraktion; samt borttagning av data från klienten. Ramverket kan hjälpa forskare och aktiva inom industrin att enkelt identifiera var i produktionsprocessen utsläppen sker, och således underlätta beräkningar av utsläppen samt identifieringen av åtgärder för att reducera utsläppen.

Vidare har pågående klimatinitiativ i industrin undersökts i förhållande till ramverket för att kartlägga vilka föreslagna åtgärder som finns och vilka utsläpp de avser att reducera. För att skapa en förståelse för hur de passar in i svenska kontexten, samt bilda en djupare förståelse för det organisatoriska perspektivet, har primärdata samlats från

hållbarhetsrapporter av svenska spelutvecklare. Rapporterna har använts för att identifiera vilket klimatavtryck de har och vilka åtgärder de har tagit för att reducera sitt klimatavtryck. För att komplimentera resultaten från rapporterna har även en intervjustudie genomförts i syfte ge arbetet ytterligare en dimension genom insamling av insikter i ämnet från industriaktiva.

Genom att analysera den insamlade informationen från initiativen, hållbarhetsrapporterna och intervjuerna går det att identifiera var åtgärder och verkan överlappar, samt var de skiljer sig åt. Om detta sedan sätts i relation till det framtagna ramverket är det möjligt kartlägga den nuvarande klimatpåverkan samt de föreslagna åtgärderna att reducera klimatpåverkan i förhållande till spelutvecklingsprocessen. Det visar sig att datorspel, likt andra digitala produkter, har störst påverkan på klimatet genom indirekta utsläpp. Där den största skillnaden från traditionella produkter är att klimatpåverkan är relativt liten i produktionen men att produkten ska distribueras och spelas vilket ackumulerar återkommande utsläpp kopplade elanvändningen av användarna.

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1. Introduction

The world is becoming ever increasingly more reliant on energy to function. After two years of decline in use, albeit correlated with the Covid-19 pandemic, the rise in electricity demand globally was estimated to grow by 5% in 2021 and another 4% in 2022 (IEA, 2021). While the share taken by renewable energy sources is growing at a high pace it is not covering the rise of energy demand which leads to the increased need for electricity generated by fossil fuels (ibid). Given this, industries need to keep increasing the energy efficiency of their practices to reduce dependencies on fossil energy.

A contributing factor to the increase is that society is becoming more digitally dependent. People carry around phones and tablets, and when they come home, they turn on their television, computer, or gaming console. In this shift, digital entertainment has become more accessible and gained a bigger presence in our daily lives. The gaming industry has seen a great influx of both players and developers, which can be attributed to the reduced barrier of entry (Marsden et al., 2020). In a report by Accenture (2021) the estimated number of people playing games amounted to roughly a third of the global population. And if we narrow our scope to the Swedish gaming scene, roughly a fourth of the world's population have played a game made in Sweden (Milton et al., 2021). This equates to about 75 percent of gamers having played a game developed in Sweden, which speaks much to the volume of the global impact any country can have in the digital space.

As the climate impact of digital products and games alike become more apparent, the shift in attitude by the practitioners follows. The gaming industry has in recent years seen a couple of climate initiatives take form, starting off with the announcement of UN's Playing for the Planet Alliance in 2019 (UNEP, 2019). Since then, more initiatives with the common goal of reducing the industry's climate footprint have started. Even though the shift is happening, research on the topic of climate change in the gaming industry, especially with focus on the game developers, has been under-researched (Gordon, 2020). Gaming companies and infrastructure providers have the most potential to steer the gaming industry's future climate impact, seeing as they are the gatekeepers of what is downloaded and played. It is in the best interest of researchers and practitioners alike to further research the complex questions that arise in the intersect of environmental sustainability and game development.

The purpose of this study is to map the current state of the Swedish gaming industry with regards to its climate impact and negative impact reducing actions. With the organization and the game development pipeline in focus this study set out to explore where game development activities have an impact on the climate, where the industry is focusing its actions to reduce this impact, and how the issue is perceived and handled by industry practitioners.

To fulfill this purpose, the following research questions will be addressed:

- How can we map the climate footprint of game development?
- What organizational activities have the largest climate impact?
- What are the suggested actions to reduce negative impact?
- What actions to reduce the climate footprint are currently in place by organizations?

2. Theoretical Background

In the following section the theoretical background for this study will be presented. Firstly, background information about the gaming industry and sustainability will be covered. Secondly, a theoretical framework will be constructed. Finally, previous research on the topic will be accounted for.

2.1 The Gaming Industry

The gaming industry consists of three central players. These are game engines, publishers and developers, and gaming devices (Cuofano, 2020). This study focuses on publishers and developers, but it is necessary to cover all players to understand the relation between them. Game engines are developed frameworks that function as a tool for the developers to create the games and are often used by independent creators. The most popular ones are Unity and Unreal Engine. Some developers are using already existing game engines to develop their games, others make their own (Cuofano, 2020). As for the game devices, developers create their products with the purpose of distributing them for play on these devices. Game engines can be understood as building blocks that developers use to make their products, and gaming devices are the limiters of how these blocks can be used (Cuofano, 2020). In the context of gaming there are three types of devices that uphold the largest player base: *personal computers (PCs), consoles*, and *mobile devices* (Cuofano, 2020).

PCs include both laptops and desktop computers and comes in a high variety with regards to performance and energy demand. Within the category of PCs there are units sold as *Gaming PCs* which are specially tuned for performance using fast *Computing Processing Units (CPUs)* and high-quality video from a state-of-the-art *Graphics Processing Units (GPUs)* (Cuofano, 2020). Because of the variety of components, and use, the power supply of desktop computers can range from 200W to 1800W, but most modern gaming systems stay within the range of 650W to 850W (Chacos & Chiappetta, 2021).

Consoles are devices built for the purpose of gaming, however in later years they have become more versatile in use allowing for video streaming and other non-gaming activities (Cuofano, 2020). Regarding gaming consoles, there are three giant players on the market, Sony with their PlayStation console, Microsoft with the Xbox, and Nintendo with the Nintendo Switch.

Mobile devices, which include phones and tablets, have become the most used devices for playing video games because of the low barrier of entry (Marsden et al., 2020). It has changed the way games are perceived.

Besides the three largest categories of gaming devices there are other forms of gaming emerging. *Virtual Reality (VR)* and *Augmented Reality (AR)* can be viewed as two sides of a coin where VR is technology used to create a simulated environment and the major

component is a *Head-Mounted Display (HMD)* which is used to stimulate the senses (Nguyen, 2022). AR on the other hand is focusing on game visuals and audio content within the user environment, which simply means that artificial things are displayed in a real-world environment (Nguyen, 2022). *Cloud gaming* is another emerging trend. The idea of cloud gaming is that you are streaming the game over the network which allows for the users to enjoy higher quality games without the need to invest in high end hardware (Marsden et al., 2020). This way the hardware components can be in a data center that handles the game rendering and sends back a video stream to the user (Roach & Parrish, 2021). Cloud gaming has increased in popularity in recent years because of the emergence of the infrastructure needed for it to function properly. Cloud networks from Microsoft, Google and Amazon have enabled cloud gaming platforms to expand rapidly through their global reach (Roach & Parrish, 2021).

2.1.1 The Swedish Gaming Industry

Swedish game companies are employing 6,596 people in Sweden and 7,177 people abroad; and the number of active companies in December 2020 was 667 (Milton et al., 2022). In Figure 1 the distribution, by size, of 659 out of the 667 companies is depicted. Game development is seen as a growth industry in Sweden as only 14 of the companies in practice today have been present since the 1990s. Another number that puts this growth into context is that over half of the active companies were registered in the last five years (Milton et al., 2022). Game development companies in Sweden have a broad profile and the games they create cover all platforms and genres (Milton et al., 2022).
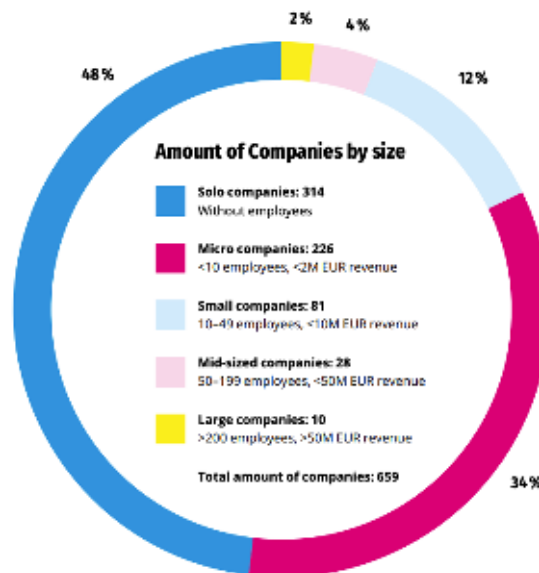

Figure 1. Distribution and number of companies by size in Sweden (Milton et al., 2022).

2.2 Game Development Pipeline

With a high variety of game genres, business models and devices, it is not surprising that the game development process is not a one size fits all. The details of the different stages vary depending on the project at hand, the size of the studio and the specifics of the game. It therefore follows that the process varies depending on who you ask but it is commonly divided into three main stages: *Pre-production*, *production*, and *post-production* (Perforce Software, 2022). Other sources claim the process to develop a game consist of anywhere from three to seven stages, but the main stages are somewhat outlined in all of them (Innovecs, 2020; Pickell, 2019; Stefyn, 2019; Mozolevskaya, 2021; Chandler, 2014; Dunlop, 2014). In this study I have worked from the definition and outline of the game development pipeline as presented by Stefyn (2019). Other sources have been used to complement the stage descriptions. The pipeline is essential to manage timeline and budget as well as to reduce inefficiencies and bottlenecks. Although the pipelines vary between projects, the process similar for different genres (Stefyn, 2019).

2.2.1 Pre-production

The first stage of the game development pipeline is pre-production (Stefyn, 2019). Pre-production is where the game concept is established, and the development and design requirements are set (Perforce Software, 2022). The first step of pre-production is to create a plan covering the resources it will take to complete the game. In the planning stage you strive to answer questions such as: "What are we building? What is our budget? Who is our audience? Which platform will it be on?" (Pickell, 2019). Answering these questions is the first step of creating your *Game Design Document (GDD),* which is a living document that exists to ensure that the vision for the project is not lost (Stefyn, 2019). Some key components included in the GDD are the: game concept, core game mechanics, artwork and world design, and the monetization strategy. The GDD is continuously updated and refined throughout the development process, and it exists to keep you organized. In the concluding stages of the pre-production, the prototypes are built, and the gameplay concept tested (Dunlop, 2014; Chandler, 2014). The purpose of a video-game prototype is to test functionality, user experience and gameplay (Stefyn, 2019). Prototyping is a way to test if the game idea will work and if it is worth committing to. It is common that ideas do not make it past this stage.

2.2.2 Production

Production is where most of the game development and design occur and it is the longest stage of the game development pipeline (Perforce Software, 2022; Stefyn, 2019). In production all the essential roles in game development work together to complete the milestones and requirements set in the pre-production to build the game (Perforce Software, 2022). Throughout the production stage the game is continuously tested as a quality assurance (Mogilevskaya, 2021). These tests are carried out to find

bugs and error areas, as well as figuring out if users find the game and its mechanics fun, too easy, or too hard (Innovecs, 2020; Pickell, 2019).

In the later stages of the production process developers enter what Pickell (2019) and Mozolevskaya (2021) refers to as the pre-launch stage. Pre-launch include the marketing campaigns that seek to notify the targeted audience that a game project is being launched (Mozolevskaya 2021). Depending on the size of the studio and game, the scale of advertisement for a game might differ. The same goes for the marketing activities which can span from commercials with gameplay, articles, screenshots, and appearances at game conferences (Mozolevskaya 2021). Alpha and Beta releases are also associated with the pre-launch, which is the first time the game is put in the hands of players (Pickell, 2019).

Once the game reaches what the industry calls the gold master, it is ready to be launched (Stefyn, 2019). Launching a game means that it is delivered to game stores for users to buy or download for free, depending on the platform and the monetization strategy (Mozolevskaya, 2021).

2.2.3 Post-production

The last stage of the game development pipeline is the post-production. This stage starts once the game has been launched (Stefyn, 2019). It is described as the maintenance phase of the pipeline and it is in this stage where the team, or a section of the team, work with bug-fixing, patching of the game, in-game events, or creating bonus content (Perforce Software, 2022; Mozolevskaya, 2021; Innovecs, 2020; Pickell, 2019; Stefyn, 2019). There are some genres of games that are never final in the traditional sense (Dunlop, 2014). Instead, they keep getting updated and expanded so that the development of new content to existing games starts to look like production pipelines of their own.

2.3 Sustainability

Regarding sustainability there are three categories that need to be highlighted, *economic, social,* and *environmental* (Hicks-Webster & Lahneman, 2022). For this study *environmental sustainability* in business will be in focus, and as Lahneman and Hicks-Webster (2022) puts it: "All businesses, regardless of their industry, rely on natural resources to make products and provide services; produce waste, including carbon dioxide (CO2); and experience climate change and associated weather changes". In the space of digital products and services the term *digital sustainability* is often used (Wut et al., 2021; George et al., 2020; Bradley, 2007).

George et al. (2020, p. 1000) defines digital sustainability as "the organizational activities that seek to advance the sustainable development goals through creative deployment of technologies that create, use, transmit, or source electronic data". A narrower definition is given by Wut et al. (2021, p. 3), who describes digital

sustainability as "the sustainable use of digital resources". An early and well recognized definition of the term was given by Bradley (2007, p. 151) who describe the term as:

> Digital sustainability, it is demonstrated, provides the context for digital preservation by considering the overall life cycle, technical, and socio-technical issues associated with the creation and management of the digital item.

The definitions do vary but they have an important role in different aspects of this study. In the definition given by George et al. (2020) the organizational activities are in focus and targets the creative deployment of technologies to advance the sustainable development goal. Furthermore, the definition by Bradley (2007) has the life cycle in focus and in the context of this study the game development pipeline and ensures that the technical, and sociotechnical issues of creating a digital item, that is the game, is considered throughout the pipeline. Whereas the definition given by Wut et al. (2021) then considers the use stage of any digital sources, those needed by developers to create the game, and the game once it is in the hands of the player.

2.3.1 Life-cycle Assessment

A way for organizations to increase their environmental awareness is to examine their products or processes with a *Life-cycle assessment (LCA)*. LCA is a technique used to assess the environmental impact of all stages of a product's life, from cradle-to-grave (Muralikrishna & Manickam, 2017). LCA can also be applied in software engineering to determine the environmental impact of a software development process (Galster, 2010). When applied to the software development process, and digital products and services in general, it is called *Virtual LCA* (Frick, 2016, ch. 1). Virtual LCA was first coined by Dr. Pete Markiewicz (ibid). The components of regular LCA and its digital counterparts are listed in Table 1.

Table 1. Dr. Pete Markiewicz comparison between standard LCA components to their digital counterparts (Frick 2016, ch. 1).

LCA	Virtual LCA
Materials	Software and visual assets
Manufacturing	Design and development
Packaging	Uploaded to the internet
Distribution	Downloaded through the network
Usage	Interaction, user experience, completing tasks
Disposal	Data erased from client

Dr. Markiewicz is using the comparison to set sustainable web design in contrast to print design. In Frick (2016, ch. 1) he is quoted saying:

Compared to the physical world, sustainable web design will de-emphasise the manufacturing (read production) stage, making it qualitatively different from print design. Why? Unlike physical products, web pages don't produce waste paper or ink after the page disappears, only heat from the electronics. For this reason, the cost of web page manufacture will be small compared to the cost of ongoing use. On the other hand, the longer a web page is viewed, the more bits it burns, so efficient use based on good user experience will be very important.

Software and visual assets: This section include the visual assets and software needed to build digital products (Frick, 2016 ch. 1). In this area it is about understanding the tools that are used in production, if they are cloud-based services that run on servers powered by renewable energy or if programs are loaded with features rarely used. But other aspects also factor in like the energy efficiency of inhouse equipment and the energy source that power the offices. Outdated hardware can impact performance, stability, and security, which means they might need replacing. When replacing hardware, it is important that the components are recycled wherever possible.

Design and development: In this stage of product development, it is possible to make efficiency gains and energy savings (Frick, 2016, ch. 1). By using progressive enhancement, it is possible to allow basic content for everyone and with feature layering allowing more enhanced features for users with capabilities to handle it. An example is to ensure that images, scripts, and other assets are compressed for fastest possible delivery.

Server uploads, network downloads: Digital products and services do not require packaging or cargo ships to get them to the users, however energy is still required to get them to their virtual destination (Frick, 2016 ch. 1). In modernized countries it is estimated that 6-9 percent of electricity used is lost in transmission and distribution. Developers can both create applications that are more efficient, and use computers powered by renewable energy to reduce the problem. It is important to understand how much energy is lost in transmission and how much is used in infrastructure, bandwidth, and front-end use.

Interaction and user experience: As stated in the quote by Dr. Markiewicz, interaction is the biggest difference between digital products and services and their physical counterparts (Frick 2016, ch. 1). To understand the impact of interaction it is good to know how much traffic there is and if the traffic comes from computers or mobile devices. As traffic from different devices varies it is important to understand how much energy different devices use. Furthermore, the data uploaded and downloaded per unit of time, as well as the average time using the product needs to be understood and factored in.

Disposal of data: With virtual products recycling is not an issue. However, digital products still need to be recycled in a sense, that is either by updating or discarding

them (Frick, 2016, ch. 1). In comparison to the use and interaction of digital products the disposal of data is minimal, but power is still used to delete applications and documents. It is common that digital products and services are built on a foundation of obsolete code and outdated systems, with a mindset that if it works there is no need to fix it. Outdated code can lead to security and performance issues, as well as wastes energy and puts data at risk. It is therefore necessary to ensure that applications are updated, and the code lean. Another thing to factor in is how to provide the users with new features in an efficient manner, how to use tools to improve code quality, and how management strategies can improve bug detection.

2.3.2 Greenhouse Gas Protocol

The Greenhouse Gas Protocol (GHG-protocol) is a way for organizations to calculate and account for their climate impact (GHG protocol, 2022a). The idea behind the protocol is to define the types of emissions that the company is emitting in terms of direct and indirect. The protocol consists of three scopes, and they constitute the following:

Scope 1 emissions are the companies' direct emissions. These include sources that are owned or controlled by the company. This could include company vehicles, in house production and company facilities (GHG Protocol, 2022b).

Scope 2 covers the indirect emissions from the generation of purchased electricity, heating, or cooling, that is used by owned or controlled equipment (GHG Protocol, 2022b).

Scope 3 is an optional reporting category that covers other indirect emissions that occur because of company activities. However, they occur from sources that are not owned or controlled by the company. More in-depth description of the categories of the up- and downstream emissions of Scope 3 are given in Table 2**.**

Table 2. Description of Scope 3 categories (GHG protocol, 2022b).

Scope 3	Category	Description
Upstream emissions	Purchased goods and services	Extraction, production, and transportation of goods and services purchased or acquired.
	Capital goods	Extraction, production, and transportation of capital goods purchased or acquired by the reporting company in the reporting year
	Fuel- and energy- related activities (not included in scope 1-2)	Upstream emission of purchased fuels and electricity. Transmission and distribution losses. Generation of purchased electricity sold to end users.
	Upstream transportation and distribution	Transportation and distribution of products and services purchased by the reporting company.

	Waste generated in operations	Disposal and treatment of waste generated in operations.
	Business Travel	Transportation of employees for business related activities.
	Employee commuting	Transportation of employees between home and work.
	Upstream leased assets	Operation of assets leased by the company. (Not included in scope 1-2)
Downstream emissions	Downstream transportation and distribution	Transportation and distribution of products sold by the company. Between operations and the end consumer.
	Processing of sold products	Processing of intermediate products sold by downstream companies
	Use of sold products	End use of goods and services sold by the company.
	End-of-life treatment of sold products	Waste disposal and treatment of sold products.
	Downstream leased assets	Operation of assets owned by the reporting company, and leased to other entities. (Not included in Scope 1-2)
	Franchises	Operation of franchises in the reporting year. (Not included in Scope 1-2)
	Investments	Operation of investments. (Not included in Scope 1-2)

GHG Protocol (2022c) provides an overview of the relationship between product life cycle emissions; the Scope 1 and Scope 2 emissions; and the Scope 3 emissions, which is depicted in Figure 2. The role of Figure 2 is to visualize the relationship between the upstream, direct, indirect, and downstream emission and where they tend to occur in the product life cycle (GHG protocol, 2022c).
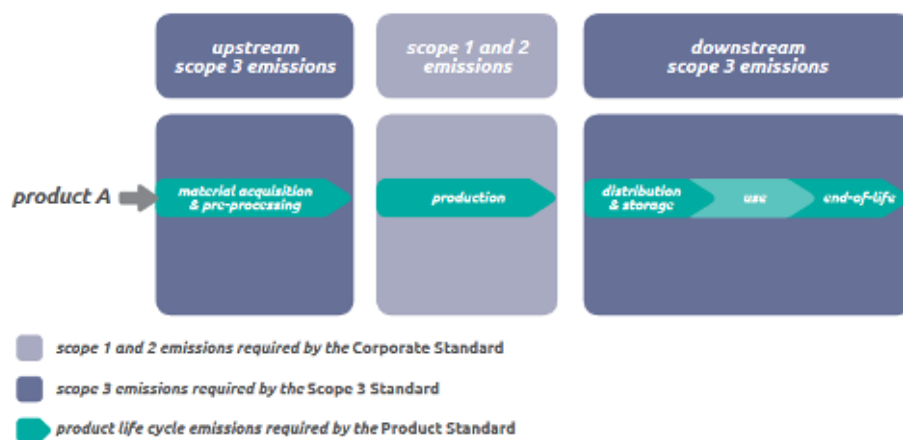

Figure 2. Relationship between the product life cycle, Scope 1 and Scope 2, and Scope 3 emissions (GHG protocol, 2022c).

2.3.3 Tangible and Intangible Actions

Lopera-Mármol and Jiménez-Morales (2021) further explores how the full scope of sustainability in the audio-visual sector can be assessed. They present two definitions, *tangible,* and *intangible,* for how industry initiatives and proposed actions can be identified and classified. *Tangible* actions refer to:

> Corporal aspects that can be modified to be sustainable, such as eco-vehicles, recycling bins, opting for vegan makeup and for environmental lighting,   work materials on-and off-screen,   technical equipment, accommodation, and avoiding paper script. etc. (Lopera-Mármol & Jiménez-Morales, 2021, p. 5)

While *intangible* actions refer to:

> Those incorporeal aspects of media that can be modified to be sustainable from the content to a working team's interculturality. The intangible elements of any production contain aspects that thematize the sustainable condition of the productions and take care of them. This classification includes components that have to do with the well-being of work teams, tolerance of multiculturalism, gender equity, concern for animal and human respect, and the environment (Lopera-Mármol & Jiménez-Morales, 2021, p. 5)

The definitions by Lopera-Mármol and Jiménez-Morales (2021) are intended to be used for the full scope of sustainability, including environmental, socio-cultural, and economic sustainability. In this study the understanding of how to make the distinction of tangible and intangible sustainability actions is the key take away.

2.4 Theoretical Framework

Following is the construct and definition of the theoretical framework that will be used continuously throughout this study. It serves to tie together all previous sections of this chapter and outline how they work in unison. A background of the gaming industry was first outlined to provide a common understanding of the foundation for which the framework is developed. The game development pipeline which in essence is the central part for understanding the gaming industry is one of two core concepts in the framework, and the other one is the Virtual LCA. By comparing the game development pipeline in section *2.2 Game Development* and the Virtual LCA in *2.3.1 Life-cycle Assessment* it is possible to identify similarities and find connections between the two. In Table 3 the intersect between the game development pipeline and the Virtual LCA is identified and described and will be used as a foundation for the theoretical framework.

Virtual LCA	Game development pipeline	Description
Software and visual assets	Pre-production	Software and visual assets are covering the initial stages of game development where technological requirements for the games are set. Here the tools needed to create the games are identified and selected, as well as the day-to-day operations of a business occur. Design ideas and energy efficiency and performance practices set in this stage will steer the direction of the rest of the game and will affect the later stages.
Design and development	Pre-production Production Post-production	This exists in an overlap between the later stages of pre-production with some prototyping. But majority of this category is associated with the design and the development that occur in the production stage. As well as design and development that occurs in post-production, bug-fixes etc.
Uploaded to the Internet	Production	In the final stage of production, the game is packed and shipped to online marketplaces and game platforms.
Downloaded through the network	Post-production	Players are downloading content online after they have bought it, they will continuously download updates and patches as they are uploaded by the developers.
Interaction, user experience, completing tasks	Post-production	Essentially post-production and the indirect effects. This is where the users are playing the contents of the game, all the hours they interact with the product. Decisions made in pre-production and production will have effect here.
Data erased from client	Post-production	Something that is not covered too much in the game development pipeline is the way developers are backing up their own systems and so forth. However, this aspect might also be linked with the previous part of the virtual LCA with how players are interacting with this content and uninstall it.

In Figure 2 the relationship between the product and its Scope 1, Scope 2, and Scope 3 emissions is outlined. If the product is a digital product, then the product life cycle can be changed for its digital counterpart, the Virtual LCA. So, by combining the findings in Table 3 with the relationship between product and the emissions in Figure 2, it possible to create the theoretical framework in Figure 3. The theoretical framework outlines a relationship which can be used to interpret the intersect between the digital product and its Virtual LCA, and the game development pipeline and its climate emissions.
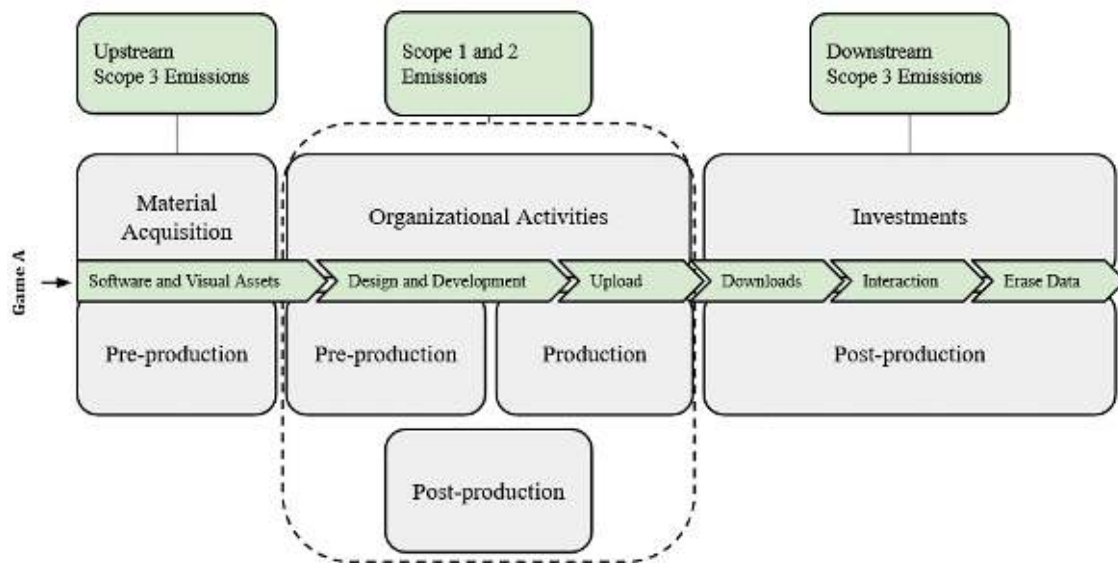
Figure 3. Theoretical framework of the emissions related to the development of digital games. Covering both the organizational aspect as well as the game related aspect (Author's interpretation).

Digital sustainability, as defined by Bradley (2007), has the life cycle in focus, the objective of this theoretical framework is to account for the technical and socio-technical issues associated with the creation and the management of a game. This is done by identifying where Virtual LCA and the game development pipeline intersect, as explained in Table 3.

Central for the framework is the product, in this case *Game A*, that is being made. The arrows are indicating the Virtual LCA of that game, the length of the arrows does not determine the length of that step, rather serves to indicate that the step might overlap between different types of emissions. The bottom half of the model, i.e., the boxes underneath Game A, is connected to the production pipeline. Pre-production emissions occur both as upstream emissions as well as Scope 1 and Scope 2 emissions thus appearing both inside and outside the dotted line. Same occur for post-production but for downstream emissions. Because the intraorganizational emissions of post-production activities are connected to design and development of new features, bug fixing and patches, as well as the upload of these changes, it appears inside the dotted line as well. The boxes above Game A are tied to the organizational activities during the life cycle that occurs outside the game development pipeline. Everything inside the dotted lines is the intraorganizational emissions, which means the direct and indirect emissions of Scope 1 and Scope 2. Upstream emissions are tied to the left side and downstream emissions the right side as they are depicted in Figure 2. The result is a framework that outlines the life cycle of a game in relation to both organizational activities as well as the game development pipeline.

As stated by Dr. Markiewicz, the Scope 3 emissions are set to have a larger impact than the direct emissions of Scope 1 for digital products (Frick, 2016, ch. 1). He specifically outlines that the largest impact should be seen in the downstream emissions, which happen in the post-production. Regarding the Scope 3 activities, the upstream emissions

are the ones occurring before the pre-production or that are essential for the organizations everyday activities that lie outside the specific game pipeline.

2.5 Previous Research

One of the most comprehensive works on the topic of climate impact and the gaming industry was published in March 2022 by Ben Abraham. In the book *Digital Games After Climate Change,* Abraham (2022) covers all aspects of the topic, ranging from why it is necessary, to how games can have an impact, and what an ecological game is. For the scope of this thesis, *chapters 4-6* have been the most related to the work this study sets out to explore. Those chapters focus on game developers and the overall life cycle of the game and ties closely to the full extent of the theoretical framework in Figure 3. *Chapter 4* is covering the energy used to make a video game, this chapter outlines both upstream emissions of traveling, flights, and purchases, as well as the indirect emissions of electricity, heating, and cooling during development. The chapter is summarized by his estimates of the total emissions of game development in 2020. To test and build upon the theoretical framework in Figure 3, Abraham's findings in *chapter 4* along with other studies that look at the impact of game development will be more thoroughly examined in *2.5.1 Pre-production and production*.

In *chapter 5* Abraham (2022) is looking at everything that happens once the game is complete. From the emissions of physical distribution of games on discs, to the emerging norm of digital distribution and the emissions that comes with it. In *Chapter 6* he covers the carbon footprints of playing games, that is the energy use and concurrent emissions that appear downstream. Both *chapter 5* and *chapter 6* cover ideas that are more related to the right-hand side of the theoretical framework in Figure 3. These findings and other studies focused on the downstream activities of game developers will be more thoroughly detailed in *2.5.2 Post-production*. The final chapter of Abraham's book, *chapter 8,* outlines the next steps that should be taken by industry stakeholders, from developers to hardware manufacturers, publishers, platform holders, and players. Abraham outlines the actions he has identified the industry can take to ensure a green future for the game industry, which will be explored in *2.5.3 Industry impact.*

2.5.1 Pre-production and production

Firstly, the upstream emissions related to pre-production and the organization are usually tied to purchases of equipment essential for production, the digital services needed, and at the core, the employees. Electronic equipment has emissions tied to its lifecycle, from production, to use, and later its disposal (Koçak et al., 2013). Travel and flights are one of the most carbon intensive parts of game development related business activities (Abraham, 2022, p. 113). Game development is becoming even more international and collaborative, which means that flights between developers and publishers are an expected part of game development, and so is traveling to press events, conferences, and other launch activities. Some organizations find that travel can

amount to triple the emission of office energy use, which is why this area of game development need to be included when calculating emissions (ibid).

The first step to achieve carbon neutrality within the industry is for organizations to measure their overall energy use (Abraham, 2022, pp. 90-91). The first step then is for the organization to calculate their Scope 2 emissions which are tied to their electricity use. However, calculating these emissions will come with some challenges that differ depending on your studio size. For example, the electricity used by solo developers are usually bundled together with their home electricity use, which makes it difficult to accurately calculate their footprints (Abraham, 2022, p. 95). An issue that 64 percent of Sweden's developers then face if they were to calculate their emissions, as seen in Figure 1.

Abraham (2022, p. 116) reaches the conclusion that a reasonable estimate of the emissions per employee per annum lies somewhere in the range of *1-5 tCO₂e* for companies Scope 1 and Scope 2 emissions. This estimate offers developers a benchmark to measure against, but where a particular organization exists within the range depends on the emission intensities of where they are located, as different countries and even areas of countries offer a different energy mix. However, given that the industry is located at two extremes of the scale with huge multinational organizations, to solo developers, and emissions are happening in bedrooms shared spaces it will be a challenge to accurately measure and act on these emissions (Abraham, 2022, p. 118). Furthermore, the rapid increase of work-from-home will make this even harder as it is not as simple for larger organizations to measure just their office use.

In the future, emissions in Scope 3 from travel and flights need to be further researched to better understand how these impact the game development's carbon footprints (Abraham, 2022, p. 119). For game developers it is important to have carbon footprint as a first-order optimization target (Gupta et al., 2021). It is important that researchers and developers across the computing stack make carbon footprint a prioritized target, and work to optimize products to lower their environmental impact because computing technologies are, and will continue to be, present in society, and so will its environmental footprint (Gupta et al., 2021). In recent years the trend has been to maximize performance while carbon footprint has been kept outside the equation (Gupta et al., 2021).

2.5.2 Post-production

Until recently, games were mainly sold in physical form whereas now the sales and distribution of games occur more frequently on digital platforms even if physical distribution still forms a substantial part of games distribution (Abraham, 2022, p. 123).

> In simplest terms, digital distribution involves a website or online store, from which consumers purchase games. The files for the game are

downloaded from a server and then stored on your local device until you delete or uninstall it. Very simple in principle, however in practice it involves a host of technologies, literal world-spanning infrastructure, dizzying arrays of different software and hardware configurations and standards, and multiple multinational companies – potentially across more than one regulatory jurisdiction. (Abraham, 2022, p. 136)

While it is simple to understand the concept of what is at work, if you peel the first layer it becomes increasingly more complex. Some researchers are looking into the use and efficiency of the data centers, which hosts the servers where games are downloaded. For data-center operators and cloud server providers, most emissions are related to construction, infrastructure, and hardware (Gupta et al., 2021). Although the overall data-center energy consumption has risen over the past years, the emissions of operations have reduced because of the shift to use of renewable energy. Gysel et al. (2013) explains that data center providers have two driving forces for reducing their energy use; one is to reduce the carbon footprint, the other is to reduce the operational costs of the data center.

It is not only the server that has an impact, but the game industry also has an impact on the network. In the height of the Covid-19 pandemic and during the first lockdown in the UK in 2020, broadband use rose by 40 percent and some ISP's reported that large updates to popular console games were responsible for a big part of this rise (Tapsell & Purchese, 2021). It resulted in liaison between ISPs and game companies which ensured that they would keep each other updated on game patches and releases. Game companies were also advised to oversee their best practices and release updates and content outside the hours of peak load. These issues were associated with regular downloads, which is why Tapsell and Purchese (2021) voices a concern over the increased popularity of cloud computing. Cloud computing involves a server that is not only handling data, but performs computing tasks on your behalf. This not only increases the load on the network, but it also increases the demand on machines in data centers and their power use (ibid). Call for research on this topic, and highlighting this potential issue, was made in 2018 by Morley et al., (2018) when they argued that electricity consumed by information and communication infrastructure will be of more importance as a share of global electricity use and will be a potential contributor to peak electricity demand on a national scale. Rather than allowing it to become a problem that will become increasingly harder to tackle once data-intensive services become the new normal, there must exist better options for dealing with internet related energy demands (Morley et al., 2018).

When it comes to the digital footprint of gameplay the complexity of the issue can best be summed up by Aslan (2020):

> There is a straightforward answer to the question "which method of gameplay has the lowest carbon footprint?", which is, "it depends". It depends on the length of time the game is played for, it depends on the file

size of the game being played, and for cloud gaming, it depends also on the type of device the game is played on (Aslan, 2020, p. 280).

This is what makes this subject both difficult and important. Even with the best estimations and the latest research, the answer is that it all depends on these different variables. Games are not one size fits all, they are played differently, created differently, with different units composed of different components, powered by electricity with varying emission intensity. It is especially true if we look at computer gaming. Consoles and mobile devices are built slightly different, but even there you must account for settings and external components. Given the rising computer power, the improvements made on graphics quality, displays with higher resolution and streaming delivery, the energy intensity of computer gaming has increased (Mills et al., 2019). With computer gaming being one of the most significant electric "plug loads". While this is problematic, the end use of a computer is both hard to understand and manage (ibid). "It is difficult to specify the precise contribution of games to environmental destruction" (Maxwell & Miller, 2012).

However, while improving the energy efficiency of devices is important, it is not an action that can be taken by most game developers (Abraham, 2022, p. 162). What developers can do instead is to change the kinds of games that are made to reduce the demand of downstream energy use. But there are multiple schools of thought for how this can be achieved. One possibility could be to create games that are designed to play less, or a certain amount of time (Abraham, 2022, p. 163). Another idea presented by Mills et al. (2019) is to allow the users to use in-game diagnostics for energy use. As instantaneous power-feedback becomes available it should be implemented in games and presented in a way that incentivizes the player to use this information for energy saving activities (Mills et al., 2019). Developers can follow best practices that result in energy savings without compromising the user experience, something that is important to think about when developing games. Improvements on energy-efficiency should not affect the experience of the game, but this is easier said than done. It is difficult to characterize in-game activities in terms of energy requirement per unit of performance (ibid). This metric is important not only in game development, but in production of any digital products or services, and it is as complex in ICT as in game development (Grosskop & Visser, 2013; Kern et al., 2013).

2.5.3 Industry Impact

Developers can reduce their impact by first reducing the emission intensity of making games, secondly by distributing games in a carbon neutral way and finally by reducing the emissions of players playing the game (Abraham, 202, p. 175). Abraham (2022, p. 241-242) lists nine actions that game developers can take to make an impact, these include: calculating workplace emissions, travel and waste, and set goals to reduce these; Switch to 100% renewable office electricity; Collect play-duration data for your games and break it down to regions for most accurate estimates; Purchase carbon offset for Scope 3 emissions from players; If offsetting is not economically feasible, factor in

costs to offset in your products; Sell games digitally and if you sell physically ensure the material is fully recyclable; Do what you can to extend the lifespan of the hardware you use; Work to reduce power demands for users to play your game, it will take a lot of work for an uncertain reward; and Inform the rest of the industry of what you are doing in order to inspire change in the industry. Abraham (2022) is not the only one advocating for climate action, there are industry initiatives that have outlined tips and ideas for how to make a change and outlined specific actions that practitioners can take (Playing for the Planet, 2022; IGDA Climate SIG, 2022a; PlayCreateGreen, 2022a; Wood, 2021). These will be investigated in more depth during the study.

3. Method

In the following section the methodological approach of this study will be covered. Initially a literature review was conducted, it concluded that a qualitative approach would be best suited for this study. The analysis in this study was done by triangulating three types of qualitative data: secondary data; interviews; and documents.

3.1 Method Overview

Because of the lack of qualitative studies within the research field, this was identified as an interesting approach for this study. Also, given the nature of the research questions and the theoretical framework, the qualitative approach made more sense. This also goes hand in hand with what Williamson (2018a) says about selecting methods.

> A golden rule for all researchers is that choosing an appropriate research design should be based on the kinds of research questions that will be the focus of the research, that is, the questions should be determined first before the research design is considered. (Williamson, 2018a, p. 20)

The study can be seen as theory building, which is good when there is little research on the topic (Latham, 2016). It can be argued that the study is descriptive in nature as it is trying to answer the questions of what is going on.

3.2 Literature Review

Latham (2016) likens the literature review as a way for researchers to join the dialogue. To become a potential contributor to the discussion one must first familiarize oneself with its current state. When it comes to literature reviews there are a couple different types of ways they can be conducted. In this study the narrative literature review was identified to be the best fit. This literature review, also called the traditional literature review, is described as a comprehensive analysis of the current knowledge on a topic (CSU, 2022). This form of literature review helps to establish the theoretical framework and the context of the research.

In the early stages of this study the literature review was a guiding factor in identifying gaps in the current field of research as well as in the construct of the theoretical framework. It was realized early that this is a relatively new field of research, which helps to explain why current research is both niche and dissimilar. Moreover, it was identified that only a small portion of the studies were qualitative in nature and most research took a quantitative approach. Researchers called for more studies on the game development aspect. These findings inspired the decision for this study to take a qualitative approach and set the goal to map the current state of the industry, to provide a foundation for future research and practices to build upon.

3.3 Data Collection

The type of data collected in this study falls into three categories: secondary data, interviews, and documents. These are three types of qualitative data that work well with the theoretical framework and to fulfill the purpose of the study.

3.3.1 Secondary Data

The first type of data collected was collected from webpages and reports of different green initiatives currently active in the game development industry. These initiatives were identified during the pre-study and exist to steer the industry towards more sustainable practices. The identified initiatives are outlined and described in Table 4.

Table 4. Climate initiatives identified and investigated in this study.

Initiative	Description
Playing for the Planet Alliance	An initiative facilitated by the UN Environment Programme and started at the UN Climate Summit in 2019 (Playing for the Planet, 2022).
The Green Games Guide	The *Green Games Guide* is a comprehensive guide aligned with the work of *Playing for the Planet Alliance.* Its purpose is to help guide gaming businesses to take action against climate change (Wood, 2021)
PlayCreateGreen	PlayCreateGreen is a Nordic initiative with the aim to provide a climate handbook for game companies, by game companies (PlayCreateGreen, 2022a,j)
The Climate SIG	International Game Developers Association (IGDA's) special interest group with focus on climate questions. (IGDA Climate SIG, 2022a)

3.3.2 Interviews

The second data collection method were interviews which is a common method to gather qualitative data in research (Williamson, 2018b). For this study semi-structured interviews were identified as the best fit as these interviews allow the author to follow up on leads on the spot (ibid). The argument for conducting a semi-structured rather than and unstructured interviews was topic sensitivity. Because it enabled the opportunity to explore ideas that rose during the interviews, while still staying on topic. For interviews that aims to answer questions regarding sustainability, it is important to ask about the respondent's perception of sustainability (Banks & Keogh 2021). It is a way to understand what shapes those values, as well as where the ideas might stem from. For the interviews, as seen in Appendix C, D & E, asking about the respondent's perception of sustainability marks the shift in the interview, from background and organizational questions to questions regarding sustainability.

To conduct the interview study, respondents had to be identified and included in the study. However, finding respondents for this study proved more difficult than first expected. When reaching out to developers in November 2021, two approaches were taken. Firstly, game studios and publishers were contacted through general inquiries,

either through forms on their webpages or e-mail. With this approach well over 20 organizations were contacted but only a handful responded. Those responding showed interest in the project but were unable to allocate people to participate because of time constraints. Another attempt was made in February 2022 reaching out to those who responded to see if that was a better time, but without any luck. The first method of sending general inquiry mails resulted in zero participants. The second approach was through direct messages to people working in the industry on LinkedIn. This method resulted in two respondents that were interested in participating, but when it came to scheduling a time for the interviews both leads fell off. Again, this method resulted in zero participants.

Dataspelsbranschen, the Swedish trade association for video game companies, were contacted to see if they could facilitate contact with game companies. Because of integrity policies they could not provide email addresses to potential respondents, but they helped forward my request to companies that they thought would be interested in participating, again no responses.

Finally, through word of mouth and some personal connections, two respondents agreed to participate in the study, one of which put me in touch with their publisher resulting in two additional respondents. In the end, the interview study consisted of three interviews with four respondents taking place in April 2022. Details regarding these interviews have been outlined in Table 5. The first interview was conducted through digital media, Zoom, and the other two were conducted in person. The third interview was conducted with Respondent 3 and Respondent 4 together.

Table 5. Respondents and interview details.

Respondent ID	Role	Company Type	Games	Date	Interview Length
Respondent 1	Developer	Game developer	Mobile	2022-04-07	40 min
Respondent 2	CEO	Game developer	PC & Console	2022-04-25	42 min
Respondent 3 Respondent 4	CEO Sustainability Officer	Game publisher	PC & Console	2022-04-25	62 min

3.3.3 Document Analysis

Because of the lack of respondents for this study the data collection method had to be evaluated and reframed to make significant findings and reliant conclusions. Document analysis can be used in qualitative studies to triangulate findings from other data sources as interviews and secondary data (Gross, 2018). "When used in triangulation, documents can corroborate or refute, elucidate, or expand on findings across other data sources, which helps to guard against bias." (Gross, 2018, p. 544).

Sustainability reports were identified as a good candidate for documents to analyze in triangulation with the interviews and the initiatives because of the ease of access and substantial quality. In Sweden, corporations that fulfill two out of the following three criteria are legally obligated to publish sustainability reports: "an annual average of over

250 employees; a net turnover of over SEK 350 million; a balance sheet total of SEK 175 million or over" (Tillväxtanalys, 2018).

To identify organizations in the gaming industry that might fulfil this criteria I turned to the Game Developer Index for 2021 published by Dataspelsbranschen (Milton et al., 2022). In the report they list the ten largest game companies in Sweden. Out of the identified organizations from the top 10 list I was able to find eight annual reports containing or referencing a sustainability report. Organizations or units' part of a larger organization may not need to publish their own sustainability report if the organization is publishing one (Worldfavor, 2022). Which might explain why neither Ubisoft Sweden, nor King Entertainment had reports that could be found, as they are owned by larger global corporations. Reports from their owners were outside the scope of the thesis, as it covers Sweden explicitly, so they were excluded. One organization, Thunderful Group, has their own physical distribution which means that their sustainability reporting in the annual report had the focus on physical distribution and distribution centers and lacked connection and reflection related to game development. Because of the big difference in the information they reported, and the information being mostly out of the scope of this study, they were excluded from the list. The final seven companies that were studied are listed in Table 6 along with the year of their report.

Table 6. List of companies and the year of the sustainability reports used in the study.

Organization	Year
Embracer Group	2020/21
G5 Entertainment	2021
Goodbye Kansas	2021
Mag Interactive	2020/21
Paradox Interactive	2021
Starbreeze	2021
Stillfront Group	2021

The analysis was narrowed down to the sustainability reports within the annual report of these organizations, and more specifically the parts that covered environmental sustainability or climate footprints. In the case of Stillfront Group whose sustainability report was referenced in, but published separately from, their annual report, both reports were included in the document analysis.

3.4 Data Analysis and Drawing Conclusions

The data analysis was done in three consecutive steps all outlining from the theoretical framework in Figure 3. First was the literature review which was conducted in the structure of general concepts of the industry then more focus towards the different stages in the game development pipeline to follow the same structure as the framework. Next step of the analysis was to review the sustainability initiatives and identify where they stand in relation to the theoretical model. That is, identifying what parts of the model are the different initiatives targeting. As well as defining the suggested actions as either tangible or intangible using the definitions presented by Lopera-Mármol and Jiménez-Morales (2021). To accurately reference different initiative actions and to efficiently map the actions to the theoretical framework each action was given a unique code as seen in Appendix F and Appendix G. Going through the initiatives it was identified that only a subsection of the suggested actions could be directly placed in relation to the theoretical framework. For this reason, Figure 5 was formed to set the climate action process as presented by the initiatives in relation to the theoretical framework. This formed the basis for how the analysis of the results of the interview and document analysis was conducted.

Finally, the sustainability reporting and the interviews was analyzed from the perspective of the theoretical framework in Figure 3 as well as the whole climate action process in Figure 5 to understand what work is currently being done in the industry. From them it was possible to identify what climate impact the organizations have, where in game development pipeline this impact lies, and what actions are taken to reduce this impact. To come to the final conclusions of this study, the results of the data analysis were discussed in accordance with the initial research questions. In this discussion the findings were triangulated and put in relation to the developed framework and previous studies.

3.5 Ethical Concerns

With transparency and distinction, the respondents' rights have been presented to them with the research information and consent form, Appendix A and B. Participants were given the option to review, revise and remove any statements they had made before the final version of the report was submitted. Caution has been taken to ensure that participants remain anonymous in this study.

3.6 Limitations

One steering limitation was the difficulty of finding respondents for the interview study. This forced me to adapt the method of data collection and include document analysis of sustainability reports. This did have an impact on getting information related to day-to-day aspect of game development, but it did complement the study with clear statements and calculations that otherwise might not have made it in. While the reports cover the

aspect of large organizations, the interviews have been investigating smaller organization which also impacts the findings.

4. Results and Analysis

In the following section the results found in the sustainability initiatives, the sustainability reports and the interviews will be presented and analyzed.

4.1 Sustainability Initiatives

In the gaming industry today there exists both global and local initiatives with the purpose of guiding industry practitioners in how they can account for their environmental impact. Most of these initiatives are new and have come to fruition after the Playing for the Planet Alliance was announced in 2019 at the UN Climate Summit (UNEP, 2019). The Alliance is the overarching initiative that other ideas stem from or strive to be in line with (Wood & Ruiz, 2021). In the pre-study, four initiatives that explicitly targets the gaming industry were identified to be interesting for this study. Besides the *Playing for the Planet Alliance*, there is IGDA's *Climate SIG*, Ukie's *Green Games Guide* and *PlayCreateGreen*. In the following sections these will be explored further to see what these initiatives are and what they are working on in terms of guiding the industry, and then outline what actions they identify that the gaming industry need to take to reduce their negative climate impact.

4.1.1 Playing for the Planet Alliance

The Playing for the Planet Alliance, henceforth *The Alliance*, works to create more visible, inspiring, and catalytic change than what any organization can achieve on their own (Playing for the Planet, 2022). At the time of its announcement in 2019 the initial commitment was to reduce the industry's CO_2e emissions by 30 million tonnes by 2030 (UNEP, 2019). The Alliance encourages any actions that result in specific outcomes, which can be anything from restoring and reforest landscapes to engaging and activating players for positive change. As stated by Inger Anderson, Executive Director at UN Environment Programme (UNEP), "the video game industry has the ability to engage, inspire and captivate the imaginations of billions of people across the world" (UNEP, 2019).

Since the initial announcement of The Alliance more organizations have joined and committed to their own individual goals within the initiative. Member commitments can include actions such as reducing carbon footprints and shift to green energy; using and implementing green nudges in games; commitments to offset emissions; circular economy design and recycling to control plastic and e-waste; and achieving more together (Playing for the Planet, 2022).

4.1.2 IGDA's Climate SIG

The International Game Developers Association (IGDA) has a Special Interest Group (SIG) with focus on the climate called the Climate SIG (IGDA Climate SIG, 2022a). After carefully reviewing their webpage and their workstreams it was concluded that

their work was not comprehensive enough at this stage to be included as a central initiative in this study. It should be noted that they are producing documentation that will be essential for game developers and researchers in the future. In April 2022 they released an alpha version of the *Environmental Game Design Playbook* which is their effort to establish a common design language for climate action in games (IGDA Climate SIG, 2022b). As Abraham (2022) specifically mentions in his book, the design of games will have a significant impact on the carbon footprints of games once they are in the hands of the players. So, the industry calls for a guide that will work as a comprehensive guide of how to design with the climate in mind which is why this book can be important. However, because of limitations of the time frame of the study, and it being the alpha version, the playbook was not further explored. They have also created an *Actions Wiki* that provides direction on messaging and activities utilized by climate advocates, as well as a *Climate Game Database* which they will fill with metadata of climate conscious actions in and by gameplay. The aim of these is that they should work in parallel with the playbook (IGDA Climate SIG, 2022b).

4.1.3 Green Games Guide

The Green Games Guide, henceforth *The Guide*, is a tool created by Ukie and Games London to help gaming businesses take steps to measure their carbon footprint; cut and offset their emissions; and integrate green themes and calls to actions in games (Wood & Ruiz, 2021). The Guide is aligned with the Playing for the Planet Alliance initiative and has its primary focus on the United Kingdom. It is however not exclusive to UK companies, and it can help steer the industry globally. "The games sector has the potential to make significant impact on both how the climate change is perceived by the global games playing community and in how we tackle it, individually as businesses and collectively as a sector" (Wood & Ruiz, 2021, p. 3). In The Guide Wood and Ruiz (2021) presents their interpretation of the games industry life cycle, which can be found in Figure 4.

Figure 4. The games industry lifecycle as presented in the Green Games Guide (Wood & Ruiz 2021, p. 8)

The life cycle in Figure 4 differs slightly from the life cycle in the theoretical framework, Figure 3. The life cycle in The Guide assesses the whole industry while the framework is covering the life cycle of a game. The framework shares its similarities with the right-hand side of Figure 4. Referencing the life cycle Wood and Ruiz (2021, p. 8) states that "where a company can have the most direct impact on emissions depends on the size and nature of your business". Generally, every part of the game sector has an impact both up and down in the life cycle chain (Wood & Ruiz, 2021). An example presented by Wood and Ruiz (2021) is that by making the rendering of a game more efficient it can have a significant positive impact on the energy consumption of a user.

The Guide can be reduced to a five-step process that businesses can follow to reduce their impact on the planet (Wood & Ruiz 2021). The five steps and what they entail are presented in Table 7. Each step comes with suggestions of actions the organization can take to fulfill that step. Examples of these actions is also presented in Table 7, and the full list of examples and their attributed codes can be found in Appendix F.

Table 7. Overview of the Green Games Guide's five step process with examples of suggested actions (Wood & Ruiz 2021, pp. 10-13). Examples are presented with their identifying code in the left column. The full table can be found in Appendix F.

Step 1	Setting your scope and timeline
Description	Measuring your carbon footprint is a crucial step toward making your business more sustainable in the long term. However, before you start gathering numbers you should take the time to understand what you want to measure.
A1	Set your scope: Before you start measuring think about the scope – for example whether you need to limit your analysis to direct internal company activity, or whether (as many P4P Alliance member companies currently do) you will also count your supply chain and the energy and indirect emissions people use while playing your game
A2	Set your timeline: Once you have established the scope and baseline of your emissions, you should set a plan for setting goals and reporting on your performance. Important milestones include setting a date for when you will move to net zero.

Step 2	Calculate your carbon footprint
Description	You have to understand more about the impact your company has if you want to effectively cut your emissions. It can take time but it will allow you to identify where you should focus your efforts, help establish short and long term targets and will motivate your team to own the activity required to reduce your emissions.
B2	Capturing data will include energy use in your office, your employees travel and capital purchases (e.g. laptops) and, depending on your scope, could include speaking to your partners and suppliers and gathering player data from your games. As you start you may need to estimate placeholder values and improve your entries as better data becomes available.
B4	Player hours - If you want to understand the energy consumed when playing your games, you will also want to understand the total number of hours that your games were played.

Step 3	Take bold and ambitious action to reduce your carbon footprint
Description	Now you have your carbon footprint, you're in prime position to identify where the biggest impacts are and to start to reduce your emissions. There are many ways you can make your office, home workspaces and your operations more energy efficient, so here are some areas you can consider.
C3C	Find savings in your cloud costs; the more you spend with your cloud provider, the higher your emissions are likely to be
C5B	When traveling longer distances consider rail over air

Step 4	When it's impossible to avoid, hit the offset button
Description	When you've looked at how you can directly reduce your business' carbon footprint, you can then offset other emissions through offsetting schemes. There are a huge range of carbon offsetting schemes to choose from, here's some tips for what to look for.
D1	When thinking about what you want to offset, consider the impact your business has in the lifecycle of a game. For example, if you're a developer it's not just your team that contributes, it's also the impact of your game being played and you can also consider offsetting this

D2	With so many offsetting schemes out there, make sure you carefully consider the right one for your business.

Step 5	**Ratchet, review and recommend to others**
Description	There is always more you can do to make your company as green and as sustainable as possible so these additional steps can take you to the next level.
E1	Ratchet and review each year: The measure, Reduce, Offset, process is a continuous improvement cycle. Each year you should evaluate and improve your data, revisit your progress against your goals
E5	Join the collective adventure to learn from others and join the collective efforts to adapt our industry to environmental challenges.

4.1.4 PlayCreateGreen

PlayCreateGreen, henceforth *PCG*, was ideated in 2019 at Bornholm Game Days when Nordic industry leaders identified climate as one of the most important contemporary issues to address the following year (PlayCreateGreen, 2022j). A climate group was facilitated by Nordisk Games, and they quickly realized that people within the industry wanted to act but did not know how to get started. To help solve this issue PCG have created a handbook that they structure around two core ideas: *reduce negative impact* and *increase awareness* (PlayCreateGreen, 2022a). The core ideas and their subsections are outlined and described in Table 8 with an example of actions for each. The handbook in its full extent can be found in Appendix G.

Table 8. Overview of the subsections of the core pillars in the PlayCreateGreen handbook, and examples of actions. Full table can be found in Appendix G.

Reduce Negative Impact

Subsection	Code	Description
Impact during game development	RNI1	This area covers the emission occurring from the day-to-day operations when you develop games (PlayCreateGreen, 2022b).
	RNI1E	Choose green energy
Impact during game marketing	RNI2	Game marketing comes in many forms, anything from digital marketing, using influencers, flying to exhibitions and events, printing posters and distributing physical sales material. In all of these there are ways to reduce carbon emissions, especially physical activities (PlayCreateGreen, 2022c).
	RNI2A	Create policies to minimize travels for sales and marketing conferences
Impact during game distribution	RNI3	Some of the largest emissions from video games come from distribution - both physical and digital. These emissions are often invisible as they are not directly attributed to the company. The emissions are generated by a contractor or service supplier, such as a hosting company or a distributor. But that doesn't make the impact less significant (PlayCreateGreen, 2022d).
	RNI3A	Choose carbon neutral hosting services

Impact during gameplay	RNI4	Playing games is recognized as the most energy-intensive use of personal computers and smartphones. 'Players' energy consumption is conventionally considered the responsibility of hardware producers and not the game producers. However, everyone must pitch in for a significant impact to happen (PlayCreateGreen, 2022e).
	RNI4B	Incorporate an 'eco-mode' where players can choose a less energy-demanding way to play
Impact of hardware end-of-life	RNI5	Carbon emissions from hardware required to play games is also an important issue. The need for new hardware when old models lose compatibility is another issue. This causes a need to produce even more products. It can have a big impact to change how hardware is produced, how often players are forced to replace it, and making it easier for everyone to choose a better solution, when discarding hardware (PlayCreateGreen, 2022f).
	RNI5A	Make sure your games support older versions of hardware or devices, so players can keep playing them on existing hardware

Increase Awareness

Subsection	Code	Description
Raise awareness in the industry	IA1	Combating climate change is a shared responsibility and we need everyone to take an active role (PlayCreateGreen, 2022g).
	IA1D	Open-source your process, work tools and conclusion
Inform and influence consumers	IA2	We already learn history by playing as soldiers in WW2, we sharpen our reflexes by stacking bricks or understand risk and math by calculating the best skill set for a warrior character. Your content and gameplay can help players learn and make better climate choices in real life (PlayCreateGreen, 2022h).
	IA2A	Incorporate green nudges into your game
Raise awareness in the community	IA3	You can utilize the community around your games, and its influencers, to create awareness on climate issues. Both digital and physical communities and events hold the potential to share knowledge and create awareness about climate issues (PlayCreateGreen, 2022i)
	IA3C	Write about climate issues and share with your community

4.1.5 Initiative Summary

This section aims to summarize the general idea of the initiatives, outline where the guides overlap, and identify how they relate to the theoretical framework in Figure 3. If we look at the guides, which is where most of the interpretation and later comparisons can be made, we can quickly see that they differ in their targets. The Green Games Guide cover the whole process from committing to and take actions, to reviewing the process and turning it into a recurring cycle. The PCG handbook on the other hand specifically targets two parts of the process outlined in *The Guide*. The first pillar of PCG called *reduce negative impact* share similarities with Step 3 in The Guide and the second pillar, *increase awareness,* shares similarities with Step 5.

If we narrow our scope on the *reduce negative impact* pillar and Step 3 of The Guide, the suggested actions can be defined as *tangible* actions, as they target corporal aspects that can be modified to be sustainable (Lopera-Mármol & Jiménez-Morales 2021). Similarly, the *increased awareness* and Step 5 can be defined as intangible actions, as they target incorporeal aspects that can be modified to be sustainable. What becomes apparent is that the intangible actions are way harder to place within the industry life cycle presented in the theoretical framework, because of them being incorporeal. For example, the subsection '*raise awareness in the industry*' in Table 8 is about helping and teaching others. This action will not have an obvious impact on the organizations carbon emissions and could theoretically reduce or increase any category depending on how the material is perceived.

Thus, the findings from the sustainability initiatives called for the construct of new model that better explains the type of suggested actions given by the initiatives and how they relate to the theoretical framework. This relation is visualized in Figure 5.
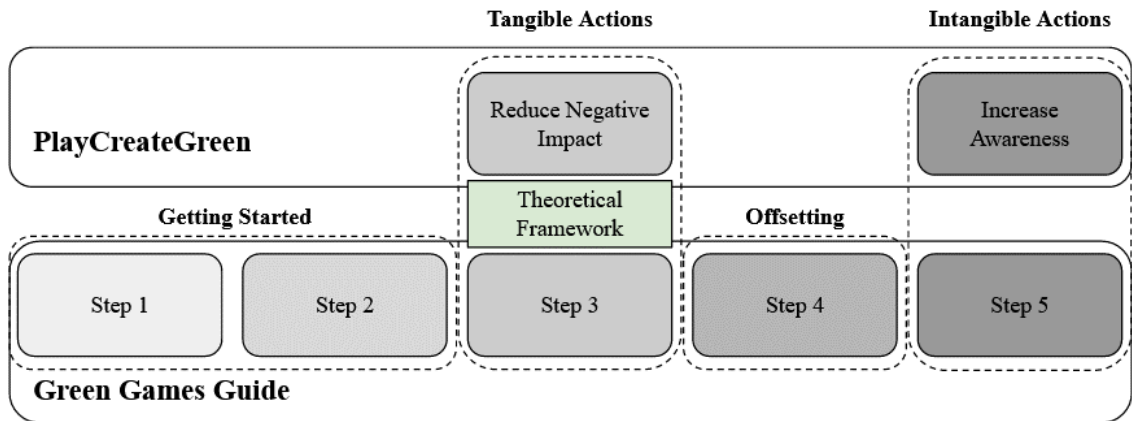
Figure 5. The climate action process in relation to the theoretical framework (Author's interpretation).

For the rest of the result and analysis chapter the climate action process in Figure 5 will be used to explore the findings from the sustainability reporting and the interviews to compare the other outlined steps in relation to what organizations are committing to do.

4.2 Sustainability Reporting

Sustainability reports are required to be presented by organizations fulfilling two out of three criteria as stated by Tillväxtanalys (2018). Working from the list of the largest organizations in Sweden as presented by Milton et al. (2022), seven organizations and their sustainability reports were analyzed and interpreted. Each organization will be presented in this section followed by a summary of what was found in their reports in relation to the theoretical model and the climate action process in Figure 5. Only four of the seven organizations have reported their carbon footprint, these are summarized in Table 9 along with a calculation of their emissions per employee.

Table 9. Reported carbon footprints in tCO₂e for each scope by the organizations (Embracer Group, 2021; MAG Interactive, 2021; Paradox Interaction, 2022; Stillfront Group, 2022).

Organization	Embracer Group	MAG Interactive*	Paradox Interactive	Stillfront Group
Employees	8500	117	721	1381
Scope 1	0	0	0	64
Scope 2	2278	74,448	236	1026
Scope 3	1041	235,752	261	31096
Total emissions	3319	310,2	497	32186
tCO₂e/employee**	0,3904705882	2,651282051	0,6893203883	23,30629978

* MAG Interactive did not use GHG-protocol, thus did not allocate their emissions to the different scopes, this was done by the author. Scope 2 emissions are their energy use which amounts to 24% of total emissions. Their Scope 3 emission is the rest of their emissions and include hours played 69%; travel: 4%; purchases 3%; meals 0%.
** tCO₂e/employee was calculated by dividing Total emissions with number of Employees.

4.2.1 Embracer Group[1]

Embracer Group is a Swedish video game and media holding company engaging more than 8,500 employees and contracting employees in more than 40 countries. They conduct management and development of IP-rights; work with publishing and development of computer, video, and mobile games; third-party publishing; and distribution of games. Their 2020/21 annual report is the first one where they are required to include a sustainability report. However, in 2019/20 they started their initial approach to become more sustainable with the guiding idea to start small and focus on what matters most.

> For Embracer Group, the majority of our environmental impact is indirect. It takes place upstream in our supply chain and downstream in our value chain. We put our focus where we can have direct impact such as promoting the transition to a low-carbon economy within our studios. (Embracer Group, 2021, p. 70).

Step 1 & Step 2 – Getting started: The scope of the report intends to cover both internal company activities as well as their supply chain and upstream emissions. For their Scope 3 emissions they have gathered data on business travel, as well as transmission and distribution losses, but they have not included emissions of their players. Embracer Group is calculating their greenhouse gas emissions, but the full scope of the group is yet to be captured. In this year's reporting the numbers they report are a bit skewed due to lack of contribution from each of their 92 entities. Business travel was collected for each entity, but due to the Covid-19 pandemic few flights were reported in 2020. Their ambition is to improve data collection by implementing a data collection strategy. Their consequent emissions are presented in Table 9 in the summary of the emissions reported by each organization.

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[1] Information in 4.2.1 has been collected from Embracer Group (2021)

Step 3 – Reduce negative impact: Embracer Group prioritizes sustainable IT and e-waste. 70% of Embracer companies have implemented reduction measures for e-waste and routines for recycling. Two thirds of their studios have requirements in place for purchasing new hardware that factors in energy efficiency and possibility for recycling.

Step 4 - Offsetting: Embracer Group has compensated for their measured emissions of 3,319 tCO_2e by 1.5 times and with a factor of 1.5 as advised. Due to lack of data this year they chose compensate a total of 30,000 tCO_2e, and they aim to improve their data collection for the next year. To address their climate footprint, they have made investments in two projects promoting clean energy, Solvatten and Prony wind power, where the latter is certified with the Gold Standard certification.

Step 5 - Increase awareness: Embracer Group is involved with the PlayCreateGreen initiative mentioned earlier in this study. Embracer's Sustainability Coordinator is a Steering Committee member of the PlayCreateGreen and they have shared insights in the form of articles, as well as provided a life cycle assessment with the goal of providing the members of the initiative with studio level insights.

4.2.2 G5 Entertainment[2]

G5 Entertainment, henceforth *G5*, is a developer and publisher of free-to-play games (F2P) played on mobile devices and PCs. G5 was founded in Sweden and holds its operations in Sweden, Malta, US, Ukraine, and Russia. They are a fast-growing company with 913 employees.

Step 1 & Step 2 – Getting started: G5 have not set any scope for how they can calculate their emissions, nor have they set a timeline. However, they show that selection of server providers has been a conscious decision. Majority of G5's servers are with Amazon Web Services (AWS), who claim that their infrastructure is 3.6 times more efficient than an average data center. AWS is also said to have clear goals for reaching 100% renewable energy sources by 2025.

Step 3 - Reduce negative impact: G5 try to find sustainable energy sources for their operations where they are available. G5 have identified that they primarily affect the environment through employee travel and dismantling end-of-life hardware. Expired and outdated equipment is sent for proper recovery and recycling is adapted to local requirements. As the company has offices located in different countries G5 strives to replace traveling with internet-based communication for environmental and cost-related reasons. During 2021 commutes by employees have been limited due to work from home because of the Covid-19 pandemic, but where transportation is required the option with the least environmental impact is selected.

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[2] Information in 4.2.2 has been collected from G5 Entertainment (2022)

Step 4 - Offsetting & Step 5 - Increase awareness: G5 do not mention any commitments to offsetting their climate footprint, nor do they mention any ways in which they are working to increase awareness

4.2.3 Goodbye Kansas Group[3]

Goodbye Kansas Group, henceforth *Goodbye Kansas*, is a supplier of technology driven visual content. They are not indefinitely a game company, rather Games & Apps are only one of their three business areas. The other two areas are Visual Content & Brand, and IP & Products. Goodbye Kansas has studios and offices in Sweden and eight other countries and employ 235 people.

Step 1 & Step 2 - Getting started: Goodbye Kansas has not set a scope for calculating their own emissions, nor have they set a timeline for climate neutrality.

Step 3 - Reduce negative impact: Goodbye Kansas have several activities that aims to contribute to sustainability work. As their operations are spread across different countries they only travel when there is a need to physically meet, otherwise they prioritize digital or cellular meetings. Waste management solutions have been implemented in select offices and they routinely work with electronic invoices and documentation to avoid unnecessary printing. For in house electricity use they have procured 100% wind power.

Step 4 - Offsetting: Goodbye Kansas do not mention offsetting.

Step 5 - Increase awareness: Goodbye Kansas has identified that they contribute to increased sustainability through its customer solutions. Their VR and AR solutions create opportunities for their business to business (B2B) customers to reduce returns, transport, and use of resources.

4.2.4 MAG Interactive[4]

MAG Interactive, henceforth *MAG*, is a mobile game developer who focuses on casual social games. MAG has studios in Sweden and the UK, and their organization has 117 employees. "Sustainability for MAG means working long-term both internally and externally to create the best possible conditions for future-proofing the company and minimizing our climate impact" (MAG Interactive, 2021, p. 25).

Step 1 & Step 2: As of 2020 MAG's scope for measuring their activities are both internal and external, thus covering all three scopes of emissions in its entirety, including downstream emissions of their players. They have strived to be climate neutral since 2019 and have compensated for all their emissions. List of their emissions and how they are distributed between the scopes can be found in Table 9. They have

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[3] Information in 4.2.3 has been collected from Goodbye Kansas Group (2022)
[4] Information in 4.2.4 has been collected from MAG Interactive (2021)

teamed up with a company called Go Climate that has helped them create a climate report that details their carbon footprint from server operations, flights, electricity use and hardware purchases. All their servers are in Google Cloud that use green electricity.

Step 3 - Reduce negative impact: Most of MAG's electricity comes from renewable energy sources, and their office in Stockholm is powered entirely by green electricity. The emissions tied to business travel have been low for 2021 due to the Covid-19 pandemic, but they anticipate that this category will increase again. To account for this MAG has reviewed their travel policy and made clearer goals of reducing air travel, and they only fly when it is necessary. When they do have to fly, Go Climate helps to compensate for those flights.

Step 4 - Offsetting: Besides offsetting for flights, MAG compensates for the remainder of their emissions by donating directly to Go Climate's Gold Standard Initiatives. Special focus has been on climate initiatives that support three of the UN's global sustainability goals.

Step 5 - Increase awareness: MAG joined Playing for the Planet Alliance in 2020, and has committed to:

> Create inspiring and educational content about the climate in our games; work on issues through play that can drive action on specific agendas, such as reforestation; strive to have a zero-carbon footprint as a company through compensatory measures and be aware of how we use resources in our business (MAG Interactive 2021).

In their report they mention two examples of these commitments. One project targeted reforestation where players could collect in-game tokens and for every 2,000 of these tokens collected they planted a tree. The project resulted in the plantation of 5,000 trees, which showed the users that their gaming contributed to the environment. Another project targeted the preservation of the world's oceans and coral reefs. MAG participated in this initiative with various sea-inspired game events in six of their active titles.

4.2.5 Paradox Interactive[5]

Paradox Interactive, henceforth *Paradox*, is a Swedish developer and publisher of PC, console, and mobile games. Paradox has nine studios across five countries and 721 employees. "Paradox's impact on society takes place both through the company itself and through the activities carried out by its suppliers, distributors and other stakeholders." (Paradox Interactive, 2022, p. 33).

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[5] Information in 4.2.5 has been collected from Paradox Interactive (2022)

Step 1 & Step 2 – Getting started: In 2021 Paradox performed climate calculations in accordance with the GHG-protocol to be able to map and develop a plan to mitigate the company's impact in 2022. In the current calculations all emissions but those accumulated from their players are included. They claim that it is not possible to calculate the player's electricity consumption on computers and consoles, which is why it has not been included. Paradox's climate footprint for 2021 was 497 tCO_2e, its distribution across the scopes can be found in Table 9**.**

Step 3 - Reduce negative impact: Paradox's international offices account for their largest climate footprint, while the Swedish offices have a smaller share due to the availability of green electricity. To reduce their negative impact Paradox is working with property owners who focus on sustainability. Paradox have identified purchases of equipment as the largest Scope 3 emission and to reduce these emissions they work with well-established suppliers for both hardware and server space that have strong focus on sustainability, as well as environmentally friendly products. Paradox strives to extend the life of all IT equipment to avoid excessive consumption. External meetings should when possible be held via digital platforms to reduce the environmental impact. They reduce the use of paper by using digital alternatives as e-signing systems and document managers.

Business travel has not had a big impact this year, but Paradox acknowledges that 2021 was not a normal year and these numbers are affected by the Covid-19 pandemic, which reduced the amount of business trips. When travel is required, for example to game fairs, Paradox will send fewer employees. Paradox will evaluate their travel policy in 2022 as well as develop clearer targets and if possible, include more categories within Scope 3. Paradox is making a shift from physical game distribution to completely digital form. Currently Paradox sells 95% of games in digital form and by going completely digital they remove both the production of physical copies as well as the transportation of these.

Step 4 - Offsetting & Step 5 - Increase awareness: Paradox do not mention any commitments to offsetting their climate footprint, nor do they mention any ways in which they are working to increase awareness.

4.2.6 Starbreeze[6]

Starbreeze is an independent developer, creator and distributor of PC and console games. They have 138 employees in four different countries. (Starbreeze, 2022a).

Step 1 & Step 2 – Getting started: Starbreeze has not set a scope for calculating their own emissions, nor have they set a timeline for climate neutrality. They do however monitor developments regarding servers and other solutions that have an environmental impact.

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[6] Information in 4.2.6 has been collected from Starbreeze (2022b)

Step 3 - Reduce negative impact: Starbreeze leases all its premises which means that the business' electricity supply, waste collection and recycling is based on agreements with property owners. Starbreeze can have an impact by pointing out when activities are not carried out as agreed upon. Starbreeze intends to upgrade outdated equipment as much as possible and ensure that they are recycled correctly. Printer toners and similar waste is sorted and returned to the supplier. However, documents are only printed when required by law or the nature of the work at hand, invoices are stored and authorized digitally. Starbreeze aspires to replace physical travel with digital communication, both for environmental and economic benefit. When traveling they prioritize the transport method with the least negative impact.

Step 4 - Offsetting & Step 5 - Increase awareness: Starbreeze do not mention any commitments to offsetting their climate footprint, nor do they mention any ways in which they are working to increase awareness.

4.2.7 Stillfront Group[7]

Stillfront Group, henceforth *Stillfront*, is a video game developer that focuses on free-to-play games primarily on mobile devices and browser platforms. Stillfront has 22 studios and 1,381 employees spread out across the globe, and their headquarters are in Sweden.

> For us, smart resource use is a given for the long-term prosperity of gaming and the planet. Our business is digital, and our largest emissions derive from the emissions of our players when playing our games. We strive to reduce our own emissions and offset the non-reducible emissions to make sure our games are carbon neutral. (Stillfront Group, 2022, p. 13)

Step 1 & Step 2 – Getting started: Stillfront have conducted yearly greenhouse-gas emission disclosures since 2019 and are climate neutral since that same year. Their strategy is to measure their footprints, reduce as much as possible and then compensate for the remains. Stillfront accounts for both upstream and downstream emission in their Scope 3. This means both their purchased goods and services as well as their player emissions, which are by far their largest categories. Their total emissions in 2021 were 32,186 tCO_2e and the distribution of emissions between the scopes are shown in Table 9. Stillfront conducted their first reduction impact analysis in 2021 which resulted in both an activity plan and a framework for their long-term targets.

Step 3 - Reduce negative impact: To reduce their Scope 1 and Scope 2 emissions has been on increasing the sources of renewable energy for company premises. For next year Stillfront will further analyze their emissions from the second largest category, purchased goods and services. Especially will they try to figure out the emissions of their performance marketing activities, which will be included in future work. Due to

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[7] Information in 4.2.7 has been collected from Stillfront Group (2022)

2021 being an anomaly with employees working predominantly from home, business travel has been limited.

Step 4 - Offsetting: Stillfront has compensated for all their emissions, which makes them climate neutral for 2021. They have compensated by partnering with South Pole who has projects that are certified Gold Standard. They have invested in three projects, one for low-carbon transportation, one for making biogas out of wastewater, and the third is a forest protection project.

Step 5 - Increase awareness: In order to be able to succeed with their reduction plan they will release a playbook in 2022 that provides strategic support for all their studios in implementing the actions.

4.3 Results from Interview Study

From the sustainability reports it was possible to account for how the largest players in the industry are approaching their climate impact, and what they chose to display in their reports. But as seen in Figure 1, large organizations only make up a small portion of gaming companies in Sweden. The interview study exists to understand how the topic of environmental sustainability is perceived by smaller organizations. The interviews can also be used to identify any differences between what organizations report and the day-to-day operations. Interview 1 and interview 3 were conducted in Swedish so any quotes and references by *respondent 1, respondent 3* and *respondent 4* have been translated from Swedish to English. The interview guides can be found in the Appendix C, D and E. Like the results from the sustainability reports, each interview will have their own section in this chapter where the organizational aspect is covered followed by an analysis of the findings in relation to the climate action process in Figure 5.

4.3.1 Small Mobile Game Developer[8]

Respondent 1 is a developer at a mobile games company that has been active in the industry over 20 years. They have previously worked on both web-based games and CD-Rom games but have in the last 10 years focused on mobile games, and for the last three years games classified as *hyper casual games*. With 5-6 employees everyone is involved in the different steps of the game development pipeline. The process usually starts with building two prototypes in parallel during a two-week period to test the game ideas. If any of these reach their set *key performance indicators (KPI)* then the project is moved to production phase where the whole team works for about a month to build the final game.

While setting the technical specifications for the game they follow some internal guidelines. For example, one of their aims is that a game needs to function on 95

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[8] Information in 4.3.1 was collected from Interview 1 with *Respondent 1* – Appendix C

percent of the mobile devices on the market, this calls for the games being adapted for both old and new devices. Using emulators, and in some cases old physical devices, they test to ensure that frame rates are on par for the different devices. On the user side they are keen on getting feedback so that they understand how their games are played and how they perform for their users. In some cases, it might happen that a user's device is overheating and draining battery from playing a game, then it is imperative to investigate the issue and solve the problem. If for example the CPU is working on 60-70% capacity it does not drain too much battery, but on low-end devices it might reach 95% and then it starts to drain the battery quickly. In these cases, they have implemented solutions that automatically adjusts the settings for that user, reducing image quality, texture quality, and removing shadows to reduce the load on the CPU.

Some of their games are connected to a cloud server, like Amazon AWS, that costs money, for these games they spend time to optimize their code to reduce costs. Optimizing for cost means reducing server calls which can reduce the power consumption. As of now their servers are in the USA because that is where most of their users are, but *respondent 1* is curious to the idea of having users connect to a server closer to them, if they are in Europe or Asia, which should not have an impact cost but might be a better alternative with the environment in mind.

For *respondent 1*, sustainability is about how each one of us lives their life. It can be how you commute to work, and it can relate to the physical equipment used for work, such as computers and monitors. Sustainability also comes down to your community and how you can best utilize it. In the interview *respondent 1* mentions ways that they are taking action to reduce their impact, and how they work with sustainability. These actions will be explored in relation to the climate action process in Figure 5**.**

Step 1 & Step 2 – Getting started: They have not set a scope for calculating their footprints, nor have they set a timeline for this.

Step 3 - Reduce negative impact: Even though they are a small company and have not set any goals of reducing their negative impact, they do conduct work that has a positive impact. Some of these seem to be general and common practices in the business such as re-using built in-game components, optimizing their server calls, and implementing measures that adapt game quality after device requirements. They do try to limit the amount of old equipment they use and update to new and more energy-efficient equipment when possible. As a company they have good policy for business travel to conferences and external meetings. They avoid flights unless it is necessary and choose either trains or electric cars when they do travel. Trains are the preferred option because it allows them to work at the same time. Another option they are exploring is to attend conferences online.

Step 4 - Offsetting: As a company in Sweden, you can give a specific amount of money to charity each year that is tax-free. "This is something we have to utilize, and we want to do it in the right way, but climate-compensating is not always that easy."

(Respondent 1). *Respondent 1* also voices a concern about buying emission rights and figuring out which organizations to support because finding the climate project that is right for the company can be tedious and hard.

Step 5 - Increase awareness: *Respondent 1* did not mention any ways in which they are working to increase awareness. However, they try to work with their community to borrow units they do not own for specific tests, which is a way that organizations can help each other reduce purchases and ownership.

4.3.2 Small PC & Console Game Developer[9]

Respondent 2 is the CEO of an indie game studio that was originally founded as a way for experienced developers to get out of the crunch of big corporations and focus on employee health and happiness. What started out as a way to create and prioritize a healthy work culture turned into a sustainable development branded organization. Something that was enabled through cooperation with their parent company. The parent company is where *respondent 3* and *respondent 4* work and will be explored in more detail in the next section. For this reason, this section will only contain background information about the game studio, and the analysis in relation to the climate action process in Figure 5 will be done in the next chapter for the full organization.

At the core, the studio wants to put creativity in the hands of their players. The first game they produced was a physics-based sandbox game, and their upcoming title will be more tied to exploration management. As they are a small studio, they are focusing on one project at a time. For their upcoming title they are about a year into the production stage after spending about six months in pre-production. For the production process you can do all the right things but as time goes by you will have to adapt the process. Even if you have started off with a plan, and successfully created your GDD and have outline for what the game is going to be, things will change. "You almost have to ride the wave of development, have a plan, have a goal, and be driven. But it will take you on a journey" (Respondent 2).

The company works agile, and *respondent 2* really emphasizes the importance of the planning aspect of building a game. It is important to understand how to break down work, tangibly. "The mountain of work that is a game, if you cannot break that down and understand that the plan obviously always adapts, and you have to constantly review that, you will never feel like you are making the progress you want to make" (Respondent 2).

Sustainability within the context of game development is viewed as economic, social, and environmental. For *respondent 2* it is about how the organization can create the right kind of environment for its employees, where you treat people with respect, give them modern and contemporary working conditions and make sure that people feel

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[9] Information in 4.3.2 was collected from *Interview 2* with *Respondent 2* – Appendix D

valuable. This ties more to the social aspect of sustainability but for the environmental aspect it can be to buy from sustainable sources when possible and know that:

> Having a sustainable game is not about simply planting trees for every copy sold, although that is a good effort, it's about game design for players to choose lower performance settings, should they wish to and tying it to achievements, accessibility options like remappable controls, adjustable text size and color, subtitles, and captions etc. (Respondent 2).

This is where *respondent 2* believes they can have an impact on the environment, but they are still trying to figure out the details. It also ties to the idea that they want to make a game sustainable and not feel like they are virtue signaling.

4.3.3 Small Game Publisher[10]

The interview with the *Small Game Publisher* was conducted with *Respondent 3,* which is the CEO of the company, and *Respondent 4,* which is their Sustainability Officer. The organization is a game publisher that owns game studios. In their role as a publisher, they assist with the release of games, sales, and marketing. In the role of owner, they assist with everything from HR and recruitment to financials and budget. The idea is to relieve their studios of some of their duties, so that they, as small companies, can focus on game development, rather than managing a company. Each studio has their own identity and their own creative freedom, but they work under the common values of the organization. In the company's business model, they have a couple of core pillars where one of them is *Sustainable Gaming,* which is a sustainability initiative. The initiative strives to make sustainability questions within the industry more transparent and easier to understand.

They have committed to publishing their sustainability report from day one because it fits their business model. Because they claim to put sustainability first, and has transparency as one of their core values, publishing a sustainability report is the right to do. "We want to, from a business perspective, build much of what we do on transparency. It does not make sense for us to talk about transparency around sustainability if we do not report what we are doing." (Respondent 3). They are also keen on addressing the fact that business is business, and that must always be factored in. "The idea is that you have a business model that you want to make as sustainable as possible, not the other way around" (Respondent 3).

As a company that has a sustainability focused business model people often assume that they make games with a sustainability focus. But the focus is more on game production and to ensure that it is handled in the right way and with the sustainability in mind (Respondent 3). *Respondent 4* builds on this and states that "there is a risk that you distance yourself from your players if you set out to educate. A lot of people just want

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[10] Information in 4.3.3 was collected from *Interview 3* with *Respondent 3 and Respondent 4,* Appendix E.

to play to relax, they do not want to think, they do not want to play to learn about the environment". So, as an organization it is important to think about these things. And if you have games that set out to educate, your targeted audience might already be people invested in the issues, which might influence the impact you can have (Respondent 4). "A better alternative is to use nudging in different ways instead of trying to persuade your players" (Respondent 4).

They also mention different ways in which you can influence your players and their impact. It is possible to include different eco-setting that in one way or another reduces the energy used by the player when gaming (Respondent 3). They see that working with existing functionalities such as achievements are ways in which they can influence their players. At the same time, it is important to understand that there are players who are driven by having top of the line equipment, having the best graphics, and the highest frames per second (FPS). So, setting restrictions is not the right way to go about it, because that would exclude those players from the target audience. Rather, launching your game with the eco-setting preset can lead to more impact, as allows them to discover that the game functions equally as well in eco-mode. "You have to do it in subtle ways, which do not restrict the user" (Respondent 3).

One complexity the organization face is that they want to expand and grow. However, with successful games and more players, an increase in *Scope 3* emissions will follow. Another current issue is that data collection of climate footprint is tedious work, and as they grow it will become increasingly difficult. For now, calculations have been conducted by *respondent 4,* but soon they need to find a solution that reduces this manual work. However, the systems out there are expensive which makes this a barrier, and some of them still require manual data entry. *Respondent 4* have tried to calculate and account for emissions connected to work-from-home, but it has been difficult to find the correct measures to do so. *Respondent 4* have taken courses on implementation of the *GHG-protocol* but find that here has been a lack of guidance for how to accurately calculate emissions connected to employees working from home, or work devices charged at home.

Another issue raised by *respondent 3* regarding sustainability within the gaming industry is the complexities of communicating ideas. "If you are not familiar with both gaming and sustainability then it is really difficult to have a rewarding discussion" (Respondent 3). *Respondent 3* then explains that their perception of the concept of sustainability within the context of game development is to give back as much as you take. Refraining from economical sustainability, which is a necessity for all businesses, each decision should be made considering its effect on the people, the players, and the planet, "to ensure that these areas are promoted, or at least not disproportionately disadvantaged by the decision" (Respondent 3). This means that Something they believe in as a business concept. As a small company they believe to have their largest impact on social sustainability which is what they are prioritizing.

As soon as you start hiring people, you have a huge impact on their life (…) so the best conditions for us to succeed as a games company is to find people that want to work for us, and want to stay with us, which is why we are making investments in social sustainability (…) for us it is clear that we have more impact on social sustainability, and that there are more realistic actions we can take that have an actual impact on people's lives. (Respondent 3).

This is also where they feel like the industry needs shift its focus. They see the gaming industry as an underdeveloped industry when it comes to structures, job security, and care for employees. It is an industry built to exploit the fact that it is many people's passion to work in the industry.

After the interview *respondent 4* provided a comprehensive spreadsheet detailing how they have calculated their emissions for 2021. It covers the emissions for each of their studios as well as their total emissions as an organization and is presented in Table 10. Emissions of the studio in which *respondent 2* works are included in these calculations.

Table 10. Calculated emissions in tCO_2e from provided spreadsheet (Respondent 4).

Employees	26
Scope 1	0
Scope 2	14.661
Scope 3	75.692
Total emissions	90.353
tCO_2e/employee	3.475

Both the *Small Game Developer* and *Small Game Publisher* have reported actions they have taken to reduce their impact, both in their report and in the interviews. These actions will be covered following the structure of the climate action process of Figure 5.

Step 1 & Step 2 – Getting started: They have set their scope for calculating their emissions and include all activities. This includes upstream emissions of business travel, commutes, and purchases; indirect emissions of electricity use; and downstream emissions of player activity. They have also committed to be climate neutral since day one. In the category of gameplay, they have calculated on the hours their users have played their games and taken it a step further and calculating specifically on where the users are based, as this this have an impact on how electricity use is translated to carbon emissions. In calculating their footprints, they have been using the GHG-protocol.

Step 3 - Reduce negative impact: In some cases, it is important to look at the long-term perspective when deciding on purchasing new equipment. Like if it is beneficial

from an energy point of view to upgrade to equipment that is more efficient or keep using old products. They have committed to choose certified renewable electricity in their offices which will reduce their impact in 2022. The idea of recycling was mentioned in passing with *respondent 2* and which is something they do, being in Sweden it is the norm. Items in their offices are primarily bought second hand, as well as some equipment which they have identified as not having to be up to date, such as their work-phones. When they do need to invest in new equipment, they evaluate suppliers and choose the most sustainable source. When they do travel, they choose rail over air when it makes the most sense. If they need to fly, they ensure that this is done in the most sustainable fashion and compensates for it.

As they have identified their player emissions to be their largest category, they have begun to implement sustainable design choices in their upcoming title. As mentioned by *respondent 2,* ideas of setting the GPU in rest mode and reducing power consumption. This is corroborated by *respondent 3* as they plan to incorporate different types of eco-settings. Reducing the FPS in pause menus and other design features that strive to reduce the energy use of playing their games.

Step 4 - Offsetting: In the words of *respondent 3,* "offsetting is not the solution, it is a last resort". It can also be seen as a paradox because there are some areas that they cannot control, for example, the exact emissions of players cannot be calculated, which means that to be climate neutral they will always have to compensate. It also means that they will have to be pessimistic when they calculate their footprint, probably offsetting more than they emit. But the general idea is to reduce as much as possible, have as small climate impact as possible, and then offset what is left. The projects they work with have been carefully selected, they have a certified Gold Standard and focus on social sustainability benefits, longevity, and robustness.

Step 5 - Increase awareness: There are some areas where they work to increase awareness. For one, let their staff donate workdays, which means that they can volunteer at charities with a sustainability focus. They also work a lot with staff training and certification. As a company that strives to be transparent, they have published their report, as well as their calculations, for everyone to see. They believe that the biggest impact they can have on the environment is to build networks among other organizations where people can help each other have a bigger impact together. However, they do raise a concern about the initiatives out there, as some of them feel like commitments become more of green washing, and others feel like you must have sinned to see the benefits of joining.

5. Discussion

In the following section the results found in the previous section will be discussed in accordance with the research questions outlined in the introduction. Each chapter covers one question and the findings from the sustainability initiatives, the sustainability reports and the interviews will be discussed and compared collectively.

5.1 Mapping the Carbon Footprints of Game Development

The theoretical framework in Figure 3 was constructed with the knowledge of the product life cycle, the Virtual LCA, GHG-protocol scopes and the game development pipeline. The intention purpose of developing the framework was to simplify the process of mapping the emissions that occur in the game development pipeline. While it does provide an overview of where in the development process the different types of emissions occur, it was noted that it might not tell the full story. When going over initiatives, reports, and interviews, it became clear that the upstream Scope 3 emissions of one game occur in the whole development pipeline, as it ties to the emissions of business travel and employees commuting. These emissions occur throughout the development process and not explicitly in the pre-production stage as the framework might infer. Thus, the framework needs to be reviewed and assessed in more detail to accurately allocate the upstream Scope 3 emissions. The framework was also created with the digital aspect of game distribution in mind which might complicate things if applied by game developers still selling physical copies. But the indication from previous research of Abraham (2022) and findings in report of Stillfront Group (2022) is that the industry is moving towards fully digital distribution thus which simplify this moving forward.

Even though these aspects might affect the use of the theoretical framework in Figure 3, it can be used to easily map and assess the carbon footprints of game development. It was created with the intention to simplify the understanding of how carbon emissions and the game development pipeline intersect. Something that did not exist previously. The framework can be used by both researchers and practitioners to understand the operations of game development and its concurrent emissions. It lends itself to be further improved as research on the topic becomes more widespread. For larger studios where there are multiple projects active at different stages, the framework can be used to quickly assess the situation of a particular game, as well as for the organization. In this case it is possible to add multiple games where the placeholder's name *Game A* is in Figure 3.

5.2 Climate Impact of the Gaming Company

The climate impact of the gaming company will depend on multiple factors, but both the results in this study and the research by Abraham (2022) suggest that the downstream Scope 3 emissions will hold the largest footprint given that organizations

account for the users playing its games. However, the upstream Scope 3 emissions should not be overlooked, as they have been reported low during 2021 due to the fact that the Covid-19 pandemic have affected business travel and commutes (Embracer Group, 2021; G5 Entertainment, 2022; MAG Interactive, 2021; Paradox Interactive, 2022; Stillfront Group, 2022). The organizations report that they believe the upstream emissions will increase again as business travel and employee commutes returns to its normal state.

The suggested idea by Dr. Markiewicz in (Frick, 2016, ch. 1) that Scope 3 emissions will uphold the largest portion of emissions for digital products instead of Scope 1 seems to hold true for game development as well. The emissions reported by the organizations in Table 9 and by the *small game publisher* in Table 10 shows that the Scope 1 emissions are minimal or zero, which give an indication that this might be true. Two of the organizations, Embracer Group and Paradox Interactive, did not account for their player emissions, which becomes apparent in their Scope 3 emissions and the significance of this can be seen in their tCO_2e emissions per employee. Abraham (2022) estimates the emissions of gaming companies to be around *1-5 tCO_2e/employee*. In the results of this study, only MAG Interactive and the *small game publisher's* emissions per employee falls within that range. Embracer Group, who has the lowest tCO_2e/employee do admit that they lack data in their calculations and committed to offset another 30,000 tCO_2e which would put their offset amount to roughly 3.53 tCO_2e/employee, thus falling within the range.

What is interesting is that Abraham's (2022) estimated range is for Scope 1 and Scope 2 emissions only and does not account for the Scope 3 emissions. This can explain why the *tCO_2e/employee* for Stillfront Group is 5-25 times larger than the estimated range. An explanation for the lower numbers that have been reported can also be related to Sweden and its energy intensity. What seems apparent though is that for gaming industries, if organizations calculate the full extent of their Scope *3* emissions, including both upstream emissions of travel and purchases, and downstream emissions of the players, then this category will amount to the largest impact by a significant margin. But the extent of the distribution will depend on the type of games made, as well as the size of your studio and the number of games you have. So, it seems that the words of Aslan (2020) can be applied here as well, "it depends". Furthermore, the calculation of footprints also comes with its challenges. First and foremost, it is tedious work, as *respondent 4* explains it. Data collection takes time and energy and unless you want to do it manually, you must invest in expensive tools, which can disincentivize smaller organizations from doing the work.

5.3 Actions Taken to Reduce Negative Impact

Organizations have taken actions in a wide variety of levels and commitment. Some have done the whole thing such as Stillfront (2022b) and the *Small Game Publisher,* and others have acknowledged that there is an issue but have not committed to the full

extent. These actions and commitments will be further discussed following the climate action process in Figure 5.

5.3.1 Step 1 and Step 2 – Getting Started

The first step to make your business more sustainable in the long term is to measure your footprint (Wood & Ruiz, 2021). But to start it is important to understand what you want to measure. At present time measuring the footprints, and the scope of what is measured, is not commonplace in the industry. Only four of the organizations whose sustainability reports were analyzed had started measuring their footprints and the scope of their emissions varied. Abraham (2022) states the industry needs to understand the full extent of the Scope 3 to successfully measure it. But the results indicate that there exist difficulties to accurately collect the data and measure the emissions of users. Paradox Interactive and Embracer Group both identify that the downstream emissions of players have an impact on their overall emissions, but that they are unable to sufficiently calculate them. And for the *small game publisher* who have calculated their player emissions the lack of certainty forces them to make pessimistic estimates.

Setting the goal for the future will come with more challenges as highlighted by Abraham (2022). Not only for small developers who have a harder time accurately calculating their Scope 2 emissions because their electricity use is shared with the household, but for larger organizations as well now that work from home has become a necessity. Measurement of emissions happening from the home of the employees or from shared workspaces is complicated to calculate (Abraham, 2022). As organizations face these challenges, it is hard to adapt when there is a lack of guidance for how this should be accounted for. *Respondent 4* has experienced challenges when trying to accurately measure the emissions of charging work devices at home, or when calculating the emissions of the electricity of the household of the employee, where there have not been any clear guides. Companies are also reporting that work from home has resulted in less commutes to and from the office, as well as between offices, but they do not mention that they account for the electricity used from home. This also comes with the increased complexity that each employee's household will be powered by different types of sources of energy. One specific action that organizations can take to target this is mentioned in C1I of the Green Games Guide, Appendix F, which suggests that the organization can support the employees in making a shift to green energy. But to see the impact of this action it must become clearer how the work from home emissions can be calculated.

5.3.2 Step 3 - Reduce Negative Impact

Step 3 and the *reduce negative impact* pillar cover the tangible actions presented by the initiatives. These are the actions that can be attributed to a specific part of the game development pipeline and targets the corporeal aspects that can be modified to be sustainable. The actions identified in the sustainability reports and the interviews will be discussed in relation to the scope of emission they target in Figure 3, left to right.

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Upstream Scope 3 emissions: Left field of the theoretical framework in Figure 3 is the upstream Scope 3 emissions, these are tied to the supply chain and emissions that occur outside the workstream. Some organizations have policies in place for how they choose what hardware they buy. They work to ensure that the brands they pick are the most sustainable and share the values of the organization. For Stillfront Group, reducing this impact was identified as one of the most critical for them to target at this moment. But when it comes to purchasing new equipment, there seems to be a misconception between researchers, initiatives, and organizations. Abraham (2022) talks about extending the life of hardware while the initiatives suggest that you should replace equipment regularly for new and more energy-efficient equipment. This also shows in the reports where Starbreeze (2022) is committing to upgrading their equipment more often while Paradox Interactive (2022) work to extend lifetime. Misconceptions like this makes it increasingly difficult for organizations make the right decisions of what actions to commit to.

The most referenced actions in the upstream Scope 3 emissions relates to traveling and commutes. Organizations have policies in place that guides how this should be done, such as choosing the most climate friendly option when possible. A common idea is to choose rail over air when travelling to games conferences and external meetings, another is to reduce the amount of people sent to these conferences and meetings. These actions are often presented together with a vague criterion that steers the decision. It can be to only fly when it is necessary, when there is a need to meet in person, or when digital is not possible. But there is no mention of what determines when it is necessary to fly, which makes these actions harder to evaluate. Also, as a result of the Covid-19 pandemic more people have started to work from home which has led to organizations prioritizing digital meetings and conferences, mainly because it reduces costs and partly because of the climate impact.

Scope 1 and Scope 2 emissions: The largest identified emissions here are the Scope 2 emissions tied to the electricity, heating, and cooling of the offices. Scope 1 emissions are essentially nonexistent for those organizations, where everyone reports low or zero emissions in the category. Scope 2 emissions related to heating and electricity are calculated and recognized as an emitter where actions can be made, both by organizations reporting as well as those who are not. The common action that is taken is to choose renewable energy sources when possible. Some state that because of their facilities being rented, or shared, it makes it more difficult to ensure that the source of energy is green. Some have left the statement at this whereas others have gone to the effort to try to put pressure on landlords to move to green energy.

Downstream Scope 3 emissions: For the downstream Scope 3 being identified as the area of largest climate footprint there are surprisingly few actions in place to reduce this impact. It might be that actions on reducing player footprints might is not commonly reported, but are implemented in the games, or it might be because of the lack of guidance in doing so. G5 Entertainment (2022) and MAG Interactive (2021) mentions

that they have chosen a particular server provider that uses green energy which can be considered a reduction action.

In the interviews on the other hand, some actions to reduce player emissions are discussed. As suggested by Mills et al. (2019), developers can follow best practices that result in energy savings without compromising the user experience. For a mobile game developer, as explained by *respondent 1,* these practices can be to reduce the quality of graphics and rendering if the users CPU use goes above a certain percentage to ensure that the game does not drain the battery. Another can be to ensure that the amount of server calls made is optimized. These features however are not implemented with the intent to reduce climate impact, but because it is a part of their best practices to keep users satisfied. This is a commonality found in all the interviews that a lot of features and technical specifications are set and optimized because of the economic value it brings. As mentioned by Abraham (2022), it is important that organizations take action to reduce the power demand of players, which will take a lot of work for an uncertain award. *Respondent 2* are exploring features they can implement in their upcoming title that intends to reduce, or limit, the GPU use in certain stages of the game to reduce power consumption. Both design choices like this and eco-modes are discussed by *respondent 2* and *respondent 3* as implementations that can reduce the player's energy use. These implementations should be done in a way that does not restrict the user, as highlighted by Mills et al. (2019) and affirmed by *respondent 3.*

5.3.3 Step 4 - Offsetting

Offsetting, or compensating for your emissions, is a way for organizations to account for their impact on the climate. Once you have calculated the emissions and understand what impact you have on the climate you can choose to invest in projects to compensate for that. In the Green Games Guide, offsetting is highlighted as an important way for organizations to take responsibility for what they do. It is important to ensure that what you are investing in is serious. For this reason, there are some standards that projects can have, and the industry is recommended to invest in projects that are of Gold Standard. Of the organizations that did calculate their footprints, three mentioned that they offset their calculated emissions, all choosing Gold Standard projects.

Respondent 3 stated that "offsetting is not the solution, it is a last resort". And as highlighted by Abraham (2022), the goal is to first calculate and then try to reduce as much as possible and finally compensate for what you cannot reduce. Something that *respondent 3* and Stillfront Group is pointing out, first they do all the work they can to reduce their emissions and once they reach a point where they cannot reduce any more, they offset. But it is also paradoxical because of the downstream emissions you will always have to offset. Organizations want to grow, but as they do their concurrent downstream Scope 3 emissions will grow with it, resulting in a larger climate footprint. So even if they can keep their Scope 1 and Scope 2 emissions at zero, they will also have offset pessimistically to ensure that the full extent of Scope 3 is covered, because of the complexities of calculating the player emissions.

5.3.4 Step 5 - Increase Awareness

Finally, Step 5 and the *increase awareness* pillar is about working together with the community, the industry, and the players, to increase awareness and inspire change. Actions outlined in these steps are intangible actions, meaning that they are incorporeal activities that can be sustainable. Some of the explored organizations have joined the initiatives that was investigated in *4.1 Sustainability Initiatives*. Embracer Group has joined PlayCreateGreen and have worked together with them to help other members conduct their sustainability work. MAG Interactive have committed to the Playing for the Planet Alliance where they have created climate theme games to highlight the issues.

Other organizations have identified that they can have an impact or utilize their community to make a difference. For example, Goodbye Kansas Group have identified that their products can be used to reduce impact in other industries. Their VR and AR solutions can be used to reduce the use of resources by their B2B customers. Another example is given by *respondent 1* where they try to utilize their community to borrow products and equipment instead of purchasing them to reduce their ownership. Stillfront Group intends to release a playbook for 2022 which will function as strategic support for their studios to conduct and implement climate initiatives as a first step for them to succeed with their reduction goals. Finally, for the *Small Game Publisher,* it is about being transparent about what you are doing, which is why they are committing to do a sustainability report from day one. They are also allowing their employees to donate some of their workdays to volunteer at charities with a sustainability focus. For *respondent 3*, the impact of one small organization does not compare to the impact of the large organizations, so the way for them to have an impact is to build networks and inspire peers to take actions to have a bigger impact together.

5.4 Future Research

Marsden et al. (2020) predicts that if cloud gaming becomes increasingly more widespread it will cause a significant increase in energy and carbon footprint of games. In the conclusion of their paper, they highlight the need for better life cycle assessment of digital game streaming services. While the theoretical framework in Figure 3 is more targeted towards the life cycle assessment of the development and use of digital games, it ties closely to game streaming and cloud gaming. The findings in this study can be used by industry practitioners to navigate the field of climate emissions in game development, either by using the framework to allocate the different types of emissions within the industry, or to identify actions and where they can be implemented.

Researchers need to further explore the full extent of *tCO_2e/employee* emissions of the gaming industry, or test other metrics that are better suited for digital games and services. As energy used by players is causing largest part of the emissions of game development, the concept of energy requirement per unit of performance, as presented by Mills et al. (2019) should be further explored as an optimization metric for games.

As the Climate SIG's book, wiki and database becomes more complete it should be further investigated to see how it can be used. As should the change in emissions over years for organizations to understand how the Covid-19 pandemic have affected the results of this study, and to provide a better understanding of the *Scope 3* emissions of a gaming company.

The intangible actions are also interesting for future studies to consider because of the perceived impact they might, or might not, have. If we as researchers can quantify the impact of green nudges, climate themes of games, and the industry impact of publishing reports, it can be easier to inspire more organizations to take actions to reduce negative impact. What is apparent however is that the industry is recognizing the need for a change, and industry practitioners are starting to make a shift towards a more sustainable future. In this they need guidance and a common perception of the ideas that steer the industry's direction. It is interesting how these can work in coherence with sustainability in its entirety, ensuring that the gaming industry prioritizes the environment, as well as socio-cultural sustainability too, seeing as this is an area that needs to be better understood.

6. Conclusion

The purpose of this study was to map the current state of the Swedish gaming industry with regards to its climate impact and negative impact reducing actions. With the organization and the game development pipeline in focus this study set out to explore where game development activities have an impact on the climate, where the industry is focusing its actions to reduce this impact, and how the issue is perceived and handled by industry practitioners

This study has outlined a theoretical framework that makes the complexities of understanding the emissions that occur during the game development pipeline and organizational activities easier to contextualize. It functions as a simple overview to understand where in the pipeline emissions occur and what type of emissions these are. This helps researchers and practitioners to better understand the climate impact of game development, and where they can make targeted efforts. Furthermore, the theoretical framework and its relation to the suggested negative impact reduction actions have been outlined in the climate action process in Figure 5. That is, when industry practitioners commit to calculate their footprint, the tangible action they can take to reduce their emissions can easily be identified and attributed to both the scope and part of the pipeline they target, which simplifies year to year comparisons.

The Swedish gaming industry today is changing and when it comes to committing to actions to reduce their impact, some have come further than others. However, it seems that those who are obligated to report all have tangible ideas for how they can, and will, reduce their emissions. Some organizations have committed to intangible actions that aim to reduce the industry emissions by influencing users or peers, some are taking actions without attributing them to climate work, and others have it all planned out. Smaller organizations feel like they want to make a difference, but for them their largest industry impact might lie in the intangibles as they join and create communities that focus on the impact they can have together.

For emissions per employee the data is inconclusive as the scope of what each organization calculated differed or was not calculated to the full extent. There are just too many variables that differ with few data entries to make a conclusive statement on the emission per employee in the Swedish games industry. What seems apparent though is that Scope 3 emissions have the biggest climate impact in the industry. Dr. Markiewicz highlighted that for digital products and services the Scope 3 emissions will have the biggest influence, and from going over the reports and interviews this appears to be the case for the gaming industry as well. These findings should highlight the importance for gaming companies to calculate the full extent of their Scope 3 emissions, because excluding the scope partly or fully will give vastly different results.

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Appendix A

Research information
You have been invited to participate in an interview study for a Master Thesis at Uppsala University about sustainable game development.

The aim of the study is to explore the sustainability efforts in place in the industry. The purpose of the interview is to see how these efforts affect (or not) the operations of game development. The interview serves to cover the internal aspects of these initiatives from the view of practitioners in the Swedish Gaming Industry.

Your participation in this project will involve taking part in an interview and answering potential questions following the interview. The end product is going to be a written report that will be published. Before publication, a draft of the thesis will be sent for your approval. At this point it will be possible to revise any statements you have made.

To ensure your anonymity a code will be used in place of your name; no identifying information will appear in written or oral presentations; any quotes will be anonymized.

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Appendix B

Consent form

Name of Participant:_____

The purpose of this form is to check that you understand what will be required of you if you agree to take part in the interview and how any information you give will be used.

1. I understand that my participation is voluntary and that I am free to withdraw at any point during the interview, and up to two weeks afterwards, without giving any reason. ☐

2. I agree for the interview to be recorded and I understand that quotations or other information provided by me in the interview may be used in publications, reports, presentations and shared with other researchers but my name will not be used. ☐

3. I agree to participate in this study ☐

Participant's signature:_____   Date:_____

Appendix C

Interview guide for the interview with respondent 1 – conducted in Swedish

Bakgrund
1. Du kan få börja med att berätta lite om vad du gör?
    a. Vad har du för roll på ditt företag?
    b. Vad innebär det? Utveckla gärna
2. Hur länge har du varit jobbat på ditt nuvarande företag?
    a. Hur länge har du varit i spelindustrin?
    b. Vad har du haft för typ av tjänster tidigare inom industrin?

Arbetsprocess
3. Jobbar du vanligtvis med ett eller flera projekt åt gången?
4. Berätta vad du kan om de projekt du jobbar med nu?
    a. Hur ser utvecklingsprocessen ut hos er?
5. Är det vanligt att du är involverad i ett projekt från start till slut?
    a. **Om inte:** När kommer du in i processen?
6. Vad är ditt ansvarsområde?
    a. Vad innebär det?
7. Eftersom ni utvecklar mobilspel, hur styr det de tekniska specifikationerna ni sätter för era spel?
8. Vad är det som styr hur ni sätter de tekniska kraven?
    a. Har ni några interna riktlinjer för dessa krav?
    b. När ni skapar ett spel, sätter ni upp riktlinjer för hur stor filen ska vara?
        i. Hur kommer ni fram till detta?
9. Följer ni några best-practices?
    a. Vad skulle de kunna vara?
10. Mäter ni olika kostnader för att köra spelet?
    a. Har ni några min- eller max krav när det kommer till?
        i. Performance
        ii. Data användning
        iii. Energianvändning
11. När en produkt är färdig, var publicerar ni spelen?
12. Hur jobbar ni med underhåll av era spel när de lanserats?
    a. Vad styr eventuella uppdateringar?
    b. Har ni interna riktlinjer för hur ofta ni uppdaterar spel?

Konceptet hållbarhet.
13. Är du bekant med begreppet hållbarhet?
    a. Hur skulle du beskriva begreppet hållbarhet i kontexten av spelutveckling?
För den här studien är jag intresserad av att ta reda på mer om hållbarhetsarbetet från miljöaspekter och fokusera på klimatförändring, energieffektivitet och green gaming.

14. Har din organisation gjort någon specifik förändring nyligen för att bli mer hållbara, när det kommer till miljöaspekter?
    a. Vad skulle det kunna vara?
    b. **Om dessa är implementerade**:

       i. Om du tänker tillbaka på det arbete som görs och förändringar ni gjort, påverkar de på något sätt hur du utför ditt arbete? Hur?
1. Styr de beslutsfattande?
2. Påverkar de resurser? Tid?
15. Följer ni några så kallade gröna praxis (exempelvis efficient coding).
    a. Detta är lite kopplat till frågan tidigare om era best-practices.
    b. Vilka är de viktigaste kraven för er kod att uppnå?
16. Mäter ni elanvändningen av de enheter ni använder internt?
    a. Om ja: *Vad används den informationen till i nuläget?*
        i. Hur påverkar det ditt arbete?
    b. ***Om nej:*** *Hur kommer det sig att ni inte gör det?*
        i. Hur skulle det påverka ditt arbete?
        ii. Finns det fler användningsområden där detta skulle vara intressant?
17. Mäter ni i dagsläget ert klimatavtryck?
    a. Om ja, mäter ni enbart de interna avtrycken eller täcker ni även de externa (dvs användning av era produkter av spelarna)

För att avsluta intervjun
18. Finns det något område i spelutvecklingsprocessen eller den interna organisatoriska verksamheten där du ser ett ökat behov för hållbarhetsarbetet?
19. Är det någonting du tycker att jag har missat att fråga och vill ta upp? Kopplat till beslutsfattande, prioriteringar, resursfördelning eller hållbarhet?

Appendix D

Interview guide for *respondent 2* – The interview was conducted in English

Background

1. What is your role at your company?
   a. What does that entail?
   b. Could you elaborate
2. How long have you been at your current company?
   a. How long have you been in the gaming industry?
   b. What have been your roles previously in the industry?

Development process
3. What type of games do you make?
   a. For what devices?
4. At your company, do you tend to work on one game at a time or do you work on multiple projects at a time?
5. Tell me what you can about the current project you are working on?
   a. What type of game is it?
   b. What stage are you in?
6. What does the production process look like for your team?
   a. Streamlined process or does it change?
   b. What part is most resource intensive? Where do you spend the most time?
7. What's your role as **Answer from 1** in the process? what is your day to day?
8. Given that you make games for **Answer from 3a**, how does this affect the technical specifications on your games?
9. What determines the technical specifications/requirements you set on your projects?
   a. Do you have any internal guidelines for these specifications?
   b. Do you set any size limitations of games in development, or do they end up however big/small at the end?
      i. What guides these limitations?
10. What kinds of best best-practices do you follow?
11. Do you measure the costs of running your games?
   a. Performance/Data use/Energy use?
   b. Do you have any min/max requirements for these?
12. Whenever a product is finished, where do you publish these games?
   a. What does this process look like?
13. How do you work with maintenance of your games when they have launched?
   a. What guides any updates?
   b. Do you have any internal guidelines for how often you update the game?

Sustainability
14. In your words, what is sustainability within the context of game development and the gaming industry?
For this study my focus is on the climate aspect of sustainability, however I do recognize that sustainability is also social and economic.

15. You have recently made a shift in organizational structure which resulted in a new focus on sustainability.
    a. What has been the biggest change for your studio?
        i. How has this affected your day-to-day operations?
        ii. Do these changes steer your decision-making?
        iii. How is it different now from what is was before (or at previous roles)?
    b. What are the adjustments/changes that you have made to be sustainable first?
        i. What are the biggest differences?
        ii. What are some similarities in your day-to-day operations?
        iii. What are some areas you thought it would have a big impact that didn't?
        iv. Has it simplified some parts of the operation?
        v. Has it made some parts of the operation more complex?
    c. Would you say this affects how you operate?
        i. Does it impact or change your production process?
            1. Time?
            2. Have you had to change some behavior?
            3. or reexamine how you have done things?
16. Do you follow any green practices?
    a. **If yes:** What are they?
    b. This may or may not be related to the previous question about your best-practices. What are the most important requirements for your code to fulfill?
17. Do you measure your electricity use of the units you use internally?
    a. If yes: What is this information used for today?
        i. How does this affect your work?
    b. If no: How come you don't measure this?
        i. How do you think it would affect your work?
        ii. Can you think of any areas where this information would be interesting?
18. How do you measure your climate footprint for your studio?
    a. Do you measure both footprints and external footprints?
19. Is there any part of the game development process or the internal organizational business where you see an increased demand for sustainability efforts?
    a. Where you might not do any work today?
    b. Where you think the issue needs to be more addressed in the future?
20. Is there anything you feel like I have missed that you want to mention in relation to decision-making, priorities, resource allocation or sustainability?

Appendix E

Interview guide for *respondent 3 and 4* – Interview was conducted in Swedish with both respondents at the same time.

Bakgrund

1. Ni kan få börja med att berätta lite om företaget och vad det är ni gör.
   a. Ni får gärna berätta lite mer specifikt vad era individuella roller innebär,
2. Hur länge har ni varit på ert nuvarande företag?
   a. Hur länge har ni varit i spelindustrin?

Hållbarhet
3. Hur skulle ni beskriva konceptet hållbarhet i kontexten av datorspel och spelutveckling?
4. Hur kommer det sig att ni valde att satsa på ett "hållbart först" tänk?
   a. Varför tycker ni att det är viktigt?
5. Ni har även valt att publicera en hållbarhetsrapport fastän ni inte är tvungna att göra det. Hur kommer det sig att ni gör detta?
6. Känner ni att detta har öppnat upp möjligheter för er som publisher och ger er en USP jämfört med konkurrenter?
   a. Hur har detta upplevts?
7. Om ni kommer från andra spelföretag, roller? Vad har varit den största skillnaden att jobba med ett fokus hållbarhet först?
   a. Hur har detta fokus mötts av era studios?
   b. Vad har varit det svåraste? Få folk ombord, hitta rätt väg för er etc.?
      i. Vilka delar av processerna har det varit svårare att implementera
   c. Finns det delar av verksamheten som var bättre hållbarhetsanpassad än vad ni kanske trott initialt?
8. Har ni behövt prioritera om på grund av ert hållbarhetsarbete? Hur?
   a. Har det påverkat delar av verksamheten ni inte först trodde? Hur?
   b. Har det påverkar hur ni fattar beslut? Hur?
      i. Skiljer det sig mycket från tidigare erfarenheter?

För den här studien är jag intresserad av att ta reda på mer om hållbarhetsarbetet från miljöaspekter och fokusera på klimatförändring, energieffektivitet och green gaming. Även om jag är fullt medveten om att hållbarhet även innebär social och ekonomisk hållbarhet.

9. Vad har ni identifierat för områden där ni som företag kan ha mest inverkan på klimatet?
   a. Vilka delar av er verksamhet känner ni att det är viktigt att effektivisera?
      i. Vilka delar av era studios är det viktigaste?
   b. Finns det områden det är svårare att påverka då de är utom er kontroll?
10. Vad har varit de största utmaningarna med att övergå till att göra klimatkalkyler i ett så pass tidigt stadie?
11. Ni identifierar i er hållbarhetsrapport att Scope 3 utsläppen är den största kategorin för er verksamhet
    a. Vilka utmaningar ser ni med det för er som bolag när ni växer och får större användarbas?

b. Vilka möjligheter har ni identifierat i er verksamhet och i branschen i stort att reducera utsläpp per användare?

12. Har ni tagit inspiration från någon/några av de hållbarhetsinitiativ som finns i branschen idag?

a. Vad har ni identifierat som bästa sätt för er organisation att göra störst skillnad?

13. Planerar ni att medverka i spelkonferenser och mässor?

a. En vanlig fråga när det kommer till klimatet är just deltagande och resa till dessa, hur tänker ni kring ert deltagande?

b. Hur tänker ni kring hur dessa kommer att genomföras i framtiden?

14. Är det någonting ni tycker jag har missat att fråga i denna intervju vad gäller hållbarhet, hållbarhetsarbetet och framtiden?

Appendix F

Steps and their descriptions and suggested actions in the *Green Games Guide* as presented by Wood & Ruiz (2021, pp.10-13). Codes have been given by the author to help identifying referencing suggested actions.

Step 1	Setting your scope and timeline
Description	*"Measuring your carbon footprint is a crucial step toward making your business more sustainable in the long term. However, before you start gathering numbers you should take the time to understand what you want to measure:"*
Code	**Tips and ideas**
A1	**Set your scope:** Before you start measuring think about the scope – for example whether you need to limit your analysis to direct internal company activity, or whether (as many P4P Alliance member companies currently do) you will also count your supply chain and the energy and indirect emissions people use while playing your game
A2	**Set your timeline:** Once you have established the scope and baseline of your emissions, you should set a plan for setting goals and reporting on your performance. Important milestones include setting a date for when you will move to net zero.
Step 2	**Calculate your carbon footprint**
Description	*"You have to understand more about the impact your company has if you want to effectively cut your emissions. It can take time but it will allow you to identify where you should focus your efforts, help establish short and long term targets and will motivate your team to own the activity required to reduce your emissions."*
Code	**Tips and ideas**
B1	When you are ready to start measuring - pick a start date. Decide when you're measuring from (most people go with January 1 of the last calendar year)
B2	Capturing data will include energy use in your office, your employees travel and capital purchases (e.g. laptops) and, depending on your scope, could include speaking to your partners and suppliers and gathering player data from your games. As you start you may need to estimate placeholder values and improve your entries as better data becomes available.
B3	Data centre and other suppliers - You'll need to talk to the people running your IT and games to understand your cloud or data centre servers and reach out to those providers to get a figure on the energy mix of your electricity.
B4	Player hours - If you want to understand the energy consumed when playing your games, you will also want to understand the total number of hours that your games were played.
B5	There are a number tools and advice available to help you do your own carbon audit i. The Green House Gas protocol - these are internationally accepted greenhouse gas (GHG) accounting and reporting standards help create a better understanding of the relative and collective impact that a business has on the environment. Read more at www.ghgprotocol.org ii. The UK Government has its emissions factors database at www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2019 iii. The Carbon Trust has a free to use generic carbon footprint tool for SMEs: https://www.carbontrust.com/resources/sme-carbon-footprint-calculator iv. UN Climate Change has an electronic equipment carbon footprinting tool at www.2030calculator.com

Step 3	**Take bold and ambitious action to reduce your carbon footprint**
Description	*"Now you have your carbon footprint, you're in prime position to identify where the biggest impacts are and to start to reduce your emissions. There are many ways you can make your office, home workspaces and your operations more energy efficient, so here are some areas you can consider"*
Code	**Tips and ideas**
C1	**Office energy use:** You can make significant reduction to your energy output (and your office costs) by:
C1A	Switching off equipment when you're not using it. PCs and monitors are the main source of energy usage so make sure you're enabling automatic power saving modes and put printers and other office/server room equipment on timers, so they are not kept on all night.
C1B	Replacing old equipment at the end of its lifespan with more energy-efficient models.
C1C	Turning your office heating down by 1%, this can also reduce heating bills by 8-10%. Set your heating to come on early, so the office is the right temperature when your teams arrive at work. Set air conditioning to come on only when temperatures exceed 24 degrees.
C1D	Make the most of natural light.
C1E	Light your office with light emitting diode (LED) bulbs or compact fluorescent lamps (CFLs), rather than tungsten bulbs.
C1F	Look into new zero energy usage technology that can improve your office's ventilation, cooling and shading for windows.
C1G	Set up timers or motion sensing lights - particularly in areas not in constant use such as toilets or meeting rooms.
C1H	Provide staff who have flexible work arrangements with energy efficient hardware that they can use both at home and when in the office
C1I	Consider whether you can support staff working from home to switch to sustainable energy providers.
C2	**Switch to sustainable energy supplier:** There are lots of great green energy suppliers who can provide your business with renewable energy tariffs but there a few things to consider.
C2A	Green' energy, means generating electricity using things like wave/hydro, solar or wind power that do not deplete the Earth's resources.
C2B	Make sure you pick the right tariff for your chosen provider. Just because a provider says they provide renewable energy, it doesn't mean that all their tariffs do this.
C2C	If you use a renewable energy supplier this doesn't necessarily mean that the actual energy your office uses will all be green, but you'll still be helping the environment. That's because all suppliers get their energy from the nationwide network which has a range of sources but by opting into a green tariff, your provider will buy the equivalent amount from a renewable source, or it invests the same amount in carbon offset schemes.
C2D	100% renewable tariffs are available but these can be more expensive than other offerings.
C2E	To help you make a decision you can check if your supplier is certified by the Ofgem energy regulator through its Renewable Energy Guarantees Origin (REGO) scheme (www.ofgem.gov.uk/environmental-programmes/rego). OFGEM's investigations tool also lets you check the compliance of every sustainable energy supplier (www.ofgem.gov.uk).

C3	**Review your data storage policies:** Data storage needs energy: the more data you store, the higher your emissions.
C3A	Do you need copies or even copies of copies of files, or do you need to send as many email attachments?
C3B	Speak to your server provider to find out how they sustainably consume and store data. Ask three questions of them: i. What's the carbon footprint of our cloud computing deployment? ii. Are there regions or data centres I can use that are more sustainable than others? iii. How can I improve the energy efficiency of my cloud deployment?
C3C	Find savings in your cloud costs; the more you spend with your cloud provider, the higher your emissions are likely to be
C3D	Can you use the latest compression standard for your storage/back-up and choose energy efficient storage media?
C3E	Make sure that you have a consolidated and central data storage process, rather than have the same files or assets saved per-team or individual.
C3F	Make sure that your server is actually delivering needed and valuable computing or data storage – you can read an interesting case study here: www.anthesisgroup.com/report-zombie-and-comatose-servers-redux-jon-taylor-and-jonathan-koomey
C4	**Reduce and recycle waste:** There are some simple principles that you can apply to the items you use and consume in your office that will cut emissions, cut waste and save you money.
C4A	Apply the waste hierarchy (above) to your operation. The most important principle you should apply is that you should first reduce or prevent waste before finding ways to reuse or recycle it.
C4B	Replace individual desk bins with communal source-segregated recycling bins or stations - WRAP recommends using one recycling bin for every six staff. (wrap.org.uk/resources/guide/recycling-guidelines)
C4C	Encourage reuse of office assets and supplies such as marketing materials, stationary supplies, cutlery, and packaging like cardboard boxes.
C4D	Install hand dryers in toilets to eliminate the use of paper towels and replace bottled water with water coolers.
C4E	Donate hardware to other causes to extend its usable lifespan, such as Ukie's Devices for All Campaign (www.ukie.org.uk/device-donation-campaign) which encourages games business to commit to donating old devices to schools to help close the digital divide.
C4F	Before recycling kitchen or canteen waste, explore opportunities to compost it on-site, subject to licencing requirements.
C4G	There may also be opportunities to work with neighboring businesses to negotiate better rates for waste collection by bulking up recyclables for economies of scale.
C4H	Review food offerings where applicable and offer more organic and vegetarian options in place of meat.
C5	**Review policies to minimise impact of staff commutes and business travel:** Transport and commuting could be a significant contributor to your business' carbon footprint. Taking a fresh look at your travel policies can significantly reduce your carbon emissions.

C5A	Commuting - Where possible use public transport or even better, encourage walking or cycling to the office through things like cycle ownership schemes.
C5B	When traveling longer distances consider rail over air.
C5C	Offset carbon emissions if you have to fly - many airlines offer this as an option on their payment page.
C5D	When flying, book direct flights.
C5E	When hiring cars, use fuel cell, electric or hybrid models.
C5F	Always think about how you can pack lighter luggage whenever you travel.
C5G	Switch to cargo bike couriers for shifting things around cities and towns.
C6	**Make your game as energy efficient as possible:** There is increasing evidence that how games are coded, digitally stored and distributed can have an impact on the energy that is used when they are downloaded, streamed or played. Essentially your games' coding will determine your audience's devices' energy consumption, for data storage, processing or network flows. This is an emerging area but there's lots of opportunity for games business to lead the thinking in this space. Some areas to think about are:
C6A	Set up a green coding group to assess the impact changes to how you make your games can affect energy consumption.
C6B	Reuse your assets from different versions of your game to avoid having multiple versions stored in different places.
C6C	Adapt your game's specifications to your audience's average set-up (for PC).
C6D	Don't bundle up all your 4K assets as your default install.
C6E	Minimise the amount of processing power going into off-screen objects.
C6F	Avoid having objects updating on every frame i.e. reduce calls on every frame whenever possible.
C6G	Determining the trade-offs between live calculations and value lookups can help reduce processing time.
C6H	You can optimise the loading of game engine tools to load only what is necessary for the user's needs, for example only artistic tools for an artist.
Step 4	**When it's impossible to avoid, hit the offset button**
Description	*"When you've looked at how you can directly reduce your business' carbon footprint, you can then offset other emissions through offsetting schemes. There are a huge range of carbon offsetting schemes to choose from, here's some tips for what to look for".*
Code	**Tips and ideas**
D1	When thinking about what you want to offset, consider the impact your business has in the lifecycle of a game. For example, if you're a developer it's not just your team that contributes, it's also the impact of your game being played and you can also consider offsetting this.
D2	With so many offsetting schemes out there, make sure you carefully consider the right one for your business.

D3	Offset projects can benefit the environment in a number of ways such as creating more renewable energy sources or replanting forests or increasing environmentally friendly land use. Many also offer pro-social/poverty benefits which add deeper value when exploring where to invest, always look for win-wins for people and the planet. It's worth shopping around as there is bound to be one that chimes with the priorities or interests that you and your teams have.
D4	You also need to make sure that the scheme delivers what they say they will. You should be confident that any scheme you work with offers permanent, quantifiable and verifiable results.
D5	There are some good accreditation programmes and standards available and you such as verified carbon standard (VCS - www.carbonfootprint.com/vcs.html), Verra (www.verra.org) or Golden Standard (www.goldstandard.org). You should check the scheme that you choose meets these standards.
D6	You can also select an offset project from the UN carbon offset platform (offset.climateneutralnow.org/allprojects) which are all certified.
Step 5	**Ratchet, review and recommend to others**
Description	*"There is always more you can do to make your company as green and as sustainable as possible so these additional steps can take you to the next level"*
Code	**Tips and ideas**
E1	Ratchet and review each year: The measure, Reduce, Offset, process is a continuous improvement cycle. Each year you should evaluate and improve your data, revisit your progress against your goals.
E2	Engage with staff - Staff engagement can not only reduce costs of action, but also increases staff retention among the growing workforce who seek companies with purpose. Achieving ambitious goals together can build skills that will propel your teams in other areas as well. Have dedicated sessions with staff to share ideas, listen to others and shape commitments with an action plan to fulfill them. Let your people volunteer for charitable, eco-friendly projects in their communities. Help your teams understand and offset their own carbon footprints (or offset it for them!) by looking at incentives to help or support home workers to switch energy supplier or help them to offset their summer holidays flights.
E3	Get your games community on board: Explore how your audience can support and engage with your work. Consider how you can integrate environmental aspects into your games and join a green game jam and riff on ideas for how to incorporate green themes and ideas into your games.
E4	Make best practice everyone's business – share your learning with others: Once you have taken the step to become carbon neutral, use your voice and influence others in the industry to consider the same by supporting them on this journey.
E5	Join the collective adventure to learn from others and join the collective efforts to adapt our industry to environmental challenges. You can sign up to Playing For tThe Planet and join Ukie's Sustainability Working Group to share thoughts and best practices with other game industry people
E6	Share your voice: Post and share your sustainability journey milestones. And follow 5 green heroes on Twitter (or your corporate twitter account) to amplify voices in this space.
E7	Legacy Emissions: Run a calculation of what it would take to achieve net zero since your company's inception (Microsoft is offsetting all emissions since 1975) and evaluate whether you can meet (or beat!) this ambition!

Appendix G

Summary of actions presented by PlayCreateGreen summarized (PlayCreateGreen 2022a, b, c, d, e, f, g, h, i). Each subsection was identified on separate sections in PlayCreateGreen (2022a) and will be referenced accordingly. Codes have been given by the author to help identifying referencing suggested actions.

Code	Reduce negative impact
RNI1	**Impact during game development (PlayCreateGreen, 2022b)** This area covers the emission occurring from the day-to-day operations when you develop games
RNI1A	Sort garbage (and recycle where possible)
RNI1B	Turn off computers when leaving the office
RNI1C	Use second-hand furniture
RNI1D	Buy local and/or organic food
RNI1E	Choose green energy
RNI1F	Incetivise climate-friendly commutes, e.g., by supplying free public transportation passes
RNI1G	Establish policies to reduce traveling between offices
RNI1H	Shift to more climate-friendly means of transportation, i.e. choose train over plane when possible.
RNI2	**Impact during game marketing (PlayCreateGreen, 2022c)** Game marketing comes in many forms, anything from digital marketing, using influencers, flying to exhibitions and events, printing posters and distributing physical sales material. In all of these there are ways to reduce carbon emissions, especially physical activities.
RNI2A	Create policies to minimize travels for sales and marketing conferences
RNI2B	Choose sustainable marketing material
RNI2C	Demand sustainable choices from conferences
RNI2D	Work with influencers who have a sustainable mindset
RNI3	**Impact during game distribution (PlayCreateGreen, 2022d)** Some of the largest emissions from video games come from distribution - both physical and digital. These emissions are often invisible as they are not directly attributed to the company. The emissions are generated by a contractor or service supplier, such as a hosting company or a distributor. But that doesn't make the impact less significant
RNI3A	Choose carbon neutral hosting services
RNI3B	Shift to sustainable packaging
RNI3C	Choose sustainable shipping options
RNI4	**Impact during gameplay (PlayCreateGreen, 2022e)** Playing games is recognized as the most energy-intensive use of personal computers and smartphones. 'Players' energy consumption is conventionally considered the responsibility of hardware producers and not the game producers. However, everyone must pitch in for a significant impact to happen
RNI4A	Optimize your game to require less energy while playing
RNI4B	Incorporate an 'eco-mode' where players can choose a less energy-demanding way to play

RNI4C	Nudge and encourage players to turn off devices after use
RNI5	**Impact of hardware end-of-life (PlayCreateGreen, 2022f)** Carbon emissions from hardware required to play games is also an important issue. "The need for new hardware when old models lose compatibility is another issue. This causes a need to produce even more products". "It can have a big impact to change how hardware is produced, how often players are forced to replace it, and making it easier for everyone to choose a better solution, when discarding hardware".
RNI5A	Make sure your games support older versions of hardware or devices, so players can keep playing them on existing hardware
RNI5B	Help players make the right decisions when discarding used hardware
RNI5C	Put pressure on hardware producers to make use of long-lasting, eco friendly and easily recyclable or upcyclable materials
RNI5D	Donate your own used hardware to people or organizations in need
Code	**Increase Awareness**
IA1	**Raise awareness in the industry (PlayCreateGreen, 2022g)** Combating climate change is a shared responsibility and we need everyone to take an active role.
IA1A	Speak publicly at events about what you do to
IA1B	Create guides for others to read and follow
IA1C	Publish articles in industry media
IA1D	Open-source your process, work tools and conclusion
IA2	**Inform and influence consumers (PlayCreateGreen, 2022h)** We already learn history by playing as soldiers in WW2, we sharpen our reflexes by stacking bricks or understand risk and math by calculating the best skill set for a warrior character. Your content and gameplay can help players learn and make better climate choices in real life
IA2A	Incorporate green nudges into your game
IA2B	Have a sustainability mindset in the ideas phase
IA2C	Consider an eco-version of your game
IA2D	Develop climate educational games within your universe of IP
IA2E	Use your skills to help educational institutions teach sustainability (such as NASA's climate kids)
IA3	**Raise awareness in the community (PlayCreateGreen, 2022i)** You can utilize the community around your games, and its influencers, to create awareness on climate issues. Both digital and physical communities and events hold the potential to share knowledge and create awareness about climate issues.
IA3A	Campaign to turn devices off after use
IA3B	Give influences the tools to talk about climate change issues related to playing games
IA3C	Write about climate issues and share with your community
IA3D	Provide your community and its influences with the tools and knowledge to make the right choices.